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Birth-cohort trends in older-age functional disability and their relationship with socio-economic status: Evidence from a pooling of repeated cross-sectional population-based studies for the UK

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Birth-cohort trends in older-age functional disability and their relationship with socio-economic status: Evidence from a pooling of repeated cross-sectional population-based studies for the UK

Abstract

We examine birth-cohort trends behind recent changes in the prevalence of functional disability in the older population living in private households in the United Kingdom (UK). By using three different socio-economic indicators available in the nationally representative cross-sectional data on older individuals interviewed between 2002 and 2012 in the Family Resource Survey (FRS) (96,733 respondents), we investigate the extent to which the overall trends have been more favourable among more advantaged than disadvantaged socioeconomic groups.

Compared to the cohort of people born in 1924, successive cohorts of older men have lower odds of having at least one functional difficulty (FD), whereas no significant trend was found for women. Among people with at least one FD, however, the number of disabilities increases for each successive cohort of older women (incidence rate ratio 1.027, 95% confidence interval 1.023 to 1.031, P<0.001) and men (incidence rate ratio 1.028, 95% confidence interval 1.024 to 1.033, P<0.001). By allowing interactions between birth cohort and SES indicators, a significant increasing cohort trend in the number of reported FDs was found among older men and women at lower SES, whereas an almost stable pattern was observed at high SES. Our results suggest that the overall slightly increasing birth-cohort trend in functional difficulties observed among current cohorts of older people in the UK hides underlying increases among low SES individuals and a relative small reduction among high SES individuals. Further studies are needed to understand the causes of such trends and to propose appropriate interventions. However, if the SES differentials in trends in FDs observed in the past continue, this could have important implications for the future costs of the public system of care and support for people with care needs.

Keywords: Disability; Older people; Socio-economic status; birth-cohort trends; UK

1. Introduction

Increasing life expectancy and the ageing of the baby-boomer generation mean that the size of the over-65 population is projected to rise significantly in many developed countries. Older people are heavy users of care services (Colombo et al., 2011; Karlsson et al., 2006) and the increase in their number is likely to affect the future sustainability of public programmes of care and support (Comas-Herrera et al., 2010; Gleckman & Fund, 2010; Office for Budget Responsibility, 2013; Wittenberg et al., 2011). Although the size of the older population influences future social care costs, it is the difficulties in undertaking basic activities for self-care that are the major drivers of the need for support. A crucial question for researchers and policymakers is therefore whether projected gains in longevity will be accompanied by an expansion or a contraction in disability-free life expectancy and hence in the number of disabled older people and the demand for care services (Crimmins, 2004; Martin et al., 2010; Robine et al., 2003).

The concept of disability is complex and there is no single agreed definition which suits all purposes (Altman, 2001; Lawton & Lawrence, 1994; Murray & Chen, 1992; WHO, 2002). The presence of difficulties in performing everyday activities is often used to operationalise the concept of disability where the purpose is to determine the need for care services. In the US, a substantial decline among older people with such disability was documented from the mid-1980s to the late 1990s (Freedman et al., 2004), despite evidence of increases in chronic conditions (Freedman & Martin, 2000). More recently, while the 85+ population still displays a declining trend in disability, the overall trend for those aged 65–84 was flat during 2000-2008, with a modest increase in rates of disability for the new cohorts approaching later life (Freedman et al., 2013; Martin et al., 2010). There are several reasons why disability may differ across successive cohorts, controlling for age and other relevant characteristics. Advances in medicine, technology and access to public health programs, increased safety at

work and a lower proportion of the workforce in manual jobs could reduce disability, whereas increasing exposure to risk factors such as obesity might increase it (Martin et al., 2010; WHO, 2011). The observed prevalence of disability can also increase if the life-expectancy of successive cohorts of people disabled earlier in life increases, even if the age of onset of disability is stable (Crimmins et al., 2009; Jarvis & Tinker, 1999).

Disparities in health and disability among older people have been widely documented in relation to various measures of socio-economic status (SES) (for reviews see Feinstein, 1993; WHO, 2014). Where the objective is to draw conclusions for policy aimed at reducing SES-related inequities, the choice of SES measure may be crucial (Deaton, 2002). A widely used indicator of SES in assessing trends in disability and SES inequalities is educational attainment (Martin et al., 2012; Schoeni et al., 2006; Sulander et al., 2006; Zaninotto et al., 2010). A causal relation with disability is hypothesised in which more-educated people adopt better lifestyles and health behaviours (Grundy & Holt, 2001), which are not observed in most nationally representative surveys (Freedman & Martin, 1999). Since individuals' education levels typically change little after a certain age, education is well suited for projection purposes (Mazzaferro et al., 2012) and is linked with many life-course determinants of later life SES such as occupation, income and wealth accumulation (Duncan, 1961). However, the distribution of educational attainment among today's older people is likely to be highly skewed since the majority left school at the minimum permitted age (Martelin, 1994). Educational attainment may therefore discriminate only between the most advantaged and the rest of the older population. There are also reasons to supplement educational attainment with measures which capture a more "materialistic" theoretical pathway (Alwan et al., 2007; Grundy & Holt, 2001) in which older people's disability depends on their economic circumstances measured by indicators such as income and wealth. In developed countries like the UK, public assistance to disabled people is partly determined

by their income and wealth. Therefore, the financial circumstance of disabled people is a determinant of future public social care costs.

