

BMJ Open

Economic inequalities in burden of illness, diagnosis and treatment of five long-term conditions in England: panel study.

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| Journal: | <i>BMJ Open</i> |
| Manuscript ID: | bmjopen-2014-005530 |
| Article Type: | Research |
| Date Submitted by the Author: | 22-Apr-2014 |
| Complete List of Authors: | Steel, Nicholas; University of East Anglia Hardcastle, Antonia; University of East Anglia, Norwich Medical School Bachmann, Max; Univeristy of East Anglia, School of Medicine, Health Policy and Practic Richards, Suzanne; University of Exeter Medical School, Mounce, Luke; University of Exeter Medical School, Clark, Allan; University of East Anglia, Norwich Medical School Lang, Iain; PenCLAHRC, Melzer, David; University of Exeter Medical School, Campbell, John; University of Exeter, Primary Care; |
| Primary Subject Heading: | Health services research |
| Secondary Subject Heading: | Health services research, Epidemiology, Public health |
| Keywords: | Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, EPIDEMIOLOGY, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT |
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5 **treatment of five long-term conditions in England: panel study.**
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Abstract

Objective:

We compared the distribution by wealth of self-reported illness burden (estimated from validated scales, biomarker and reported symptoms) for angina, cataract, depression, diabetes and osteoarthritis, with the distribution of self-reported medical diagnosis and treatment. We aimed to determine if the greater illness burden borne by poorer participants was matched by appropriately higher levels of diagnosis and treatment.

Design:

The English Longitudinal Study of Ageing, a panel study of 12,765 participants aged 50 years and older in four waves from 2004 to 2011, selected using a stratified random sample of households in England. Distribution of illness burden, diagnosis and treatment by wealth was estimated using regression analysis.

Outcome measures:

The main outcome measures were odds ratios (ORs) for the illness burden, diagnosis and treatment respectively, adjusted for age, sex and wealth. We estimated the illness burden for angina with the Rose Angina scale, diabetes with fasting glycosylated haemoglobin, depression with the Centre for Epidemiologic Studies Depression Scale, osteoarthritis with self-reported pain and disability, and cataract with self-reported poor vision. Medical diagnoses were self-reported for all conditions. Treatment was defined as beta-blocker prescription for angina, surgery for osteoarthritis and cataract, and receipt of pre-defined effective interventions for diabetes and depression.

Results:

Compared to the wealthiest, the least wealthy participant had substantially higher odds for illness burden from any of the five conditions at all four time points, with odds ratios ranging from 4.2 (95% confidence interval 2.6 to 6.8) for diabetes to 15.1 (11.4 to 20.0) for osteoarthritis. The odds ratios for diagnosis and treatment were smaller in all 5 conditions, and ranged from 0.9 (0.5 to 1.4) for diabetes treatment to 4.5 (3.3 to 6.0) for angina diagnosis.

Conclusions:

The substantially higher illness burden in less wealthy participants was not matched by appropriately higher levels of diagnosis and treatment.

Strengths and limitations of this study

- The English Longitudinal Study of Ageing (ELSA) is a unique single source of detailed longitudinal data on socioeconomic status and health, and this is the first study to compare inequalities in illness burden, medical diagnosis and treatment of long-term conditions on the same population over time
- Highly detailed measures of individual wealth were used alongside standardised scales and blood biomarker to assess the illness burden of depression, angina and diabetes
- Standardised scales were not included in ELSA for osteoarthritis and cataract, so assessment of illness burden for these two conditions was based on attributed symptoms which were not specific for osteoarthritis and cataract
- The study used self-reported data collected using an extensively tested structured questionnaire, but no information from medical records was collected
- An analysis of pooled data from 4 waves of ELSA was used to maximise the sample size, and the main finding that less wealthy participants are relatively underdiagnosed requires validation in a larger longitudinal study.

Main text

Introduction

Poverty is associated with poor health, poor access to health care and poor health outcomes in many countries and across different health care systems¹⁻³. Much of this variation is caused by recognised broad social determinants of health⁴. Considerable political effort has been directed at attempts to narrow health inequalities by reducing poverty and social exclusion. However, as health care has become more effective at improving health, its potential contribution to ameliorating health inequalities has increased. McKeown demonstrated in the 1970s that health services had contributed little to health improvement⁵, but the same claim could not be made today. The past 30 years have seen the introduction of a wide range of effective interventions, particularly for the prevention and management of chronic disease⁶. Yet although these new interventions improve health, they are not necessarily applied equally across the population. Health inequalities will widen if effective services are offered, or taken up, with greater frequency by wealthier than less wealthy people. The reverse is also true, however, and there is an opportunity for healthcare to reduce social inequalities if it reaches those most in need⁷.

Little is known about pathways into poor health. The National Health Service provides medical care free at point-of-need to all UK residents, but there is scope for inequalities to occur in the pathway from identification of early symptoms through diagnosis and on to effective treatment. Individuals in more deprived social groups may be more reluctant to present to doctors with their symptoms and so may not receive a diagnosis^{8,9}. Diagnosis is a key step that has meaning for both patient and physician in all health systems, and ‘diagnostic confusion’ may act as a barrier to health care for vulnerable populations^{10,8,11}. Previous studies have found socio-economic variation in either diagnosis or treatment rates, but have not been able to compare inequalities in illness burden, rates of diagnosis and treatment modalities in the same population¹²⁻¹⁴.

The English Longitudinal Study of Ageing (ELSA) provides new data that can be used to identify barriers to equitable receipt of healthcare, and constitutes a unique source of information on illness burden, diagnosis and treatment. Other data sources cover symptoms, or diagnosis, or treatment, but no other single source covers all three. ELSA collects data on symptoms and validated markers of common health conditions, as well as diagnosis and treatment. It also contains detailed socio-demographic information, including direct measures of personal wealth, on a sample selected to be representative of the population of England aged 50 years and older. These data can be used to compare socio-economic inequalities for several conditions, providing insight into a healthcare system with no direct financial barriers to treatment (the National Health Service in England). We aimed to assess socio-economic inequalities in the burden of illness (estimated by validated scales, biomarker, and reported symptoms) of angina, cataract, depression, diabetes and osteoarthritis, and compare them with inequalities in reported medical diagnosis and treatment, in order to determine whether key components of health care were received equitably.

Methods

We obtained data from the ELSA cohort, an interview survey of a sample of the population aged 50 years or older in England¹⁵. Participants are interviewed in their homes or care homes every two years about a wide range of health, economic and social topics. We used

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3 data collected from core participants who had been interviewed in any of four waves of
4 ELSA from wave 2 in 2004-5 until wave 5 in 2010-11. Wave 2 was the first wave to include
5 questions on receipt of quality-indicated healthcare, and information was not collected on
6 every variable in every wave. Ethical approval was received from the London Multi-Centre
7 Research Ethics Committee. We studied five common and important long-term conditions:
8 angina, diabetes, depression, osteoarthritis, and cataract. Effective treatment is freely
9 available for all five conditions from the National Health Service.
10

11 **Variables**

12 We collected data on illness burden, medical diagnosis and treatment of angina, cataract,
13 depression, diabetes and osteoarthritis. The illness burden for angina was defined as grade 2
14 on the Rose Angina scale (pain or discomfort in chest when walking at an ordinary pace on
15 the level on most occasions or more often, which makes subject stop or slow down if occurs
16 while walking, and which then goes away within 10 minutes, and which includes either
17 sternum (any level), or left arm and left anterior chest). Illness burden for diabetes was
18 defined as a fasting HbA1c level of >7.5%¹⁶. Illness burden for depression was defined as a
19 score of 3 or more on the eight-item Centre for Epidemiologic Studies Depression Scale
20 (CES-D). The application of these standardised scales in ELSA has been described
21 previously¹. Illness burden for osteoarthritis was defined as self-reported pain in the hip or
22 knee of 5 or more on a scale of 0 to 10¹⁷. Illness burden for cataract was defined broadly as
23 reporting poor vision or blindness. Cataract is responsible for about a quarter of poor vision
24 in the UK, so this measure is the least specific and includes those with other causes of poor
25 vision, such as age-related macular degeneration, which is responsible for about a third of
26 poor vision^{18;19}.
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31 A medical diagnosis was considered to exist if a participant answered 'yes' when asked
32 whether a doctor had ever told them they had the condition of interest. For arthritis, a follow-
33 up question asked whether they had been told they had osteoarthritis, rheumatoid or other
34 arthritis.
35

36 Treatment for depression and diabetes was defined by reported achievement of quality of care
37 indicators, derived through a robust process of literature reviews, expert panel assessment and
38 piloting^{20;21}. For depression, the quality indicator was about receipt of treatment since the
39 previous wave: *'if a person is diagnosed with clinical depression, then antidepressive
40 treatment, talking treatment or electroconvulsive treatment should be offered within 2 weeks
41 after diagnosis unless within that period the patient has improved, or unless the patient has
42 substance abuse or dependence, in which case treatment may wait until 8 weeks after the
43 patient is in a drug-or alcohol-free state'*. For diabetes, treatment was measurement of
44 glycosylated haemoglobin or fructosamine levels in the preceding 12 months. Treatment for
45 angina was defined as ever being offered or currently taking beta-blockers (ELSA variables
46 hebeta or hebetb). Treatment for osteoarthritis and cataract were defined as reporting ever
47 having had surgery for the condition. For osteoarthritis this excluded those with hips or knees
48 replaced due to fracture. Data on hip and knee replacements were only available for
49 respondents aged 60 and over, and so respondents aged less than 60 years (n= 3,186) were
50 excluded from the analysis of osteoarthritis.
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54 Wealth was defined as the sum of financial, physical and housing wealth plus state and
55 private pension income. Age was categorised into three groups, 50-59 years, 60-74 years and
56 75 years and older.
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Analysis

We used two approaches to analysis, a main analysis using serial cross sectional data and then a subsidiary analysis using longitudinal data. Multivariable binomial regression analysis was used, with the outcome variables defined as one of illness burden, medical diagnosis or treatment for each of the five conditions in each cross-sectional wave (STATA statistical software version 12.1). This regression analysis was repeated for each of the four waves of ELSA from 2004 to 2011 separately and then 'overall' for all four waves combined. For the 'overall' analysis, the data were reshaped into 'long' format in Stata statistical software, with each participant having a separate record for each wave. Intra-person correlation of outcomes was accounted for using robust adjustment with Stata, with each participant's unique identifier included in the regression equation as a cluster variable. Missing data were excluded from the analyses.

The independent variables were age group, sex and slope order of inequality. We used the slope order of inequality as an independent variable to estimate the relationship between the outcome measures and the categorised measure of wealth^{22,23}. The slope order of inequality consisted of wealth quintiles with values of 0.1, 0.3, 0.5, 0.7 and 0.9, that is, the midpoints of each quintile on a scale of zero (least wealthy) to one (most wealthy). The slope order of inequality was modelled as a continuous variable, and its odds ratio represents the ratio of the least wealthy compared with the wealthiest participant. This odds ratio is also known as a relative index of inequality²². Advantages of this method of quantifying inequality are that it includes all participants, instead of just comparing the highest and lowest quintiles, it accounts for the number of participants in each category and it provides a single overall measure of inequality.

We included all participants in the main cross sectional analysis in order to compare the distribution of illness burden in the whole population with the distributions of diagnoses and treatments in the whole population. This meant that diagnosis was assessed even in those who did not meet the criteria for 'illness burden', and treatment was assessed even in those with no diagnosis. For the subsidiary analysis using longitudinal data, we estimated the odds ratio of receiving a diagnosis by a subsequent wave only for those who had met the criteria for 'illness burden' in a previous wave, and then the likelihood of receiving treatment only for those who had received a diagnosis in a previous wave. This was a subsidiary analysis as the numbers of participants that could be followed over time in this manner was small, particularly for treatment in angina and depression.

Results

The whole sample (n=12,765) was composed of participants aged 50 years or more who had responded to at least one wave of ELSA from 2004-5 until 2010-11. The response rate in 2004-5 was 82%.^{24,25} Over half were women, or aged between 60 and 74 years (Table 1). Medical diagnosis for all five conditions increased as wealth decreased, for example in depression from 4% in the wealthiest quintile to 11% in the poorest (Table 1). There was little variation between the waves for each of the five conditions (Table 2).

The hypothetically least wealthy participant had substantially higher odds than the hypothetically most wealthy of meeting the criteria for 'illness burden' from any of the five conditions at all four time points (overall odds ratios (OR) ranged from 4.2 to 15.1) (Table 3). The least wealthy participant also had higher odds of diagnosis (ORs 1.1 to 4.5) and either no different or relatively small odds of treatment (ORs 0.9 to 2.6) (Table 3, Figure 1).

For angina, the overall odds ratio for meeting the criteria for 'illness burden' was 7.6, indicating that the hypothetically least wealthy individual was seven times more likely to have angina symptoms (defined by the Rose angina scale) than the wealthiest. The odds ratio for reported medical diagnosis was 4.5, suggesting that some less wealthy people with angina symptoms had not received a diagnosis of angina, as the expected odds ratio for equitably distributed diagnosis would have been 7.6. The odds ratio for treatment was 3.2, and again the expected odds ratios for equitably distributed treatment would have been 7.6. For depression, the overall odds ratio for illness burden was 6.4, for medical diagnosis was 3.3, and for treatment was 2.6, again suggesting that some poorer people with symptoms of depression were less likely to have received a diagnosis or indicated health care, as the expected odds ratios for equitably distributed treatment would have been 6.4.

For diabetes, the overall odds ratio for illness burden was 4.2 and 4.0 for diagnosis, suggesting that for diabetes diagnosis was distributed equitably. However, the odds ratio for treatment was 0.9 and not statistically significantly different from 1, again suggesting that some less wealthy people with medically diagnosed diabetes had not received treatment, as the expected odds ratios for equitably distributed treatment would have been 4.2.

The subsidiary analysis calculated the odds ratios of receiving a diagnosis by a subsequent wave only for those who had met the criteria for 'illness burden' for the relevant long term condition in a previous wave; and then the likelihood of receiving treatment only for those who had received a medical diagnosis in a previous wave. The substantial inequalities in the illness burden of conditions by wealth are identical to Table 3, as expected, and subsequently the numbers of eligible participants dwindle rapidly due to the nested nature of the analysis, with some wide confidence intervals and 9 out of 10 results not statistically significant (Supplemental file 1).

Table 1: Characteristics of ELSA participants at wave 5 (2010-11) and medical diagnosis of angina, cataract, depression, diabetes and osteoarthritis.

| | | Whole sample | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|------------------|---------|--------------|--------|----------|------------|----------|----------------|
| | | N | % | % | % | % | % |
| Sex | Male | 3,886 | 8.2 | 13.4 | 5.4 | 13.3 | 19.8 |
| | Female | 4,843 | 6.3 | 20.4 | 7.8 | 9.4 | 32.9 |
| Age (years) | 50-59 | 1,906 | 2.2 | 3.7 | 10.1 | 7.2 | 17.1 |
| | 60-74 | 4,766 | 5.8 | 14.5 | 7.0 | 11.0 | 28.1 |
| | 75+ | 2,057 | 15.0 | 36.6 | 2.9 | 15.0 | 34.1 |
| Wealth quintile* | 1 | 1,716 | 3.4 | 13.8 | 4.1 | 6.0 | 21.5 |
| | 2 | 1,714 | 4.9 | 15.5 | 5.9 | 8.0 | 24.2 |
| | 3 | 1,723 | 6.6 | 20.1 | 5.7 | 11.3 | 25.7 |
| | 4 | 1,716 | 8.2 | 18.6 | 6.7 | 13.6 | 31.6 |
| | 5 | 1,715 | 12.9 | 19.2 | 11.5 | 16.7 | 33.1 |
| | missing | 145 | 5.5 | 9.7 | 4.8 | 9.7 | 20.0 |
| Total | | 8,729 | 7.2 | 17.3 | 6.7 | 11.1 | 27.1 |

*1=wealthiest quintile, 5=least wealthy quintile

Table 2. Illness burden, medical diagnosis, and treatment for angina, cataract, depression, diabetes and osteoarthritis in four waves of ELSA

| | Angina N (%) | Cataract N (%) | Depression N (%) | Diabetes N (%) | Osteoarthritis N (%) |
|---|------------------------|--------------------------|----------------------------|--------------------------|--------------------------------|
| Illness burden | | | | | |
| Wave 2 (2004-5) | 397 (4.6) | 308 (3.5) | 2,037 (23.4) | 160 (1.8) | 1,106 (12.7) |
| Wave 3 (2006-7) | 300 (3.6) | 317 (3.8) | 1,929 (23.3) | n/a | 917 (11.1) |
| Wave 4 (2008-9) | 300 (3.1) | 331 (3.5) | 2,049 (21.4) | 220 (2.3) | 1,088 (11.4) |
| Wave 5 (2010-11) | 254 (2.9) | 320 (3.7) | 1,956 (22.4) | n/a | 1,046 (12.0) |
| Medical diagnosis | | | | | |
| Wave 2 (2004-5) | 668 (7.6) | 1,050 (12.1) | 402 (4.6) | 715 (8.2) | 1,861 (21.4) |
| Wave 3 (2006-7) | 591 (7.1) | 1,294 (15.7) | 490 (5.9) | 935 (11.3) | 1,952 (23.6) |
| Wave 4 (2008-9) | 645 (6.7) | 1,421 (14.8) | 601 (6.3) | 1,215 (12.7) | 2,262 (23.6) |
| Wave 5 (2010-11) | 655 (7.5) | 1,566 (17.9) | 602 (6.9) | 1,413 (16.2) | 2,416 (27.7) |
| Treatment | | | | | |
| Wave 2 (2004-5) | 85 (1.0) | 535 (6.2) | 98 (1.1) | 552 (6.4) | 202 (2.3) |
| Wave 3 (2006-7) | n/a | 379 (4.9) | n/a | 618 (7.5) | 141 (1.7) |
| Wave 4 (2008-9) | n/a | 444 (4.6) | 155 (1.6) | 671 (7.0) | 226 (2.4) |
| Wave 5 (2010-11) | 88 (1.0) | 646 (7.4) | n/a | 748 (8.6) | 208 (2.4) |
| Total number of participants in each wave: wave 2: 8,688; wave 3: 8,268; wave 4: 9,578; wave 5: 8,729 | | | | | |
| n/a = data not available for that condition in that wave | | | | | |

Table 3. Illness burden, medical diagnosis and treatment of angina, cataract, depression, diabetes and osteoarthritis, comparing the least wealthy with the most wealthy: binomial regression.

| | | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|---------------------------------------|-------------------|---------------------------|---------------------------|--------------------------|--------------------------|-----------------------------|
| Odds ratios (95% confidence interval) | | | | | | |
| Wave 2* (2004-5) | Illness burden | 5.6 (3.8, 8.3) | 7.2 (4.5, 11.5) | 5.1 (4.3, 6.2) | 4.4 (2.5, 8.0) | 11.0 (8.1, 14.9) |
| | Medical diagnosis | 2.9 (2.2, 3.9) | 1.3 (1.0, 1.6) | 4.8 (3.3, 7.0) | 3.1 (2.3, 4.2) | 1.6 (1.3, 2.0) |
| | Treatment | 2.6 (1.2, 5.7) | 1.5 (1.0, 2.2) | 0.6 (0.1, 2.9) | 0.7 (0.3, 1.5) | 1.1 (0.7, 1.9) |
| Wave 3* (2006-7) | Illness burden | 8.7 (5.5, 13.8) | 8.2 (5.1, 13.1) | 6.9 (5.7, 8.5) | | 12.7 (9.1, 17.8) |
| | Medical diagnosis | 4.9 (3.6, 6.8) | 1.2 (1.0, 1.5) | 0.7 (0.4, 1.4) | 3.4 (2.6, 4.4) | 0.6 (0.4, 0.8) |
| | Treatment | | 1.3 (0.8, 1.9) | | 1.2 (0.6, 2.4) | 1.0 (0.6, 1.9) |
| Wave 4* (2008-9) | Illness burden | 6.7 (4.2, 10.5) | 5.5 (3.6, 8.6) | 5.9 (4.9, 7.1) | 3.9 (2.4, 6.4) | 14.0 (10.3, 19.1) |
| | Medical diagnosis | 4.3 (3.2, 5.9) | 1.1 (0.9, 1.4) | 0.7 (0.4, 1.2) | 3.9 (3.1, 5.1) | 0.6 (0.4, 0.8) |
| | Treatment | | 1.1 (0.7, 1.6) | 2.4 (1.0, 5.9) | 0.2 (0.1, 0.6) | 1.0 (0.6, 1.6) |
| Wave 5* (2010-11) | Illness burden | 8.4 (5.1, 13.7) | 6.2 (3.9, 9.9) | 5.9 (4.8, 7.1) | | 16.0 (11.7, 21.8) |
| | Medical diagnosis | 5.3 (3.9, 7.3) | 1.3 (1.0, 1.5) | 1.7 (1.0, 2.8) | 4.3 (3.4, 5.4) | 0.6 (0.4, 0.8) |
| | Treatment | 3.3 (1.5, 7.3) | 1.8 (1.2, 2.6) | | 0.8 (0.4, 1.6) | 1.2 (0.7, 2.0) |
| Overall† | Illness burden | 7.6 (5.4, 10.8) | 8.0 (5.4, 11.9) | 6.4 (5.5, 7.5) | 4.2 (2.6, 6.8) | 15.1 (11.4, 20.0) |
| | Medical diagnosis | 4.5 (3.3, 6.0) | 1.3 (1.1, 1.5) | 3.3 (2.4, 4.5) | 4.0 (3.1, 5.2) | 1.1 (0.9, 1.3) |
| | Treatment | 3.2 (1.7, 6.0) | 1.3 (1.0, 1.8) | 2.6 (1.1, 6.1) | 0.9 (0.5, 1.4) | 1.2 (0.8, 1.6) |

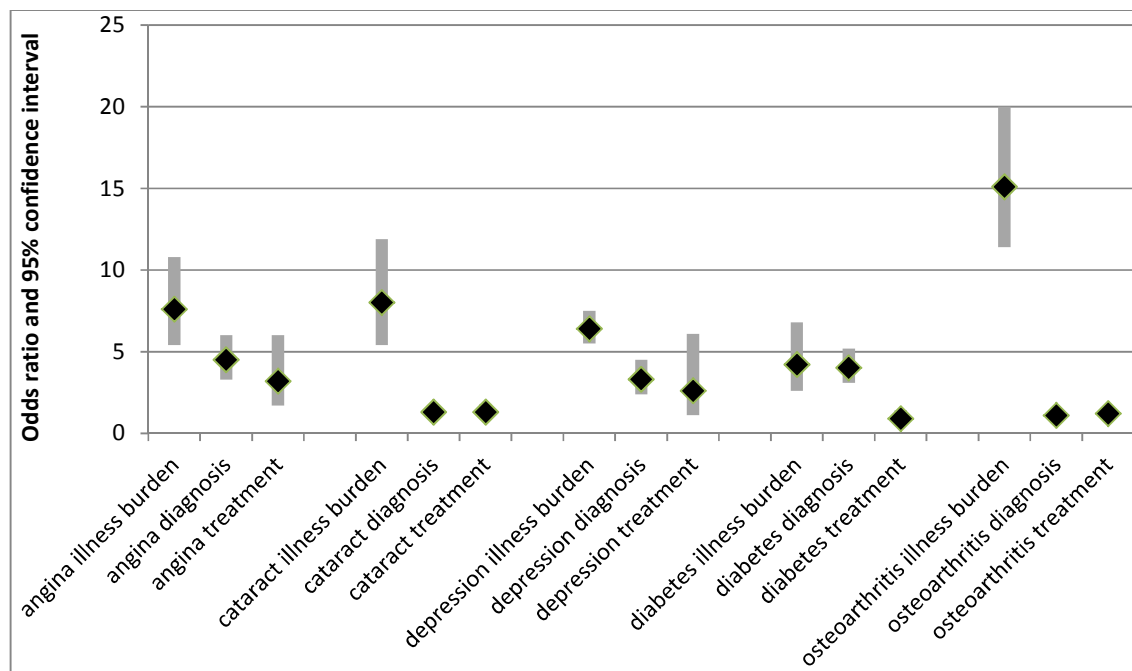
*Odds ratios adjusted for age group and sex

†Odds ratios adjusted for age group, sex and unique participant identifier

**Analyses for osteoarthritis excluded those younger than 60 years, as data on osteoarthritis treatment were only collected in those aged 60 or over.

Odds ratios where the 95% confidence intervals do not include 1 (before rounding to one decimal place) are shown in bold

Figure 1. Illness burden, medical diagnosis, and treatment of angina, cataract, depression, diabetes and osteoarthritis, comparing the least wealthy with the most wealthy: Overall odds ratios (adjusted for age and sex) and 95% confidence bars (binomial regression)



Discussion

We found that while there were strong inverse associations between wealth and the burden of illness (based on validated scales, symptoms and biomarker) of a long-term condition, there were smaller or absent inequalities in receipt of self-reported medical diagnosis or treatment for the conditions considered. This suggests that the substantially higher illness burden in less wealthy participants was not matched by appropriately higher levels of diagnosis and treatment, and that equitable receipt of a medical diagnosis may have an important role in reducing inequalities in health.

ELSA is a unique single source of detailed longitudinal data on socioeconomic status and health, and this is the first study to compare inequalities in illness burden, medical diagnosis and treatment of long-term conditions on the same population over time. ELSA used robust measures of individual socio-economic position, and standardised scales and blood biomarkers to assess health status. This exploratory study has some limitations and the results should be interpreted with caution and tested in subsequent research. Whilst standardised measures were used to estimate the illness burden of depression, angina and diabetes, symptoms alone were used for osteoarthritis and cataract, and the attributed symptoms were not specific for osteoarthritis and cataract. However, this lack of specificity is unlikely to vary with wealth, and so is not likely to be an important source of bias. Self-reported data may be a source of bias if self-report varies by factors other than objective health status, such as wealth or social experience. This is a recognised problem with some self-reported morbidity data, but is less of a problem with measures of pain, where self-report is the best means of assessment²⁶.

