Social Science & Medicine xxx (xxxx) xxx

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

How does arthritis affect employment? Longitudinal evidence on 18,000 British adults with arthritis compared to matched controls

Nasir Rajah [a,b], Edward J.D. Webb [a], Claire Hulme [c], Sarah R. Kingsbury [d], Robert West [e], Adam Martin [a,*]

[a] Academic Unit of Health Economics, Leeds Institute of Health Sciences, Faculty of Medicine and Health, University of Leeds, UK
[b] Centre for Longitudinal Studies, University College London, UK
[c] Health Economics Group, Institute of Health Research, University of Exeter Medical School, UK
[d] Leeds Institute of Rheumatic and Musculoskeletal Medicine, Faculty of Medicine and Health, University of Leeds, UK
[e] Leeds Institute of Health Sciences, Faculty of Medicine and Health, University of Leeds, UK

ARTICLE INFO

Keywords:
Chronic illness
Panel data
Arthritis
Musculoskeletal conditions
Labour market outcomes
Economics
Employment
Retirement

ABSTRACT

Introduction: One in ten working age people in the UK live with arthritis or a similar condition affecting their joints. This impacts their quality of life, including through their work. But little is known about how arthritis affects labour market outcomes and the types of people most likely to be affected.

Methods: Data from three population-representative household panel surveys (BHPS, ELSA, UKHLS) collected in 2001–2019 was harmonised. Propensity score matching was used to match 18,014 UK adults aged 18–80 who have arthritis with comparable adults without arthritis. The relationship between arthritis and employment, and earnings and work hours conditional on employment, were assessed using multilevel regression modelling. Heterogeneity in these relationships were assessed by age, gender, degree-level education status, NS-SEC job classification and employer type.

Results: On average, arthritis was associated with a 3 percentage point reduction in the probability of employment. The effect size varied over people's life course and was larger amongst females, people without a degree, and those in routine or intermediate occupations (when compared to those in professional occupations) or working for small private companies (when compared to large private companies and non-private employers). Our models predict, for instance, that arthritis is associated with an 11 percentage point reduction in the probability of employment among 50-year-old women without a degree. This contrasts with a 5 percentage point reduction among 50-year-old men without a degree. If employed, men with a degree earned less if they had arthritis, whereas others (including women with a degree and men without a degree) had similar earnings regardless of their arthritis status. Those in professional occupations with arthritis also earnt less, especially if they were women aged over 40, with indications that this was driven by reduced work hours.

Conclusion: Policy interventions to support people with arthritis who wish to remain in work might be designed with people in routine work in mind, and targeted at those working in smaller private firms. More research on the cost-effectiveness of those interventions is needed.

1. Introduction

Arthritis is a common condition that causes pain and inflammation in the joint. In the UK, one in ten people of working age have arthritis, or other similar conditions that affect the joints (Versus Arthritis, 2021). This is a major policy concern, not least because of its potential impact on their employment (Department for Work and Pensions, 2017, 2017a), including in terms of early labour market exit, underemployment and failure to achieve their career potential or ambitions. This can have substantial and enduring financial consequences for individuals and the wider economy, as well as consequences for the health and wellbeing of individuals and their families due to missed opportunities that stem from work. These include opportunities for learning, social interaction, nurturing personal identity and self-esteem, achieving financial security, and enabling wealth accumulation which may be used to support good health and wellbeing in retirement (Department for Work and Pensions, 2017; , 2017a; , 2017b;

* Corresponding author.
E-mail address: A.Martin1@Leeds.ac.uk (A. Martin).

https://doi.org/10.1016/j.socscimed.2022.115606
Received 17 May 2022; Received in revised form 3 December 2022; Accepted 8 December 2022
Available online 30 January 2023

Goda and Streeter, 2021).

Understanding the degree to which arthritis affects people's labour supply decisions and how this varies between different groups of individuals and at different life stages is fundamental to informing decisions by policy makers, employers and healthcare systems around maintaining employment opportunities and supporting employees. An early study by Bury (1982) posits that arthritis causes biographical disruption, with heterogeneous effects across different socio-economic classifications of work, which include the adoption of adaptive processes in people's daily routines, including by reducing work hours or exiting the labour market (Reeve et al., 2010; Booker et al., 2020). Nevertheless, few empirical studies have specifically assessed the impact of arthritis on these labour market outcomes. Those that have indicate that people with arthritis are more prone to stop work on health grounds (Barrett et al., 2000), take early retirement (Conaghan et al., 2015) and are less likely to be in full-time work (Majeed et al., 2017). Yet these studies are limited by a lack of appropriate control group and/or by small, unrepresentative sample sizes or other potential sources of bias (e.g. relying on retrospective life-history data (Majeed et al., 2017)). None of those studies, and few studies from the broader literature examining relationships between health conditions and labour market outcomes (Booker et al., 2020; Goda and Streeter, 2021; Parker et al., 2020; Rajah et al., 2022; Syddall et al., 2020; Piper et al., 2023), have identified the types of individuals (e.g., by gender, socioeconomic classification or education) and the life stages that are most prone to suffering labour market consequences, or the types of work or employer where these individuals are most likely to be found. Such understanding is necessary to ensure that policies and interventions are designed and targeted in such a way that delivers the greatest benefits and maximises their likelihood of being cost-effective.

In this study, we use data from three population-representative household panel surveys to explore the effects of arthritis on labour market performance in 18,014 people aged 18–80 years old in the United Kingdom who have arthritis when compared to closely matched controls. We address two research questions:

1) How does arthritis affect labour market outcomes and how does this vary by individual-level characteristics including age, gender and educational status?
2) Is the observed relationship between arthritis and labour market outcomes dependent on the type of work in which people are employed or the type of employer?

The particular labour market outcomes we study are: probability of employment, and earnings and work hours (full- or part-time work) conditional on employment.