Moreover the current financial circumstances of older people generally reflect lifetime access to economic resources and are more important correlates of physical disability than position in earlier adulthood (education, occupation or social class (Costa-Font, 2008; Gjonca et al., 2009; Knesebeck et al., 2003)). However, indicators of current financial circumstances are relatively limited in health surveys, difficult to collect and may be influenced by, as well as influencing, health or disability (Adda et al., 2003; Goldman, 2001; Grundy & Holt, 2001; Smith & Kington, 1997). To date, only two studies have used income to document trends in disability or health, both with repeated cross-sectional data. A US study (Schoeni et al., 2005) found that, during the 1990s, those who benefited most from reductions in disability were individuals in the highest quintile of the income distribution whereas no improvements were found for those who belonged to the lowest quintile. In Europe (Kunst et al., 2005), the relationship between self-rated health and SES measured by educational attainment by cohort of birth was almost stable in the 1980s and 1990s. However, when household equivalent income was used as the measure of SES, inequalities in self-rated health increased.

Our study examines birth-cohort trends in functional difficulties (FDs) among older people in the UK, assessed from self-reported difficulties in eight domains of FD, using a repeated large-scale population survey over a 10 year period. By exploiting the range of SES indicators in the data (measures of educational attainment, income components, and home-ownership), we can quantify the relative strength of the association of each with functional disability and investigate whether the overall trends observed among women and men born between 1924 and 1945 have favoured more advantaged socioeconomic groups. We aim to assess whether there are cohort trends differing by SES, which would have implication for future social care costs.

2. Methodology

2.1. Study population

We used pooled annual samples from the UK Family Resource Survey (FRS) covering 2002/3 to 2011/12. The FRS is a large-cross sectional survey, sponsored by the Department for Work and Pensions (DWP) and used to derive official statistics on income, poverty and welfare and disability program targeting (Department for Work and Pensions, 2013; Kasparova et al., 2007). Each cross-section survey uses the Postcode Address File (PAF) as a sampling frame, and data are collected mainly by face-to-face interviews, performed by trained interviewers, from a large representative sample of individuals (on average about 45 thousand individuals aged 16+ per year) living in private households in the UK. The FRS has an overall response rate of around 60 percent (Department for Work and Pensions, various years) and data were adjusted for possible differential non-response using weights constructed by DWP. Analysis was conducted for respondents aged over 65 and born before 1945. To protect confidentiality, age was top-coded at the age of 80, necessitating exclusion of those born before 1924. After deleting a few cases with relevant information missing, a sample of 96,733 was selected. We split the analysis by gender and control for within-UK country of residence.

2.2. Functional Disability

FRS respondents were asked the following question: '*Do you have any long-standing illness, disability or infirmity? By 'long-standing' I mean anything that has troubled you over a period of at least 12 months or that is likely to affect you over a period of at least 12 months*'. Those who answered '*yes*' were then asked if '*these health problem(s) or disability(ies) mean that you have substantial difficulties with any of these areas of your life*': mobility (moving

about); lifting, carrying or moving objects; manual dexterity (using your hands to carry out everyday tasks); continence (bladder and bowel control); memory or ability to concentrate, learn or understand; recognising when you are in physical danger; physical co-ordination (e.g.: balance); other health problem or disability. We defined respondents as disabled if they reported functional difficulty (FD) in at least one domain of life due to long-standing illness, disability or infirmity, and as not disabled if they reported no FDs or did not report having a long-standing illness, disability or infirmity (LSI). The number of reported FDs was used as an index of the severity of disability among those defined as disabled.

The use of a screen to precede a disability question raises the possibility of misclassifying some people with FDs who do not see themselves as having a 'condition'. There is evidence on this from a randomized experiment in the *Understanding Society* survey (Al-Baghal, 2014; Jäckle & Pudney, 2015), where the screening question was found to reduce measured disability prevalence by up to 20% (6 percentage points) in the whole adult sample. However, individuals who answered 'no' to the screening question but then reported any FDs, on average reported fewer than half the number of FDs than those who answered 'yes' to the screen (1.27 compared to 2.69). Thus the design of the FRS instrument is less sensitive to mild disability than instruments with no screening question. Whether this represents a 'bias' is arguable, but it should be borne in mind when interpreting our results.

2.3. Covariates

The sample was divided into birth-cohorts, with some cohorts observed for longer than others because of the age restriction. Table 1 presents a Lexis diagram for the observed 21 birth-cohorts by age and year of the interview. To identify age and cohort effects, we make the usual assumption that they are dominant and that period effects come primarily from transient events occurring randomly through time; such events would be absorbed in the residual term in statistical models, allowing cohort and age effects to be isolated. If period effects actually

have a trend for some reason, it would be necessary to reinterpret our estimates of the cohort trend as a composite of the cohort and period effects (but note there would be no distortion of the SES gradient if any period effects are uniform across SES groups).