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4 We have not adjusted for health-related factors that are also more prevalent in poorer
5 populations, such as smoking, obesity and comorbidity, because none of these are a reason
6 for not making a diagnosis. Comorbid conditions are commoner in those with lower socio-
7 economic status, but there is no evidence that comorbidities make a new diagnosis less likely.
8 On the contrary, a higher number of comorbid conditions in older people may be associated
9 with higher quality of care²⁷. We found different patterns in different conditions, which fits
10 with other research showing that wealth acts differently in different conditions, and for
11 example, has no association with referral for post-menopausal bleeding²⁸. Major national
12 policy interventions such as the Quality and Outcomes Framework payment for performance
13 scheme in primary care²⁹ have been associated with improved healthcare for included
14 conditions such as angina and diabetes, more than for excluded conditions such as osteoarthritis
15 and poor vision³⁰⁻³².

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18 The serial cross-sectional analysis of 4 waves of ELSA included all eligible participants in
19 each wave in order to maximise the sample size. This approach meant that some participants
20 with a diagnosed condition would no longer have had symptoms or raised biomarkers, if they
21 were being successfully treated. Examples would be diabetic participants whose blood sugar
22 levels were being successfully controlled by treatment, and participants with successfully
23 treated depression. We therefore checked our main results with the secondary (longitudinal)
24 analysis, which assessed subsequent diagnosis in those had met the criteria for ‘illness
25 burden’, and subsequent treatment in those with a medical diagnosis, but the number of
26 participants who could be followed through the waves in this way was too small to allow
27 meaningful conclusions to be drawn from the results.
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31 Our results fit with previous findings that a greater proportion of people in deprived groups
32 had Rose angina, but there was no difference in the proportions receiving a general
33 practitioner diagnosis of coronary heart disease¹⁴. Care-seeking behaviour and patient
34 preferences may differ with wealth. Given the same information, patients may want fewer
35 medical interventions than their doctors recommend^{33;34} and pessimism about availability of
36 treatment may make older people reluctant to seek help³⁵. Older people may view living with
37 symptoms (such as pain, or emotional problems) as a normal part of ageing³⁶. The response
38 of the primary care physician may also vary with the wealth of the patient. For example, the
39 physician might be more likely to consider symptoms of breathlessness as a medical problem
40 requiring a diagnosis, whereas aches and pains, poor vision, and low mood might be
41 considered part of the tapestry of life, or the natural ageing process. Comorbidity is more
42 common in deprived populations, and may make diagnosis of all conditions harder for
43 doctors within the constraints of a short consultation³⁷.
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46 At a system level, the results may be partially explained by wealthier people living in areas
47 where there are more healthcare resources. Wennberg introduced the concept of ‘supply-
48 sensitive care’ to describe how the quantity of healthcare resources allocated to a particular
49 population was a major determinant of the frequency of use of health services by that
50 population, and gives an example in which ‘a doubling of the supply of internists or
51 cardiologists results in roughly a halving of the interval between repeat visits’^{38;39}. Where
52 healthcare resources are relatively plentiful, patients with chronic diseases will consult more,
53 use more diagnostic tests, and be referred to hospital more. Further research could helpfully
54 investigate whether those missing out on diagnosis are not accessing health services, or are
55 seeing a doctor but not being diagnosed. The participants were selected to be nationally
56 representative of the population of England, and so the findings are likely to be generalisable
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3 to England, but not to countries with different healthcare systems. If validated, our findings
4 that inequalities in receipt of diagnoses are potential barriers to equitable healthcare for five
5 common long-term conditions, suggest that future policy interventions to reduce socio-
6 economic inequalities in healthcare should consider improving access to diagnosis as well as
7 treatment.
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13 **Funding statement:** This article presents independent research commissioned by the UK
14 National Institute for Health Research (NIHR) under the Health Services Research
15 programme: HSR Project 10/2002/06 – ‘The dynamics of quality: a national panel study of
16 evidence-based standards’. IL’s work was supported by the NIHR Collaboration for Applied
17 Health Research and Care (CLAHRC) for the South West Peninsula. The views expressed in
18 this publication are those of the authors and not necessarily those of the NHS, the NIHR or
19 the Department of Health.
20

21
22 **Competing interests:** All authors have completed the ICMJE uniform disclosure form at
23 www.icmje.org/coi_disclosure.pdf and declare: all authors had financial support from the
24 National Institute for Health Research for the submitted work, DM had financial support from
25 Age UK; no financial relationships with any organisations that might have an interest in the
26 submitted work in the previous three years; no other relationships or activities that could
27 appear to have influenced the submitted work.
28

29
30 **Ethics approval:** The English Longitudinal Study of Ageing received ethics approval from
31 the National Research Ethics Service: 09/H0505/124. Participants gave informed consent
32 before taking part.
33

34 **Contributors:** NS contributed to the study design, oversaw data analysis and interpretation,
35 and drafted the paper. NS is guarantor. AH undertook data preparation, analysis and
36 interpretation, and contributed to drafting the paper. LM undertook data preparation and
37 analysis. MB and AC advised on statistical techniques. SR, JC and IL advised on data
38 analysis and interpretation. DM contributed to the study design and advised on data analysis
39 and interpretation. All authors contributed to data interpretation and revised the paper
40 critically. Dave Stott and Amander Wellings, representatives of Public and Patient
41 Involvement in Research (PPIRes), brought a helpful lay perspective to this research.
42
43

44 **Data sharing:** The ELSA dataset and technical documentation are available from the UK
45 Data Service at: <http://discover.ukdataservice.ac.uk/catalogue?sn=5050>.
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Reference List

- 1
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3
4
5 (1) Marmot M, Banks J, Blundell R, Lessof C, Nazroo J. Health, Wealth and Lifestyles of
6 the Older Population in England: the 2002 English Longitudinal Study of Ageing.
7 London: The Institute for Fiscal Studies; 2003.
8
- 9
10 (2) Börsch-Supan A, Brugiavini A, Jürges H, Mackenbach J, Siegris J, Weber G. Health,
11 Ageing and Retirement in Europe. First Results from the Survey of Health, Ageing
12 and Retirement in Europe. Mannheim: Mannheim Research Institute for the
13 Economics of Aging (MEA); 2005.
14
- 15 (3) Hemingway H, Shipley M, Macfarlane P, Marmot M. Impact of socioeconomic status
16 on coronary mortality in people with symptoms, electrocardiographic abnormalities,
17 both or neither: the original Whitehall study 25 year follow up. *J Epidemiol
18 Community Health* 2000; 54(7):510-516.
19
- 20 (4) Wilkinson R, Marmot M. Social determinants of health: the solid facts. 2nd edition
21 ed. Copenhagen: World Health Organisation; 2003.
22
- 23 (5) McKeown T. The role of medicine: dream, mirage or nemesis? 1 ed. London:
24 Nuffield Principal Hospital Trust; 1976.
25
- 26 (6) Bunker JP. The role of medical care in contributing to health improvements within
27 societies. *Int J Epidemiol* 2001; 30(6):1260-1263.
28
- 29 (7) Watt G. The inverse care law today. *Lancet* 2002; 360:252-4.
30
- 31 (8) Richards HM, Reid ME, Watt GCM. Socioeconomic variations in responses to chest
32 pain: qualitative study. *BMJ* 2002; 324(7349):1308.
33
- 34 (9) Gardner K, Chapple A. Barriers to referral in patients with angina: qualitative study.
35 *BMJ* 1999; 319(7207):418-421.
36
- 37 (10) Berger J, Mohr J. A fortunate man: the story of a country doctor. London: Penguin;
38 1967.
39
- 40 (11) Tod AM, Read C, Lacey A, Abbott J. Barriers to uptake of services for coronary heart
41 disease: qualitative. *BMJ* 2001; 323(7306):214.
42
- 43 (12) Chaturvedi N, Ben Shlomo Y. From the surgery to the surgeon: does deprivation
44 influence consultation and operation rates? *Br J Gen Pract* 1995; 45(392):127-131.
45
- 46 (13) Mahomed NN, Barrett JA, Katz JN, Phillips CB, Losina E, Lew RA et al. Rates and
47 outcomes of primary and revision total hip replacement in the United States medicare
48 population. *J Bone Joint Surg Am* 2003; 85-A(1):27-32.
49
- 50 (14) Richards H, McConnachie A, Morrison C, Murray K, Watt G. Social and gender
51 variation in the prevalence, presentation and general practitioner provisional diagnosis
52 of chest pain. *J Epidemiol Community Health* 2000; 54(9):714-718.
53
- 54 (15) Natcen Social Research. English Longitudinal Study of Ageing (ELSA) Wave One to
55 Wave Five User Guide. <http://www.esds.ac>
56
57
58
59
60

uk/doc/5050/mrdoc/pdf/5050_User_Guide_to_the_ELSA_Datasets_Waves_1_to_5
pdf [2012 [cited 2013 Sept. 28];

- (16) Scholes S, Taylor R, Cheshire H, Cox K, Lessof C. Retirement, health and relationships of the older population in England: The 2004 English Longitudinal Study of Ageing. Technical Report P2808. London: National Centre for Social Research; 2008.
- (17) Steel N, Melzer D, Gardener E, McWilliams B. Need for and receipt of hip and knee replacement--a national population survey. *Rheumatology* 2006;(45):1437-1441.
- (18) Evans JR, Fletcher AE, Wormald RPL, Siu-Woon Ng E, Sterling S, Smeeth L et al. Prevalence of partial sight and blindness in people aged 75 years and older in Britain: results from the MRC trial of assessment and management of older people in the community. *Br J Ophthalmol* 2002; 86:795-800.
- (19) Congdon N, O'Colmain B, Klaver CCW, Klein R, Munoz B, Friedman DS et al. Causes and Prevalence of Partial sight and blindness among adults in the United States. *Arch Ophthalmol* 2004; 122:477-485.
- (20) Steel N, Melzer D, Shekelle PG, Wenger NS, Forsyth D, McWilliams BC. Developing quality indicators for older adults: transfer from the USA to the UK is feasible. *Quality and Safety in Health Care* 2004; 13(4):260-264.
- (21) Steel N, Bachmann M, Maisey S, Shekelle P, Breeze E, Marmot M et al. Self reported receipt of care consistent with 32 quality indicators: National population survey of adults aged 50 or more in England. *BMJ* 2008; 337:a957.
- (22) Wagstaff A, Paci P, Van Doorslaer E. On the measurement of inequalities in health. *Soc Sci Med* 1991; 33(5):545-557.
- (23) Bachmann MO, Eachus J, Hopper CD, Davey SG, Propper C, Pearson NJ et al. Socio-economic inequalities in diabetes complications, control, attitudes and health service use: a cross-sectional study. *Diabet Med* 2003; 20(11):921-929.
- (24) Banks J, Breeze E, Lessof C, Nazroo J. Retirement, health and relationships of the older population in England: The 2004 English Longitudinal Study of Ageing (Wave 2). London: The Institute for Fiscal Studies; 2006.
- (25) Cheshire H, Hussey D, Medina J, Pickering K, Wood N, Ward K et al. Financial circumstances, health and well-being of the older population in England: The 2008 English Longitudinal Study of Ageing. Wave 4 Technical Report. London: National Centre for Social Research; 2012.
- (26) Sen A. Health: perception versus observation. *BMJ* 2002; 324(7342):860-861.
- (27) Min LC, Reuben DB, MacLean CH, Shekelle PG, Solomon DH, Higashi T et al. Predictors of Overall Quality of Care Provided to Vulnerable Older People. *J Am Geriatr Soc* 2005; 53(10):1705-1711.
- (28) McBride D, Hardoon S, Walters K, Gilmour S, Raine R. Explaining variation in referral from primary to secondary care: cohort study. *BMJ* 2010; 341.

- 1
2
3 (29) NHS Employers and the General Practitioners Committee. Quality and Outcomes
4 Framework for 2012/13. Guidance for PCOs and practices. London: NHS Employers;
5 2012.
6
7 (30) Gillam S, Steel N. The Quality and Outcomes Framework: where next? BMJ 2013;
8 346.
9
10 (31) Gillam SJ, Siriwardena AN, Steel N. Pay-for-Performance in the United Kingdom:
11 Impact of the Quality and Outcomes Framework - A Systematic Review. The Annals
12 of Family Medicine 2012; 10(5):461-468.
13
14 (32) Steel N, Maisey S, Clark A, Fleetcroft R, Howe A. Quality of clinical primary care
15 and targeted incentive payments: an observational study. Br J Gen Pract
16 2007;(57):449-454.
17
18 (33) Steel N. Thresholds for taking antihypertensive drugs in different professional and lay
19 groups: questionnaire survey. BMJ 2000; 320:1446-7.
20
21 (34) Montgomery AA, Fahey T. How do patients' treatment preferences compare with
22 those of clinicians? Quality in health care 2001; 10 (Suppl I):i39-i43.
23
24 (35) Sanders C, Donovan JL, Dieppe PA. Unmet need for joint replacement: a qualitative
25 investigation of barriers to treatment among individuals with severe pain and
26 disability of the hip and knee. Rheumatology 2004; 43(3):353-357.
27
28 (36) Murray J, Banerjee S, Byng R, Tylee A, Bhugra D, Macdonald A. Primary care
29 professionals' perceptions of depression in older people: a qualitative study. Social
30 Science & Medicine 2006; 63:1363-73.
31
32 (37) Mercer SW, Guthrie B, Furler J, Watt G, Tudor Hart J. Multimorbidity and the
33 inverse care law in primary care. BMJ 2012; 344.
34
35 (38) Wennberg JE. Understanding Geographic Variations in Health Care Delivery. The
36 New England Journal of Medicine 1999; 340(1):52-53.
37
38 (39) Wennberg JE. Unwarranted variations in healthcare delivery: implications for
39 academic medical centres. BMJ 2002; 325(7370):961-964.
40
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42
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Supplemental file 1

Supplemental Table 1. Odds ratios for meeting the ‘illness burden’ criteria for angina, cataract, depression, diabetes and osteoarthritis, medical diagnosis for those estimated to have a condition, and treatment for those with a diagnosis, comparing the least wealthy with the most wealthy: binomial regression

| Condition | Adjusted odds ratios* (95% CI) | | | |
|----------------|--------------------------------|----------------------------------|-----------------------|-----------------|
| | Illness burden (Wave 3) | Medical diagnosis (Wave 4) | Treatment (Wave 5) | N in treatment† |
| Angina | 8.7 (5.5, 13.8) | 1.4 (0.5, 4.0) | 1.6 (0.3, 9.0) | 11 |
| Cataract | 8.2 (5.1, 13.1) | 1.0 (0.3, 3.1) | 2.2 (1.2, 3.8) | 83 |
| Osteoarthritis | 12.7 (9.1, 17.8) | 0.7 (0.3, 1.6) | 0.7 (0.3, 1.6) | 30 |
| | Adjusted odds ratios* (95% CI) | | | |
| | Illness burden (Wave 2) | Medical diagnosis (Wave 3) | Treatment (Wave 4) | N in treatment† |
| Depression | 5.1 (4.3, 6.2) | 0.4 (0.1, 1.4) | 17.3 (0.5, 604) | 12 |
| Diabetes | 4.4 (2.5, 8.0) | 0.1 (0.0, 3.6) | 0.5 (0.2, 1.1) | 99 |

*adjusted for age group and sex

†followed through the waves

Waves used in analysis were the most recent with available data

Odds ratios where the 95% confidence intervals do not include 1 (before rounding to one decimal place) are shown in bold

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

| Section/Topic | Item # | Recommendation | Reported on page # |
|---------------------------|--------|--|--------------------|
| Title and abstract | 1 | (a) Indicate the study’s design with a commonly used term in the title or the abstract | 1&2 |
| | | (b) Provide in the abstract an informative and balanced summary of what was done and what was found | 2 |
| Introduction | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 4 |
| Methods | | | |
| Study design | 4 | Present key elements of study design early in the paper | 4-6 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 4-5 |
| Participants | 6 | (a) Give the eligibility criteria, and the sources and methods of selection of participants | 4-6 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 5 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5 |
| Bias | 9 | Describe any efforts to address potential sources of bias | 6 |
| Study size | 10 | Explain how the study size was arrived at | 6 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 6 |
| Statistical methods | 12 | (a) Describe all statistical methods, including those used to control for confounding | 6 |
| | | (b) Describe any methods used to examine subgroups and interactions | 6 |
| | | (c) Explain how missing data were addressed | 6 |
| | | (d) If applicable, describe analytical methods taking account of sampling strategy | 6 |
| | | (e) Describe any sensitivity analyses | 6 |
| Results | | | |

| | | | |
|--------------------------|-----|--|-------|
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 6-8 |
| | | (b) Give reasons for non-participation at each stage | 6-8 |
| | | (c) Consider use of a flow diagram | |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 7 |
| | | (b) Indicate number of participants with missing data for each variable of interest | |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 8 |
| Main results | 16 | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 7-9 |
| | | (b) Report category boundaries when continuous variables were categorized | 7 |
| | | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 7 |
| Discussion | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 10 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 10-11 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 11 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 11-12 |
| Other information | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 12 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Economic inequalities in burden of illness, diagnosis and treatment of five long-term conditions in England: panel study.

| | |
|---------------------------------|---|
| Journal: | <i>BMJ Open</i> |
| Manuscript ID: | bmjopen-2014-005530.R1 |
| Article Type: | Research |
| Date Submitted by the Author: | 28-Jul-2014 |
| Complete List of Authors: | Steel, Nicholas; University of East Anglia Hardcastle, Antonia; University of East Anglia, Norwich Medical School Bachmann, Max; Univeristy of East Anglia, School of Medicine, Health Policy and Practic Richards, Suzanne; University of Exeter Medical School, Mounce, Luke; University of Exeter Medical School, Clark, Allan; University of East Anglia, Norwich Medical School Lang, Iain; PenCLAHRC, Melzer, David; University of Exeter Medical School, Campbell, John; University of Exeter, Primary Care; |
| Primary Subject Heading: | Health services research |
| Secondary Subject Heading: | Health services research, Epidemiology, Public health, Sociology |
| Keywords: | Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, EPIDEMIOLOGY, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT |
| | |

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4 **Economic inequalities in burden of illness, diagnosis and**
5 **treatment of five long-term conditions in England: panel study.**
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Abstract

Objective:

We compared the distribution by wealth of self-reported illness burden (estimated from validated scales, biomarker and reported symptoms) for angina, cataract, depression, diabetes and osteoarthritis, with the distribution of self-reported medical diagnosis and treatment. We aimed to determine if the greater illness burden borne by poorer participants was matched by appropriately higher levels of diagnosis and treatment.

Design:

The English Longitudinal Study of Ageing, a panel study of 12,765 participants aged 50 years and older in four waves from 2004 to 2011, selected using a stratified random sample of households in England. Distribution of illness burden, diagnosis and treatment by wealth was estimated using regression analysis.

Outcome measures:

The main outcome measures were odds ratios (ORs) for the illness burden, diagnosis and treatment respectively, adjusted for age, sex and wealth. We estimated the illness burden for angina with the Rose Angina scale, diabetes with fasting glycosylated haemoglobin, depression with the Centre for Epidemiologic Studies Depression Scale, osteoarthritis with self-reported pain and disability, and cataract with self-reported poor vision. Medical diagnoses were self-reported for all conditions. Treatment was defined as beta-blocker prescription for angina, surgery for osteoarthritis and cataract, and receipt of pre-defined effective interventions for diabetes and depression.

Results:

Compared to the wealthiest, the least wealthy participant had substantially higher odds for illness burden from any of the five conditions at all four time points, with odds ratios ranging from 4.2 (95% confidence interval 2.6 to 6.8) for diabetes to 15.1 (11.4 to 20.0) for osteoarthritis. The odds ratios for diagnosis and treatment were smaller in all 5 conditions, and ranged from 0.9 (0.5 to 1.4) for diabetes treatment to 4.5 (3.3 to 6.0) for angina diagnosis.

Conclusions:

The substantially higher illness burden in less wealthy participants was not matched by appropriately higher levels of diagnosis and treatment.

Strengths and limitations of this study

- The English Longitudinal Study of Ageing (ELSA) is a unique single source of detailed longitudinal data on socioeconomic status and health, and this is the first study to compare inequalities in illness burden, self-reported medical diagnosis and treatment of long-term conditions in a longitudinal panel study
- Highly detailed measures of individual wealth were used alongside standardised scales and blood biomarker to assess the illness burden of depression, angina and diabetes
- Standardised scales were not included in ELSA for osteoarthritis and cataract, so assessment of illness burden for these two conditions was based on attributed symptoms which were not specific for osteoarthritis and cataract
- The study used self-reported data collected using an extensively tested structured questionnaire, but no information from medical records was collected
- An analysis of pooled data from 4 waves of ELSA was used to maximise the sample size, and the main finding that less wealthy participants are relatively underdiagnosed requires validation in a larger longitudinal study.

Main text

Introduction

Poverty is associated with poor health, poor access to health care and poor health outcomes in many countries and across different health care systems¹⁻³. Much of this variation is caused by recognised broad social determinants of health⁴. Considerable political effort has been directed at attempts to narrow health inequalities by reducing poverty and social exclusion. However, as health care has become more effective at improving health, its potential contribution to ameliorating health inequalities has increased. McKeown demonstrated in the 1970s that health services had contributed little to health improvement⁵, but the same claim could not be made today. The past 30 years have seen the introduction of a wide range of effective interventions, particularly for the prevention and management of chronic disease⁶. Yet although these new interventions improve health, they are not necessarily applied equally across the population. Health inequalities will widen if effective services are offered, or taken up, with greater frequency by wealthier than less wealthy people. The reverse is also true, however, and there is an opportunity for healthcare to reduce social inequalities if it reaches those most in need⁷.

Little is known about pathways into poor health. The National Health Service provides medical care free at point-of-need to all UK residents, but there is scope for inequalities to occur in the pathway from identification of early symptoms through diagnosis and on to effective treatment. Individuals in more deprived social groups may be more reluctant to present to doctors with their symptoms and so may not receive a diagnosis^{8,9}. Diagnosis is a key step that has meaning for both patient and physician in all health systems, and 'diagnostic confusion' may act as a barrier to health care for vulnerable populations^{10,8,11}. Previous studies have found socio-economic variation in either diagnosis or treatment rates, but have not been able to compare inequalities in illness burden, rates of diagnosis and treatment modalities in the same population¹²⁻¹⁴.

The English Longitudinal Study of Ageing (ELSA) provides new data that can be used to identify barriers to equitable receipt of healthcare, and constitutes a unique source of information on illness burden, self-reported medical diagnosis and treatment. Other data sources cover symptoms, or diagnosis, or treatment, but no other single source covers all three. ELSA collects data on symptoms and validated markers of common health conditions, as well as diagnosis and treatment. It also contains detailed socio-demographic information, including direct measures of personal wealth, on a sample selected to be representative of the population of England aged 50 years and older. These data can be used to compare socio-economic inequalities for several conditions, providing insight into a healthcare system with no direct financial barriers to treatment (the National Health Service in England). We aimed to assess socio-economic inequalities in the burden of illness (estimated by validated scales, biomarker, and reported symptoms) of angina, cataract, depression, diabetes and osteoarthritis, and compare them with inequalities in self-reported medical diagnosis and treatment, in order to determine whether key components of health care were received equitably.

Methods

We obtained data from the ELSA cohort, an interview survey of a sample of the population aged 50 years or older in England. The sample was selected from households that had previously responded to the Health Survey for England, and drawn from selected postcode sectors stratified by health authority and deprivation to be representative of adults aged 50 or more living in private households in England¹⁵. Participants are interviewed in their homes or care homes every two years about a wide range of health, economic and social topics. We used data collected from core participants who had been interviewed in any of four waves of ELSA from wave 2 in 2004-5 until wave 5 in 2010-11. Wave 2 was the first wave to include questions on receipt of quality-indicated healthcare, and information was not collected on every variable in every wave. Ethical approval was received from the London Multi-Centre Research Ethics Committee. We studied five common and important long-term conditions: angina, diabetes, depression, osteoarthritis, and cataract. Effective treatment is freely available for all five conditions from the National Health Service.

Variables

We collected data on illness burden, self-reported medical diagnosis and treatment of angina, cataract, depression, diabetes and osteoarthritis. The illness burden for angina was defined as grade 2 on the Rose Angina scale (pain or discomfort in chest when walking at an ordinary pace on the level on most occasions or more often, which makes subject stop or slow down if occurs while walking, and which then goes away within 10 minutes, and which includes either sternum (any level), or left arm and left anterior chest). Illness burden for diabetes was defined as a fasting HbA1c level of >7.5%¹⁶. Illness burden for depression was defined as a score of 3 or more on the eight-item Centre for Epidemiologic Studies Depression Scale (CES-D). The application of these standardised scales in ELSA has been described previously¹. Illness burden for osteoarthritis was defined as self-reported pain in the hip or knee of 5 or more on a scale of 0 to 10¹⁷. Illness burden for cataract was defined broadly as reporting poor vision or blindness. Cataract is responsible for about a quarter of poor vision in the UK, so this measure is the least specific and includes those with other causes of poor vision, such as age-related macular degeneration, which is responsible for about a third of poor vision^{18;19}.

A medical diagnosis was considered to exist if a participant answered 'yes' when asked whether a doctor had ever told them they had the condition of interest. For arthritis, a follow-up question asked whether they had been told they had osteoarthritis, rheumatoid or other arthritis.