2. Methods

2.1. Dataset description and sample selection

Three population-representative household panel survey datasets were used: British Household Panel Survey (BHPS) (data collected annually in 18 waves, 1991–2009, although the data collected before 2001 is excluded from our analyses), UK Household Longitudinal Study (UKHLS; also known as 'Understanding Society') (data collected annually in 10 waves, 2009–2019) (University of Essex, Institute for Social and Economic Research, 2020) and English Longitudinal Study of Ageing (ELSA) (data collected every two years in 8 waves, 2002–2019) (Clemens et al., 2019).

Each dataset includes a population-representative sample of households, with individual-level data collected on each household member. The first wave of BHPS recruited in Great Britain in 1991, with recruitment expanded to the whole of the UK by 2001 (the UK has four constituent parts: England which comprises 85% of the UK population; Scotland; Wales; and Northern Ireland. England, Scotland and Wales together comprise Great Britain which accounts for 97% of the UK population). BHPS ended after 18 waves in 2009. UKHLS recruited UK households between January 2009 and June 2011, including some households who had participated in BHPS. UKHLS participants are followed-up to the present day. Individuals join the UKHLS cohort if they move into the sample of households and new households may be created when individuals move elsewhere. The ELSA study is population representative of those aged $\geq$50 years living in England in private households. The original sample was drawn from households that had previously responded between 1998 and 2001 to the Health Survey for England, which is a separate series of annual surveys about the health of people living in England. The sample was replenished to address sample attrition in waves 3, 4, 6 and 7. In BHPS and UKHLS, adult household members complete an annual questionnaire (in face-to-face interviews at home or online), whereas in ELSA, participants are interviewed every two years.

Survey participants were included in our study if they were aged 18 to 80 at the time of data collection and if they responded at least once to a question about whether they currently had or had ever had an arthritis diagnosis (data were excluded from waves 1 to 10 of BHPS since the relevant arthritis question is first asked in wave 11, meaning the studied time-period is 2001–2019). The exact wording of the arthritis questions are shown in Fig. 1 and data on the proportion of participants reporting an arthritis diagnosis are shown in Appendix 1 and 2. Fig. 1 also shows the reasons for excluding participants from our analyses, which included if no information was collected on their ethnicity, education status, marital status, location of residence (Scotland, Wales, Northern Ireland or English Government Office Region) or number of children in the household.

2.1.1. Ethical approval

Our study is based on secondary analysis of BHPS, UKHLS and ELSA data, for which all participants gave their informed consent to take part in each wave of the study. Participants were enrolled only after consent was provided. The datasets have been approved by the relevant bodies.[1,2] No further ethical approval was required for the analyses conducted in this study. The datasets were accessed via the UK Data Service and were general releases ('safeguarded') versions of the data (i.e., steps had already been taken to maintain the confidentiality of responses).

2.2. Variable identification and data harmonisation

Variables were identified to address the research questions a priori on the basis of existing literature on health and employment (Booker et al., 2020; Pelkowski and Berger, 2004). Appropriate measures in each of the datasets were then identified and selected for use in the data harmonisation across all three datasets which followed a method informed by the DataSHaPER approach (Fortier et al., 2010, 2011). This included assessing their viability to be shared across datasets, defining appropriate data processing algorithms and setting rules for recoding variables so they were coded consistently across individuals regardless of the source dataset or time point. Clustered data, within individuals over multiple time points, were then pooled in preparation for analysis. All data preparation and data harmonisation was conducted in Stata v.11.

[1] https://www.understandingsociety.ac.uk/documentation/mainstage/user-guides/main-survey-user-guide/ethics.

[2] https://www.elsa-project.ac.uk/ethical-approval.