As indicators of SES, we used level of education (compulsory education versus post-compulsory education), home ownership and household income. It is not straightforward to define an appropriate measure of income to capture SES in relation to disability. There are two forms of 'endogeneity' to be considered. The individual's history of economic opportunity and behaviour may have jointly influenced later-life health and income. This cannot plausibly be addressed in a sequence of cross-sections (or with any other observational data except under strong assumptions). In this study, we are interested in documenting the evolution of disability in relation to social position rather than searching for an (arguably unattainable) causal model of that relationship, which – in any case – is irrelevant for the design of public policies to support those with care needs. If the number of low-income people becoming disabled is projected to rise, that has important policy implications, whatever the underlying joint cause of low-income and disability.

The second link between current income and disability is a direct institutional link. In the UK, anyone with sufficiently severe disability qualifies for a non-means-tested income supplement by virtue of that disability alone. That component of income has little connection with pre-disability income or social position and little value as an indicator of SES. Hancock et al. (2015) and Hancock & Pudney (2014) point out the misleading conclusions that can result from including disability-triggered benefit in the income variable used to classify individuals without also subtracting the extra costs of disability that it is designed to offset. Consequently we exclude cash benefits paid by the state to offset the extra costs of disability, and our income variable was constructed as the sum of wages and salaries, self-employment income, public pensions, non-disability social security income and capital income (interest,

rent, dividends, private pensions and annuities), net of income tax. Note that pensions and income from capital represent returns on assets accumulated over the lifecycle and are consequently good indicators of past access to resources with an expected cumulative positive influence on health, as is home ownership, (Morciano et al., 2014).

Income is aggregated across household members and divided by the square root of household size. This equivalization method is widely used (Burniaux et al., 1998; OECD, 2011). Since most households in our analysis consist of one or two adults, other conventional scales, such as the OECD modified equivalence scale (OECD, 2011), would not yield substantially different results.

2.4. Statistical analysis

When the data are in count form, the Poisson regression model and its extensions are more appropriate than standard regression analysis (Zaninotto & Falaschetti, 2011). We estimated Zero-Inflated Negative Binomial (ZINB) models (using STATA 13/MP) to allow for the high incidence of zeros (individuals without FDs) and high variance of the outcome variable (see Figure 1) which invalidates standard Poisson regression (Lambert, 1992; Mullahy, 1986). The ZINB specification is a mixture model; it uses a logistic mechanism to distinguish two unobservable subpopulations in the sample: a group who have no disability and thus never report any FD; and another group with some degree of disability who may (but may not) report one or more FDs in the survey interview. Thus a zero FD count can occur in one of two ways – as an accurate report by a non-disabled person, or as a response by a person with some disability who feels at the time of interview that the consequent difficulties are not sufficiently serious to justify reporting. The two components of the ZINB model are: (*i*) the binary logistic mechanism to distinguish the (potential) disability-reporters and (*ii*) a negative binomial regression model for the count of FDs actually reported by the latter group. The

"overdispersion" of the negative binomial component can be rationalised formally as the effect of unobserved individual heterogeneity with a gamma distribution (Cameron & Trivedi, 2010).

The income distribution is approximately lognormal, so we follow common practice and use income in log transformed form. To simplify exposition of results, the birth-cohort indicator is set to 1 for the first birth cohort in our sample (the 1924 cohort) and increased by 1 for each successive cohort. In the baseline model (model A), birth cohort was entered linearly to assess the presence of birth-cohort shifts. We checked for the presence of SES-specific paths by birth cohort by introducing terms for interactions between birth cohort and each SES indicator (model B). Finally, predicted probabilities from model B were used to inspect graphically birth-cohort trends according to SES.

3. Results

3.1. Descriptive statistics

Table 2 shows the main characteristics of the study population disaggregated by gender. Gender differences were almost all significant at the 1% level. Despite their marginally lower prevalence of LSI, women reported higher FD prevalence and severity than men ($p<0.001$). They also reported higher prevalence of the four most common types of FD (mobility, lifting, dexterity and co-ordination), while three less common types (incontinence, communication and memory) were reported a little more frequently by men. There was no statistically significant gender difference in the least common FD: the inability to recognize physical danger.

The sample median age was 73 (men) and 74 (women). Mean household income (expressed in 2012 prices) was £367 per week (men) and £321 (women). The majority of respondents

were homeowners (80% men; 76% women), most had a post-compulsory school qualification (67% men; 65% women), and most were resident in England (84%).

Table 3 shows significant socio-economic differentials in the prevalence of FDs ($p<0.001$). The proportions reporting at least one FD, four or more FDs and the average number of reported FDs amongst those with at least one FD, were all higher among people without post-compulsory education, non homeowners and those in the poorest quartile of the income distribution.

Table 4 reports the prevalence and severity of FD, and means of the SES variables by birth-cohort and age group. For each age group, apart from 80+, disability was slightly less prevalent in successive birth cohorts but, among those reporting disability, its severity increased significantly for successive cohorts in all age groups. Successive birth cohorts displayed significant improvements in SES, mainly in the percentage of individuals with post-compulsory education.