Treatment for depression and diabetes was defined by reported achievement of quality of care indicators, derived through a robust process of literature reviews, expert panel assessment and piloting^{20;21}. For depression, the quality indicator was about receipt of treatment since the previous wave: '*if a person is diagnosed with clinical depression, then antidepressive treatment, talking treatment or electroconvulsive treatment should be offered within 2 weeks after diagnosis unless within that period the patient has improved, or unless the patient has substance abuse or dependence, in which case treatment may wait until 8 weeks after the patient is in a drug-or alcohol-free state*'. For diabetes, treatment was measurement of glycosylated haemoglobin or fructosamine levels in the preceding 12 months. Treatment for angina was defined as ever being offered or currently taking beta-blockers (ELSA variables

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2
3 hebeta or hebetb). Treatment for osteoarthritis and cataract were defined as reporting ever
4 having had surgery for the condition. For osteoarthritis this excluded those with hips or knees
5 replaced due to fracture. Data on hip and knee replacements were only available for
6 respondents aged 60 and over, and so respondents aged less than 60 years (n= 3,186) were
7 excluded from the analysis of osteoarthritis.
8

9
10 Wealth was defined as the sum of financial, physical and housing wealth plus state and
11 private pension income. Age was categorised into three groups, 50-59 years, 60-74 years and
12 75 years and older.
13

14 **Analysis**

15 We used two approaches to analysis, a main analysis using serial cross sectional data and
16 then a subsidiary analysis using longitudinal data. Multivariable logistic regression analysis
17 was used, with the outcome variables defined as one of illness burden, self-reported medical
18 diagnosis or treatment for each of the five conditions in each cross-sectional wave (STATA
19 statistical software version 12.1). This regression analysis was repeated for each of the four
20 waves of ELSA from 2004 to 2011 separately and then 'overall' for all four waves combined.
21 For the 'overall' analysis, the data were reshaped into 'long' format in Stata statistical
22 software, with each participant having a separate record for each wave. Intra-person
23 correlation of outcomes was accounted for using robust adjustment with Stata, with each
24 participant's unique identifier included in the regression equation as a cluster variable.
25 Missing data were excluded from the analyses.
26
27

28
29 The independent variables were age group, sex and slope order of inequality. We used the
30 slope order of inequality as an independent variable to estimate the relationship between the
31 outcome measures and the categorised measure of wealth^{22,23}. The slope order of inequality
32 consisted of wealth quintiles with values of 0.1, 0.3, 0.5, 0.7 and 0.9, that is, the midpoints of
33 each quintile on a scale of zero (least wealthy) to one (most wealthy). The slope order of
34 inequality was modelled as a continuous variable, so that the slope or coefficient of a logit
35 linear regression line across all five quintiles represents the difference in outcome between
36 the hypothetically wealthiest and least wealthy participant. Exponentiating this slope
37 coefficient results in an odds ratio, which is the ratio of the odds of the outcome in the
38 wealthiest compared with the least wealthy participant. This odds ratio is also known as a
39 relative index of inequality²². Advantages of this method of quantifying inequality are that it
40 includes all participants, instead of just comparing the highest and lowest quintiles, it
41 accounts for the number of participants in each category and it provides a single overall
42 measure of inequality.
43
44

45 We included all participants in the main cross sectional analysis in order to compare the
46 distribution of illness burden in the whole population with the distributions of diagnoses and
47 treatments in the whole population. This meant that diagnosis was assessed even in those who
48 did not meet the criteria for 'illness burden', and treatment was assessed even in those with
49 no diagnosis. For the subsidiary analysis using longitudinal data, we estimated the odds ratio
50 of receiving a diagnosis by a subsequent wave only for those who had met the criteria for
51 'illness burden' in a previous wave, and then the likelihood of receiving treatment only for
52 those who had received a diagnosis in a previous wave. This was a subsidiary analysis as the
53 numbers of participants that could be followed over time in this manner was small,
54 particularly for treatment in angina and depression.
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Results

The whole sample (n=12,765) was composed of participants aged 50 years or more who had responded to at least one wave of ELSA from 2004-5 until 2010-11. The response rate in 2004-5 was 82%.^{24;25} In wave 5 (2010-11), over half of the sample of 8,729 were women, or were aged between 60 and 74 years (Table 1). Self-reported medical diagnosis for all five conditions increased as wealth decreased, for example in depression from 4% in the wealthiest quintile to 11% in the poorest (Table 1). There was little variation between the waves for each of the five conditions (Table 2).

The hypothetically least wealthy participant had substantially higher odds than the hypothetically most wealthy of meeting the criteria for 'illness burden' from any of the five conditions at all four time points (overall odds ratios (OR) ranged from 4.2 to 15.1) (Table 3). The least wealthy participant also had higher odds of diagnosis (ORs 1.1 to 4.5) and either no different or relatively small odds of treatment (ORs 0.9 to 2.6) (Table 3, Figure 1).

For angina, the overall odds ratio for meeting the criteria for 'illness burden' was 7.6, indicating that the hypothetically least wealthy individual was seven times more likely to have angina symptoms (defined by the Rose angina scale) than the wealthiest. The odds ratio for self-reported medical diagnosis was 4.5, suggesting that some less wealthy people with angina symptoms had not received a diagnosis of angina, as the expected odds ratio for equitably distributed diagnosis would have been 7.6. The odds ratio for treatment was 3.2, and again the expected odds ratios for equitably distributed treatment would have been 7.6. For depression, the overall odds ratio for illness burden was 6.4, for medical diagnosis was 3.3, and for treatment was 2.6, again suggesting that some poorer people with symptoms of depression were less likely to have received a diagnosis or indicated health care, as the expected odds ratios for equitably distributed treatment would have been 6.4.

For diabetes, the overall odds ratio for illness burden was 4.2 and 4.0 for diagnosis, suggesting that for diabetes diagnosis was distributed equitably. However, the odds ratio for treatment was 0.9 and not statistically significantly different from 1, again suggesting that some less wealthy people with medically diagnosed diabetes had not received treatment, as the expected odds ratios for equitably distributed treatment would have been 4.2.

The subsidiary analysis calculated the odds ratios of receiving a diagnosis by a subsequent wave only for those who had met the criteria for 'illness burden' for the relevant long term condition in a previous wave; and then the likelihood of receiving treatment only for those who had received a medical diagnosis in a previous wave. The substantial inequalities in the illness burden of conditions by wealth are identical to Table 3, as expected, and subsequently the numbers of eligible participants dwindle rapidly due to the nested nature of the analysis, with some wide confidence intervals and 9 out of 10 results not statistically significant (Supplemental file 1).

Table 1: Characteristics of ELSA participants at wave 5 (2010-11) and self-reported medical diagnosis of angina, cataract, depression, diabetes and osteoarthritis.

| | | Whole sample | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|------------------|---------|---------------------|---------------|-----------------|-------------------|-----------------|-----------------------|
| | | N | % | % | % | % | % |
| Sex | Male | 3,886 | 8.2 | 13.4 | 5.4 | 13.3 | 19.8 |
| | Female | 4,843 | 6.3 | 20.4 | 7.8 | 9.4 | 32.9 |
| Age (years) | 50-59 | 1,906 | 2.2 | 3.7 | 10.1 | 7.2 | 17.1 |
| | 60-74 | 4,766 | 5.8 | 14.5 | 7.0 | 11.0 | 28.1 |
| | 75+ | 2,057 | 15.0 | 36.6 | 2.9 | 15.0 | 34.1 |
| Wealth quintile* | 1 | 1,716 | 3.4 | 13.8 | 4.1 | 6.0 | 21.5 |
| | 2 | 1,714 | 4.9 | 15.5 | 5.9 | 8.0 | 24.2 |
| | 3 | 1,723 | 6.6 | 20.1 | 5.7 | 11.3 | 25.7 |
| | 4 | 1,716 | 8.2 | 18.6 | 6.7 | 13.6 | 31.6 |
| | 5 | 1,715 | 12.9 | 19.2 | 11.5 | 16.7 | 33.1 |
| | missing | 145 | 5.5 | 9.7 | 4.8 | 9.7 | 20.0 |
| Total | | 8,729 | 7.2 | 17.3 | 6.7 | 11.1 | 27.1 |

*1=wealthiest quintile, 5=least wealthy quintile

Table 2. Prevalence of illness burden, self-reported medical diagnosis, and treatment for angina, cataract, depression, diabetes and osteoarthritis in four waves of ELSA

| | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|---|---------------|-----------------|-------------------|-----------------|-----------------------|
| | N (%) | N (%) | N (%) | N (%) | N (%) |
| Illness burden | | | | | |
| Wave 2 (2004-5) | 397 (4.6) | 308 (3.5) | 2,037 (23.4) | 160 (1.8) | 1,106 (12.7) |
| Wave 3 (2006-7) | 300 (3.6) | 317 (3.8) | 1,929 (23.3) | n/a | 917 (11.1) |
| Wave 4 (2008-9) | 300 (3.1) | 331 (3.5) | 2,049 (21.4) | 220 (2.3) | 1,088 (11.4) |
| Wave 5 (2010-11) | 254 (2.9) | 320 (3.7) | 1,956 (22.4) | n/a | 1,046 (12.0) |
| Medical diagnosis | | | | | |
| Wave 2 (2004-5) | 668 (7.6) | 1,050 (12.1) | 402 (4.6) | 715 (8.2) | 1,861 (21.4) |
| Wave 3 (2006-7) | 591 (7.1) | 1,294 (15.7) | 490 (5.9) | 935 (11.3) | 1,952 (23.6) |
| Wave 4 (2008-9) | 645 (6.7) | 1,421 (14.8) | 601 (6.3) | 1,215 (12.7) | 2,262 (23.6) |
| Wave 5 (2010-11) | 655 (7.5) | 1,566 (17.9) | 602 (6.9) | 1,413 (16.2) | 2,416 (27.7) |
| Treatment | | | | | |
| Wave 2 (2004-5) | 85 (1.0) | 535 (6.2) | 98 (1.1) | 552 (6.4) | 202 (2.3) |
| Wave 3 (2006-7) | n/a | 379 (4.9) | n/a | 618 (7.5) | 141 (1.7) |
| Wave 4 (2008-9) | n/a | 444 (4.6) | 155 (1.6) | 671 (7.0) | 226 (2.4) |
| Wave 5 (2010-11) | 88 (1.0) | 646 (7.4) | n/a | 748 (8.6) | 208 (2.4) |
| Total number of participants in each wave: wave 2: 8,688; wave 3: 8,268; wave 4: 9,578; wave 5: 8,729 | | | | | |
| n/a = data not available for that condition in that wave | | | | | |

Table 3. Illness burden, self-reported medical diagnosis and treatment of angina, cataract, depression, diabetes and osteoarthritis, comparing the least wealthy with the most wealthy: logistic regression.

| | | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|---------------------------------------|-------------------|---------------------------|---------------------------|--------------------------|--------------------------|-----------------------------|
| Odds ratios (95% confidence interval) | | | | | | |
| Wave 2* (2004-5) | Illness burden | 5.6 (3.8, 8.3) | 7.2 (4.5, 11.5) | 5.1 (4.3, 6.2) | 4.4 (2.5, 8.0) | 11.0 (8.1, 14.9) |
| | Medical diagnosis | 2.9 (2.2, 3.9) | 1.3 (1.0, 1.6) | 4.8 (3.3, 7.0) | 3.1 (2.3, 4.2) | 1.6 (1.3, 2.0) |
| | Treatment | 2.6 (1.2, 5.7) | 1.5 (1.0, 2.2) | 0.6 (0.1, 2.9) | 0.7 (0.3, 1.5) | 1.1 (0.7, 1.9) |
| Wave 3* (2006-7) | Illness burden | 8.7 (5.5, 13.8) | 8.2 (5.1, 13.1) | 6.9 (5.7, 8.5) | | 12.7 (9.1, 17.8) |
| | Medical diagnosis | 4.9 (3.6, 6.8) | 1.2 (1.0, 1.5) | 0.7 (0.4, 1.4) | 3.4 (2.6, 4.4) | 0.6 (0.4, 0.8) |
| | Treatment | | 1.3 (0.8, 1.9) | | 1.2 (0.6, 2.4) | 1.0 (0.6, 1.9) |
| Wave 4* (2008-9) | Illness burden | 6.7 (4.2, 10.5) | 5.5 (3.6, 8.6) | 5.9 (4.9, 7.1) | 3.9 (2.4, 6.4) | 14.0 (10.3, 19.1) |
| | Medical diagnosis | 4.3 (3.2, 5.9) | 1.1 (0.9, 1.4) | 0.7 (0.4, 1.2) | 3.9 (3.1, 5.1) | 0.6 (0.4, 0.8) |
| | Treatment | | 1.1 (0.7, 1.6) | 2.4 (1.0, 5.9) | 0.2 (0.1, 0.6) | 1.0 (0.6, 1.6) |
| Wave 5* (2010-11) | Illness burden | 8.4 (5.1, 13.7) | 6.2 (3.9, 9.9) | 5.9 (4.8, 7.1) | | 16.0 (11.7, 21.8) |
| | Medical diagnosis | 5.3 (3.9, 7.3) | 1.3 (1.0, 1.5) | 1.7 (1.0, 2.8) | 4.3 (3.4, 5.4) | 0.6 (0.4, 0.8) |
| | Treatment | 3.3 (1.5, 7.3) | 1.8 (1.2, 2.6) | | 0.8 (0.4, 1.6) | 1.2 (0.7, 2.0) |
| Overall† | Illness burden | 7.6 (5.4, 10.8) | 8.0 (5.4, 11.9) | 6.4 (5.5, 7.5) | 4.2 (2.6, 6.8) | 15.1 (11.4, 20.0) |
| | Medical diagnosis | 4.5 (3.3, 6.0) | 1.3 (1.1, 1.5) | 3.3 (2.4, 4.5) | 4.0 (3.1, 5.2) | 1.1 (0.9, 1.3) |
| | Treatment | 3.2 (1.7, 6.0) | 1.3 (1.0, 1.8) | 2.6 (1.1, 6.1) | 0.9 (0.5, 1.4) | 1.2 (0.8, 1.6) |

*Odds ratios adjusted for age group and sex

†Odds ratios adjusted for age group, sex and unique participant identifier

**Analyses for osteoarthritis excluded those younger than 60 years, as data on osteoarthritis treatment were only collected in those aged 60 or over.

Odds ratios where the 95% confidence intervals do not include 1 (before rounding to one decimal place) are shown in bold

Discussion

We found that while there were strong inverse associations between wealth and the burden of illness (based on validated scales, symptoms and biomarker) of a long-term condition, there were smaller or absent inequalities in receipt of self-reported medical diagnosis or treatment for the conditions considered. This suggests that the substantially higher illness burden in less wealthy participants was not matched by appropriately higher levels of diagnosis and treatment, and that equitable receipt of a medical diagnosis may have an important role in reducing inequalities in health.

ELSA is a unique single source of detailed longitudinal data on socioeconomic status and health, and this is the first study to compare inequalities in illness burden, self-reported medical diagnosis and treatment of long-term conditions in a longitudinal panel study. ELSA used robust measures of individual socio-economic position, and standardised scales and blood biomarker to assess health status. This exploratory study has some limitations and the results should be interpreted with caution and tested in subsequent research. Whilst standardised measures were used to estimate the illness burden of depression, angina and diabetes, symptoms alone were used for osteoarthritis and cataract, and the attributed symptoms were not specific for osteoarthritis and cataract. However, this lack of specificity is unlikely to vary with wealth, and so is not likely to be an important source of bias. Self-reported data may be a source of bias if self-report varies by factors other than objective health status, such as wealth or social experience. This is a recognised problem with some self-reported morbidity data, but is less of a problem with sensory assessment for pain, which is essentially self-perceived, and where self-report is the best means of assessment ²⁶.

We have not adjusted for health-related factors that are also more prevalent in poorer populations, such as smoking, obesity and comorbidity, because none of these are a reason for not making a diagnosis. Comorbid conditions are commoner in those with lower socio-economic status, but there is no evidence that comorbidities make a new diagnosis less likely. On the contrary, a higher number of comorbid conditions in older people may be associated with higher quality of care ²⁷. We found different patterns in different conditions, which fits with other research showing that wealth acts differently in different conditions, and for example, has no association with referral for post-menopausal bleeding ²⁸. Major national policy interventions such as the Quality and Outcomes Framework payment for performance scheme in primary care ²⁹ have been associated with improved healthcare for included conditions such as angina and diabetes, more than for excluded conditions such as osteoarthritis and poor vision ³⁰⁻³².

The serial cross-sectional analysis of 4 waves of ELSA included all eligible participants in each wave in order to maximise the sample size. This approach meant that some participants with a diagnosed condition would no longer have had symptoms or raised biomarkers, if they were being successfully treated. Examples would be diabetic participants whose blood sugar levels were being successfully controlled by treatment, and participants with successfully treated depression. We therefore checked our main results with the secondary (longitudinal) analysis, which assessed subsequent diagnosis in those had met the criteria for 'illness burden', and subsequent treatment in those with a medical diagnosis, but the number of participants who could be followed through the waves in this way was too small to allow meaningful conclusions to be drawn from the results.

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3 Our results fit with previous findings that a greater proportion of people in deprived groups
4 had Rose angina, but there was no difference in the proportions receiving a general
5 practitioner diagnosis of coronary heart disease¹⁴. Care-seeking behaviour and patient
6 preferences may differ with wealth. Given the same information, patients may want fewer
7 medical interventions than their doctors recommend^{33;34}, and pessimism about availability of
8 treatment may make older people reluctant to seek help³⁵. Older people may view living with
9 symptoms (such as pain, or emotional problems) as a normal part of ageing³⁶. The response
10 of the primary care physician may also vary with the wealth of the patient. For example, the
11 physician might be more likely to consider symptoms of breathlessness as a medical problem
12 requiring a diagnosis, whereas aches and pains, poor vision, and low mood might be
13 considered part of the tapestry of life, or the natural ageing process. Comorbidity is more
14 common in deprived populations, and may make diagnosis of all conditions harder for
15 doctors within the constraints of a short consultation³⁷.

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18 At a system level, the results may be partially explained by wealthier people living in areas
19 where there are more healthcare resources. Wennberg introduced the concept of 'supply-
20 sensitive care' to describe how the quantity of healthcare resources allocated to a particular
21 population was a major determinant of the frequency of use of health services by that
22 population, and gives an example in which 'a doubling of the supply of internists or
23 cardiologists results in roughly a halving of the interval between repeat visits'^{38;39}. Where
24 healthcare resources are relatively plentiful, patients with chronic diseases will consult more,
25 use more diagnostic tests, and be referred to hospital more. Further research could helpfully
26 investigate whether those missing out on diagnosis are not accessing health services, or are
27 seeing a doctor but not being diagnosed. The participants were selected to be nationally
28 representative of the population of England, and so the findings are likely to be generalisable
29 to England, but not to countries with different healthcare systems. If validated, our findings
30 that inequalities in receipt of diagnoses are potential barriers to equitable healthcare for five
31 common long-term conditions, suggest that future policy interventions to reduce socio-
32 economic inequalities in healthcare should consider improving access to diagnosis as well as
33 treatment.
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55 **Funding statement:** This article presents independent research commissioned by the UK
56 National Institute for Health Research (NIHR) under the Health Services Research
57 programme: HSR Project 10/2002/06 – 'The dynamics of quality: a national panel study of
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3 evidence-based standards'. IL's work was supported by the NIHR Collaboration for Applied
4 Health Research and Care (CLAHRC) for the South West Peninsula. The views expressed in
5 this publication are those of the authors and not necessarily those of the NHS, the NIHR or
6 the Department of Health.
7

8
9 **Competing interests:** All authors have completed the ICMJE uniform disclosure form at
10 www.icmje.org/coi_disclosure.pdf and declare: all authors had financial support from the
11 National Institute for Health Research for the submitted work, DM had financial support from
12 Age UK; no financial relationships with any organisations that might have an interest in the
13 submitted work in the previous three years; no other relationships or activities that could
14 appear to have influenced the submitted work.
15

16
17 **Ethics approval:** The English Longitudinal Study of Ageing received ethics approval from
18 the National Research Ethics Service: 09/H0505/124. Participants gave informed consent
19 before taking part.
20

21
22 **Contributors:** NS contributed to the study design, oversaw data analysis and interpretation,
23 and drafted the paper. NS is guarantor. AH undertook data preparation, analysis and
24 interpretation, and contributed to drafting the paper. LM undertook data preparation and
25 analysis. MB and AC advised on statistical techniques. SR, JC and IL advised on data
26 analysis and interpretation. DM contributed to the study design and advised on data analysis
27 and interpretation. All authors contributed to data interpretation and revised the paper
28 critically. Dave Stott and Amander Wellings, representatives of Public and Patient
29 Involvement in Research (PPIRes), brought a helpful lay perspective to this research.
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32 **Data sharing:** The ELSA dataset and technical documentation are available from the UK
33 Data Service at: <http://discover.ukdataservice.ac.uk/catalogue?sn=5050>.
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57
58
59
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Reference List

- (1) Marmot M, Banks J, Blundell R, et al. Health, Wealth and Lifestyles of the Older Population in England: the 2002 English Longitudinal Study of Ageing. London: The Institute for Fiscal Studies; 2003.
- (2) Börsch-Supan A, Brugiavini A, Jürges H, et al. Health, Ageing and Retirement in Europe. First Results from the Survey of Health, Ageing and Retirement in Europe. Mannheim: Mannheim Research Institute for the Economics of Aging (MEA); 2005.
- (3) Hemingway H, Shipley M, Macfarlane P, et al. Impact of socioeconomic status on coronary mortality in people with symptoms, electrocardiographic abnormalities, both or neither: the original Whitehall study 25 year follow up. *J Epidemiol Community Health* 2000; 54(7):510-516.
- (4) Wilkinson R, Marmot M. Social determinants of health: the solid facts. 2nd edition ed. Copenhagen: World Health Organisation; 2003.
- (5) McKeown T. The role of medicine: dream, mirage or nemesis? 1 ed. London: Nuffield Principal Hospital Trust; 1976.
- (6) Bunker JP. The role of medical care in contributing to health improvements within societies. *Int J Epidemiol* 2001; 30(6):1260-1263.
- (7) Watt G. The inverse care law today. *Lancet* 2002; 360:252-4.
- (8) Richards HM, Reid ME, Watt GCM. Socioeconomic variations in responses to chest pain: qualitative study. *BMJ* 2002; 324(7349):1308.
- (9) Gardner K, Chapple A. Barriers to referral in patients with angina: qualitative study. *BMJ* 1999; 319(7207):418-421.
- (10) Berger J, Mohr J. A fortunate man: the story of a country doctor. London: Penguin; 1967.
- (11) Tod AM, Read C, Lacey A, et al. Barriers to uptake of services for coronary heart disease: qualitative. *BMJ* 2001; 323(7306):214.
- (12) Chaturvedi N, Ben Shlomo Y. From the surgery to the surgeon: does deprivation influence consultation and operation rates? *Br J Gen Pract* 1995; 45(392):127-131.
- (13) Mahomed NN, Barrett JA, Katz JN, et al. Rates and outcomes of primary and revision total hip replacement in the United States medicare population. *J Bone Joint Surg Am* 2003; 85-A(1):27-32.
- (14) Richards H, McConnachie A, Morrison C, et al. Social and gender variation in the prevalence, presentation and general practitioner provisional diagnosis of chest pain. *J Epidemiol Community Health* 2000; 54(9):714-718.
- (15) Natcen Social Research. English Longitudinal Study of Ageing (ELSA) Wave One to Wave Five User Guide. <http://www.esds.ac>

1
2
3 uk/doc/5050/mrdoc/pdf/5050_User_Guide_to_the_ELSA_Datasets_Waves_1_to_5
4 pdf [2012 [cited 2013 Sept. 28];
5

- 6 (16) Scholes S, Taylor R, Cheshire H, et al. Retirement, health and relationships of the
7 older population in England: The 2004 English Longitudinal Study of Ageing.
8 Technical Report P2808. London: National Centre for Social Research; 2008.
9
- 10 (17) Steel N, Melzer D, Gardener E, et al. Need for and receipt of hip and knee
11 replacement--a national population survey. *Rheumatology* 2006;(45):1437-1441.
12
- 13 (18) Evans JR, Fletcher AE, Wormald RPL, et al. Prevalence of partial sight and blindness
14 in people aged 75 years and older in Britain: results from the MRC trial of assessment
15 and management of older people in the community. *Br J Ophthalmol* 2002; 86:795-
16 800.
17
- 18 (19) Congdon N, O'Colmain B, Klaver CCW, et al. Causes and Prevalence of Partial sight
19 and blindness among adults in the United States. *Arch Ophthalmol* 2004; 122:477-
20 485.
21
- 22 (20) Steel N, Melzer D, Shekelle PG, et al. Developing quality indicators for older adults:
23 transfer from the USA to the UK is feasible. *Quality and Safety in Health Care* 2004;
24 13(4):260-264.
25
- 26 (21) Steel N, Bachmann M, Maisey S, et al. Self reported receipt of care consistent with 32
27 quality indicators: National population survey of adults aged 50 or more in England.
28 *BMJ* 2008; 337:a957.
29
- 30 (22) Wagstaff A, Paci P, Van Doorslaer E. On the measurement of inequalities in health.
31 *Soc Sci Med* 1991; 33(5):545-557.
32
- 33 (23) Bachmann MO, Eachus J, Hopper CD, et al. Socio-economic inequalities in diabetes
34 complications, control, attitudes and health service use: a cross-sectional study.
35 *Diabet Med* 2003; 20(11):921-929.
36
- 37 (24) Banks J, Breeze E, Lessof C, et al. Retirement, health and relationships of the older
38 population in England: The 2004 English Longitudinal Study of Ageing (Wave 2).
39 London: The Institute for Fiscal Studies; 2006.
40
- 41 (25) Cheshire H, Hussey D, Medina J, et al. Financial circumstances, health and well-
42 being of the older population in England: The 2008 English Longitudinal Study of
43 Ageing. Wave 4 Technical Report. London: National Centre for Social Research;
44 2012.
45
- 46 (26) Sen A. Health: perception versus observation. *BMJ* 2002; 324(7342):860-861.
47
- 48 (27) Min LC, Reuben DB, MacLean CH, et al. Predictors of Overall Quality of Care
49 Provided to Vulnerable Older People. *J Am Geriatr Soc* 2005; 53(10):1705-1711.
50
- 51 (28) McBride D, Hardoon S, Walters K, et al. Explaining variation in referral from
52 primary to secondary care: cohort study. *BMJ* 2010; 341.
53
54
55
56
57
58
59
60

- 1
2
3 (29) NHS Employers and the General Practitioners Committee. Quality and Outcomes
4 Framework for 2012/13. Guidance for PCOs and practices. London: NHS Employers;
5 2012.
6
7 (30) Gillam S, Steel N. The Quality and Outcomes Framework: where next? BMJ 2013;
8 346.
9
10 (31) Gillam SJ, Siriwardena AN, Steel N. Pay-for-Performance in the United Kingdom:
11 Impact of the Quality and Outcomes Framework - A Systematic Review. The Annals
12 of Family Medicine 2012; 10(5):461-468.
13
14 (32) Steel N, Maisey S, Clark A, et al. Quality of clinical primary care and targeted
15 incentive payments: an observational study. Br J Gen Pract 2007;(57):449-454.
16
17 (33) Steel N. Thresholds for taking antihypertensive drugs in different professional and lay
18 groups: questionnaire survey. BMJ 2000; 320:1446-7.
19
20 (34) Montgomery AA, Fahey T. How do patients' treatment preferences compare with
21 those of clinicians? Quality in health care 2001; 10 (Suppl I):i39-i43.
22
23 (35) Sanders C, Donovan JL, Dieppe PA. Unmet need for joint replacement: a qualitative
24 investigation of barriers to treatment among individuals with severe pain and
25 disability of the hip and knee. Rheumatology 2004; 43(3):353-357.
26
27 (36) Murray J, Banerjee S, Byng R, et al. Primary care professionals' perceptions of
28 depression in older people: a qualitative study. Social Science & Medicine 2006;
29 63:1363-73.
30
31 (37) Mercer SW, Guthrie B, Furler J, et al. Multimorbidity and the inverse care law in
32 primary care. BMJ 2012; 344.
33
34 (38) Wennberg JE. Understanding Geographic Variations in Health Care Delivery. The
35 New England Journal of Medicine 1999; 340(1):52-53.
36
37 (39) Wennberg JE. Unwarranted variations in healthcare delivery: implications for
38 academic medical centres. BMJ 2002; 325(7370):961-964.
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43 **Figure 1.** Illness burden (in blue), self-reported medical diagnosis (in green), and treatment
44 (in red) of angina, cataract, depression, diabetes and osteoarthritis, comparing the least
45 wealthy with the most wealthy: Overall odds ratios (adjusted for age and sex) and 95%
46 confidence bars (binomial regression)
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8 **Economic inequalities in burden of illness, diagnosis and**
9 **treatment of five long-term conditions in England: panel study.**
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Abstract

Objective:

We compared the distribution by wealth of self-reported illness burden (estimated from validated scales, biomarker and reported symptoms) for angina, cataract, depression, diabetes and osteoarthritis, with the distribution of self-reported medical diagnosis and treatment. We aimed to determine if the greater illness burden borne by poorer participants was matched by appropriately higher levels of diagnosis and treatment.