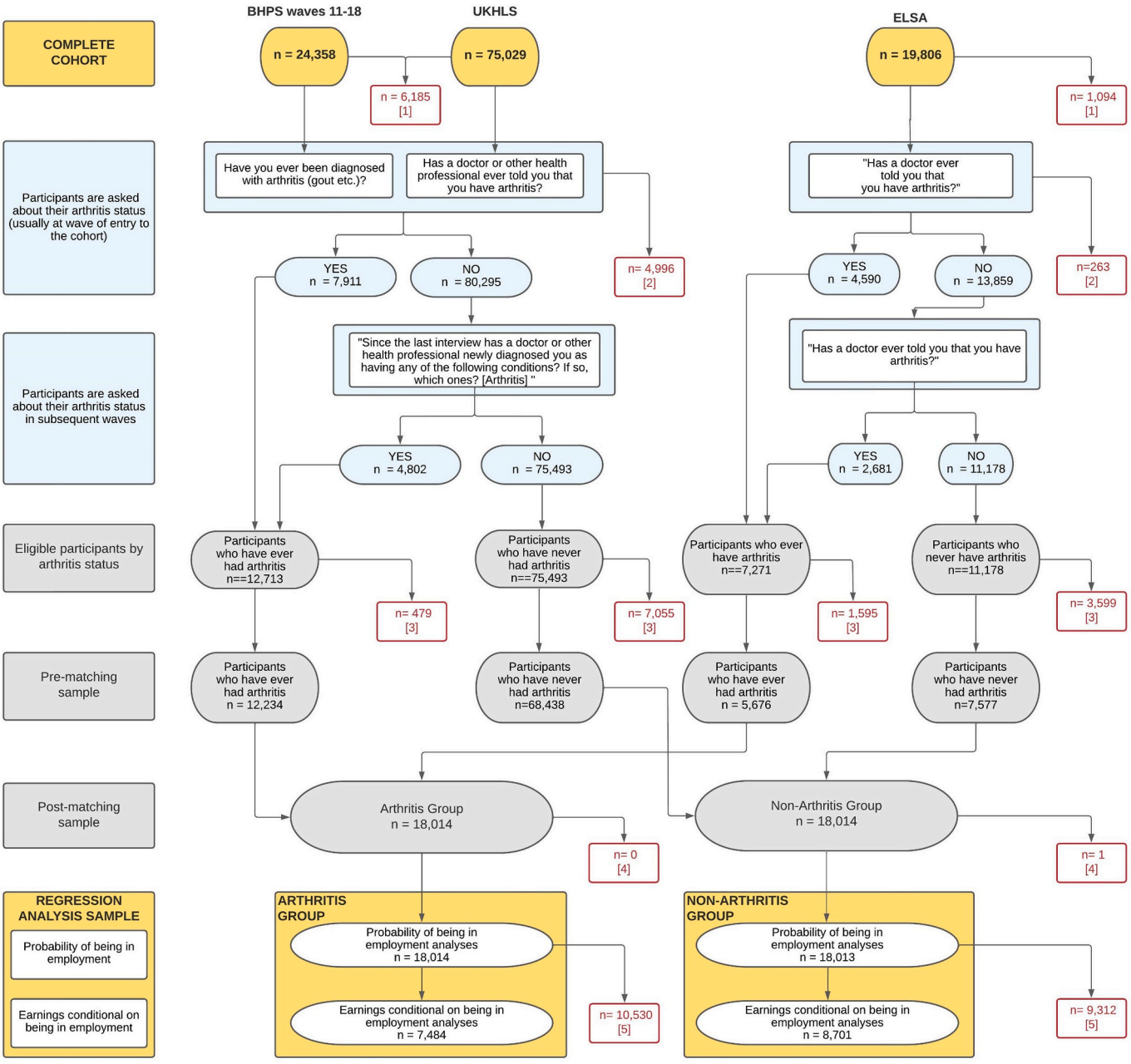


Fig. 1. Sample selection criteria and sample size derivation.
Reasons for excluding participants (shown in red) are as follows:
[1]: Due to age across all waves <18 or age >80.
[2]: Due to missing data across all waves on whether they currently have or have ever had arthritis.
[3]: Due to missing data across all waves on ethnicity, education status, marital status, location of residence or number of children in the household.
[4]: Due to missing employment data across all waves.
[5]: Excluded from analysis of earnings conditional on employment due to not being employed (observations=36,003) or due to annual earnings <£150 across all waves (observations=24). n=number of individuals.

2.3. Descriptive statistics

Descriptive statistics for the selected variables were generated for all eligible participants at the wave of entry to the cohorts and, separately, across all time points.

2.4. Propensity score matching

Propensity score matching was conducted on a 1:1 ratio, with each individual who reported having an arthritis diagnosis at any time in their life prior to exiting the cohort (the 'arthritis group') being matched to one individual who reported never having had an arthritis diagnosis at any time prior to exiting the cohort (the 'non-arthritis group') (Austin, 2011). This means that some individuals in the 'arthritis group' may not have had arthritis when they entered the cohort but reported a new diagnosis in subsequent waves. Individual-level variables were selected for use in the matching process and taken from the wave of entry to the cohort (after dropping BHPS waves 1–10) for both the arthritis and non-arthritis groups. These variables were: age, gender, degree-level education status, number of children in household, ethnicity, location

Table 1
Variable definitions.

Variable	Time-varying?	Details
Arthritis status (M_{it})	Y	0 if no arthritis diagnosis at time *t*, 1 if arthritis reported at time *t* and subsequently all future time points.
Employment status	Y	1 if employed/self-employed (including part-time), 0 if unemployed, retired, or otherwise economically inactive
Log annual earnings conditional on employment	Y	Log sum of annual earnings across an individual's main employment, secondary employment and self-employment (where applicable) after adjusted for inflation using the HM Treasury GDP deflator (2019 base year) (HM Treasury, 2019)
Hours worked conditional on employment	Y	1 if works ≤35 h/week, 0 if works >0 and < 35 h/week
National Statistics-Socioeconomic Classification (NS-SEC)	Y	Three level employment classification: 1 if routine (e.g. lorry drivers, bar staff), 2 if intermediate (e.g. paramedics, bank staff), 3 if professional (e.g. lawyers, doctors)
Age*	Y	Age in years
Marital status	Y	1 if currently/previously married (or equivalent), 0 if never married
Children in household*	Y	1 if at least on child in household, 0 if no children in household
Gender*	N	1 if female, 0 if not female
Ethnicity*	N	1 if non-white, 0 if white
Degree-level education status*	Y	1 if have degree/equivalent qualification, 0 otherwise
Location of residence*	Y	Ten dummy variables for Scotland, Wales, and eight English Government Office Regions (=1) with London (=0) as a reference category..

•Time-invariant characteristics are based on the first point in time in which they are recorded (normally at wave of entry).
•Asterisk indicates variables that were included in the propensity score matching models

of residence, the source dataset (to account for any cohort-specific effects) and the number of observations (to potentially equalise any non-response bias between groups). Their definitions are given in Table 1. The nearest-neighbour algorithm was used with a caliper distance of 0.2, which defines the distance between the propensity score of the treated (arthritis) and untreated (non-arthritis) groups. Having a caliper distance of 0.2 is argued to reduce bias from measured confounders (Austin, 2011). The post-matching sample of participants defined our analysis sample, after exclusion of participants who had no data on labour market status across all waves of data collection.

2.5. Regression models

To address research question 1, we first use a multilevel logistic regression model (with each observation clustered within individuals) predicting the log odds of employment (Y_{it}) for each individual *i* (i = i…n, for n individuals in the dataset) at time point *t* (t = t…T, for T time points that an individual is in the dataset):

$$Y_{it} = ln\frac{p_{it}}{1-p_{it}} = \beta_0 + \boldsymbol{\beta}_X \boldsymbol{X}_{it} + \boldsymbol{\beta}_Z \boldsymbol{Z}_i + \beta_M M_{it} + e_{it} + u_i$$

(Equation 1: Log odds of being employed).