3.2. Regression results

Gender-specific models were estimated to allow for differences in the reporting of FDs (Crimmins et al., 2011; Oksuzyan et al., 2010; Zaninotto et al., 2010). Table 5 reports the two parts of the ZINB model for each covariate as: (*i*) the odds ratio for the existence of disability; and (*ii*) a measure known as the incidence rate-ratio (IRR) which gives the proportionate impact of a 1-unit increase in the covariate on severity, conditional on being in the potentially disabled group. For both measures, a value greater that one indicates that the covariate has a positive effect on the expected number of FDs, holding other covariates constant. Note that the overdispersion of FDs is statistically significant at the 1% level, justifying the use of the more complex ZINB model rather than Poisson regression.

In model A, prevalence increases significantly with age ($p<0.001$), as does the severity of disability (IRRs 1.046 for men and 1.040 for women, p-values<0.001). Contrasting model A with a simpler age and birth cohort model (not shown), the addition of SES covariates reduces the significance and magnitude of the birth-cohort coefficient. There is clear evidence of a negative gradient of disability prevalence and severity with all three SES indicators ($p<0.001$), with the single exception that severity of disability is not statistically associated with income.

There is some geographical variation within the UK; compared to residents of England, people in Wales were more likely to report disability ($p<0.001$), and severity was also higher for women in Northern Ireland. We found no significant difference between England and Scotland in terms of prevalence or severity.

Birth cohort effects are our main focus. The results for model A suggest that being born one year later is associated with a reduction in the probability of disability for men (odds ratio 0.972, p-value<0.001), with no significant trend for women. However, significant positive birth-cohort trends in severity were found for both women and men (IRRs 1.027 and 1.028, p-values<0.001), indicating that, while the prevalence of functional disability may be lower in successive birth cohorts, its severity is increasing significantly.

Model A gives an unduly simple picture of disability trends. We tested for the presence of SES-related birth-cohort trends, by adding interactions between birth cohort and each of the SES indicators (model B). This model fits the data very much better (likelihood ratio tests: p-value<0.001 for male and female samples) and indicates significant birth-cohort trends which differ substantially by SES, particularly as measured by income.

3.3. Illustrative model predictions

To aid the interpretation of model B, we compare its implications for three hypothetical groups of men and women aged 73 and living in England: at the 25th (low SES), 50th (median SES) and 75th (high SES) percentiles of the income distribution (Figure 2). Both median and high SES individuals have post-compulsory education and are homeowners. The low SES individuals have only compulsory education and are not homeowners. These simulations take account of both the prevalence and severity parts of the ZINB model and capture the overall SES-specific trends in the predicted number of FDs across birth cohorts. For the low SES male and female groups, the trend in the predicted number of FDs across birth cohort is steeply rising. For the median SES male and female groups there is only a slight upward trend while, for the high SES groups, the trend is flat for women and slightly downward for men.

4. Discussion

Our aim is to investigate birth-cohort trends in self-reported functional difficulties among older adults, as observed in 10 years (2002-2012) of a large household-population survey, representative of the UK population of non-institutionalised people. Overall, we found no evidence of birth-cohort trends in the prevalence of FD among women born between 1924 and 1945 but a significant falling trend among men. For those with disability, we found significant evidence of an increasing trend for men and women in the severity of disability as measured by the number of functional difficulties. Birth-cohort trends in FDs are SES related and SES inequalities in FDs have increased among successive cohorts of non-institutionalised older people.

Looking ahead, increasing life expectancy and the ageing of the baby-boomer generation means the over-65 UK population is projected to increase from around 10 million observed in 2010 to about 17 million in 2035 (Office for National Statistics, 2011). If the SES-differential

trends in FDs observed in our study continue, we will see an expansion of disability among older people from low SES groups but a stable pattern among older people from higher SES groups. This has important implications for the division between the state and the individual of the costs of care and support for people with care needs, since low-SES people with disabilities are less likely to have private financial resources and are thus more likely to be entitled to public provision of services under the UK means-tested care system. Previous projections of the public cost of long term care in the UK have not taken this cohort trend into account (Karlsson et al., 2006; Pickard et al., 2007; Wittenberg et al., 2011), and it could counteract other trends, such as increases in home ownership, which underlie recent projections of falling proportions of older people entitled to public support.

4.1. What this study adds

To assess the robustness of association between functional difficulties and SES and the presence of SES-related birth-cohort effects, we used three different indicators which enable us to quantify the relative impact of each separate dimension of SES on functional disability. As far we are aware, this is the first study that has documented significant diverging birth-cohort trends among high and low socioeconomic groups for the UK, controlling jointly for individual's level of education, income and home-ownership. We found that the statistical significance of the interactions of birth cohort and current income are greater than those of the interactions with educational attainment, in particular for women. Identifying the driving forces behind changes in the prevalence of functional disability is important for defining preventive strategies and making projection about the possible future costs of the public system of care and support for older people with care needs.

4.2. Strengths and limitations of the study

The study pooled ten repeated cross-sections to estimate SES-specific cohort trends in functional difficulties in the older UK population. The FRS has a large sample size and is representative at the national level, so it is well suited for making inferences about the population of older people living in private households in the UK. Its detailed income information makes it a valuable data source for studying the SES gradient in functional difficulties. In contrast to other health-related surveys commonly used in the analysis of SES-related health inequality, it enabled us to construct an income measure which excludes a component (cash disability benefit) which is a major source of spurious correlation with disability. This improves the validity of our income indicator of social position.