Design:

The English Longitudinal Study of Ageing, a panel study of 12,765 participants aged 50 years and older in four waves from 2004 to 2011, selected using a stratified random sample of households in England. Distribution of illness burden, diagnosis and treatment by wealth was estimated using regression analysis.

Outcome measures:

The main outcome measures were odds ratios (ORs) for the illness burden, diagnosis and treatment respectively, adjusted for age, sex and wealth. We estimated the illness burden for angina with the Rose Angina scale, diabetes with fasting glycosylated haemoglobin, depression with the Centre for Epidemiologic Studies Depression Scale, osteoarthritis with self-reported pain and disability, and cataract with self-reported poor vision. Medical diagnoses were self-reported for all conditions. Treatment was defined as beta-blocker prescription for angina, surgery for osteoarthritis and cataract, and receipt of pre-defined effective interventions for diabetes and depression.

Results:

Compared to the wealthiest, the least wealthy participant had substantially higher odds for illness burden from any of the five conditions at all four time points, with odds ratios ranging from 4.2 (95% confidence interval 2.6 to 6.8) for diabetes to 15.1 (11.4 to 20.0) for osteoarthritis. The odds ratios for diagnosis and treatment were smaller in all 5 conditions, and ranged from 0.9 (0.5 to 1.4) for diabetes treatment to 4.5 (3.3 to 6.0) for angina diagnosis.

Conclusions:

The substantially higher illness burden in less wealthy participants was not matched by appropriately higher levels of diagnosis and treatment.

Strengths and limitations of this study

- The English Longitudinal Study of Ageing (ELSA) is a unique single source of detailed longitudinal data on socioeconomic status and health, and this is the first study to compare inequalities in illness burden, self-reported medical diagnosis and treatment of long-term conditions on the same population over time in a longitudinal panel study
- Highly detailed measures of individual wealth were used alongside standardised scales and blood biomarker to assess the illness burden of depression, angina and diabetes
- Standardised scales were not included in ELSA for osteoarthritis and cataract, so assessment of illness burden for these two conditions was based on attributed symptoms which were not specific for osteoarthritis and cataract
- The study used self-reported data collected using an extensively tested structured questionnaire, but no information from medical records was collected
- An analysis of pooled data from 4 waves of ELSA was used to maximise the sample size, and the main finding that less wealthy participants are relatively underdiagnosed requires validation in a larger longitudinal study.

Main text

Introduction

Poverty is associated with poor health, poor access to health care and poor health outcomes in many countries and across different health care systems¹⁻³. Much of this variation is caused by recognised broad social determinants of health⁴. Considerable political effort has been directed at attempts to narrow health inequalities by reducing poverty and social exclusion. However, as health care has become more effective at improving health, its potential contribution to ameliorating health inequalities has increased. McKeown demonstrated in the 1970s that health services had contributed little to health improvement⁵, but the same claim could not be made today. The past 30 years have seen the introduction of a wide range of effective interventions, particularly for the prevention and management of chronic disease⁶. Yet although these new interventions improve health, they are not necessarily applied equally across the population. Health inequalities will widen if effective services are offered, or taken up, with greater frequency by wealthier than less wealthy people. The reverse is also true, however, and there is an opportunity for healthcare to reduce social inequalities if it reaches those most in need⁷.

Little is known about pathways into poor health. The National Health Service provides medical care free at point-of-need to all UK residents, but there is scope for inequalities to occur in the pathway from identification of early symptoms through diagnosis and on to effective treatment. Individuals in more deprived social groups may be more reluctant to present to doctors with their symptoms and so may not receive a diagnosis^{8,9}. Diagnosis is a key step that has meaning for both patient and physician in all health systems, and 'diagnostic confusion' may act as a barrier to health care for vulnerable populations^{10,8,11}. Previous studies have found socio-economic variation in either diagnosis or treatment rates, but have not been able to compare inequalities in illness burden, rates of diagnosis and treatment modalities in the same population¹²⁻¹⁴.

The English Longitudinal Study of Ageing (ELSA) provides new data that can be used to identify barriers to equitable receipt of healthcare, and constitutes a unique source of information on illness burden, self-reported medical diagnosis and treatment. Other data sources cover symptoms, or diagnosis, or treatment, but no other single source covers all three. ELSA collects data on symptoms and validated markers of common health conditions, as well as diagnosis and treatment. It also contains detailed socio-demographic information, including direct measures of personal wealth, on a sample selected to be representative of the population of England aged 50 years and older. These data can be used to compare socio-economic inequalities for several conditions, providing insight into a healthcare system with no direct financial barriers to treatment (the National Health Service in England). We aimed to assess socio-economic inequalities in the burden of illness (estimated by validated scales, biomarker, and reported symptoms) of angina, cataract, depression, diabetes and osteoarthritis, and compare them with inequalities in self-reported reported medical diagnosis and treatment, in order to determine whether key components of health care were received equitably.

Methods

We obtained data from the ELSA cohort, an interview survey of a sample of the population aged 50 years or older in England The sample was selected from households that had

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7 previously responded to the Health Survey for England, and drawn from selected postcode
8 sectors stratified by health authority and deprivation to be representative of adults aged 50 or
9 more living in private households in England¹⁵. Participants are interviewed in their homes
10 or care homes every two years about a wide range of health, economic and social topics. We
11 used data collected from core participants who had been interviewed in any of four waves of
12 ELSA from wave 2 in 2004-5 until wave 5 in 2010-11. Wave 2 was the first wave to include
13 questions on receipt of quality-indicated healthcare, and information was not collected on
14 every variable in every wave. Ethical approval was received from the London Multi-Centre
15 Research Ethics Committee. We studied five common and important long-term conditions:
16 angina, diabetes, depression, osteoarthritis, and cataract. Effective treatment is freely
17 available for all five conditions from the National Health Service.

18 Variables

19 We collected data on illness burden, self-reported medical diagnosis and treatment of angina,
20 cataract, depression, diabetes and osteoarthritis. The illness burden for angina was defined as
21 grade 2 on the Rose Angina scale (pain or discomfort in chest when walking at an ordinary
22 pace on the level on most occasions or more often, which makes subject stop or slow down if
23 occurs while walking, and which then goes away within 10 minutes, and which includes
24 either sternum (any level), or left arm and left anterior chest). Illness burden for diabetes was
25 defined as a fasting HbA1c level of >7.5%¹⁶. Illness burden for depression was defined as a
26 score of 3 or more on the eight-item Centre for Epidemiologic Studies Depression Scale
27 (CES-D). The application of these standardised scales in ELSA has been described
28 previously¹. Illness burden for osteoarthritis was defined as self-reported pain in the hip or
29 knee of 5 or more on a scale of 0 to 10¹⁷. Illness burden for cataract was defined broadly as
30 reporting poor vision or blindness. Cataract is responsible for about a quarter of poor vision
31 in the UK, so this measure is the least specific and includes those with other causes of poor
32 vision, such as age-related macular degeneration, which is responsible for about a third of
33 poor vision^{18,19}.

34 A medical diagnosis was considered to exist if a participant answered 'yes' when asked
35 whether a doctor had ever told them they had the condition of interest. For arthritis, a follow-
36 up question asked whether they had been told they had osteoarthritis, rheumatoid or other
37 arthritis.

38
39 Treatment for depression and diabetes was defined by reported achievement of quality of care
40 indicators, derived through a robust process of literature reviews, expert panel assessment and
41 piloting^{20,21}. For depression, the quality indicator was about receipt of treatment since the
42 previous wave: '*if a person is diagnosed with clinical depression, then antidepressive*
43 *treatment, talking treatment or electroconvulsive treatment should be offered within 2 weeks*
44 *after diagnosis unless within that period the patient has improved, or unless the patient has*
45 *substance abuse or dependence, in which case treatment may wait until 8 weeks after the*
46 *patient is in a drug-or alcohol-free state*'. For diabetes, treatment was measurement of
47 glycosylated haemoglobin or fructosamine levels in the preceding 12 months. Treatment for
48 angina was defined as ever being offered or currently taking beta-blockers (ELSA variables
49 hebeta or hebetc). Treatment for osteoarthritis and cataract were defined as reporting ever
50 having had surgery for the condition. For osteoarthritis this excluded those with hips or knees
51 replaced due to fracture. Data on hip and knee replacements were only available for
52 respondents aged 60 and over, and so respondents aged less than 60 years (n= 3,186) were
53 excluded from the analysis of osteoarthritis.

Wealth was defined as the sum of financial, physical and housing wealth plus state and private pension income. Age was categorised into three groups, 50-59 years, 60-74 years and 75 years and older.

Analysis

We used two approaches to analysis, a main analysis using serial cross sectional data and then a subsidiary analysis using longitudinal data. Multivariable ~~binomial~~-logistic regression analysis was used, with the outcome variables defined as one of illness burden, ~~self-reported~~ medical diagnosis or treatment for each of the five conditions in each cross-sectional wave (STATA statistical software version 12.1). This regression analysis was repeated for each of the four waves of ELSA from 2004 to 2011 separately and then 'overall' for all four waves combined. For the 'overall' analysis, the data were reshaped into 'long' format in Stata statistical software, with each participant having a separate record for each wave. Intra-person correlation of outcomes was accounted for using robust adjustment with Stata, with each participant's unique identifier included in the regression equation as a cluster variable. Missing data were excluded from the analyses.

The independent variables were age group, sex and slope order of inequality. We used the slope order of inequality as an independent variable to estimate the relationship between the outcome measures and the categorised measure of wealth^{22,23}. The slope order of inequality consisted of wealth quintiles with values of 0.1, 0.3, 0.5, 0.7 and 0.9, that is, the midpoints of each quintile on a scale of zero (least wealthy) to one (most wealthy). -The slope order of inequality was modelled as a continuous variable, ~~so that the slope or coefficient of a logit linear regression line across all five quintiles represents the difference in outcome between the hypothetically wealthiest and least wealthy participant. Exponentiating this slope coefficient results in an odds ratio, which is the ratio of the odds of the outcome in the wealthiest compared with the least wealthy participant and its odds ratio represents the ratio of the least wealthy compared with the wealthiest participant.~~ This odds ratio is also known as a relative index of inequality²². Advantages of this method of quantifying inequality are that it includes all participants, instead of just comparing the highest and lowest quintiles, it accounts for the number of participants in each category and it provides a single overall measure of inequality.

We included all participants in the main cross sectional analysis in order to compare the distribution of illness burden in the whole population with the distributions of diagnoses and treatments in the whole population. This meant that diagnosis was assessed even in those who did not meet the criteria for 'illness burden', and treatment was assessed even in those with no diagnosis. For the subsidiary analysis using longitudinal data, we estimated the odds ratio of receiving a diagnosis by a subsequent wave only for those who had met the criteria for 'illness burden' in a previous wave, and then the likelihood of receiving treatment only for those who had received a diagnosis in a previous wave. This was a subsidiary analysis as the numbers of participants that could be followed over time in this manner was small, particularly for treatment in angina and depression.

Results

The whole sample (n=12,765) was composed of participants aged 50 years or more who had responded to at least one wave of ELSA from 2004-5 until 2010-11. The response rate in 2004-5 was 82%.^{24,25} ~~In wave 5 (2010-11), o~~ver half ~~of the sample of 8,729~~ were women, or ~~were~~ aged between 60 and 74 years (Table 1). ~~Self-reported M~~medical diagnosis for all five conditions increased as wealth decreased, for example in depression from 4% in the

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7 wealthiest quintile to 11% in the poorest (Table 1). There was little variation between the
8 waves for each of the five conditions (Table 2).

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10 The hypothetically least wealthy participant had substantially higher odds than the
11 hypothetically most wealthy of meeting the criteria for 'illness burden' from any of the five
12 conditions at all four time points (overall odds ratios (OR) ranged from 4.2 to 15.1) (Table 3).
13 The least wealthy participant also had higher odds of diagnosis (ORs 1.1 to 4.5) and either no
14 different or relatively small odds of treatment (ORs 0.9 to 2.6) (Table 3, Figure 1).

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16 For angina, the overall odds ratio for meeting the criteria for 'illness burden' was 7.6,
17 indicating that the hypothetically least wealthy individual was seven times more likely to
18 have angina symptoms (defined by the Rose angina scale) than the wealthiest. The odds ratio
19 for ~~self-reported~~ reported medical diagnosis was 4.5, suggesting that some less wealthy
20 people with angina symptoms had not received a diagnosis of angina, as the expected odds
21 ratio for equitably distributed diagnosis would have been 7.6. The odds ratio for treatment
22 was 3.2, and again the expected odds ratios for equitably distributed treatment would have
23 been 7.6. For depression, the overall odds ratio for illness burden was 6.4, for medical
24 diagnosis was 3.3, and for treatment was 2.6, again suggesting that some poorer people with
25 symptoms of depression were less likely to have received a diagnosis or indicated health care,
26 as the expected odds ratios for equitably distributed treatment would have been 6.4.

27
28 For diabetes, the overall odds ratio for illness burden was 4.2 and 4.0 for diagnosis,
29 suggesting that for diabetes diagnosis was distributed equitably. However, the odds ratio for
30 treatment was 0.9 and not statistically significantly different from 1, again suggesting that
31 some less wealthy people with medically diagnosed diabetes had not received treatment, as
32 the expected odds ratios for equitably distributed treatment would have been 4.2.

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34 The subsidiary analysis calculated the odds ratios of receiving a diagnosis by a subsequent
35 wave only for those who had met the criteria for 'illness burden' for the relevant long term
36 condition in a previous wave; and then the likelihood of receiving treatment only for those
37 who had received a medical diagnosis in a previous wave. The substantial inequalities in the
38 illness burden of conditions by wealth are identical to Table 3, as expected, and subsequently
39 the numbers of eligible participants dwindle rapidly due to the nested nature of the analysis,
40 with some wide confidence intervals and 9 out of 10 results not statistically significant
41 (Supplemental file 1).
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Table 1: Characteristics of ELSA participants at wave 5 (2010-11) and self-reported medical diagnosis of angina, cataract, depression, diabetes and osteoarthritis.

| | | Whole sample | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|------------------|---------|--------------|--------|----------|------------|----------|----------------|
| | | N | % | % | % | % | % |
| Sex | Male | 3,886 | 8.2 | 13.4 | 5.4 | 13.3 | 19.8 |
| | Female | 4,843 | 6.3 | 20.4 | 7.8 | 9.4 | 32.9 |
| Age (years) | 50-59 | 1,906 | 2.2 | 3.7 | 10.1 | 7.2 | 17.1 |
| | 60-74 | 4,766 | 5.8 | 14.5 | 7.0 | 11.0 | 28.1 |
| | 75+ | 2,057 | 15.0 | 36.6 | 2.9 | 15.0 | 34.1 |
| Wealth quintile* | 1 | 1,716 | 3.4 | 13.8 | 4.1 | 6.0 | 21.5 |
| | 2 | 1,714 | 4.9 | 15.5 | 5.9 | 8.0 | 24.2 |
| | 3 | 1,723 | 6.6 | 20.1 | 5.7 | 11.3 | 25.7 |
| | 4 | 1,716 | 8.2 | 18.6 | 6.7 | 13.6 | 31.6 |
| | 5 | 1,715 | 12.9 | 19.2 | 11.5 | 16.7 | 33.1 |
| | missing | 145 | 5.5 | 9.7 | 4.8 | 9.7 | 20.0 |
| Total | | 8,729 | 7.2 | 17.3 | 6.7 | 11.1 | 27.1 |

*1=wealthiest quintile, 5=least wealthy quintile

Table 2. Prevalence of illness burden, self-reported medical diagnosis, and treatment for angina, cataract, depression, diabetes and osteoarthritis in four waves of ELSA

| | Angina N (%) | Cataract N (%) | Depression N (%) | Diabetes N (%) | Osteoarthritis N (%) |
|--------------------------|-----------------|-------------------|---------------------|-------------------|-------------------------|
| Illness burden | | | | | |
| Wave 2 (2004-5) | 397 (4.6) | 308 (3.5) | 2,037 (23.4) | 160 (1.8) | 1,106 (12.7) |
| Wave 3 (2006-7) | 300 (3.6) | 317 (3.8) | 1,929 (23.3) | n/a | 917 (11.1) |
| Wave 4 (2008-9) | 300 (3.1) | 331 (3.5) | 2,049 (21.4) | 220 (2.3) | 1,088 (11.4) |
| Wave 5 (2010-11) | 254 (2.9) | 320 (3.7) | 1,956 (22.4) | n/a | 1,046 (12.0) |
| Medical diagnosis | | | | | |
| Wave 2 (2004-5) | 668 (7.6) | 1,050 (12.1) | 402 (4.6) | 715 (8.2) | 1,861 (21.4) |
| Wave 3 (2006-7) | 591 (7.1) | 1,294 (15.7) | 490 (5.9) | 935 (11.3) | 1,952 (23.6) |
| Wave 4 (2008-9) | 645 (6.7) | 1,421 (14.8) | 601 (6.3) | 1,215 (12.7) | 2,262 (23.6) |
| Wave 5 (2010-11) | 655 (7.5) | 1,566 (17.9) | 602 (6.9) | 1,413 (16.2) | 2,416 (27.7) |
| Treatment | | | | | |
| Wave 2 (2004-5) | 85 (1.0) | 535 (6.2) | 98 (1.1) | 552 (6.4) | 202 (2.3) |
| Wave 3 (2006-7) | n/a | 379 (4.9) | n/a | 618 (7.5) | 141 (1.7) |
| Wave 4 (2008-9) | n/a | 444 (4.6) | 155 (1.6) | 671 (7.0) | 226 (2.4) |
| Wave 5 (2010-11) | 88 (1.0) | 646 (7.4) | n/a | 748 (8.6) | 208 (2.4) |

Total number of participants in each wave: wave 2: 8,688; wave 3: 8,268; wave 4: 9,578; wave 5: 8,729

n/a = data not available for that condition in that wave

Table 3. Illness burden, self-reported medical diagnosis and treatment of angina, cataract, depression, diabetes and osteoarthritis, comparing the least wealthy with the most wealthy: binomial logistic regression.

| | | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|---------------------------------------|-------------------|---------------------------|---------------------------|--------------------------|--------------------------|-----------------------------|
| Odds ratios (95% confidence interval) | | | | | | |
| Wave 2* (2004-5) | Illness burden | 5.6 (3.8, 8.3) | 7.2 (4.5, 11.5) | 5.1 (4.3, 6.2) | 4.4 (2.5, 8.0) | 11.0 (8.1, 14.9) |
| | Medical diagnosis | 2.9 (2.2, 3.9) | 1.3 (1.0, 1.6) | 4.8 (3.3, 7.0) | 3.1 (2.3, 4.2) | 1.6 (1.3, 2.0) |
| | Treatment | 2.6 (1.2, 5.7) | 1.5 (1.0, 2.2) | 0.6 (0.1, 2.9) | 0.7 (0.3, 1.5) | 1.1 (0.7, 1.9) |
| Wave 3* (2006-7) | Illness burden | 8.7 (5.5, 13.8) | 8.2 (5.1, 13.1) | 6.9 (5.7, 8.5) | | 12.7 (9.1, 17.8) |
| | Medical diagnosis | 4.9 (3.6, 6.8) | 1.2 (1.0, 1.5) | 0.7 (0.4, 1.4) | 3.4 (2.6, 4.4) | 0.6 (0.4, 0.8) |
| | Treatment | | 1.3 (0.8, 1.9) | | 1.2 (0.6, 2.4) | 1.0 (0.6, 1.9) |
| Wave 4* (2008-9) | Illness burden | 6.7 (4.2, 10.5) | 5.5 (3.6, 8.6) | 5.9 (4.9, 7.1) | 3.9 (2.4, 6.4) | 14.0 (10.3, 19.1) |
| | Medical diagnosis | 4.3 (3.2, 5.9) | 1.1 (0.9, 1.4) | 0.7 (0.4, 1.2) | 3.9 (3.1, 5.1) | 0.6 (0.4, 0.8) |
| | Treatment | | 1.1 (0.7, 1.6) | 2.4 (1.0, 5.9) | 0.2 (0.1, 0.6) | 1.0 (0.6, 1.6) |
| Wave 5* (2010-11) | Illness burden | 8.4 (5.1, 13.7) | 6.2 (3.9, 9.9) | 5.9 (4.8, 7.1) | | 16.0 (11.7, 21.8) |
| | Medical diagnosis | 5.3 (3.9, 7.3) | 1.3 (1.0, 1.5) | 1.7 (1.0, 2.8) | 4.3 (3.4, 5.4) | 0.6 (0.4, 0.8) |
| | Treatment | 3.3 (1.5, 7.3) | 1.8 (1.2, 2.6) | | 0.8 (0.4, 1.6) | 1.2 (0.7, 2.0) |
| Overall† | Illness burden | 7.6 (5.4, 10.8) | 8.0 (5.4, 11.9) | 6.4 (5.5, 7.5) | 4.2 (2.6, 6.8) | 15.1 (11.4, 20.0) |
| | Medical diagnosis | 4.5 (3.3, 6.0) | 1.3 (1.1, 1.5) | 3.3 (2.4, 4.5) | 4.0 (3.1, 5.2) | 1.1 (0.9, 1.3) |
| | Treatment | 3.2 (1.7, 6.0) | 1.3 (1.0, 1.8) | 2.6 (1.1, 6.1) | 0.9 (0.5, 1.4) | 1.2 (0.8, 1.6) |

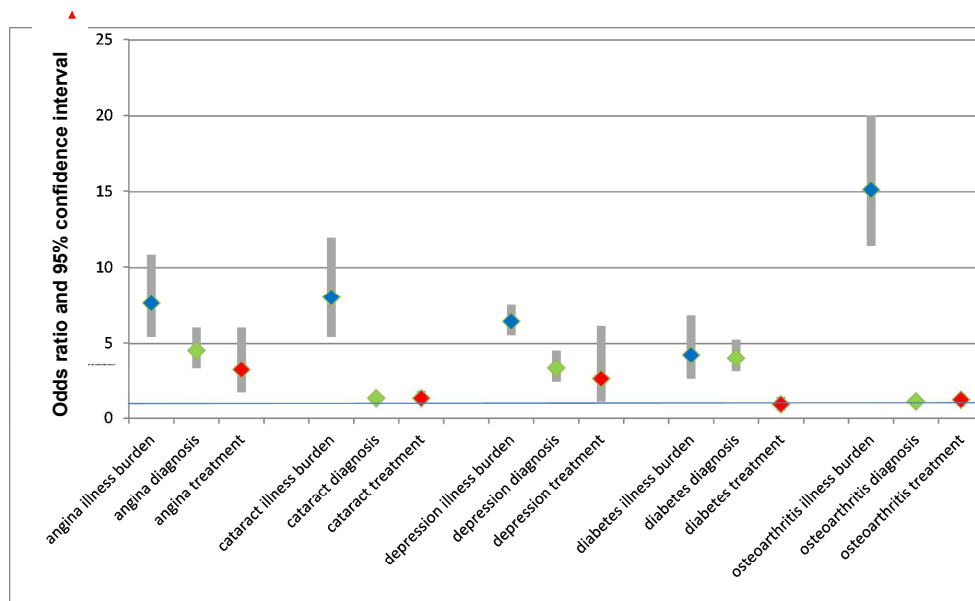
*Odds ratios adjusted for age group and sex

†Odds ratios adjusted for age group, sex and unique participant identifier

**Analyses for osteoarthritis excluded those younger than 60 years, as data on osteoarthritis treatment were only collected in those aged 60 or over.

Odds ratios where the 95% confidence intervals do not include 1 (before rounding to one decimal place) are shown in bold

Figure 1. Illness burden (in blue), self-reported medical diagnosis (in green), and treatment (in red) of angina, cataract, depression, diabetes and osteoarthritis, comparing the least wealthy with the most wealthy: Overall odds ratios (adjusted for age and sex) and 95% confidence bars (binomial regression)



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Discussion

We found that while there were strong inverse associations between wealth and the burden of illness (based on validated scales, symptoms and biomarker) of a long-term condition, there were smaller or absent inequalities in receipt of self-reported medical diagnosis or treatment for the conditions considered. This suggests that the substantially higher illness burden in less wealthy participants was not matched by appropriately higher levels of diagnosis and treatment, and that equitable receipt of a medical diagnosis may have an important role in reducing inequalities in health.