In this equation, p_{it} is the probability of employment at time *t*. The independent variable of interest is M_{it}, a binary variable representing self-reported arthritis status at time *t*. M_{it} takes a value of zero for all observations in the non-arthritis group, but is time-varying for those participants in the arthritis group who develop arthritis whilst in the cohort. We assume that individuals in the arthritis group always have arthritis once a diagnosis is recorded (i.e. arthritis is non-reversible), so that observations from subsequent waves were included even if arthritis status was missing. $\mathbf{Z}_i$ is a vector of time-invariant variables; and $\mathbf{X}_{it}$ is a vector of time-varying variables, including age. Since age has a non-linear relationship with the outcome variable, a natural cubic spline was included in the model (the key difference when compared to a non-transformed age variable being that age is now transformed into 6 knots) (Hastie et al., 2009). There are two error terms: e_{it}, which reflects random effects for individual *i* at time *t* within individual, and u_i, the individual-level residuals. Both were assumed to be identical and independently distributed. $\beta_0, \boldsymbol{\beta}_X, \boldsymbol{\beta}_Z$ and β_M are parameters to be estimated.

Second, we use a multilevel linear regression model to predict earnings conditional on employment:

$$Y_{it} = \gamma_0 + \boldsymbol{\gamma}_X \boldsymbol{X}_{it} + \boldsymbol{\gamma}_Z \boldsymbol{Z}_i + \gamma_M M_{it} + e_{it} + u_i$$

(Equation 2: Earnings conditional on employment).

In this equation, Y_{it} represents earnings (log of annual inflation adjusted earnings across an individual's main employment, secondary employment and self-employment) for individual *i* at time *t*. The independent variables ($\mathbf{X_{it}}$, $\mathbf{Z_i}$, and M_{it}) and the residuals are as described above, and γ_0, $\boldsymbol{\gamma}_X$, $\boldsymbol{\gamma}_Z$ and γ_M are parameters to be estimated.

To address research question 2, a series of subgroup analyses were conducted. These subgroups were created by including observations from individuals whose current or most recent employment was within a given employer- or work-type, as follows:

(1) Work type classification (three NS-SEC groups: routine, intermediate, professional). It is anticipated that the observed variation in differences in employment and earnings for the arthritis vs non-arthritis groups by degree-level education status and by gender may be due to different types of work that these groups undertake (Bartley et al., 2004).
(2) Type of employer (four types: large private companies, small private companies, large non-private and small non-private employers). The size of the employer was based on responses to a UKHLS question "How many people are employed at the place where you work?" Responses >=50 employees were classed as large and those <50 employees were classed as small. It is anticipated that some variation in the difference in employment and earnings for people in the arthritis vs non-arthritis groups could be due to differences in support available to people with arthritis who work in different types of organisations. For example, some employers might be more likely to have more extensive occupational health schemes to support people with arthritis, and larger employers might have more opportunities to switch to more appropriate roles within the same organisation after an arthritis diagnosis (Young and Bhaumik, 2011).

These subgroups were generated (and subsequent analyses conducted) for the UKHLS sample only, since relevant variables are not reported in BHPS or ELSA. Participants with no work history recorded in any survey wave were excluded from the subgroup analyses. The analysis was similar to that of research question 1 in that employment (equation 1) and earnings conditional on employment (equation 2) were analysed separately. As participants were included in subgroups based on their employment record, a distinction arises between how the employment model is interpreted in research question 1 and research question 2. In research question 2, the individual was assumed to be in the labour market initially, and the topic of interest was whether or not they were subsequently able to remain employed.

To examine the extent to which differences in earnings (conditional on employment) for the arthritis vs non-arthritis groups are driven by differences in hours worked, a multilevel logistic regression was additionally used to estimate the relationship between having arthritis and hours worked (conditional on employment). In this analysis, equation 2 was adapted such that Y_{it} represented the log odds of working full time ($\geq$ 35 h/week) compared to working less than full time (>0 and < 35 h).

All data cleaning and analysis was conducted in R version 1.4.1103. Marginal effects were calculated for M_{it} for all analyses by selected characteristics (age, gender, degree-level education status) using the prediction method from R's ggeffects package (1.0.1) (i.e., using the coefficients from the relevant regression models to predict either probability of employment or earnings conditional on employment). Graphical representations of the regression models were also generated using R's predict function and are smoothed using a generalised additive model (Hastie et al., 2009). Diagnostics were conducted on all models. For the employment status regression models, the ability of the model to correctly classify cases was analysed using a receiver operating characteristic (ROC) curve. For the linear regression models, our assumptions of independence of both levels of residuals were tested by analysing the distribution of the mean and variance of the residual values (Appendix 3). We also explored the effect of participants being in different cohorts, by running our analyses separately for each dataset (Appendix 4).

3. Results

3.1. Data description and sample selection

Fig. 1 illustrates the selection process and how the analysis sample was arrived at, with BHPS and UKHLS on the left-hand side and ELSA on the right-hand side. The complete cohort across all waves of data collection is shown at the top and the analysis sample is shown at the bottom. A total of 6% of the complete cohort were excluded due to there being no observations for them when aged ≥18 or aged ≤80. A further 5% were excluded due to missing data on whether they currently have or have ever had arthritis, 12% due to missing covariates, and <0.1% due to missing labour market data. Across all three datasets, the complete cohort consisted of 119,193 individuals, with a sample of 18,014 remaining in each of the two groups in the post-matching sample. In total, 245,759 observations across 36,027 individuals formed our analysis sample. There were 123,796 observations of individuals in the arthritis group (of which 93,316 observations were recorded after the participants' arthritis had been diagnosed) and 121,963 observations in the non-arthritis group, all of which were used in the regression models with employment as the outcome. Of these, 82,168 observations across 16,185 individuals were used in the regression models where earnings was the outcome.