Our statistical approach exploited data on the number of functional difficulties, avoiding the common practice of collapsing count data to a few categories or a dichotomous variable and using ordinal or binary regression analysis, with a consequent waste of information and dilution of statistical power (Gardner et al., 1995).

Nevertheless, there are some limitations. First, the cross-sectional nature of the data impedes causal inference, although our estimates provide information about the factors and trends associated with FDs, without limiting the analysis to a specific view of the chain of causality.

Second, our FD severity index is necessarily zero for those who did not report LSI or who did not attribute their FD to LSI. Thus our disability measure is likely to exclude short-term FDs and disabilities which respondents do not consider to cause significant FDs. Any differences across cohorts in reporting LSI or in perceived FDs conditional on reporting a LSI could affect the interpretation of our findings. To investigate this further, we used a probit model with sample selection, finding that the probability of reporting LSI was not associated with birth cohort for women ($p= 0.207$) or men ($p= 0.438$) in contrast with a declining birth-cohort trend in the probability of being free of FD (odds-ratio 0.976 for women and 0.987 for men,

p<0.001) conditional on reporting LSI, so this possible limitation of the FRS design does not appear to have a large impact.

Third, our data cover only the private household population. Some of the most severely disabled people live in care homes and there is evidence that some aspects of socioeconomic advantage (e.g. home-ownership) reduce the risk of care home entry (Hancock et al., 2002). If there were a substantial decrease in the proportion of the older population in care homes, it would partly explain the trends reported here. However, comparison of the 2001 and 2011 Census of the UK population shows that the (small) percentage of people over 65 resident in 'medical and care' establishments fell only very slightly from 3.8% to 3.3% (calculated from 2001 and 2011 Census data of Scotland, Northern Ireland, England and Wales). Even if all of this reduction consisted of low SES individuals, it would explain only a very small part of the trends we find for the household population.

Fourth, to protect confidentiality, the age of FRS respondents was top coded at 80+, preventing us from extending the analysis to those born before 1924.

Fifth, despite its other advantages, the FRS does not collect information on specific diseases and associated risk factors needed to understand the reasons for the observed birth-cohort trends.

Finally, as in many other studies, the analysis relies on the reliability of self-reported disability. In the absence of objective measures of disability or anchoring vignettes (d'Uva et al., 2011; King et al., 2004) we are not able to investigate the possibility that SES differences in reporting disability have changed across birth cohorts.

Conclusion

This study shows that birth-cohort trends in functional difficulties among older people in the UK born between 1924 and 1945 have been diverging by socio-economic status: a stable or

slightly declining cohort trend was observed for high SES, while a clear upward disability trends was found among low SES individuals. These divergent trends have generally been neglected in projections of the division of future social care costs between the individual and the state. Our results are strengthened by being based on analysis which used three different indicators of SES including an appropriately constructed income measure made possible by the comprehensive recording of income components in our data source. Further research is needed to understand the causes and to propose appropriate interventions.

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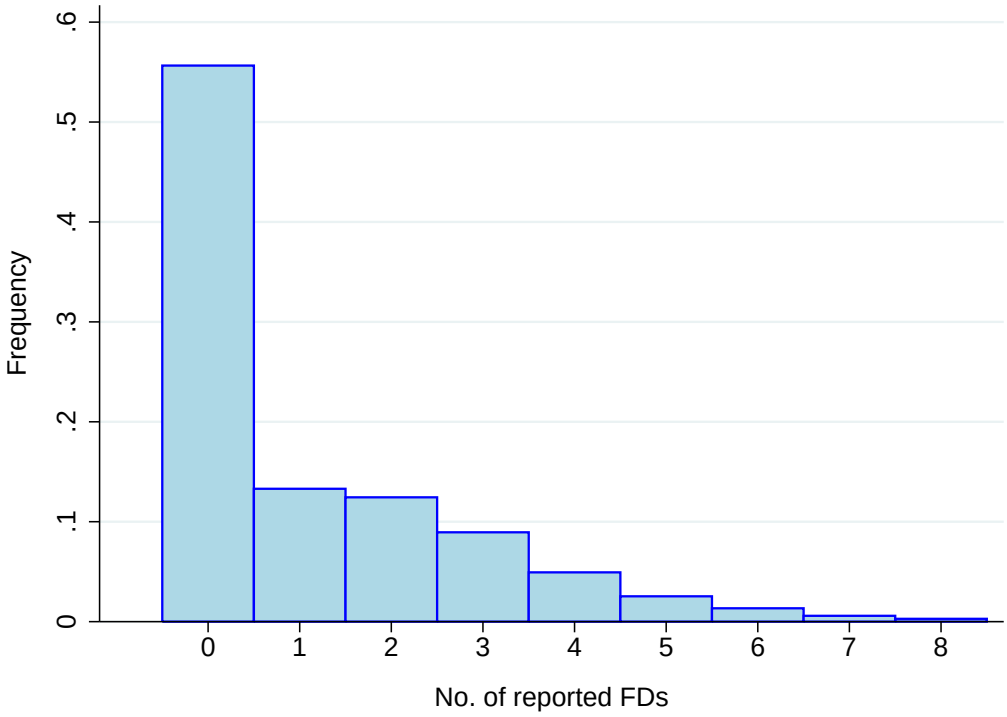
Table 1: Lexis diagram of the observed Cohorts by age and year of the interview