ELSA is a unique single source of detailed longitudinal data on socioeconomic status and health, and this is the first study to compare inequalities in illness burden, self-reported medical diagnosis and treatment of long-term conditions in a longitudinal panel study on the same population over time. ELSA used robust measures of individual socio-economic position, and standardised scales and blood biomarker to assess health status. This exploratory study has some limitations and the results should be interpreted with caution and tested in subsequent research. Whilst standardised measures were used to estimate the illness burden of depression, angina and diabetes, symptoms alone were used for osteoarthritis and cataract, and the attributed symptoms were not specific for osteoarthritis and cataract. However, this lack of specificity is unlikely to vary with wealth, and so is not likely to be an important source of bias. Self-reported data may be a source of bias if self-report varies by factors other than objective health status, such as wealth or social experience. This is a recognised problem with some self-reported morbidity data, but is less of a problem with

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7 | sensory assessment for measures of pain, which is essentially self-perceived, and where self-
8 report is the best means of assessment ²⁶.

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10 We have not adjusted for health-related factors that are also more prevalent in poorer
11 populations, such as smoking, obesity and comorbidity, because none of these are a reason
12 for not making a diagnosis. Comorbid conditions are commoner in those with lower socio-
13 economic status, but there is no evidence that comorbidities make a new diagnosis less likely.
14 On the contrary, a higher number of comorbid conditions in older people may be associated
15 with higher quality of care ²⁷. We found different patterns in different conditions, which fits
16 with other research showing that wealth acts differently in different conditions, and for
17 example, has no association with referral for post-menopausal bleeding ²⁸. Major national
18 policy interventions such as the Quality and Outcomes Framework payment for performance
19 scheme in primary care ²⁹ have been associated with improved healthcare for included
20 conditions such as angina and diabetes, more than for excluded conditions such osteoarthritis
21 and poor vision ³⁰⁻³².

22 The serial cross-sectional analysis of 4 waves of ELSA included all eligible participants in
23 each wave in order to maximise the sample size. This approach meant that some participants
24 with a diagnosed condition would no longer have had symptoms or raised biomarkers, if they
25 were being successfully treated. Examples would be diabetic participants whose blood sugar
26 levels were being successfully controlled by treatment, and participants with successfully
27 treated depression. We therefore checked our main results with the secondary (longitudinal)
28 analysis, which assessed subsequent diagnosis in those had met the criteria for 'illness
29 burden', and subsequent treatment in those with a medical diagnosis, but the number of
30 participants who could be followed through the waves in this way was too small to allow
31 meaningful conclusions to be drawn from the results.

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33 Our results fit with previous findings that a greater proportion of people in deprived groups
34 had Rose angina, but there was no difference in the proportions receiving a general
35 practitioner diagnosis of coronary heart disease ¹⁴. Care-seeking behaviour and patient
36 preferences may differ with wealth. Given the same information, patients may want fewer
37 medical interventions than their doctors recommend ^{33,34}, and pessimism about availability of
38 treatment may make older people reluctant to seek help ³⁵. Older people may view living with
39 symptoms (such as pain, or emotional problems) as a normal part of ageing ³⁶. The response
40 of the primary care physician may also vary with the wealth of the patient. For example, the
41 physician might be more likely to consider symptoms of breathlessness as a medical problem
42 requiring a diagnosis, whereas aches and pains, poor vision, and low mood might be
43 considered part of the tapestry of life, or the natural ageing process. Comorbidity is more
44 common in deprived populations, and may make diagnosis of all conditions harder for
45 doctors within the constraints of a short consultation ³⁷.

46 At a system level, the results may be partially explained by wealthier people living in areas
47 where there are more healthcare resources. Wennberg introduced the concept of 'supply-
48 sensitive care' to describe how the quantity of healthcare resources allocated to a particular
49 population was a major determinant of the frequency of use of health services by that
50 population, and gives an example in which 'a doubling of the supply of internists or
51 cardiologists results in roughly a halving of the interval between repeat visits' ^{38,39}. Where
52 healthcare resources are relatively plentiful, patients with chronic diseases will consult more,
53 use more diagnostic tests, and be referred to hospital more. Further research could helpfully
54 investigate whether those missing out on diagnosis are not accessing health services, or are
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7 seeing a doctor but not being diagnosed. The participants were selected to be nationally
8 representative of the population of England, and so the findings are likely to be generalisable
9 to England, but not to countries with different healthcare systems. If validated, our findings
10 that inequalities in receipt of diagnoses are potential barriers to equitable healthcare for five
11 common long-term conditions, suggest that future policy interventions to reduce socio-
12 economic inequalities in healthcare should consider improving access to diagnosis as well as
13 treatment.

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17 **Funding statement:** This article presents independent research commissioned by the UK
18 National Institute for Health Research (NIHR) under the Health Services Research
19 programme: HSR Project 10/2002/06 – ‘The dynamics of quality: a national panel study of
20 evidence-based standards’. IL’s work was supported by the NIHR Collaboration for Applied
21 Health Research and Care (CLAHRC) for the South West Peninsula. The views expressed in
22 this publication are those of the authors and not necessarily those of the NHS, the NIHR or
23 the Department of Health.

24
25 **Competing interests:** All authors have completed the ICMJE uniform disclosure form at
26 www.icmje.org/coi_disclosure.pdf and declare: all authors had financial support from the
27 National Institute for Health Research for the submitted work, DM had financial support from
28 Age UK; no financial relationships with any organisations that might have an interest in the
29 submitted work in the previous three years; no other relationships or activities that could
30 appear to have influenced the submitted work.

31
32 **Ethics approval:** The English Longitudinal Study of Ageing received ethics approval from
33 the National Research Ethics Service: 09/H0505/124. Participants gave informed consent
34 before taking part.

35
36 **Contributors:** NS contributed to the study design, oversaw data analysis and interpretation,
37 and drafted the paper. NS is guarantor. AH undertook data preparation, analysis and
38 interpretation, and contributed to drafting the paper. LM undertook data preparation and
39 analysis. MB and AC advised on statistical techniques. SR, JC and IL advised on data
40 analysis and interpretation. DM contributed to the study design and advised on data analysis
41 and interpretation. All authors contributed to data interpretation and revised the paper
42 critically. Dave Stott and Amander Wellings, representatives of Public and Patient
43 Involvement in Research (PPIRes), brought a helpful lay perspective to this research.

44
45 **Data sharing:** The ELSA dataset and technical documentation are available from the UK
46 Data Service at: <http://discover.ukdataservice.ac.uk/catalogue?sn=5050>.

Reference List

- (1) Marmot M, Banks J, Blundell R, Lessof C, Nazroo J. Health, Wealth and Lifestyles of the Older Population in England: the 2002 English Longitudinal Study of Ageing. London: The Institute for Fiscal Studies; 2003.
- (2) Börsch-Supan A, Brugiavini A, Jürges H, Mackenbach J, Siegris J, Weber G. Health, Ageing and Retirement in Europe. First Results from the Survey of Health, Ageing and Retirement in Europe. Mannheim: Mannheim Research Institute for the Economics of Aging (MEA); 2005.
- (3) Hemingway H, Shipley M, Macfarlane P, Marmot M. Impact of socioeconomic status on coronary mortality in people with symptoms, electrocardiographic abnormalities, both or neither: the original Whitehall study 25 year follow up. *J Epidemiol Community Health* 2000; 54(7):510-516.
- (4) Wilkinson R, Marmot M. Social determinants of health: the solid facts. 2nd edition ed. Copenhagen: World Health Organisation; 2003.
- (5) McKeown T. The role of medicine: dream, mirage or nemesis? 1 ed. London: Nuffield Principal Hospital Trust; 1976.
- (6) Bunker JP. The role of medical care in contributing to health improvements within societies. *Int J Epidemiol* 2001; 30(6):1260-1263.
- (7) Watt G. The inverse care law today. *Lancet* 2002; 360:252-4.
- (8) Richards HM, Reid ME, Watt GCM. Socioeconomic variations in responses to chest pain: qualitative study. *BMJ* 2002; 324(7349):1308.
- (9) Gardner K, Chapple A. Barriers to referral in patients with angina: qualitative study. *BMJ* 1999; 319(7207):418-421.
- (10) Berger J, Mohr J. A fortunate man: the story of a country doctor. London: Penguin; 1967.
- (11) Tod AM, Read C, Lacey A, Abbott J. Barriers to uptake of services for coronary heart disease: qualitative. *BMJ* 2001; 323(7306):214.
- (12) Chaturvedi N, Ben Shlomo Y. From the surgery to the surgeon: does deprivation influence consultation and operation rates? *Br J Gen Pract* 1995; 45(392):127-131.
- (13) Mahomed NN, Barrett JA, Katz JN, Phillips CB, Losina E, Lew RA et al. Rates and outcomes of primary and revision total hip replacement in the United States medicare population. *J Bone Joint Surg Am* 2003; 85-A(1):27-32.
- (14) Richards H, McConnachie A, Morrison C, Murray K, Watt G. Social and gender variation in the prevalence, presentation and general practitioner provisional diagnosis of chest pain. *J Epidemiol Community Health* 2000; 54(9):714-718.
- (15) Natcen Social Research. English Longitudinal Study of Ageing (ELSA) Wave One to Wave Five User Guide. <http://www.esds.ac>

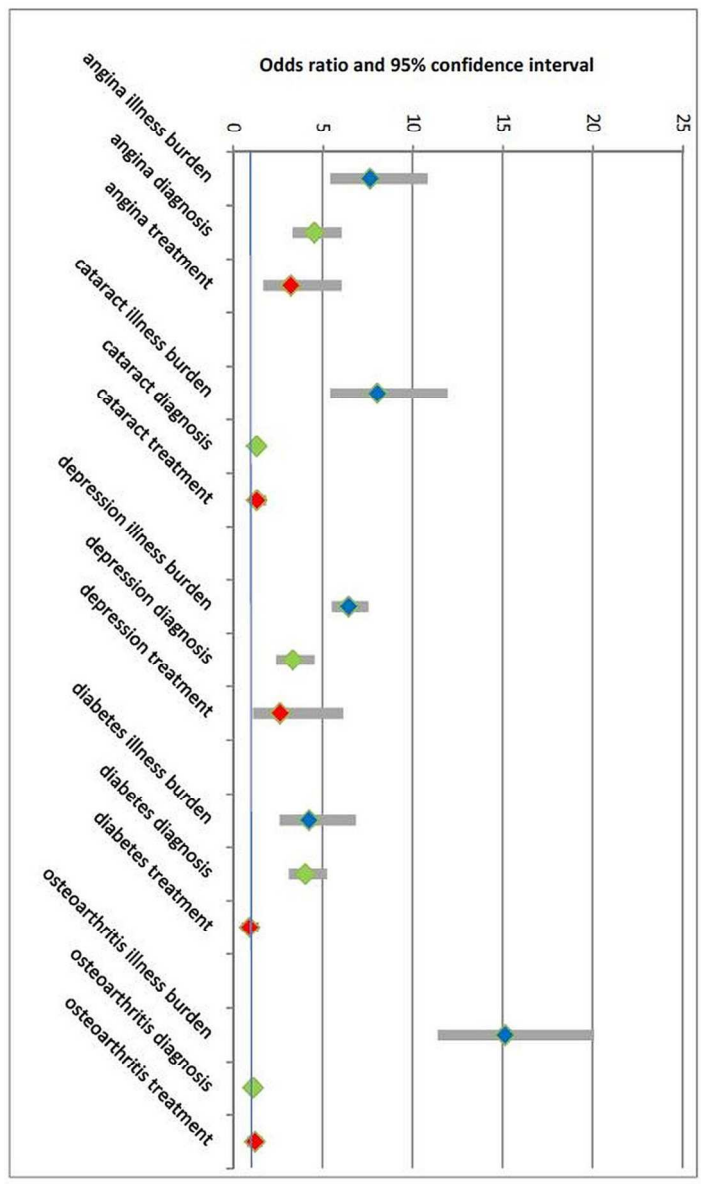
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uk/doc/5050/mrdoc/pdf/5050_User_Guide_to_the_ELSA_Datasets_Waves_1_to_5
pdf [2012 [cited 2013 Sept. 28];

- (16) Scholes S, Taylor R, Cheshire H, Cox K, Lessof C. Retirement, health and relationships of the older population in England: The 2004 English Longitudinal Study of Ageing. Technical Report P2808. London: National Centre for Social Research; 2008.
- (17) Steel N, Melzer D, Gardener E, McWilliams B. Need for and receipt of hip and knee replacement--a national population survey. *Rheumatology* 2006;(45):1437-1441.
- (18) Evans JR, Fletcher AE, Wormald RPL, Siu-Woon Ng E, Sterling S, Smeeth L et al. Prevalence of partial sight and blindness in people aged 75 years and older in Britain: results from the MRC trial of assessment and management of older people in the community. *Br J Ophthalmol* 2002; 86:795-800.
- (19) Congdon N, O'Colmain B, Klaver CCW, Klein R, Munoz B, Friedman DS et al. Causes and Prevalence of Partial sight and blindness among adults in the United States. *Arch Ophthalmol* 2004; 122:477-485.
- (20) Steel N, Melzer D, Shekelle PG, Wenger NS, Forsyth D, McWilliams BC. Developing quality indicators for older adults: transfer from the USA to the UK is feasible. *Quality and Safety in Health Care* 2004; 13(4):260-264.
- (21) Steel N, Bachmann M, Maisey S, Shekelle P, Breeze E, Marmot M et al. Self reported receipt of care consistent with 32 quality indicators: National population survey of adults aged 50 or more in England. *BMJ* 2008; 337:a957.
- (22) Wagstaff A, Paci P, Van Doorslaer E. On the measurement of inequalities in health. *Soc Sci Med* 1991; 33(5):545-557.
- (23) Bachmann MO, Eachus J, Hopper CD, Davey SG, Propper C, Pearson NJ et al. Socio-economic inequalities in diabetes complications, control, attitudes and health service use: a cross-sectional study. *Diabet Med* 2003; 20(11):921-929.
- (24) Banks J, Breeze E, Lessof C, Nazroo J. Retirement, health and relationships of the older population in England: The 2004 English Longitudinal Study of Ageing (Wave 2). London: The Institute for Fiscal Studies; 2006.
- (25) Cheshire H, Hussey D, Medina J, Pickering K, Wood N, Ward K et al. Financial circumstances, health and well-being of the older population in England: The 2008 English Longitudinal Study of Ageing. Wave 4 Technical Report. London: National Centre for Social Research; 2012.
- (26) Sen A. Health: perception versus observation. *BMJ* 2002; 324(7342):860-861.
- (27) Min LC, Reuben DB, MacLean CH, Shekelle PG, Solomon DH, Higashi T et al. Predictors of Overall Quality of Care Provided to Vulnerable Older People. *J Am Geriatr Soc* 2005; 53(10):1705-1711.
- (28) McBride D, Hardoon S, Walters K, Gilmour S, Raine R. Explaining variation in referral from primary to secondary care: cohort study. *BMJ* 2010; 341.

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5
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7 (29) NHS Employers and the General Practitioners Committee. Quality and Outcomes
8 Framework for 2012/13. Guidance for PCOs and practices. London: NHS Employers;
9 2012.
- 10 (30) Gillam S, Steel N. The Quality and Outcomes Framework: where next? BMJ 2013;
11 346.
- 12 (31) Gillam SJ, Siriwardena AN, Steel N. Pay-for-Performance in the United Kingdom:
13 Impact of the Quality and Outcomes Framework - A Systematic Review. The Annals
14 of Family Medicine 2012; 10(5):461-468.
- 15 (32) Steel N, Maisey S, Clark A, Fleetcroft R, Howe A. Quality of clinical primary care
16 and targeted incentive payments: an observational study. Br J Gen Pract
17 2007;(57):449-454.
- 18 (33) Steel N. Thresholds for taking antihypertensive drugs in different professional and lay
19 groups: questionnaire survey. BMJ 2000; 320:1446-7.
- 20 (34) Montgomery AA, Fahey T. How do patients' treatment preferences compare with
21 those of clinicians? Quality in health care 2001; 10 (Suppl I):i39-i43.
- 22 (35) Sanders C, Donovan JL, Dieppe PA. Unmet need for joint replacement: a qualitative
23 investigation of barriers to treatment among individuals with severe pain and
24 disability of the hip and knee. Rheumatology 2004; 43(3):353-357.
- 25 (36) Murray J, Banerjee S, Byng R, Tylee A, Bhugra D, Macdonald A. Primary care
26 professionals' perceptions of depression in older people: a qualitative study. Social
27 Science & Medicine 2006; 63:1363-73.
- 28 (37) Mercer SW, Guthrie B, Furler J, Watt G, Tudor Hart J. Multimorbidity and the
29 inverse care law in primary care. BMJ 2012; 344.
- 30 (38) Wennberg JE. Understanding Geographic Variations in Health Care Delivery. The
31 New England Journal of Medicine 1999; 340(1):52-53.
- 32 (39) Wennberg JE. Unwarranted variations in healthcare delivery: implications for
33 academic medical centres. BMJ 2002; 325(7370):961-964.
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Supplemental file 1

Supplemental Table 1. Odds ratios for meeting the ‘illness burden’ criteria for angina, cataract, depression, diabetes and osteoarthritis, medical diagnosis for those estimated to have a condition, and treatment for those with a diagnosis, comparing the least wealthy with the most wealthy: binomial regression

| Condition | Adjusted odds ratios* (95% CI) | | | |
|----------------|--------------------------------|----------------------------------|-----------------------|-----------------|
| | Illness burden (Wave 3) | Medical diagnosis (Wave 4) | Treatment (Wave 5) | N in treatment† |
| Angina | 8.7 (5.5, 13.8) | 1.4 (0.5, 4.0) | 1.6 (0.3, 9.0) | 11 |
| Cataract | 8.2 (5.1, 13.1) | 1.0 (0.3, 3.1) | 2.2 (1.2, 3.8) | 83 |
| Osteoarthritis | 12.7 (9.1, 17.8) | 0.7 (0.3, 1.6) | 0.7 (0.3, 1.6) | 30 |
| | Adjusted odds ratios* (95% CI) | | | |
| | Illness burden (Wave 2) | Medical diagnosis (Wave 3) | Treatment (Wave 4) | N in treatment† |
| Depression | 5.1 (4.3, 6.2) | 0.4 (0.1, 1.4) | 17.3 (0.5, 604) | 12 |
| Diabetes | 4.4 (2.5, 8.0) | 0.1 (0.0, 3.6) | 0.5 (0.2, 1.1) | 99 |

*adjusted for age group and sex

†followed through the waves

Waves used in analysis were the most recent with available data

Odds ratios where the 95% confidence intervals do not include 1 (before rounding to one decimal place) are shown in bold

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

| Section/Topic | Item # | Recommendation | Reported on page # |
|---------------------------|--------|--|--------------------|
| Title and abstract | 1 | (a) Indicate the study’s design with a commonly used term in the title or the abstract | 1&2 |
| | | (b) Provide in the abstract an informative and balanced summary of what was done and what was found | 2 |
| Introduction | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 4 |
| Methods | | | |
| Study design | 4 | Present key elements of study design early in the paper | 4-6 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 4-5 |
| Participants | 6 | (a) Give the eligibility criteria, and the sources and methods of selection of participants | 4-6 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 5 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5 |
| Bias | 9 | Describe any efforts to address potential sources of bias | 6 |
| Study size | 10 | Explain how the study size was arrived at | 6 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 6 |
| Statistical methods | 12 | (a) Describe all statistical methods, including those used to control for confounding | 6 |
| | | (b) Describe any methods used to examine subgroups and interactions | 6 |
| | | (c) Explain how missing data were addressed | 6 |
| | | (d) If applicable, describe analytical methods taking account of sampling strategy | 6 |
| | | (e) Describe any sensitivity analyses | 6 |
| Results | | | |

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|--------------------------|-----|--|-------|
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 6-8 |
| | | (b) Give reasons for non-participation at each stage | 6-8 |
| | | (c) Consider use of a flow diagram | |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 7 |
| | | (b) Indicate number of participants with missing data for each variable of interest | |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 8 |
| Main results | 16 | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 7-9 |
| | | (b) Report category boundaries when continuous variables were categorized | 7 |
| | | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 7 |
| Discussion | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 10 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 10-11 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 11 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 11-12 |
| Other information | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 12 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Economic inequalities in burden of illness, diagnosis and treatment of five long-term conditions in England: panel study.

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|---------------------------------|---|
| Journal: | <i>BMJ Open</i> |
| Manuscript ID: | bmjopen-2014-005530.R2 |
| Article Type: | Research |
| Date Submitted by the Author: | 01-Sep-2014 |
| Complete List of Authors: | Steel, Nicholas; University of East Anglia Hardcastle, Antonia; University of East Anglia, Norwich Medical School Bachmann, Max; Univeristy of East Anglia, School of Medicine, Health Policy and Practic Richards, Suzanne; University of Exeter Medical School, Mounce, Luke; University of Exeter Medical School, Clark, Allan; University of East Anglia, Norwich Medical School Lang, Iain; PenCLAHRC, Melzer, David; University of Exeter Medical School, Campbell, John; University of Exeter, Primary Care; |
| Primary Subject Heading: | Health services research |
| Secondary Subject Heading: | Health services research, Epidemiology, Public health, Sociology |
| Keywords: | Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, EPIDEMIOLOGY, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT |
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4 **Economic inequalities in burden of illness, diagnosis and**
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Abstract

Objective:

We compared the distribution by wealth of self-reported illness burden (estimated from validated scales, biomarker and reported symptoms) for angina, cataract, depression, diabetes and osteoarthritis, with the distribution of self-reported medical diagnosis and treatment. We aimed to determine if the greater illness burden borne by poorer participants was matched by appropriately higher levels of diagnosis and treatment.

Design:

The English Longitudinal Study of Ageing, a panel study of 12,765 participants aged 50 years and older in four waves from 2004 to 2011, selected using a stratified random sample of households in England. Distribution of illness burden, diagnosis and treatment by wealth was estimated using regression analysis.

Outcome measures:

The main outcome measures were odds ratios (ORs) for the illness burden, diagnosis and treatment respectively, adjusted for age, sex and wealth. We estimated the illness burden for angina with the Rose Angina scale, diabetes with fasting glycosylated haemoglobin, depression with the Centre for Epidemiologic Studies Depression Scale, osteoarthritis with self-reported pain and disability, and cataract with self-reported poor vision. Medical diagnoses were self-reported for all conditions. Treatment was defined as beta-blocker prescription for angina, surgery for osteoarthritis and cataract, and receipt of pre-defined effective interventions for diabetes and depression.

Results:

Compared to the wealthiest, the least wealthy participant had substantially higher odds for illness burden from any of the five conditions at all four time points, with odds ratios ranging from 4.2 (95% confidence interval 2.6 to 6.8) for diabetes to 15.1 (11.4 to 20.0) for osteoarthritis. The odds ratios for diagnosis and treatment were smaller in all 5 conditions, and ranged from 0.9 (0.5 to 1.4) for diabetes treatment to 4.5 (3.3 to 6.0) for angina diagnosis.

Conclusions:

The substantially higher illness burden in less wealthy participants was not matched by appropriately higher levels of diagnosis and treatment.

Strengths and limitations of this study

- The English Longitudinal Study of Ageing (ELSA) is a unique single source of detailed data on socioeconomic status and health, and this is the first study to compare inequalities in illness burden, self-reported medical diagnosis and treatment of long-term conditions in a panel study over time
- Highly detailed measures of individual wealth were used alongside standardised scales and blood biomarker to assess the illness burden of depression, angina and diabetes
- Standardised scales were not included in ELSA for osteoarthritis and cataract, so assessment of illness burden for these two conditions was based on attributed symptoms which were not specific for osteoarthritis and cataract
- The study used self-reported data collected using an extensively tested structured questionnaire, but no information from medical records was collected
- An analysis of pooled data from 4 waves of ELSA was used to maximise the sample size, and the main finding that less wealthy participants are relatively underdiagnosed requires validation in a larger longitudinal study.

Main text

Introduction

Poverty is associated with poor health, poor access to health care and poor health outcomes in many countries and across different health care systems¹⁻³. Much of this variation is caused by recognised broad social determinants of health⁴. Considerable political effort has been directed at attempts to narrow health inequalities by reducing poverty and social exclusion. However, as health care has become more effective at improving health, its potential contribution to ameliorating health inequalities has increased. McKeown demonstrated in the 1970s that health services had contributed little to health improvement⁵, but the same claim could not be made today. The past 30 years have seen the introduction of a wide range of effective interventions, particularly for the prevention and management of chronic disease⁶. Yet although these new interventions improve health, they are not necessarily applied equally across the population. Health inequalities will widen if effective services are offered, or taken up, with greater frequency by wealthier than less wealthy people. The reverse is also true, however, and there is an opportunity for healthcare to reduce social inequalities if it reaches those most in need⁷.

Little is known about pathways into poor health. The National Health Service provides medical care free at point-of-need to all UK residents, but there is scope for inequalities to occur in the pathway from identification of early symptoms through diagnosis and on to effective treatment. Individuals in more deprived social groups may be more reluctant to present to doctors with their symptoms and so may not receive a diagnosis^{8,9}. Diagnosis is a key step that has meaning for both patient and physician in all health systems, and 'diagnostic confusion' may act as a barrier to health care for vulnerable populations^{10,8,11}. Previous studies have found socio-economic variation in either diagnosis or treatment rates, but have not been able to compare inequalities in illness burden, rates of diagnosis and treatment modalities in the same population¹²⁻¹⁴.