Table 2
Descriptive statistics.

	Pre-matching sample			Post-matching sample		
	Non Arthritis Group (N = 86,671)	Arthritis Group (N = 19,984)	Overall (N = 106,655)	Non Arthritis Group (N = 18,014)	Arthritis Group (N = 18,014)	Overall (N = 36,028)
Age						
Mean (sd)	41.2 (17.2)	58.6 (12.1)	44.4 (17.7)	58.6 (12.9)	58.3 (12.2)	58.4 (12.6)
Median [Min, Max]	40.0 [18.0, 80.0]	59.0 [18.0, 80.0]	45.0 [18.0, 80.0]	59.0 [18.0, 80.0]	59.0 [18.0, 80.0]	59.0 [18.0, 80.0]
Gender						
Male	42,131 (48.6%)	7328 (36.7%)	49,459 (46.4%)	7201 (40.0%)	6564 (36.4%)	13,765 (38.2%)
Female	44,540 (51.4%)	12,656 (63.3%)	57,196 (53.6%)	10,813 (60.0%)	11,450 (63.6%)	22,263 (61.8%)
Degree-level education status						
No Degree	64,976 (75.0%)	16,438 (82.3%)	81,414 (76.3%)	16,070 (89.2%)	15,920 (88.4%)	31,990 (88.8%)
Degree	16,525 (19.1%)	2148 (10.7%)	18,673 (17.5%)	1944 (10.8%)	2094 (11.6%)	4038 (11.2%)
Missing	5170 (6.0%)	1398 (7.0%)	6568 (6.2%)			
Number of children in household						
None	60,111 (69.4%)	15,746 (78.8%)	75,857 (71.1%)	14,275 (79.2%)	14,304 (79.4%)	28,579 (79.3%)
One or More	26,542 (30.6%)	4223 (21.1%)	30,765 (28.8%)	373 (20.7%)	3704 (20.6%)	7441 (20.7%)
Missing	18 (0.0%)	15 (0.1%)	33 (0.0%)	2 (0.0%)	6 (0.0%)	8 (0.0%)
Ethnicity						
White	61,395 (70.8%)	16,765 (83.9%)	78,160 (73.3%)	15,621 (86.7%)	15,554 (86.3%)	31,175 (86.5%)
Non-White	20,764 (24.0%)	2656 (13.3%)	23,420 (22.0%)	2393 (13.3%)	2460 (13.7%)	4853 (13.5%)
Missing	4512 (5.2%)	563 (2.8%)	5075 (4.8%)			
Location of residence						
Not living in London	73,486 (84.8%)	18,040 (90.3%)	91,526 (85.8%)	16,452 (91.3%)	16,341 (90.7%)	32,793 (91.0%)
Living in London	12,986 (15.0%)	1918 (9.6%)	14,904 (14.0%)	1562 (8.7%)	1673 (9.3%)	3235 (9.0%)
Missing	199 (0.2%)	26 (0.1%)	225 (0.2%)			
Employment status						
Unemployed or economically inactive (excluding retired)	24,824 (28.6%)	4480 (22.4%)	29,304 (27.5%)	2557 (14.2%)	4026 (22.3%)	6583 (18.3%)
Retired	12,247 (14.1%)	8183 (40.9%)	20,430 (19.2%)	7344 (40.8%)	7223 (40.1%)	14,567 (40.4%)
Economically Active	49,530 (57.1%)	7321 (36.6%)	56,851 (53.3%)	8112 (45.0%)	6765 (37.6%)	14,877 (41.3%)
Missing	70 (0.1%)	0 (0%)	70 (0.1%)	1 (0.0%)	0 (0.0%)	1 (0.0%)
Inflation adjusted annual earnings conditional on employment (2019 British Pounds)						
Mean (sd)	23000 (19300)	20300 (17600)	22700 (19200)	21500 (18300)	20500 (17500)	21000 (18000)
Median [Min, Max]	8600 [-10600, 266000]	16400 [0, 234000]	18200 [-10600, 266000]	17200 [-10600, 236000]	16600 [0, 234000]	16900 [-10600, 236000]
Number of observations						
Mean (sd)	5.19 (4.15)	6.60 (4.16)	5.46 (4.19)	6.98 (4.37)	7.01 (4.16)	6.99 (4.27)
Median [Min, Max]	4.00 [1.00, 17.0]	6.00 [1.00, 17.0]	4.00 [1.00, 17.0]	7.00 [1.00, 17.0]	7.00 [1.00, 17.0]	7.00 [1.00, 17.0]

Note:
Employment status and inflation adjusted pay are outcome variables in the regression analyses and were not included in the propensity score matching model.