Cohort of birth	age 65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80+
1924														2002	2003	2004
1925													2002	2003	2004	2005
1926												2002	2003	2004	2005	2006
1927											2002	2003	2004	2005	2006	2007
1928										2002	2003	2004	2005	2006	2007	2008
1929									2002	2003	2004	2005	2006	2007	2008	2009
1930								2002	2003	2004	2005	2006	2007	2008	2009	2010
1931							2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1932						2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1933					2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
1934				2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012		
1935			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012			
1936		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012				
1937	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012					
1938	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012						
1939	2004	2005	2006	2007	2008	2009	2010	2011	2012							
1940	2005	2006	2007	2008	2009	2010	2011	2012								
1941	2006	2007	2008	2009	2010	2011	2012									
1942	2007	2008	2009	2010	2011	2012										
1943	2008	2009	2010	2011	2012											
1944	2009	2010	2011	2012												
1945	2010	2011	2012													

Source: Data on 65+ respondents born between 1924-1945, interviewed in the FRS survey from 2002/3-2011/12.

Figure 1: Distribution of the number of reported FDs in the sample



Notes: Mean=1.120; Variance=1.599; Overdispension index=(variance-mean)/mean=0.43.

Table 2: Functional Difficulties (FDs) and selected socio-economic indicators in the pooled sample of FRS.

	Men		Women		
	mean	standard error	mean	standard error	Difference
Presence of a long standing illness, disability or infirmity	61.4%	0.487	60.9%	0.488	0.0106***
Presence of individual FD (as proportion of total sample)					
Mobility	31.2%	0.463	35.7%	0.479	-0.034***
Lifting	28.3%	0.450	33.0%	0.470	-0.036***
Dexterity	10.9%	0.311	14.6%	0.353	-0.034***
Co-ordination	9.9%	0.299	11.5%	0.319	-0.011***
Communication	9.8%	0.297	8.8%	0.283	0.014***
Incontinence	8.4%	0.277	7.5%	0.263	0.011***
Memory	7.8%	0.268	7.0%	0.255	0.011***
Recognize when in danger	1.6%	0.126	1.9%	0.137	-0.001
No FDs reported	*56.7%*	*0.495*	*53.9%*	*0.499*	*0.019****
1 or more FDs reported	*43.3%*	*0.495*	*46.1%*	*0.499*	*-0.019****
4 or more FDs reported	*9.4%*	*0.292*	*10.8%*	*0.310*	*-0.008****
number of FDs (among disabled)	*2.49*	*1.516*	*2.60*	*1.516*	*-0.073****
Median age of adult last birthday[a]	73	5.114	74	5.246	-1***
Equivalised pre-disability benefit household income (£ pw, 2012 prices)[b]	366.72	322.57	321.18	272.07	41.122***
Post-compulsory school	67.9%	0.467	65.0%	0.477	0.008**
Home ownership	79.9%	0.401	75.7%	0.429	0.04***
England	83.9%	0.368	83.3%	0.373	0.014***
Wales	5.5%	0.227	5.4%	0.225	0.002
Scotland	8.2%	0.275	8.8%	0.283	-0.013***
Northern Ireland	2.4%	0.154	2.5%	0.157	-0.003*

Source: Weighted data on 65+ respondents born between 1924-1945, interviewed in the FRS survey from 2002/3-2011/12. *Unweighted sample size:* 52,229 women and 44,504 men. *Notes:* [a] To protect confidentiality, FRS data were released with a top-coding at the age of 80. Therefore, we reported median rather than mean values. Consequently, a Pearson chi-squared test of the equality of the medians of the difference between men and women was performed. [b] For definition of household income see text. *Level of significance:* * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3: Prevalence and severity of disability by SES

SES indicator	Reporting at least 1 FD	Reporting at least 4 FDs	Average number of reported FDs (among disabled)
Education			
compulsory education	56.3%	14.6%	2.70
post-compulsory education	39.0%	8.0%	2.45
Home ownership			
non-home owner	59.5%	15.3%	2.70
home owner	40.6%	8.7%	2.49
Quantiles of pre-disability income[a]			
the poorest 25%	49.2%	11.0%	2.55
the richest 25%	32.4%	6.8%	2.44
overall	44.9%	10.2%	2.55

Source: Weighted data on 65+ respondents born between 1924-1945, interviewed in the FRS survey from 2002/3-2011/12. *Unweighted sample size:* 52,229 women and 44,504 men. *Notes:* Differences between groups were all statistically significant at 1% level. [a] For definition of household income see text.