The English Longitudinal Study of Ageing (ELSA) provides new data that can be used to identify barriers to equitable receipt of healthcare, and constitutes a unique source of information on illness burden, self-reported medical diagnosis and treatment. Other data sources cover symptoms, or diagnosis, or treatment, but no other single source covers all three. ELSA collects data on symptoms and validated markers of common health conditions, as well as diagnosis and treatment. It also contains detailed socio-demographic information, including direct measures of personal wealth, on a sample selected to be representative of the population of England aged 50 years and older. These data can be used to compare socio-economic inequalities for several conditions, providing insight into a healthcare system with no direct financial barriers to treatment (the National Health Service in England). We aimed to assess socio-economic inequalities in the burden of illness (estimated by validated scales, biomarker, and reported symptoms) of angina, cataract, depression, diabetes and osteoarthritis, and compare them with inequalities in self-reported medical diagnosis and treatment, in order to determine whether key components of health care were received equitably.

Methods

We obtained data from the ELSA cohort, an interview survey of a sample of the population aged 50 years or older in England. The sample was selected from households that had

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3 previously responded to the Health Survey for England, and drawn from selected postcode
4 sectors stratified by health authority and deprivation to be representative of adults aged 50 or
5 more living in private households in England¹⁵. Participants are interviewed in their homes
6 or care homes every two years about a wide range of health, economic and social topics. We
7 used data collected from core participants who had been interviewed in any of four waves of
8 ELSA from wave 2 in 2004-5 until wave 5 in 2010-11. Wave 2 was the first wave to include
9 questions on receipt of quality-indicated healthcare, and information was not collected on
10 every variable in every wave. Ethical approval was received from the London Multi-Centre
11 Research Ethics Committee. We studied five common and important long-term conditions:
12 angina, diabetes, depression, osteoarthritis, and cataract. Effective treatment is freely
13 available for all five conditions from the National Health Service.
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15

16 Variables

17 We collected data on illness burden, self-reported medical diagnosis and treatment of angina,
18 cataract, depression, diabetes and osteoarthritis. The illness burden for angina was defined as
19 grade 2 on the Rose Angina scale (pain or discomfort in chest when walking at an ordinary
20 pace on the level on most occasions or more often, which makes subject stop or slow down if
21 occurs while walking, and which then goes away within 10 minutes, and which includes
22 either sternum (any level), or left arm and left anterior chest). Illness burden for diabetes was
23 defined as a fasting HbA1c level of >7.5%¹⁶. Illness burden for depression was defined as a
24 score of 3 or more on the eight-item Centre for Epidemiologic Studies Depression Scale
25 (CES-D). The application of these standardised scales in ELSA has been described
26 previously¹. Illness burden for osteoarthritis was defined as self-reported pain in the hip or
27 knee of 5 or more on a scale of 0 to 10¹⁷. Illness burden for cataract was defined broadly as
28 reporting poor vision or blindness. Cataract is responsible for about a quarter of poor vision
29 in the UK, so this measure is the least specific and includes those with other causes of poor
30 vision, such as age-related macular degeneration, which is responsible for about a third of
31 poor vision^{18,19}.
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35 A medical diagnosis was considered to exist if a participant answered 'yes' when asked
36 whether a doctor had ever told them they had the condition of interest. For arthritis, a follow-
37 up question asked whether they had been told they had osteoarthritis, rheumatoid or other
38 arthritis.
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40 Treatment for depression and diabetes was defined by reported achievement of quality of care
41 indicators, derived through a robust process of literature reviews, expert panel assessment and
42 piloting^{20,21}. For depression, the quality indicator was about receipt of treatment since the
43 previous wave: *'if a person is diagnosed with clinical depression, then antidepressive
44 treatment, talking treatment or electroconvulsive treatment should be offered within 2 weeks
45 after diagnosis unless within that period the patient has improved, or unless the patient has
46 substance abuse or dependence, in which case treatment may wait until 8 weeks after the
47 patient is in a drug-or alcohol-free state'*. For diabetes, treatment was measurement of
48 glycosylated haemoglobin or fructosamine levels in the preceding 12 months. Treatment for
49 angina was defined as ever being offered or currently taking beta-blockers (ELSA variables
50 hebeta or hebetc). Treatment for osteoarthritis and cataract were defined as reporting ever
51 having had surgery for the condition. For osteoarthritis this excluded those with hips or knees
52 replaced due to fracture. Data on hip and knee replacements were only available for
53 respondents aged 60 and over, and so respondents aged less than 60 years (n= 3,186) were
54 excluded from the analysis of osteoarthritis.
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Wealth was defined as the sum of financial, physical and housing wealth plus state and private pension income. Age was categorised into three groups, 50-59 years, 60-74 years and 75 years and older.

Analysis

We used two approaches to analysis, a main analysis using serial cross sectional data and then a subsidiary analysis using longitudinal data. Multivariable logistic regression analysis was used, with the outcome variables defined as one of illness burden, self-reported medical diagnosis or treatment for each of the five conditions in each cross-sectional wave (STATA statistical software version 12.1). This regression analysis was repeated for each of the four waves of ELSA from 2004 to 2011 separately and then 'overall' for all four waves combined. For the 'overall' analysis, the data were reshaped into 'long' format in Stata statistical software, with each participant having a separate record for each wave. Intra-person correlation of outcomes was accounted for using robust adjustment with Stata, with each participant's unique identifier included in the regression equation as a cluster variable. Missing data were excluded from the analyses.

The independent variables were age group, sex and slope order of inequality. We used the slope order of inequality as an independent variable to estimate the relationship between the outcome measures and the categorised measure of wealth^{22,23}. The slope order of inequality consisted of wealth quintiles with values of 0.1, 0.3, 0.5, 0.7 and 0.9, that is, the midpoints of each quintile on a scale of zero (least wealthy) to one (most wealthy). The slope order of inequality was modelled as a continuous variable, so that the slope or coefficient of a logit linear regression line across all five quintiles represents the difference in outcome between the hypothetically wealthiest and least wealthy participant. Exponentiating this slope coefficient results in an odds ratio, which is the ratio of the odds of the outcome in the wealthiest compared with the least wealthy participant. This odds ratio is also known as a relative index of inequality²². Advantages of this method of quantifying inequality are that it includes all participants, instead of just comparing the highest and lowest quintiles, it accounts for the number of participants in each category and it provides a single overall measure of inequality.

We included all participants in the main cross sectional analysis in order to compare the distribution of illness burden in the whole population with the distributions of diagnoses and treatments in the whole population. This meant that diagnosis was assessed even in those who did not meet the criteria for 'illness burden', and treatment was assessed even in those with no diagnosis. For the subsidiary analysis using longitudinal data, we estimated the odds ratio of receiving a diagnosis by a subsequent wave only for those who had met the criteria for 'illness burden' in a previous wave, and then the likelihood of receiving treatment only for those who had received a diagnosis in a previous wave. This was a subsidiary analysis as the numbers of participants that could be followed over time in this manner was small, particularly for treatment in angina and depression.

Results

The whole sample (n=12,765) was composed of participants aged 50 years or more who had responded to at least one wave of ELSA from 2004-5 until 2010-11. The response rate in 2004-5 was 82%.^{24,25} In wave 5 (2010-11), self-reported medical diagnosis for all five conditions increased as wealth decreased, for example in depression from 4% in the wealthiest quintile to 11% in the poorest (Table 1). There was little variation between the waves for each of the five conditions (Table 2).

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4 The hypothetically least wealthy participant had substantially higher odds than the
5 hypothetically most wealthy of meeting the criteria for 'illness burden' from any of the five
6 conditions at all four time points (overall odds ratios (OR) ranged from 4.2 to 15.1) (Table 3).
7 The least wealthy participant also had higher odds of diagnosis (ORs 1.1 to 4.5) and either no
8 different or relatively small odds of treatment (ORs 0.9 to 2.6) (Table 3, Figure 1).
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11 For angina, the overall odds ratio for meeting the criteria for 'illness burden' was 7.6,
12 indicating that the hypothetically least wealthy individual was seven times more likely to
13 have angina symptoms (defined by the Rose angina scale) than the wealthiest. The odds ratio
14 for self-reported medical diagnosis was 4.5, suggesting that some less wealthy people with
15 angina symptoms had not received a diagnosis of angina, as the expected odds ratio for
16 equitably distributed diagnosis would have been 7.6. The odds ratio for treatment was 3.2,
17 and again the expected odds ratios for equitably distributed treatment would have been 7.6.
18 For depression, the overall odds ratio for illness burden was 6.4, for medical diagnosis was
19 3.3, and for treatment was 2.6, again suggesting that some poorer people with symptoms of
20 depression were less likely to have received a diagnosis or indicated health care, as the
21 expected odds ratios for equitably distributed treatment would have been 6.4.
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24 For diabetes, the overall odds ratio for illness burden was 4.2 and 4.0 for diagnosis,
25 suggesting that for diabetes diagnosis was distributed equitably. However, the odds ratio for
26 treatment was 0.9 and not statistically significantly different from 1, again suggesting that
27 some less wealthy people with medically diagnosed diabetes had not received treatment, as
28 the expected odds ratios for equitably distributed treatment would have been 4.2.
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31 The subsidiary analysis calculated the odds ratios of receiving a diagnosis by a subsequent
32 wave only for those who had met the criteria for 'illness burden' for the relevant long term
33 condition in a previous wave; and then the likelihood of receiving treatment only for those
34 who had received a medical diagnosis in a previous wave. The substantial inequalities in the
35 illness burden of conditions by wealth are identical to Table 3, as expected, and subsequently
36 the numbers of eligible participants dwindle rapidly due to the nested nature of the analysis,
37 with some wide confidence intervals and 9 out of 10 results not statistically significant
38 (Supplemental file 1).
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Table 1: Characteristics of ELSA participants at wave 5 (2010-11) and self-reported medical diagnosis of angina, cataract, depression, diabetes and osteoarthritis.

| | | Whole sample | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|------------------|---------|---------------------|---------------|-----------------|-------------------|-----------------|-----------------------|
| | | N | % | % | % | % | % |
| Sex | Male | 3,886 | 8.2 | 13.4 | 5.4 | 13.3 | 19.8 |
| | Female | 4,843 | 6.3 | 20.4 | 7.8 | 9.4 | 32.9 |
| Age (years) | 50-59 | 1,906 | 2.2 | 3.7 | 10.1 | 7.2 | 17.1 |
| | 60-74 | 4,766 | 5.8 | 14.5 | 7.0 | 11.0 | 28.1 |
| | 75+ | 2,057 | 15.0 | 36.6 | 2.9 | 15.0 | 34.1 |
| Wealth quintile* | 1 | 1,716 | 3.4 | 13.8 | 4.1 | 6.0 | 21.5 |
| | 2 | 1,714 | 4.9 | 15.5 | 5.9 | 8.0 | 24.2 |
| | 3 | 1,723 | 6.6 | 20.1 | 5.7 | 11.3 | 25.7 |
| | 4 | 1,716 | 8.2 | 18.6 | 6.7 | 13.6 | 31.6 |
| | 5 | 1,715 | 12.9 | 19.2 | 11.5 | 16.7 | 33.1 |
| | missing | 145 | 5.5 | 9.7 | 4.8 | 9.7 | 20.0 |
| Total | | 8,729 | 7.2 | 17.3 | 6.7 | 11.1 | 27.1 |

*1=wealthiest quintile, 5=least wealthy quintile

Table 2. Prevalence of illness burden, self-reported medical diagnosis, and treatment for angina, cataract, depression, diabetes and osteoarthritis in four waves of ELSA

| | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|---|---------------|-----------------|-------------------|-----------------|-----------------------|
| | N (%) | N (%) | N (%) | N (%) | N (%) |
| Illness burden | | | | | |
| Wave 2 (2004-5) | 397 (4.6) | 308 (3.5) | 2,037 (23.4) | 160 (1.8) | 1,106 (12.7) |
| Wave 3 (2006-7) | 300 (3.6) | 317 (3.8) | 1,929 (23.3) | n/a | 917 (11.1) |
| Wave 4 (2008-9) | 300 (3.1) | 331 (3.5) | 2,049 (21.4) | 220 (2.3) | 1,088 (11.4) |
| Wave 5 (2010-11) | 254 (2.9) | 320 (3.7) | 1,956 (22.4) | n/a | 1,046 (12.0) |
| Medical diagnosis | | | | | |
| Wave 2 (2004-5) | 668 (7.6) | 1,050 (12.1) | 402 (4.6) | 715 (8.2) | 1,861 (21.4) |
| Wave 3 (2006-7) | 591 (7.1) | 1,294 (15.7) | 490 (5.9) | 935 (11.3) | 1,952 (23.6) |
| Wave 4 (2008-9) | 645 (6.7) | 1,421 (14.8) | 601 (6.3) | 1,215 (12.7) | 2,262 (23.6) |
| Wave 5 (2010-11) | 655 (7.5) | 1,566 (17.9) | 602 (6.9) | 1,413 (16.2) | 2,416 (27.7) |
| Treatment | | | | | |
| Wave 2 (2004-5) | 85 (1.0) | 535 (6.2) | 98 (1.1) | 552 (6.4) | 202 (2.3) |
| Wave 3 (2006-7) | n/a | 379 (4.9) | n/a | 618 (7.5) | 141 (1.7) |
| Wave 4 (2008-9) | n/a | 444 (4.6) | 155 (1.6) | 671 (7.0) | 226 (2.4) |
| Wave 5 (2010-11) | 88 (1.0) | 646 (7.4) | n/a | 748 (8.6) | 208 (2.4) |
| Total number of participants in each wave: wave 2: 8,688; wave 3: 8,268; wave 4: 9,578; wave 5: 8,729 | | | | | |
| n/a = data not available for that condition in that wave | | | | | |

Table 3. Illness burden, self-reported medical diagnosis and treatment of angina, cataract, depression, diabetes and osteoarthritis, comparing the least wealthy with the most wealthy: logistic regression.

| | | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|---------------------------------------|-------------------|---------------------------|---------------------------|--------------------------|--------------------------|-----------------------------|
| Odds ratios (95% confidence interval) | | | | | | |
| Wave 2* (2004-5) | Illness burden | 5.6 (3.8, 8.3) | 7.2 (4.5, 11.5) | 5.1 (4.3, 6.2) | 4.4 (2.5, 8.0) | 11.0 (8.1, 14.9) |
| | Medical diagnosis | 2.9 (2.2, 3.9) | 1.3 (1.0, 1.6) | 4.8 (3.3, 7.0) | 3.1 (2.3, 4.2) | 1.6 (1.3, 2.0) |
| | Treatment | 2.6 (1.2, 5.7) | 1.5 (1.0, 2.2) | 0.6 (0.1, 2.9) | 0.7 (0.3, 1.5) | 1.1 (0.7, 1.9) |
| Wave 3* (2006-7) | Illness burden | 8.7 (5.5, 13.8) | 8.2 (5.1, 13.1) | 6.9 (5.7, 8.5) | | 12.7 (9.1, 17.8) |
| | Medical diagnosis | 4.9 (3.6, 6.8) | 1.2 (1.0, 1.5) | 0.7 (0.4, 1.4) | 3.4 (2.6, 4.4) | 0.6 (0.4, 0.8) |
| | Treatment | | 1.3 (0.8, 1.9) | | 1.2 (0.6, 2.4) | 1.0 (0.6, 1.9) |
| Wave 4* (2008-9) | Illness burden | 6.7 (4.2, 10.5) | 5.5 (3.6, 8.6) | 5.9 (4.9, 7.1) | 3.9 (2.4, 6.4) | 14.0 (10.3, 19.1) |
| | Medical diagnosis | 4.3 (3.2, 5.9) | 1.1 (0.9, 1.4) | 0.7 (0.4, 1.2) | 3.9 (3.1, 5.1) | 0.6 (0.4, 0.8) |
| | Treatment | | 1.1 (0.7, 1.6) | 2.4 (1.0, 5.9) | 0.2 (0.1, 0.6) | 1.0 (0.6, 1.6) |
| Wave 5* (2010-11) | Illness burden | 8.4 (5.1, 13.7) | 6.2 (3.9, 9.9) | 5.9 (4.8, 7.1) | | 16.0 (11.7, 21.8) |
| | Medical diagnosis | 5.3 (3.9, 7.3) | 1.3 (1.0, 1.5) | 1.7 (1.0, 2.8) | 4.3 (3.4, 5.4) | 0.6 (0.4, 0.8) |
| | Treatment | 3.3 (1.5, 7.3) | 1.8 (1.2, 2.6) | | 0.8 (0.4, 1.6) | 1.2 (0.7, 2.0) |
| Overall† | Illness burden | 7.6 (5.4, 10.8) | 8.0 (5.4, 11.9) | 6.4 (5.5, 7.5) | 4.2 (2.6, 6.8) | 15.1 (11.4, 20.0) |
| | Medical diagnosis | 4.5 (3.3, 6.0) | 1.3 (1.1, 1.5) | 3.3 (2.4, 4.5) | 4.0 (3.1, 5.2) | 1.1 (0.9, 1.3) |
| | Treatment | 3.2 (1.7, 6.0) | 1.3 (1.0, 1.8) | 2.6 (1.1, 6.1) | 0.9 (0.5, 1.4) | 1.2 (0.8, 1.6) |

*Odds ratios adjusted for age group and sex

†Odds ratios adjusted for age group, sex and unique participant identifier

**Analyses for osteoarthritis excluded those younger than 60 years, as data on osteoarthritis treatment were only collected in those aged 60 or over.

Statistically significant odds ratios (where the 95% confidence intervals do not include 1 before rounding to one decimal place) are shown in bold

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3 **Figure 1.** Illness burden (in blue), self-reported medical diagnosis (in green), and treatment
4 (in red) of angina, cataract, depression, diabetes and osteoarthritis, comparing the least
5 wealthy with the most wealthy: Overall odds ratios (adjusted for age and sex) and 95%
6 confidence bars: logistic regression
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9 INSERT FIGURE 1 HERE

10 11 **Discussion**

12 We found that while there were strong inverse associations between wealth and the burden of
13 illness (based on validated scales, symptoms and biomarker) of a long-term condition, there
14 were smaller or absent inequalities in receipt of self-reported medical diagnosis or treatment
15 for the conditions considered. This suggests that the substantially higher illness burden in less
16 wealthy participants was not matched by appropriately higher levels of diagnosis and
17 treatment, and that equitable receipt of a medical diagnosis may have an important role in
18 reducing inequalities in health.
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20
21 ELSA is a unique single source of detailed data on socioeconomic status and health, and this
22 is the first study to compare inequalities in illness burden, self-reported medical diagnosis and
23 treatment of long-term conditions in a panel study over time. ELSA used robust measures of
24 individual socio-economic position, and standardised scales and blood biomarker to assess
25 health status. This exploratory study has some limitations and the results should be
26 interpreted with caution and tested in subsequent research. Whilst standardised measures
27 were used to estimate the illness burden of depression, angina and diabetes, symptoms alone
28 were used for osteoarthritis and cataract, and the attributed symptoms were not specific for
29 osteoarthritis and cataract. However, this lack of specificity is unlikely to vary with wealth,
30 and so is not likely to be an important source of bias. Self-reported data may be a source of
31 bias if self-report varies by factors other than objective health status, such as wealth or social
32 experience. This is a recognised problem with some self-reported morbidity data, but is less
33 of a problem with sensory assessment for pain, which is essentially self-perceived, and
34 where self-report is the best means of assessment ²⁶.
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38 We have not adjusted for health-related factors that are also more prevalent in poorer
39 populations, such as smoking, obesity and comorbidity, because none of these are a reason
40 for not making a diagnosis. Comorbid conditions are commoner in those with lower socio-
41 economic status, but there is no evidence that comorbidities make a new diagnosis less likely.
42 On the contrary, a higher number of comorbid conditions in older people may be associated
43 with higher quality of care ²⁷. We found different patterns in different conditions, which fits
44 with other research showing that wealth acts differently in different conditions, and for
45 example, has no association with referral for post-menopausal bleeding ²⁸. Major national
46 policy interventions such as the Quality and Outcomes Framework payment for performance
47 scheme in primary care ²⁹ have been associated with improved healthcare for included
48 conditions such as angina and diabetes, more than for excluded conditions such osteoarthritis
49 and poor vision ³⁰⁻³².
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52 The serial cross-sectional analysis of 4 waves of ELSA included all eligible participants in
53 each wave in order to maximise the sample size. This approach meant that some participants
54 with a diagnosed condition would no longer have had symptoms or raised biomarkers, if they
55 were being successfully treated. Examples would be diabetic participants whose blood sugar
56 levels were being successfully controlled by treatment, and participants with successfully
57 treated depression. We therefore checked our main results with the secondary (longitudinal)
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3 analysis, which assessed subsequent diagnosis in those had met the criteria for ‘illness
4 burden’, and subsequent treatment in those with a medical diagnosis, but the number of
5 participants who could be followed through the waves in this way was too small to allow
6 meaningful conclusions to be drawn from the results.
7

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9 Our results fit with previous findings that a greater proportion of people in deprived groups
10 had Rose angina, but there was no difference in the proportions receiving a general
11 practitioner diagnosis of coronary heart disease¹⁴. Care-seeking behaviour and patient
12 preferences may differ with wealth. Given the same information, patients may want fewer
13 medical interventions than their doctors recommend^{33,34} and pessimism about availability of
14 treatment may make older people reluctant to seek help³⁵. Older people may view living with
15 symptoms (such as pain, or emotional problems) as a normal part of ageing³⁶. The response
16 of the primary care physician may also vary with the wealth of the patient. For example, the
17 physician might be more likely to consider symptoms of breathlessness as a medical problem
18 requiring a diagnosis, whereas aches and pains, poor vision, and low mood might be
19 considered part of the tapestry of life, or the natural ageing process. Comorbidity is more
20 common in deprived populations, and may make diagnosis of all conditions harder for
21 doctors within the constraints of a short consultation³⁷.
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24 At a system level, the results may be partially explained by wealthier people living in areas
25 where there are more healthcare resources. Wennberg introduced the concept of ‘supply-
26 sensitive care’ to describe how the quantity of healthcare resources allocated to a particular
27 population was a major determinant of the frequency of use of health services by that
28 population, and gives an example in which ‘a doubling of the supply of internists or
29 cardiologists results in roughly a halving of the interval between repeat visits’^{38,39}. Where
30 healthcare resources are relatively plentiful, patients with chronic diseases will consult more,
31 use more diagnostic tests, and be referred to hospital more. Further research could helpfully
32 investigate whether those missing out on diagnosis are not accessing health services, or are
33 seeing a doctor but not being diagnosed. The participants were selected to be nationally
34 representative of the population of England, and so the findings are likely to be generalisable
35 to England, but not to countries with different healthcare systems. If validated, our findings
36 that inequalities in receipt of diagnoses are potential barriers to equitable healthcare for five
37 common long-term conditions, suggest that future policy interventions to reduce socio-
38 economic inequalities in healthcare should consider improving access to diagnosis as well as
39 treatment.
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4 **Funding statement:** This article presents independent research commissioned by the UK
5 National Institute for Health Research (NIHR) under the Health Services Research
6 programme: HSR Project 10/2002/06 – ‘The dynamics of quality: a national panel study of
7 evidence-based standards’. IL’s work was supported by the NIHR Collaboration for Applied
8 Health Research and Care (CLAHRC) for the South West Peninsula. The views expressed in
9 this publication are those of the authors and not necessarily those of the NHS, the NIHR or
10 the Department of Health.
11

12
13 **Competing interests:** All authors have completed the ICMJE uniform disclosure form at
14 www.icmje.org/coi_disclosure.pdf and declare: all authors had financial support from the
15 National Institute for Health Research for the submitted work, DM had financial support from
16 Age UK; no financial relationships with any organisations that might have an interest in the
17 submitted work in the previous three years; no other relationships or activities that could
18 appear to have influenced the submitted work.
19

20
21 **Ethics approval:** The English Longitudinal Study of Ageing received ethics approval from
22 the National Research Ethics Service: 09/H0505/124. Participants gave informed consent
23 before taking part.
24

25 **Contributors:** NS contributed to the study design, oversaw data analysis and interpretation,
26 and drafted the paper. NS is guarantor. AH undertook data preparation, analysis and
27 interpretation, and contributed to drafting the paper. LM undertook data preparation and
28 analysis. MB and AC advised on statistical techniques. SR, JC and IL advised on data
29 analysis and interpretation. DM contributed to the study design and advised on data analysis
30 and interpretation. All authors contributed to data interpretation and revised the paper
31 critically.
32

33
34 **Acknowledgements:** Dave Stott and Amander Wellings, representatives of Public and
35 Patient Involvement in Research (PPIRes), brought a helpful lay perspective to this research.
36

37 **Data sharing:** The ELSA dataset and technical documentation are available from the UK
38 Data Service at: <http://discover.ukdataservice.ac.uk/catalogue?sn=5050>.
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Reference List

- 1
2
3
4
5 (1) Marmot M, Banks J, Blundell R, et al. Health, Wealth and Lifestyles of the Older
6 Population in England: the 2002 English Longitudinal Study of Ageing. London: The
7 Institute for Fiscal Studies; 2003.
8
- 9
10 (2) Börsch-Supan A, Brugiavini A, Jürges H, et al. Health, Ageing and Retirement in
11 Europe. First Results from the Survey of Health, Ageing and Retirement in Europe.
12 Mannheim: Mannheim Research Institute for the Economics of Aging (MEA); 2005.
13
- 14 (3) Hemingway H, Shipley M, Macfarlane P, et al. Impact of socioeconomic status on
15 coronary mortality in people with symptoms, electrocardiographic abnormalities, both
16 or neither: the original Whitehall study 25 year follow up. *J Epidemiol Community*
17 *Health* 2000; 54(7):510-516.
18
- 19 (4) Wilkinson R, Marmot M. Social determinants of health: the solid facts. 2nd edition
20 ed. Copenhagen: World Health Organisation; 2003.
21
- 22 (5) McKeown T. The role of medicine: dream, mirage or nemesis? 1 ed. London:
23 Nuffield Principal Hospital Trust; 1976.
24
- 25 (6) Bunker JP. The role of medical care in contributing to health improvements within
26 societies. *Int J Epidemiol* 2001; 30(6):1260-1263.
27
- 28 (7) Watt G. The inverse care law today. *Lancet* 2002; 360:252-4.
29
- 30 (8) Richards HM, Reid ME, Watt GCM. Socioeconomic variations in responses to chest
31 pain: qualitative study. *BMJ* 2002; 324(7349):1308.
32
- 33 (9) Gardner K, Chapple A. Barriers to referral in patients with angina: qualitative study.
34 *BMJ* 1999; 319(7207):418-421.
35
- 36 (10) Berger J, Mohr J. A fortunate man: the story of a country doctor. London: Penguin;
37 1967.
38
- 39 (11) Tod AM, Read C, Lacey A, et al. Barriers to uptake of services for coronary heart
40 disease: qualitative. *BMJ* 2001; 323(7306):214.
41
- 42 (12) Chaturvedi N, Ben Shlomo Y. From the surgery to the surgeon: does deprivation
43 influence consultation and operation rates? *Br J Gen Pract* 1995; 45(392):127-131.
44
- 45 (13) Mahomed NN, Barrett JA, Katz JN, et al. Rates and outcomes of primary and revision
46 total hip replacement in the United States medicare population. *J Bone Joint Surg Am*
47 2003; 85-A(1):27-32.
48
- 49 (14) Richards H, McConnachie A, Morrison C, et al. Social and gender variation in the
50 prevalence, presentation and general practitioner provisional diagnosis of chest pain. *J*
51 *Epidemiol Community Health* 2000; 54(9):714-718.
52
- 53 (15) Natcen Social Research. English Longitudinal Study of Ageing (ELSA) Wave One to
54 Wave Five User Guide. <http://www.esds.ac>
55
56
57
58
59
60