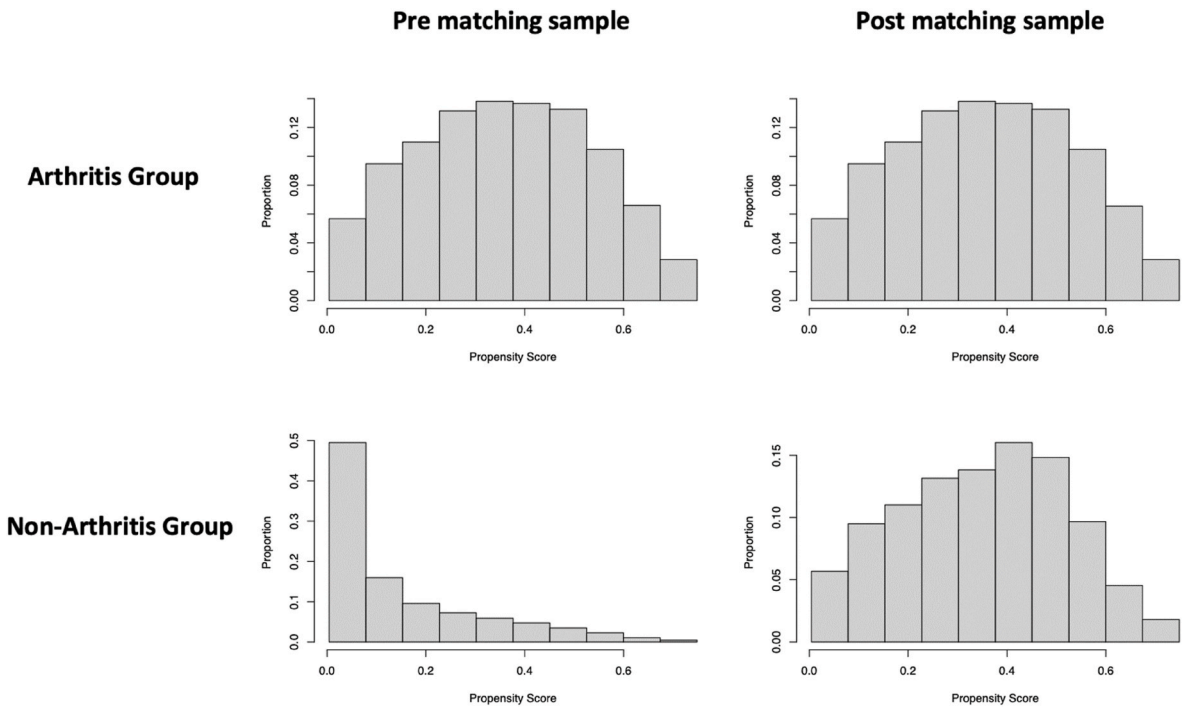


Fig. 2. Distribution of propensity scores for the arthritis and non-arthritis groups in the pre- and post-matching samples.

3.2. Descriptive statistics

Table 2 (LHS) reports descriptive statistics for the complete cohort as they enter the dataset, after exclusion of observations where individuals are aged <18 or >80 years (n = 106,655). People who report ever having arthritis are older (median age 59.0, compared to 40.0 for those who have never had an arthritis diagnosis), more likely to be female than male (63.3% of those who have ever had arthritis, compared to 51.4% who have not), to have a degree and to have children in the household. They are also less likely to be in work and, if they are in work, to have lower earnings (£20,300 vs £23,000 for those without arthritis). Fig. 3 (top panel) and Fig. 4 (top panel), which plots this descriptive data by age, gender and degree status, shows that there exists a gap between the arthritis and non-arthritis observations for employment and earnings, respectively.

3.3. Propensity score matching

Descriptive statistics for the post-matching sample are shown in Table 2 (RHS), which indicates that the arthritis and non-arthritis groups were more comparable on observed variables when compared to the pre-matching sample (LHS): e.g. age (59.0 years in both groups, vs a gap of 19 years in the median age in the pre-matched data), gender and degree-level education status.

Differences remained in the proportion who were employed (37.6% in the arthritis group vs. 45.0% in the non-arthritis group) and their earnings conditional on employment (£20,500 vs. £21,500). However, compared to the pre-matching data in Table 2 (LHS), these differences are smaller, indicating that those initial differences are partly attributable to differences in the selected variables used in the matching process, including age. Fig. 2 shows the improvement in the distribution of the propensity score for the non-arthritis group after the matching process, suggesting that it has reduced observable differences. Fig. 3 (top and middle panel) and Fig. 4 (top and middle panel) also show that differences in the probability of employment between the arthritis groups has been reduced by the matching process, but is still prominent regardless of gender or degree-level education status. In Fig. 4, however, a difference in earnings is only seen in males with a degree after the matching process is complete.

3.4. Regression analysis

3.4.1. Research question 1 (relationship between arthritis and labour market outcomes)

Research question 1 assesses differences in the likelihood of being employed and predicts differences in earnings (conditional on employment) between the two matched groups.

3.4.1.1. Employment (logistic regression models). The coefficient for the arthritis variable in the logistic regression model indicates that arthritis had a (statistically significant) negative effect on employment (OR = 0.49), which is equivalent to a 3 percentage point reduction in the probability of being employed (Table 3).

The marginal effects of the regression model are plotted by age, gender and degree-level education status in Fig. 3 (bottom panel), alongside the predicted probability of employment reported for the unmatched data (top panel) and the matched data prior to the regression analysis (middle panel). These plots show differences in the likelihood of being in work among people with arthritis compared to the matched controls are not homogenous. For example, arthritis appears to be associated with a larger effect among women and people who did not have a degree-level education. As an indication of the magnitude of these differences, estimates from our regression models show that the percentage point reduction in the probability of being in work that is associated with having arthritis varies as follows: 2 percentage points for 50 year-old men with a degree; 5 percentage points for 50 year-old men without a degree; 6 percentage points for 50 year-old women with a degree; 11 percentage points for 50 year-old women without a degree;