Table 4: Birth-cohort trends in prevalence of disability and SES by age-group

	age group																			
	65-69					70-74					75-79					80+				
	Functional disability		SES indicator			Functional disability		SES indicator			Functional disability		SES indicator			Functional disability		SES indicator		
cohort of birth	prevalence (a)	Severity (b)	Education (c)	Income (d)	Home-ownership (%)	prevalence (a)	Severity (b)	Education (c)	Income (d)	Home-ownership (%)	prevalence (a)	Severity (b)	Education (c)	Income (d)	Home-ownership (%)	prevalence (a)	Severity (b)	Education (c)	Income (d)	Home-ownership (%)
1924	.	.	.	.	.	.	.	.	.	.	0.55	2.23	0.35	283.46	0.70	0.60	2.79	0.37	286.46	0.67
1925	.	.	.	.	.	.	.	.	.	.	0.55	2.28	0.38	285.42	0.70	0.59	2.87	0.36	283.31	0.68
1926	.	.	.	.	.	.	.	.	.	.	0.50	2.32	0.39	301.22	0.73	0.60	2.96	0.39	291.07	0.70
1927	.	.	.	.	.	.	.	.	.	.	0.48	2.34	0.37	295.69	0.74	0.61	2.91	0.41	299.16	0.72
1928	.	.	.	.	.	0.44	2.22	0.36	286.53	0.77	0.47	2.37	0.40	305.15	0.75	0.61	2.87	0.39	308.43	0.74
1929	.	.	.	.	.	0.49	2.15	0.37	311.40	0.73	0.47	2.50	0.42	318.02	0.77	0.62	2.98	0.40	309.40	0.74
1930	.	.	.	.	.	0.40	2.13	0.39	318.15	0.77	0.48	2.56	0.43	331.82	0.78	0.62	2.84	0.42	313.55	0.75
1931	.	.	.	.	.	0.41	2.28	0.45	323.76	0.79	0.48	2.47	0.44	334.77	0.78	0.60	2.93	0.43	299.07	0.76
1932	.	.	.	.	.	0.43	2.14	0.44	319.71	0.78	0.48	2.58	0.48	335.58	0.80	0.63	3.01	0.45	329.87	0.78
1933	0.39	1.94	0.60	353.00	0.78	0.39	2.30	0.59	338.21	0.79	0.46	2.64	0.60	340.80	0.79	.	.	.	.	.
1934	0.36	2.03	0.83	328.56	0.79	0.41	2.44	0.85	333.79	0.80	0.45	2.70	0.87	351.90	0.81	.	.	.	.	.
1935	0.37	2.14	0.88	340.19	0.79	0.40	2.38	0.88	351.87	0.80	0.41	2.49	0.88	335.13	0.79	.	.	.	.	.
1936	0.35	2.30	0.91	354.11	0.80	0.40	2.44	0.90	353.13	0.80	0.42	2.42	0.88	344.85	0.83	.	.	.	.	.
1937	0.36	2.19	0.92	367.81	0.81	0.40	2.57	0.91	347.47	0.81	0.42	2.62	0.92	351.38	0.82	.	.	.	.	.
1938	0.36	2.23	0.93	393.31	0.81	0.40	2.48	0.91	356.63	0.81	.	.	.	.	.	.	.	.	.	.
1939	0.35	2.39	0.93	381.99	0.81	0.38	2.46	0.93	362.13	0.81	.	.	.	.	.	.	.	.	.	.
1940	0.34	2.38	0.94	386.78	0.81	0.37	2.33	0.94	353.50	0.79	.	.	.	.	.	.	.	.	.	.
1941	0.33	2.46	0.94	395.87	0.80	0.35	2.21	0.95	358.50	0.79	.	.	.	.	.	.	.	.	.	.
1942	0.32	2.45	0.95	413.92	0.82	0.34	2.55	0.97	411.81	0.84	.	.	.	.	.	.	.	.	.	.
1943	0.32	2.45	0.95	406.14	0.81	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1944	0.29	2.48	0.96	441.57	0.81	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1945	0.31	2.45	0.96	421.56	0.81	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tests for Stationarity (p-values)																				
ADF	0.99	0.16	0.62	0.75	0.04	0.99	0.53	0.52	0.89	0.59	0.81	0.48	0.97	0.66	0.27	0.65	0.00	0.99	0.01	0.86
PP	0.53	0.03	0.09	0.88	0.03	0.72	0.53	0.71	0.93	0.79	0.53	0.47	0.97	0.65	0.52	0.66	0.01	0.99	0.95	0.88