1
2
3 uk/doc/5050/mrdoc/pdf/5050_User_Guide_to_the_ELSA_Datasets_Waves_1_to_5
4 pdf [2012 [cited 2013 Sept. 28];
5

- 6 (16) Scholes S, Taylor R, Cheshire H, et al. Retirement, health and relationships of the
7 older population in England: The 2004 English Longitudinal Study of Ageing.
8 Technical Report P2808. London: National Centre for Social Research; 2008.
9
- 10 (17) Steel N, Melzer D, Gardener E, McWilliams B. Need for and receipt of hip and knee
11 replacement--a national population survey. *Rheumatology* 2006;(45):1437-1441.
12
- 13 (18) Evans JR, Fletcher AE, Wormald RPL, et al. Prevalence of partial sight and blindness
14 in people aged 75 years and older in Britain: results from the MRC trial of assessment
15 and management of older people in the community. *Br J Ophthalmol* 2002; 86:795-
16 800.
17
- 18 (19) Congdon N, O'Colmain B, Klaver CCW, et al. Causes and Prevalence of Partial sight
19 and blindness among adults in the United States. *Arch Ophthalmol* 2004; 122:477-
20 485.
21
- 22 (20) Steel N, Melzer D, Shekelle PG, et al. Developing quality indicators for older adults:
23 transfer from the USA to the UK is feasible. *Quality and Safety in Health Care* 2004;
24 13(4):260-264.
25
- 26 (21) Steel N, Bachmann M, Maisey S, et al. Self reported receipt of care consistent with 32
27 quality indicators: National population survey of adults aged 50 or more in England.
28 *BMJ* 2008; 337:a957.
29
- 30 (22) Wagstaff A, Paci P, Van Doorslaer E. On the measurement of inequalities in health.
31 *Soc Sci Med* 1991; 33(5):545-557.
32
- 33 (23) Bachmann MO, Eachus J, Hopper CD, et al. Socio-economic inequalities in diabetes
34 complications, control, attitudes and health service use: a cross-sectional study.
35 *Diabet Med* 2003; 20(11):921-929.
36
- 37 (24) Banks J, Breeze E, Lessof C, et al. Retirement, health and relationships of the older
38 population in England: The 2004 English Longitudinal Study of Ageing (Wave 2).
39 London: The Institute for Fiscal Studies; 2006.
40
- 41 (25) Cheshire H, Hussey D, Medina J, et al. Financial circumstances, health and well-
42 being of the older population in England: The 2008 English Longitudinal Study of
43 Ageing. Wave 4 Technical Report. London: National Centre for Social Research;
44 2012.
45
- 46 (26) Sen A. Health: perception versus observation. *BMJ* 2002; 324(7342):860-861.
47
- 48 (27) Min LC, Reuben DB, MacLean CH, et al. Predictors of Overall Quality of Care
49 Provided to Vulnerable Older People. *J Am Geriatr Soc* 2005; 53(10):1705-1711.
50
- 51 (28) McBride D, Hardoon S, Walters K, et al. Explaining variation in referral from
52 primary to secondary care: cohort study. *BMJ* 2010; 341.
53
54
55
56
57
58
59
60

- 1
2
3 (29) NHS Employers and the General Practitioners Committee. Quality and Outcomes
4 Framework for 2012/13. Guidance for PCOs and practices. London: NHS Employers;
5 2012.
6
7 (30) Gillam S, Steel N. The Quality and Outcomes Framework: where next? BMJ 2013;
8 346.
9
10 (31) Gillam SJ, Siriwardena AN, Steel N. Pay-for-Performance in the United Kingdom:
11 Impact of the Quality and Outcomes Framework - A Systematic Review. The Annals
12 of Family Medicine 2012; 10(5):461-468.
13
14 (32) Steel N, Maisey S, Clark A, et al. Quality of clinical primary care and targeted
15 incentive payments: an observational study. Br J Gen Pract 2007;(57):449-454.
16
17 (33) Steel N. Thresholds for taking antihypertensive drugs in different professional and lay
18 groups: questionnaire survey. BMJ 2000; 320:1446-7.
19
20 (34) Montgomery AA, Fahey T. How do patients' treatment preferences compare with
21 those of clinicians? Quality in health care 2001; 10 (Suppl I):i39-i43.
22
23 (35) Sanders C, Donovan JL, Dieppe PA. Unmet need for joint replacement: a qualitative
24 investigation of barriers to treatment among individuals with severe pain and
25 disability of the hip and knee. Rheumatology 2004; 43(3):353-357.
26
27 (36) Murray J, Banerjee S, Byng R, et al. Primary care professionals' perceptions of
28 depression in older people: a qualitative study. Social Science & Medicine 2006;
29 63:1363-73.
30
31 (37) Mercer SW, Guthrie B, Furler J, et al. Multimorbidity and the inverse care law in
32 primary care. BMJ 2012; 344.
33
34 (38) Wennberg JE. Understanding Geographic Variations in Health Care Delivery. The
35 New England Journal of Medicine 1999; 340(1):52-53.
36
37 (39) Wennberg JE. Unwarranted variations in healthcare delivery: implications for
38 academic medical centres. BMJ 2002; 325(7370):961-964.
39
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4 **Economic inequalities in burden of illness, diagnosis and**
5 **treatment of five long-term conditions in England: panel study.**
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Abstract

Objective:

We compared the distribution by wealth of self-reported illness burden (estimated from validated scales, biomarker and reported symptoms) for angina, cataract, depression, diabetes and osteoarthritis, with the distribution of self-reported medical diagnosis and treatment. We aimed to determine if the greater illness burden borne by poorer participants was matched by appropriately higher levels of diagnosis and treatment.

Design:

The English Longitudinal Study of Ageing, a panel study of 12,765 participants aged 50 years and older in four waves from 2004 to 2011, selected using a stratified random sample of households in England. Distribution of illness burden, diagnosis and treatment by wealth was estimated using regression analysis.

Outcome measures:

The main outcome measures were odds ratios (ORs) for the illness burden, diagnosis and treatment respectively, adjusted for age, sex and wealth. We estimated the illness burden for angina with the Rose Angina scale, diabetes with fasting glycosylated haemoglobin, depression with the Centre for Epidemiologic Studies Depression Scale, osteoarthritis with self-reported pain and disability, and cataract with self-reported poor vision. Medical diagnoses were self-reported for all conditions. Treatment was defined as beta-blocker prescription for angina, surgery for osteoarthritis and cataract, and receipt of pre-defined effective interventions for diabetes and depression.

Results:

Compared to the wealthiest, the least wealthy participant had substantially higher odds for illness burden from any of the five conditions at all four time points, with odds ratios ranging from 4.2 (95% confidence interval 2.6 to 6.8) for diabetes to 15.1 (11.4 to 20.0) for osteoarthritis. The odds ratios for diagnosis and treatment were smaller in all 5 conditions, and ranged from 0.9 (0.5 to 1.4) for diabetes treatment to 4.5 (3.3 to 6.0) for angina diagnosis.

Conclusions:

The substantially higher illness burden in less wealthy participants was not matched by appropriately higher levels of diagnosis and treatment.

Strengths and limitations of this study

- The English Longitudinal Study of Ageing (ELSA) is a unique single source of detailed ~~longitudinal~~ data on socioeconomic status and health, and this is the first study to compare inequalities in illness burden, self-reported medical diagnosis and treatment of long-term conditions in a ~~longitudinal~~ panel study over time
- Highly detailed measures of individual wealth were used alongside standardised scales and blood biomarker to assess the illness burden of depression, angina and diabetes
- Standardised scales were not included in ELSA for osteoarthritis and cataract, so assessment of illness burden for these two conditions was based on attributed symptoms which were not specific for osteoarthritis and cataract
- The study used self-reported data collected using an extensively tested structured questionnaire, but no information from medical records was collected
- An analysis of pooled data from 4 waves of ELSA was used to maximise the sample size, and the main finding that less wealthy participants are relatively underdiagnosed requires validation in a larger longitudinal study.

Main text

Introduction

Poverty is associated with poor health, poor access to health care and poor health outcomes in many countries and across different health care systems¹⁻³. Much of this variation is caused by recognised broad social determinants of health⁴. Considerable political effort has been directed at attempts to narrow health inequalities by reducing poverty and social exclusion. However, as health care has become more effective at improving health, its potential contribution to ameliorating health inequalities has increased. McKeown demonstrated in the 1970s that health services had contributed little to health improvement⁵, but the same claim could not be made today. The past 30 years have seen the introduction of a wide range of effective interventions, particularly for the prevention and management of chronic disease⁶. Yet although these new interventions improve health, they are not necessarily applied equally across the population. Health inequalities will widen if effective services are offered, or taken up, with greater frequency by wealthier than less wealthy people. The reverse is also true, however, and there is an opportunity for healthcare to reduce social inequalities if it reaches those most in need⁷.

Little is known about pathways into poor health. The National Health Service provides medical care free at point-of-need to all UK residents, but there is scope for inequalities to occur in the pathway from identification of early symptoms through diagnosis and on to effective treatment. Individuals in more deprived social groups may be more reluctant to present to doctors with their symptoms and so may not receive a diagnosis^{8,9}. Diagnosis is a key step that has meaning for both patient and physician in all health systems, and 'diagnostic confusion' may act as a barrier to health care for vulnerable populations^{10,8,11}. Previous studies have found socio-economic variation in either diagnosis or treatment rates, but have not been able to compare inequalities in illness burden, rates of diagnosis and treatment modalities in the same population¹²⁻¹⁴.

The English Longitudinal Study of Ageing (ELSA) provides new data that can be used to identify barriers to equitable receipt of healthcare, and constitutes a unique source of information on illness burden, self-reported medical diagnosis and treatment. Other data sources cover symptoms, or diagnosis, or treatment, but no other single source covers all three. ELSA collects data on symptoms and validated markers of common health conditions, as well as diagnosis and treatment. It also contains detailed socio-demographic information, including direct measures of personal wealth, on a sample selected to be representative of the population of England aged 50 years and older. These data can be used to compare socio-economic inequalities for several conditions, providing insight into a healthcare system with no direct financial barriers to treatment (the National Health Service in England). We aimed to assess socio-economic inequalities in the burden of illness (estimated by validated scales, biomarker, and reported symptoms) of angina, cataract, depression, diabetes and osteoarthritis, and compare them with inequalities in self-reported medical diagnosis and treatment, in order to determine whether key components of health care were received equitably.

Methods

We obtained data from the ELSA cohort, an interview survey of a sample of the population aged 50 years or older in England. The sample was selected from households that had

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3 previously responded to the Health Survey for England, and drawn from selected postcode
4 sectors stratified by health authority and deprivation to be representative of adults aged 50 or
5 more living in private households in England¹⁵. Participants are interviewed in their homes
6 or care homes every two years about a wide range of health, economic and social topics. We
7 used data collected from core participants who had been interviewed in any of four waves of
8 ELSA from wave 2 in 2004-5 until wave 5 in 2010-11. Wave 2 was the first wave to include
9 questions on receipt of quality-indicated healthcare, and information was not collected on
10 every variable in every wave. Ethical approval was received from the London Multi-Centre
11 Research Ethics Committee. We studied five common and important long-term conditions:
12 angina, diabetes, depression, osteoarthritis, and cataract. Effective treatment is freely
13 available for all five conditions from the National Health Service.
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16 Variables

17 We collected data on illness burden, self-reported medical diagnosis and treatment of angina,
18 cataract, depression, diabetes and osteoarthritis. The illness burden for angina was defined as
19 grade 2 on the Rose Angina scale (pain or discomfort in chest when walking at an ordinary
20 pace on the level on most occasions or more often, which makes subject stop or slow down if
21 occurs while walking, and which then goes away within 10 minutes, and which includes
22 either sternum (any level), or left arm and left anterior chest). Illness burden for diabetes was
23 defined as a fasting HbA1c level of >7.5%¹⁶. Illness burden for depression was defined as a
24 score of 3 or more on the eight-item Centre for Epidemiologic Studies Depression Scale
25 (CES-D). The application of these standardised scales in ELSA has been described
26 previously¹. Illness burden for osteoarthritis was defined as self-reported pain in the hip or
27 knee of 5 or more on a scale of 0 to 10¹⁷. Illness burden for cataract was defined broadly as
28 reporting poor vision or blindness. Cataract is responsible for about a quarter of poor vision
29 in the UK, so this measure is the least specific and includes those with other causes of poor
30 vision, such as age-related macular degeneration, which is responsible for about a third of
31 poor vision^{18,19}.
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35 A medical diagnosis was considered to exist if a participant answered 'yes' when asked
36 whether a doctor had ever told them they had the condition of interest. For arthritis, a follow-
37 up question asked whether they had been told they had osteoarthritis, rheumatoid or other
38 arthritis.
39

40 Treatment for depression and diabetes was defined by reported achievement of quality of care
41 indicators, derived through a robust process of literature reviews, expert panel assessment and
42 piloting^{20,21}. For depression, the quality indicator was about receipt of treatment since the
43 previous wave: *'if a person is diagnosed with clinical depression, then antidepressive
44 treatment, talking treatment or electroconvulsive treatment should be offered within 2 weeks
45 after diagnosis unless within that period the patient has improved, or unless the patient has
46 substance abuse or dependence, in which case treatment may wait until 8 weeks after the
47 patient is in a drug-or alcohol-free state'*. For diabetes, treatment was measurement of
48 glycosylated haemoglobin or fructosamine levels in the preceding 12 months. Treatment for
49 angina was defined as ever being offered or currently taking beta-blockers (ELSA variables
50 hebeta or hebetc). Treatment for osteoarthritis and cataract were defined as reporting ever
51 having had surgery for the condition. For osteoarthritis this excluded those with hips or knees
52 replaced due to fracture. Data on hip and knee replacements were only available for
53 respondents aged 60 and over, and so respondents aged less than 60 years (n= 3,186) were
54 excluded from the analysis of osteoarthritis.
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Wealth was defined as the sum of financial, physical and housing wealth plus state and private pension income. Age was categorised into three groups, 50-59 years, 60-74 years and 75 years and older.

Analysis

We used two approaches to analysis, a main analysis using serial cross sectional data and then a subsidiary analysis using longitudinal data. Multivariable logistic regression analysis was used, with the outcome variables defined as one of illness burden, self-reported medical diagnosis or treatment for each of the five conditions in each cross-sectional wave (STATA statistical software version 12.1). This regression analysis was repeated for each of the four waves of ELSA from 2004 to 2011 separately and then 'overall' for all four waves combined. For the 'overall' analysis, the data were reshaped into 'long' format in Stata statistical software, with each participant having a separate record for each wave. Intra-person correlation of outcomes was accounted for using robust adjustment with Stata, with each participant's unique identifier included in the regression equation as a cluster variable. Missing data were excluded from the analyses.

The independent variables were age group, sex and slope order of inequality. We used the slope order of inequality as an independent variable to estimate the relationship between the outcome measures and the categorised measure of wealth^{22,23}. The slope order of inequality consisted of wealth quintiles with values of 0.1, 0.3, 0.5, 0.7 and 0.9, that is, the midpoints of each quintile on a scale of zero (least wealthy) to one (most wealthy). The slope order of inequality was modelled as a continuous variable, so that the slope or coefficient of a logit linear regression line across all five quintiles represents the difference in outcome between the hypothetically wealthiest and least wealthy participant. Exponentiating this slope coefficient results in an odds ratio, which is the ratio of the odds of the outcome in the wealthiest compared with the least wealthy participant. This odds ratio is also known as a relative index of inequality²². Advantages of this method of quantifying inequality are that it includes all participants, instead of just comparing the highest and lowest quintiles, it accounts for the number of participants in each category and it provides a single overall measure of inequality.

We included all participants in the main cross sectional analysis in order to compare the distribution of illness burden in the whole population with the distributions of diagnoses and treatments in the whole population. This meant that diagnosis was assessed even in those who did not meet the criteria for 'illness burden', and treatment was assessed even in those with no diagnosis. For the subsidiary analysis using longitudinal data, we estimated the odds ratio of receiving a diagnosis by a subsequent wave only for those who had met the criteria for 'illness burden' in a previous wave, and then the likelihood of receiving treatment only for those who had received a diagnosis in a previous wave. This was a subsidiary analysis as the numbers of participants that could be followed over time in this manner was small, particularly for treatment in angina and depression.

Results

The whole sample (n=12,765) was composed of participants aged 50 years or more who had responded to at least one wave of ELSA from 2004-5 until 2010-11. The response rate in 2004-5 was 82%.^{24,25} In wave 5 (2010-11), ~~over half of the sample of 8,729 were women, or were aged between 60 and 74 years (Table 1).~~ Self-reported medical diagnosis for all five conditions increased as wealth decreased, for example in depression from 4% in the

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3 wealthiest quintile to 11% in the poorest (Table 1). There was little variation between the
4 waves for each of the five conditions (Table 2).

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6 The hypothetically least wealthy participant had substantially higher odds than the
7 hypothetically most wealthy of meeting the criteria for 'illness burden' from any of the five
8 conditions at all four time points (overall odds ratios (OR) ranged from 4.2 to 15.1) (Table 3).
9 The least wealthy participant also had higher odds of diagnosis (ORs 1.1 to 4.5) and either no
10 different or relatively small odds of treatment (ORs 0.9 to 2.6) (Table 3, Figure 1).
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13 For angina, the overall odds ratio for meeting the criteria for 'illness burden' was 7.6,
14 indicating that the hypothetically least wealthy individual was seven times more likely to
15 have angina symptoms (defined by the Rose angina scale) than the wealthiest. The odds ratio
16 for self-reported medical diagnosis was 4.5, suggesting that some less wealthy people with
17 angina symptoms had not received a diagnosis of angina, as the expected odds ratio for
18 equitably distributed diagnosis would have been 7.6. The odds ratio for treatment was 3.2,
19 and again the expected odds ratios for equitably distributed treatment would have been 7.6.
20 For depression, the overall odds ratio for illness burden was 6.4, for medical diagnosis was
21 3.3, and for treatment was 2.6, again suggesting that some poorer people with symptoms of
22 depression were less likely to have received a diagnosis or indicated health care, as the
23 expected odds ratios for equitably distributed treatment would have been 6.4.
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26 For diabetes, the overall odds ratio for illness burden was 4.2 and 4.0 for diagnosis,
27 suggesting that for diabetes diagnosis was distributed equitably. However, the odds ratio for
28 treatment was 0.9 and not statistically significantly different from 1, again suggesting that
29 some less wealthy people with medically diagnosed diabetes had not received treatment, as
30 the expected odds ratios for equitably distributed treatment would have been 4.2.
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33 The subsidiary analysis calculated the odds ratios of receiving a diagnosis by a subsequent
34 wave only for those who had met the criteria for 'illness burden' for the relevant long term
35 condition in a previous wave; and then the likelihood of receiving treatment only for those
36 who had received a medical diagnosis in a previous wave. The substantial inequalities in the
37 illness burden of conditions by wealth are identical to Table 3, as expected, and subsequently
38 the numbers of eligible participants dwindle rapidly due to the nested nature of the analysis,
39 with some wide confidence intervals and 9 out of 10 results not statistically significant
40 (Supplemental file 1).
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Table 1: Characteristics of ELSA participants at wave 5 (2010-11) and self-reported medical diagnosis of angina, cataract, depression, diabetes and osteoarthritis.

| | | Whole sample | Angina | Cataract | Depression | Diabetes | Osteo- arthritis |
|------------------|---------|---------------------|---------------|-----------------|-------------------|-----------------|-----------------------------|
| | | N | % | % | % | % | % |
| Sex | Male | 3,886 | 8.2 | 13.4 | 5.4 | 13.3 | 19.8 |
| | Female | 4,843 | 6.3 | 20.4 | 7.8 | 9.4 | 32.9 |
| Age (years) | 50-59 | 1,906 | 2.2 | 3.7 | 10.1 | 7.2 | 17.1 |
| | 60-74 | 4,766 | 5.8 | 14.5 | 7.0 | 11.0 | 28.1 |
| | 75+ | 2,057 | 15.0 | 36.6 | 2.9 | 15.0 | 34.1 |
| Wealth quintile* | 1 | 1,716 | 3.4 | 13.8 | 4.1 | 6.0 | 21.5 |
| | 2 | 1,714 | 4.9 | 15.5 | 5.9 | 8.0 | 24.2 |
| | 3 | 1,723 | 6.6 | 20.1 | 5.7 | 11.3 | 25.7 |
| | 4 | 1,716 | 8.2 | 18.6 | 6.7 | 13.6 | 31.6 |
| | 5 | 1,715 | 12.9 | 19.2 | 11.5 | 16.7 | 33.1 |
| | missing | 145 | 5.5 | 9.7 | 4.8 | 9.7 | 20.0 |
| Total | | 8,729 | 7.2 | 17.3 | 6.7 | 11.1 | 27.1 |

*1=wealthiest quintile, 5=least wealthy quintile

Table 2. Prevalence of illness burden, self-reported medical diagnosis, and treatment for angina, cataract, depression, diabetes and osteoarthritis in four waves of ELSA

| | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|---|---------------|-----------------|-------------------|-----------------|-----------------------|
| | N (%) | N (%) | N (%) | N (%) | N (%) |
| Illness burden | | | | | |
| Wave 2 (2004-5) | 397 (4.6) | 308 (3.5) | 2,037 (23.4) | 160 (1.8) | 1,106 (12.7) |
| Wave 3 (2006-7) | 300 (3.6) | 317 (3.8) | 1,929 (23.3) | n/a | 917 (11.1) |
| Wave 4 (2008-9) | 300 (3.1) | 331 (3.5) | 2,049 (21.4) | 220 (2.3) | 1,088 (11.4) |
| Wave 5 (2010-11) | 254 (2.9) | 320 (3.7) | 1,956 (22.4) | n/a | 1,046 (12.0) |
| Medical diagnosis | | | | | |
| Wave 2 (2004-5) | 668 (7.6) | 1,050 (12.1) | 402 (4.6) | 715 (8.2) | 1,861 (21.4) |
| Wave 3 (2006-7) | 591 (7.1) | 1,294 (15.7) | 490 (5.9) | 935 (11.3) | 1,952 (23.6) |
| Wave 4 (2008-9) | 645 (6.7) | 1,421 (14.8) | 601 (6.3) | 1,215 (12.7) | 2,262 (23.6) |
| Wave 5 (2010-11) | 655 (7.5) | 1,566 (17.9) | 602 (6.9) | 1,413 (16.2) | 2,416 (27.7) |
| Treatment | | | | | |
| Wave 2 (2004-5) | 85 (1.0) | 535 (6.2) | 98 (1.1) | 552 (6.4) | 202 (2.3) |
| Wave 3 (2006-7) | n/a | 379 (4.9) | n/a | 618 (7.5) | 141 (1.7) |
| Wave 4 (2008-9) | n/a | 444 (4.6) | 155 (1.6) | 671 (7.0) | 226 (2.4) |
| Wave 5 (2010-11) | 88 (1.0) | 646 (7.4) | n/a | 748 (8.6) | 208 (2.4) |
| Total number of participants in each wave: wave 2: 8,688; wave 3: 8,268; wave 4: 9,578; wave 5: 8,729 | | | | | |
| n/a = data not available for that condition in that wave | | | | | |

Table 3. Illness burden, self-reported medical diagnosis and treatment of angina, cataract, depression, diabetes and osteoarthritis, comparing the least wealthy with the most wealthy: logistic regression.