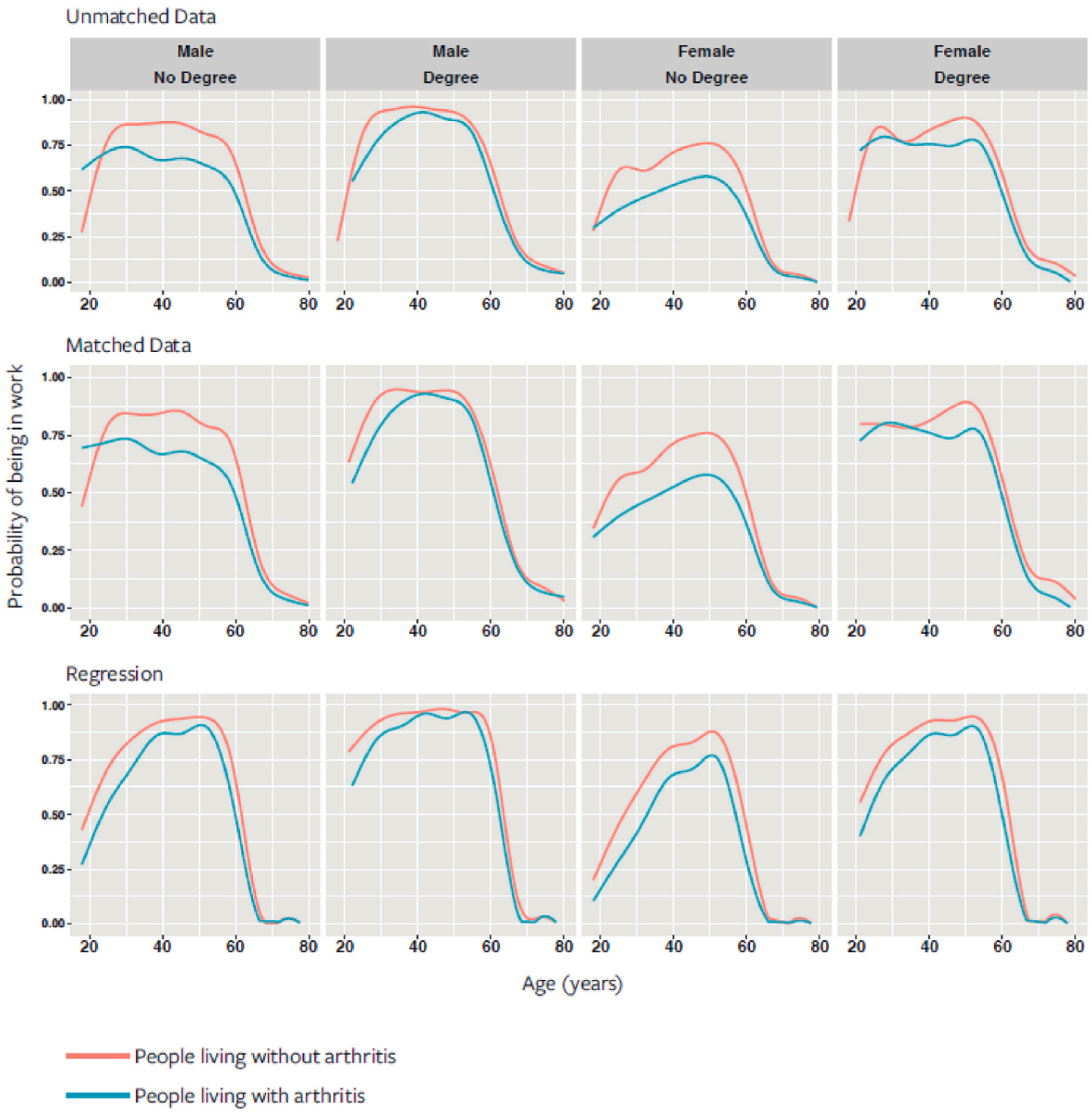


Fig. 3. Probability of being employed, by arthritis group, age, gender and degree status (RQ1): unmatched data (top panel), matched data (middle panel), marginal effects in logistic regression analysis (bottom panel).

and 17 percentage points for 60 year-old women without a degree.

Comparing the top, middle and bottom panels of Fig. 3 shows that the regression models further narrow the difference in labour market outcomes between the groups.

3.4.1.2. Earnings conditional on employment (linear regression model). Results from the regression model suggest that arthritis is associated with an average 4% reduction in earnings (Table 4). This effect is largest among men with degrees, for whom arthritis is associated with reduced mean earnings of £1290. Among men without a degree, the predicted reduction is £837.

The marginal effects of the regression model are plotted by age, gender and degree status in Fig. 4 (bottom panel), alongside comparisons with the unmatched data and the matched data prior to the regression analysis. The regression results (bottom panel) indicates that the effect of arthritis on earnings is mainly found among men with degrees before age 50, whereas men without degrees and women do not appear to experience a difference in earnings due to arthritis.

3.4.2. Research question 2 (the role of work-related factors in explaining differences in labour market outcomes)

Research question 2 assesses the degree to which observed differences in the relationship between arthritis and labour market outcomes observed in research question 1 can be explained by the nature of the work in which people are employed.

3.4.2.1. Work-type subgroups. The regression models showed that arthritis reduces the probability of employment (equation 1) for people employed in all three NS-SEC work-type subgroups (Table 5 with full detail in Appendix 5 and 6). However, as illustrated in Fig. 5, this effect is greater for routine than professional work. For instance, the reduction in the predicted probability of employment for 45-year-old men was 2 percentage points, yet a similar aged man in the professional subgroup was predicted to have no arthritis-related reduction in employment. Fig. 5 also indicates that this effect of arthritis is particularly prominent in lower NS-SEC groups beyond 55 years of age.

In contrast, the regression models also suggested that the effect of arthritis on earnings conditional on employment (equation 2) was greater