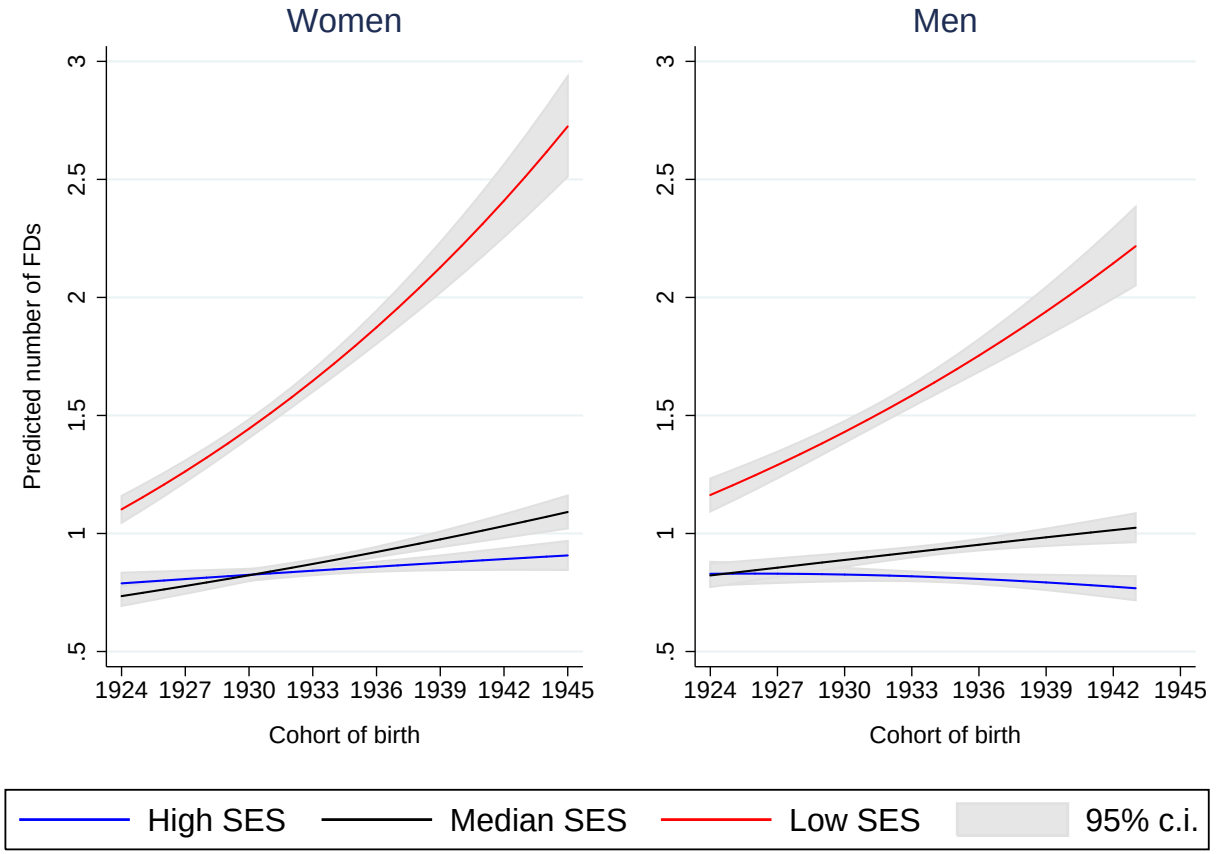
Source: Weighted data on 65+ respondents born between 1924-1945, interviewed in the FRS survey from 2002/3-2011/12. *Unweighted sample size:* 52,229 women and 44,504 men. *Notes:* [a] % of people reporting at least one FD; [b] number of FDs reported amongst those who reported at least one FD; [c] % of individuals reporting post-compulsory school; [d] Equivalised pre-disability benefit household income (£ pw, 2012 prices). See text for the income definition. We tests for time-trends in the data using both the Augmented Dickey–Fuller (ADF) and the Phillips–Perron (PP) tests (null hypothesis of a unit root) with two lagged difference terms included in the covariate lists. Experiments with fewer or more lags in the augmented regression yield similar conclusion.

Table 5: Estimates of the Zero-Inflated Negative Binomial model of the number of FDs

	model A				model B			
	women		men		women		men	
	odds-ratio	IRR	odds-ratio	IRR	odds-ratio	IRR	odds-ratio	IRR
Age of adult last birthday	1.059***	1.046***	1.031***	1.040***	1.059***	1.045***	0.962***	1.040***
Post-compulsory school	0.735***	0.933***	0.845***	0.954***	0.728***	0.897***	1.113***	0.898***
household income (logarithm)[a]	0.783***	1.02	0.543***	1.003	1.206***	1.138***	0.917***	1.091***
Home ownership	0.491***	0.901***	0.507***	0.899***	0.677***	0.995	1.045	0.957
Scotland	1.007	1.018	0.946	1.026	1.007	1.019	0.975	1.025
Wales	1.594***	1.041*	1.468***	1.062**	1.594***	1.041*	0.943**	1.060**
Northern Ireland	1.154***	0.957**	0.962	0.967	1.146***	0.958**	1.029	0.971
Birth cohort	0.995	1.027***	0.972***	1.028***	1.259***	1.100***	0.928***	1.078***
Birth cohort * post-compulsory school					0.996	1.004*	0.994**	1.006**
Birth cohort * income					0.964***	0.988***	1.009***	0.991***
Birth cohort * home ownership					0.971***	0.989***	1.007***	0.993***
log over-dispersion coefficient	-2.604***		-1.840***		-2.682***		-1.904***	
Observations	52,229		44,504		52,229		44,504	
AIC	145,333		120,512		145,026		120,298	
Log-likelihood	-72647		-60237		-72488		-60124	

Notes: [a] For definition of household income see text. *Level of significance:* * p < 0.05, ** p < 0.01, *** p < 0.001

Figure 2: Predicted number of FDs by cohort of birth and SES



Notes: [a] For definition of High/Median/Low SES see text.

Birth-cohort trends in older-age functional disability and their relationship with socio-economic status: Evidence from a pooling of repeated cross-sectional population-based studies for the UK

Highlights

- We studied later life functional difficulty (FD) and socio-economic status (SES).
- We used 3 measures of SES and examined birth-cohort trends.
- The number of FDs has risen steadily for successive cohorts of lower SES groups.
- Later life SES inequalities in FDs have increased among successive birth cohorts.
- This trend may increase the share of later life care costs borne by the state.