| | | Angina | Cataract | Depression | Diabetes | Osteoarthritis |
|---------------------------------------|-------------------|---------------------------|---------------------------|--------------------------|--------------------------|-----------------------------|
| Odds ratios (95% confidence interval) | | | | | | |
| Wave 2* (2004-5) | Illness burden | 5.6 (3.8, 8.3) | 7.2 (4.5, 11.5) | 5.1 (4.3, 6.2) | 4.4 (2.5, 8.0) | 11.0 (8.1, 14.9) |
| | Medical diagnosis | 2.9 (2.2, 3.9) | 1.3 (1.0, 1.6) | 4.8 (3.3, 7.0) | 3.1 (2.3, 4.2) | 1.6 (1.3, 2.0) |
| | Treatment | 2.6 (1.2, 5.7) | 1.5 (1.0, 2.2) | 0.6 (0.1, 2.9) | 0.7 (0.3, 1.5) | 1.1 (0.7, 1.9) |
| Wave 3* (2006-7) | Illness burden | 8.7 (5.5, 13.8) | 8.2 (5.1, 13.1) | 6.9 (5.7, 8.5) | | 12.7 (9.1, 17.8) |
| | Medical diagnosis | 4.9 (3.6, 6.8) | 1.2 (1.0, 1.5) | 0.7 (0.4, 1.4) | 3.4 (2.6, 4.4) | 0.6 (0.4, 0.8) |
| | Treatment | | 1.3 (0.8, 1.9) | | 1.2 (0.6, 2.4) | 1.0 (0.6, 1.9) |
| Wave 4* (2008-9) | Illness burden | 6.7 (4.2, 10.5) | 5.5 (3.6, 8.6) | 5.9 (4.9, 7.1) | 3.9 (2.4, 6.4) | 14.0 (10.3, 19.1) |
| | Medical diagnosis | 4.3 (3.2, 5.9) | 1.1 (0.9, 1.4) | 0.7 (0.4, 1.2) | 3.9 (3.1, 5.1) | 0.6 (0.4, 0.8) |
| | Treatment | | 1.1 (0.7, 1.6) | 2.4 (1.0, 5.9) | 0.2 (0.1, 0.6) | 1.0 (0.6, 1.6) |
| Wave 5* (2010-11) | Illness burden | 8.4 (5.1, 13.7) | 6.2 (3.9, 9.9) | 5.9 (4.8, 7.1) | | 16.0 (11.7, 21.8) |
| | Medical diagnosis | 5.3 (3.9, 7.3) | 1.3 (1.0, 1.5) | 1.7 (1.0, 2.8) | 4.3 (3.4, 5.4) | 0.6 (0.4, 0.8) |
| | Treatment | 3.3 (1.5, 7.3) | 1.8 (1.2, 2.6) | | 0.8 (0.4, 1.6) | 1.2 (0.7, 2.0) |
| Overall† | Illness burden | 7.6 (5.4, 10.8) | 8.0 (5.4, 11.9) | 6.4 (5.5, 7.5) | 4.2 (2.6, 6.8) | 15.1 (11.4, 20.0) |
| | Medical diagnosis | 4.5 (3.3, 6.0) | 1.3 (1.1, 1.5) | 3.3 (2.4, 4.5) | 4.0 (3.1, 5.2) | 1.1 (0.9, 1.3) |
| | Treatment | 3.2 (1.7, 6.0) | 1.3 (1.0, 1.8) | 2.6 (1.1, 6.1) | 0.9 (0.5, 1.4) | 1.2 (0.8, 1.6) |

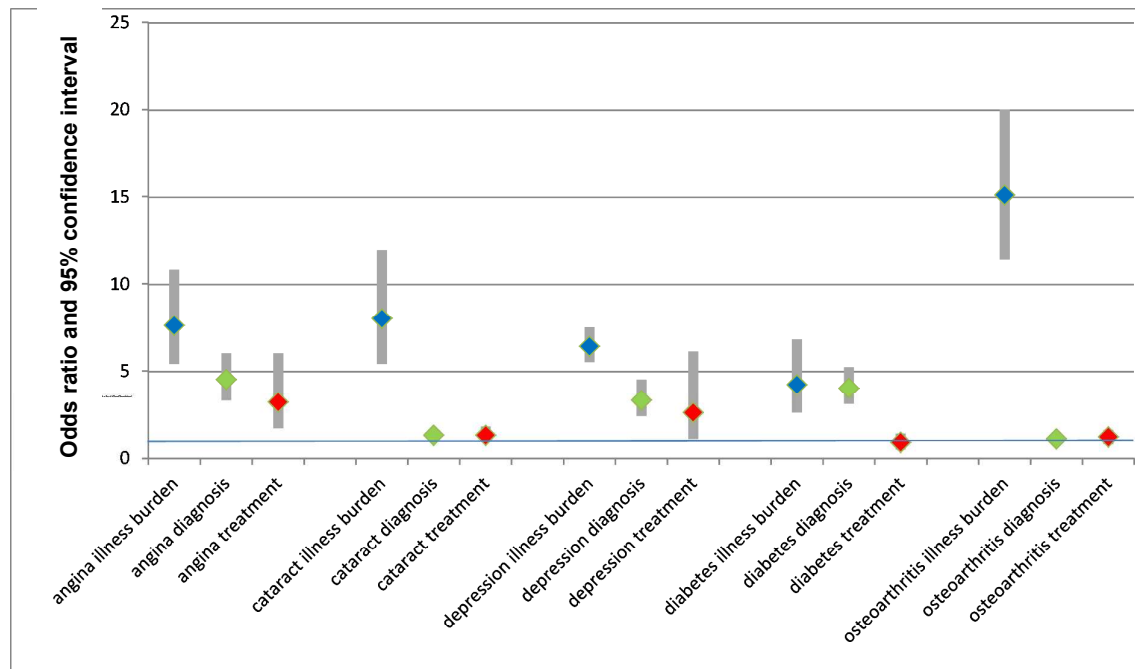
*Odds ratios adjusted for age group and sex

†Odds ratios adjusted for age group, sex and unique participant identifier

**Analyses for osteoarthritis excluded those younger than 60 years, as data on osteoarthritis treatment were only collected in those aged 60 or over.

Statistically significant odds ratios (where the 95% confidence intervals do not include 1) before rounding to one decimal place) are shown in bold

Figure 1. Illness burden (in blue), self-reported medical diagnosis (in green), and treatment (in red) of angina, cataract, depression, diabetes and osteoarthritis, comparing the least wealthy with the most wealthy: Overall odds ratios (adjusted for age and sex) and 95% confidence bars: [logistic regression](#) (~~binomial regression~~)



Discussion

We found that while there were strong inverse associations between wealth and the burden of illness (based on validated scales, symptoms and biomarker) of a long-term condition, there were smaller or absent inequalities in receipt of self-reported medical diagnosis or treatment for the conditions considered. This suggests that the substantially higher illness burden in less wealthy participants was not matched by appropriately higher levels of diagnosis and treatment, and that equitable receipt of a medical diagnosis may have an important role in reducing inequalities in health.

ELSA is a unique single source of detailed ~~longitudinal~~ data on socioeconomic status and health, and this is the first study to compare inequalities in illness burden, self-reported medical diagnosis and treatment of long-term conditions in a ~~longitudinal~~ panel study over time. ELSA used robust measures of individual socio-economic position, and standardised scales and blood biomarker to assess health status. This exploratory study has some limitations and the results should be interpreted with caution and tested in subsequent research. Whilst standardised measures were used to estimate the illness burden of depression, angina and diabetes, symptoms alone were used for osteoarthritis and cataract, and the attributed symptoms were not specific for osteoarthritis and cataract. However, this lack of specificity is unlikely to vary with wealth, and so is not likely to be an important source of bias. Self-reported data may be a source of bias if self-report varies by factors other than objective health status, such as wealth or social experience. This is a recognised problem with some self-reported morbidity data, but is less of a problem with sensory assessment for

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3 pain, which is essentially self-perceived, and where self-report is the best means of
4 assessment²⁶.

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6 We have not adjusted for health-related factors that are also more prevalent in poorer
7 populations, such as smoking, obesity and comorbidity, because none of these are a reason
8 for not making a diagnosis. Comorbid conditions are commoner in those with lower socio-
9 economic status, but there is no evidence that comorbidities make a new diagnosis less likely.
10 On the contrary, a higher number of comorbid conditions in older people may be associated
11 with higher quality of care²⁷. We found different patterns in different conditions, which fits
12 with other research showing that wealth acts differently in different conditions, and for
13 example, has no association with referral for post-menopausal bleeding²⁸. Major national
14 policy interventions such as the Quality and Outcomes Framework payment for performance
15 scheme in primary care²⁹ have been associated with improved healthcare for included
16 conditions such as angina and diabetes, more than for excluded conditions such osteoarthritis
17 and poor vision³⁰⁻³².

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20 The serial cross-sectional analysis of 4 waves of ELSA included all eligible participants in
21 each wave in order to maximise the sample size. This approach meant that some participants
22 with a diagnosed condition would no longer have had symptoms or raised biomarkers, if they
23 were being successfully treated. Examples would be diabetic participants whose blood sugar
24 levels were being successfully controlled by treatment, and participants with successfully
25 treated depression. We therefore checked our main results with the secondary (longitudinal)
26 analysis, which assessed subsequent diagnosis in those had met the criteria for 'illness
27 burden', and subsequent treatment in those with a medical diagnosis, but the number of
28 participants who could be followed through the waves in this way was too small to allow
29 meaningful conclusions to be drawn from the results.

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32 Our results fit with previous findings that a greater proportion of people in deprived groups
33 had Rose angina, but there was no difference in the proportions receiving a general
34 practitioner diagnosis of coronary heart disease¹⁴. Care-seeking behaviour and patient
35 preferences may differ with wealth. Given the same information, patients may want fewer
36 medical interventions than their doctors recommend^{33,34}, and pessimism about availability of
37 treatment may make older people reluctant to seek help³⁵. Older people may view living with
38 symptoms (such as pain, or emotional problems) as a normal part of ageing³⁶. The response
39 of the primary care physician may also vary with the wealth of the patient. For example, the
40 physician might be more likely to consider symptoms of breathlessness as a medical problem
41 requiring a diagnosis, whereas aches and pains, poor vision, and low mood might be
42 considered part of the tapestry of life, or the natural ageing process. Comorbidity is more
43 common in deprived populations, and may make diagnosis of all conditions harder for
44 doctors within the constraints of a short consultation³⁷.

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47 At a system level, the results may be partially explained by wealthier people living in areas
48 where there are more healthcare resources. Wennberg introduced the concept of 'supply-
49 sensitive care' to describe how the quantity of healthcare resources allocated to a particular
50 population was a major determinant of the frequency of use of health services by that
51 population, and gives an example in which 'a doubling of the supply of internists or
52 cardiologists results in roughly a halving of the interval between repeat visits'^{38,39}. Where
53 healthcare resources are relatively plentiful, patients with chronic diseases will consult more,
54 use more diagnostic tests, and be referred to hospital more. Further research could helpfully
55 investigate whether those missing out on diagnosis are not accessing health services, or are
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3 seeing a doctor but not being diagnosed. The participants were selected to be nationally
4 representative of the population of England, and so the findings are likely to be generalisable
5 to England, but not to countries with different healthcare systems. If validated, our findings
6 that inequalities in receipt of diagnoses are potential barriers to equitable healthcare for five
7 common long-term conditions, suggest that future policy interventions to reduce socio-
8 economic inequalities in healthcare should consider improving access to diagnosis as well as
9 treatment.
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15 **Funding statement:** This article presents independent research commissioned by the UK
16 National Institute for Health Research (NIHR) under the Health Services Research
17 programme: HSR Project 10/2002/06 – ‘The dynamics of quality: a national panel study of
18 evidence-based standards’. IL’s work was supported by the NIHR Collaboration for Applied
19 Health Research and Care (CLAHRC) for the South West Peninsula. The views expressed in
20 this publication are those of the authors and not necessarily those of the NHS, the NIHR or
21 the Department of Health.
22
23

24 **Competing interests:** All authors have completed the ICMJE uniform disclosure form at
25 www.icmje.org/coi_disclosure.pdf and declare: all authors had financial support from the
26 National Institute for Health Research for the submitted work, DM had financial support from
27 Age UK; no financial relationships with any organisations that might have an interest in the
28 submitted work in the previous three years; no other relationships or activities that could
29 appear to have influenced the submitted work.
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31

32 **Ethics approval:** The English Longitudinal Study of Ageing received ethics approval from
33 the National Research Ethics Service: 09/H0505/124. Participants gave informed consent
34 before taking part.
35

36 **Contributors:** NS contributed to the study design, oversaw data analysis and interpretation,
37 and drafted the paper. NS is guarantor. AH undertook data preparation, analysis and
38 interpretation, and contributed to drafting the paper. LM undertook data preparation and
39 analysis. MB and AC advised on statistical techniques. SR, JC and IL advised on data
40 analysis and interpretation. DM contributed to the study design and advised on data analysis
41 and interpretation. All authors contributed to data interpretation and revised the paper
42 critically.
43
44

45 **Acknowledgements:** Dave Stott and Amander Wellings, representatives of Public and
46 Patient Involvement in Research (PPIRes), brought a helpful lay perspective to this research.
47

48 **Data sharing:** The ELSA dataset and technical documentation are available from the UK
49 Data Service at: <http://discover.ukdataservice.ac.uk/catalogue?sn=5050>.
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Reference List

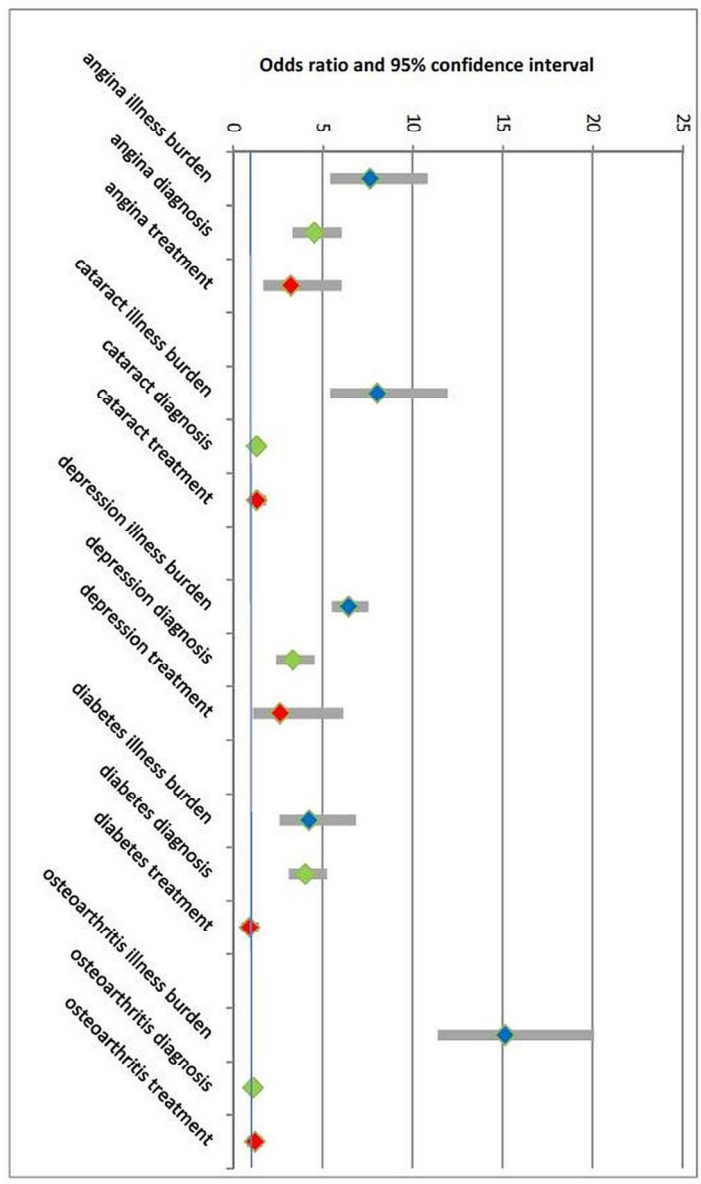
- 1
2
3
4
5 (1) Marmot M, Banks J, Blundell R, Lessof C, Nazroo J. Health, Wealth and Lifestyles of
6 the Older Population in England: the 2002 English Longitudinal Study of Ageing.
7 London: The Institute for Fiscal Studies; 2003.
8
- 9
10 (2) Börsch-Supan A, Brugiavini A, Jürges H, Mackenbach J, Siegris J, Weber G. Health,
11 Ageing and Retirement in Europe. First Results from the Survey of Health, Ageing
12 and Retirement in Europe. Mannheim: Mannheim Research Institute for the
13 Economics of Aging (MEA); 2005.
14
- 15 (3) Hemingway H, Shipley M, Macfarlane P, Marmot M. Impact of socioeconomic status
16 on coronary mortality in people with symptoms, electrocardiographic abnormalities,
17 both or neither: the original Whitehall study 25 year follow up. *J Epidemiol
18 Community Health* 2000; 54(7):510-516.
19
- 20 (4) Wilkinson R, Marmot M. Social determinants of health: the solid facts. 2nd edition
21 ed. Copenhagen: World Health Organisation; 2003.
22
- 23 (5) McKeown T. The role of medicine: dream, mirage or nemesis? 1 ed. London:
24 Nuffield Principal Hospital Trust; 1976.
25
- 26 (6) Bunker JP. The role of medical care in contributing to health improvements within
27 societies. *Int J Epidemiol* 2001; 30(6):1260-1263.
28
- 29 (7) Watt G. The inverse care law today. *Lancet* 2002; 360:252-4.
30
- 31 (8) Richards HM, Reid ME, Watt GCM. Socioeconomic variations in responses to chest
32 pain: qualitative study. *BMJ* 2002; 324(7349):1308.
33
- 34 (9) Gardner K, Chapple A. Barriers to referral in patients with angina: qualitative study.
35 *BMJ* 1999; 319(7207):418-421.
36
- 37 (10) Berger J, Mohr J. A fortunate man: the story of a country doctor. London: Penguin;
38 1967.
39
- 40 (11) Tod AM, Read C, Lacey A, Abbott J. Barriers to uptake of services for coronary heart
41 disease: qualitative. *BMJ* 2001; 323(7306):214.
42
- 43 (12) Chaturvedi N, Ben Shlomo Y. From the surgery to the surgeon: does deprivation
44 influence consultation and operation rates? *Br J Gen Pract* 1995; 45(392):127-131.
45
- 46 (13) Mahomed NN, Barrett JA, Katz JN, Phillips CB, Losina E, Lew RA et al. Rates and
47 outcomes of primary and revision total hip replacement in the United States medicare
48 population. *J Bone Joint Surg Am* 2003; 85-A(1):27-32.
49
- 50 (14) Richards H, McConnachie A, Morrison C, Murray K, Watt G. Social and gender
51 variation in the prevalence, presentation and general practitioner provisional diagnosis
52 of chest pain. *J Epidemiol Community Health* 2000; 54(9):714-718.
53
- 54 (15) Natcen Social Research. English Longitudinal Study of Ageing (ELSA) Wave One to
55 Wave Five User Guide. <http://www.esds.ac>
56
57
58
59
60

uk/doc/5050/mrdoc/pdf/5050_User_Guide_to_the_ELSA_Datasets_Waves_1_to_5
pdf [2012 [cited 2013 Sept. 28];

- (16) Scholes S, Taylor R, Cheshire H, Cox K, Lessof C. Retirement, health and relationships of the older population in England: The 2004 English Longitudinal Study of Ageing. Technical Report P2808. London: National Centre for Social Research; 2008.
- (17) Steel N, Melzer D, Gardener E, McWilliams B. Need for and receipt of hip and knee replacement--a national population survey. *Rheumatology* 2006;(45):1437-1441.
- (18) Evans JR, Fletcher AE, Wormald RPL, Siu-Woon Ng E, Sterling S, Smeeth L et al. Prevalence of partial sight and blindness in people aged 75 years and older in Britain: results from the MRC trial of assessment and management of older people in the community. *Br J Ophthalmol* 2002; 86:795-800.
- (19) Congdon N, O'Colmain B, Klaver CCW, Klein R, Munoz B, Friedman DS et al. Causes and Prevalence of Partial sight and blindness among adults in the United States. *Arch Ophthalmol* 2004; 122:477-485.
- (20) Steel N, Melzer D, Shekelle PG, Wenger NS, Forsyth D, McWilliams BC. Developing quality indicators for older adults: transfer from the USA to the UK is feasible. *Quality and Safety in Health Care* 2004; 13(4):260-264.
- (21) Steel N, Bachmann M, Maisey S, Shekelle P, Breeze E, Marmot M et al. Self reported receipt of care consistent with 32 quality indicators: National population survey of adults aged 50 or more in England. *BMJ* 2008; 337:a957.
- (22) Wagstaff A, Paci P, Van Doorslaer E. On the measurement of inequalities in health. *Soc Sci Med* 1991; 33(5):545-557.
- (23) Bachmann MO, Eachus J, Hopper CD, Davey SG, Propper C, Pearson NJ et al. Socio-economic inequalities in diabetes complications, control, attitudes and health service use: a cross-sectional study. *Diabet Med* 2003; 20(11):921-929.
- (24) Banks J, Breeze E, Lessof C, Nazroo J. Retirement, health and relationships of the older population in England: The 2004 English Longitudinal Study of Ageing (Wave 2). London: The Institute for Fiscal Studies; 2006.
- (25) Cheshire H, Hussey D, Medina J, Pickering K, Wood N, Ward K et al. Financial circumstances, health and well-being of the older population in England: The 2008 English Longitudinal Study of Ageing. Wave 4 Technical Report. London: National Centre for Social Research; 2012.
- (26) Sen A. Health: perception versus observation. *BMJ* 2002; 324(7342):860-861.
- (27) Min LC, Reuben DB, MacLean CH, Shekelle PG, Solomon DH, Higashi T et al. Predictors of Overall Quality of Care Provided to Vulnerable Older People. *J Am Geriatr Soc* 2005; 53(10):1705-1711.
- (28) McBride D, Hardoon S, Walters K, Gilmour S, Raine R. Explaining variation in referral from primary to secondary care: cohort study. *BMJ* 2010; 341.

- 1
2
3 (29) NHS Employers and the General Practitioners Committee. Quality and Outcomes
4 Framework for 2012/13. Guidance for PCOs and practices. London: NHS Employers;
5 2012.
6
7 (30) Gillam S, Steel N. The Quality and Outcomes Framework: where next? BMJ 2013;
8 346.
9
10 (31) Gillam SJ, Siriwardena AN, Steel N. Pay-for-Performance in the United Kingdom:
11 Impact of the Quality and Outcomes Framework - A Systematic Review. The Annals
12 of Family Medicine 2012; 10(5):461-468.
13
14 (32) Steel N, Maisey S, Clark A, Fleetcroft R, Howe A. Quality of clinical primary care
15 and targeted incentive payments: an observational study. Br J Gen Pract
16 2007;(57):449-454.
17
18 (33) Steel N. Thresholds for taking antihypertensive drugs in different professional and lay
19 groups: questionnaire survey. BMJ 2000; 320:1446-7.
20
21 (34) Montgomery AA, Fahey T. How do patients' treatment preferences compare with
22 those of clinicians? Quality in health care 2001; 10 (Suppl I):i39-i43.
23
24 (35) Sanders C, Donovan JL, Dieppe PA. Unmet need for joint replacement: a qualitative
25 investigation of barriers to treatment among individuals with severe pain and
26 disability of the hip and knee. Rheumatology 2004; 43(3):353-357.
27
28 (36) Murray J, Banerjee S, Byng R, Tylee A, Bhugra D, Macdonald A. Primary care
29 professionals' perceptions of depression in older people: a qualitative study. Social
30 Science & Medicine 2006; 63:1363-73.
31
32 (37) Mercer SW, Guthrie B, Furler J, Watt G, Tudor Hart J. Multimorbidity and the
33 inverse care law in primary care. BMJ 2012; 344.
34
35 (38) Wennberg JE. Understanding Geographic Variations in Health Care Delivery. The
36 New England Journal of Medicine 1999; 340(1):52-53.
37
38 (39) Wennberg JE. Unwarranted variations in healthcare delivery: implications for
39 academic medical centres. BMJ 2002; 325(7370):961-964.
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41
42
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44
45
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Supplemental file 1

Supplemental Table 1. Odds ratios for meeting the ‘illness burden’ criteria for angina, cataract, depression, diabetes and osteoarthritis, medical diagnosis for those estimated to have a condition, and treatment for those with a diagnosis, comparing the least wealthy with the most wealthy: binomial regression

| Condition | Adjusted odds ratios* (95% CI) | | | |
|----------------|--------------------------------|----------------------------------|-----------------------|-----------------|
| | Illness burden (Wave 3) | Medical diagnosis (Wave 4) | Treatment (Wave 5) | N in treatment† |
| Angina | 8.7 (5.5, 13.8) | 1.4 (0.5, 4.0) | 1.6 (0.3, 9.0) | 11 |
| Cataract | 8.2 (5.1, 13.1) | 1.0 (0.3, 3.1) | 2.2 (1.2, 3.8) | 83 |
| Osteoarthritis | 12.7 (9.1, 17.8) | 0.7 (0.3, 1.6) | 0.7 (0.3, 1.6) | 30 |
| | Adjusted odds ratios* (95% CI) | | | |
| | Illness burden (Wave 2) | Medical diagnosis (Wave 3) | Treatment (Wave 4) | N in treatment† |
| Depression | 5.1 (4.3, 6.2) | 0.4 (0.1, 1.4) | 17.3 (0.5, 604) | 12 |
| Diabetes | 4.4 (2.5, 8.0) | 0.1 (0.0, 3.6) | 0.5 (0.2, 1.1) | 99 |

*adjusted for age group and sex

†followed through the waves

Waves used in analysis were the most recent with available data

Odds ratios where the 95% confidence intervals do not include 1 (before rounding to one decimal place) are shown in bold

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

| Section/Topic | Item # | Recommendation | Reported on page # |
|------------------------------|--------|--|--------------------|
| Title and abstract | 1 | (a) Indicate the study's design with a commonly used term in the title or the abstract | 1&2 |
| | | (b) Provide in the abstract an informative and balanced summary of what was done and what was found | 2 |
| Introduction | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 4 |
| Methods | | | |
| Study design | 4 | Present key elements of study design early in the paper | 4-6 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 4-5 |
| Participants | 6 | (a) Give the eligibility criteria, and the sources and methods of selection of participants | 4-6 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 5 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5 |
| Bias | 9 | Describe any efforts to address potential sources of bias | 6 |
| Study size | 10 | Explain how the study size was arrived at | 6 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 6 |
| Statistical methods | 12 | (a) Describe all statistical methods, including those used to control for confounding | 6 |
| | | (b) Describe any methods used to examine subgroups and interactions | 6 |
| | | (c) Explain how missing data were addressed | 6 |
| | | (d) If applicable, describe analytical methods taking account of sampling strategy | 6 |
| | | (e) Describe any sensitivity analyses | 6 |
| Results | | | |

| | | | |
|--------------------------|-----|--|-------|
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 6-8 |
| | | (b) Give reasons for non-participation at each stage | 6-8 |
| | | (c) Consider use of a flow diagram | |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 7 |
| | | (b) Indicate number of participants with missing data for each variable of interest | |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 8 |
| Main results | 16 | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 7-9 |
| | | (b) Report category boundaries when continuous variables were categorized | 7 |
| | | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 7 |
| Discussion | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 10 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 10-11 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 11 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 11-12 |
| Other information | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 12 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.