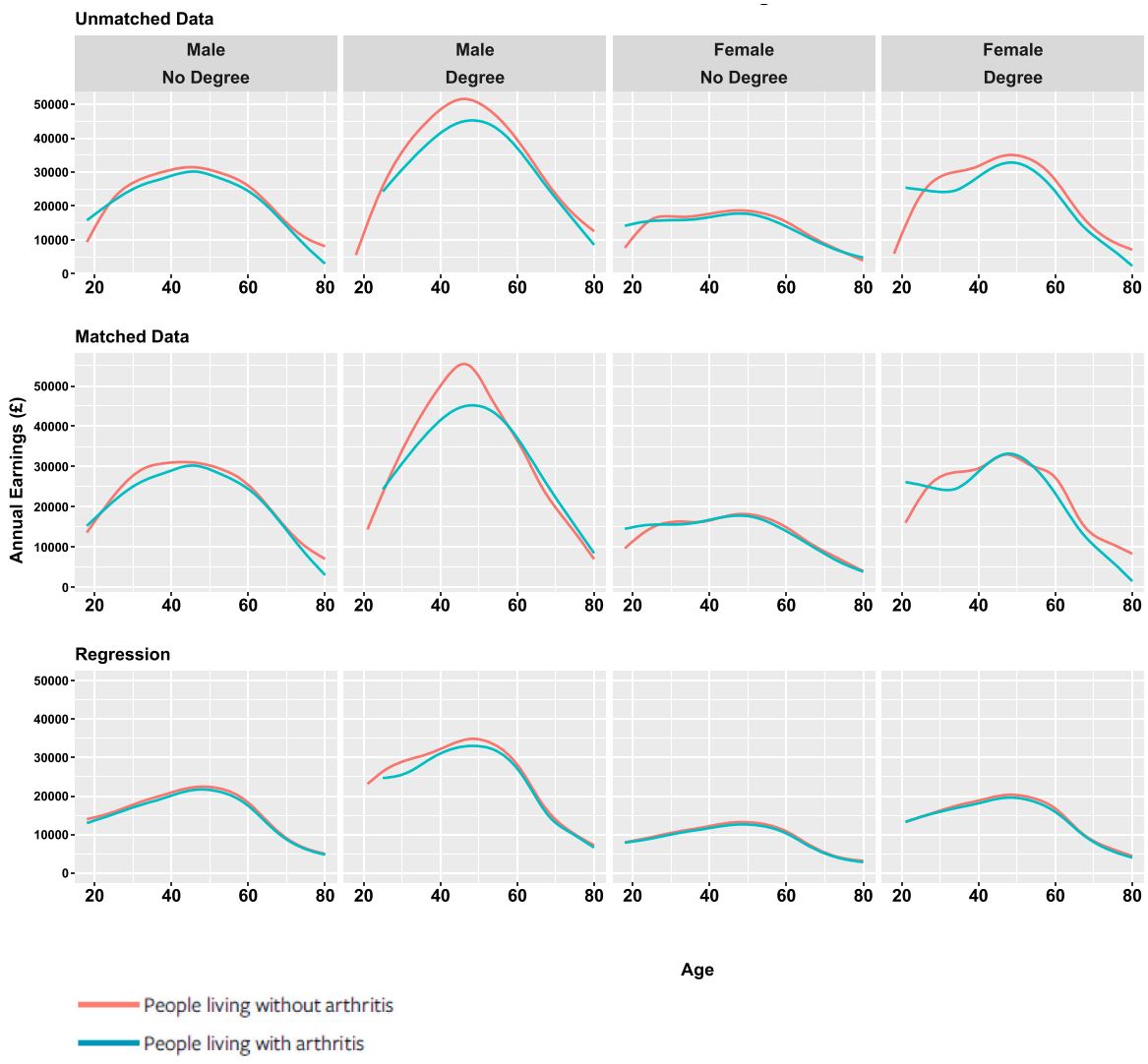


Fig. 4. Inflation adjusted annual earnings conditional on employment, by arthritis group, age, gender and degree status (RQ1): unmatched data (top panel), matched data (middle panel), marginal effects in regression model (bottom panel).

Table 3
Results (RQ1, equation 1: Employment)

Predictors	Odds Ratios	95% confidence interval	p-value
Intercept	0.84	0.59 to 1.19	0.327
Gender	0.36	0.32 to 0.40	**<0.001**
Ethnicity	0.75	0.67 to 0.84	**<0.001**
Arthritis status	0.49	0.45 to 0.53	**<0.001**
Children in household	0.67	0.62 to 0.73	**<0.001**
Marital status	1.42	1.25 to 1.60	**<0.001**
Degree-level education status	2.70	2.36 to 3.09	**<0.001**
Age [1]	10.58	7.74 to 14.44	**<0.001**
Age [2]	0.56	0.40 to 0.78	**0.001**
Age [3]	0.02	0.01 to 0.02	**<0.001**
Age [4]	0.00	0.00 to 0.00	**<0.001**
Age [5]	0.03	0.02 to 0.06	**<0.001**
Age [6]	0.00	0.00 to 0.00	**<0.001**
North East England	0.69	0.53 to 0.90	**0.006**
North West England	0.96	0.79 to 1.16	0.660
Yorkshire	0.78	0.63 to 0.96	**0.021**
East Midlands	1.16	0.94 to 1.43	0.157
West Midlands	1.12	0.91 to 1.37	0.296
East of England	1.65	1.35 to 2.01	**<0.001**
South East England	1.65	1.37 to 1.99	**<0.001**
South West Enjgland	1.40	1.14 to 1.72	**0.001**
Wales	0.89	0.71 to 1.12	0.311
Scotland	1.13	0.89 to 1.42	0.308
n	36,027		
N	245,759		
Pseudo R^2	0.893		

Table 4
Results (RQ1, equation 2: Inflation adjusted annual earnings).

Predictors	Estimates	95% confidence interval	p-value
Intercept	9.62	9.55 to 9.69	**<0.001**
Gender	−0.53	−0.56 to −0.51	**<0.001**
Ethnicity	−0.07	−0.10 to −0.05	**<0.001**
Arthritis status	−0.04	−0.06 to −0.02	**<0.001**
Children in household	−0.09	−0.10 to −0.07	**<0.001**
Marital status	−0.03	−0.05 to −0.01	**0.014**
Degree-level education status	0.43	0.41 to 0.46	**<0.001**
Age [1]	0.48	0.42 to 0.54	**<0.001**
Age [2]	0.24	0.17 to 0.30	**<0.001**
Age [3]	−0.30	−0.36 to −0.23	**<0.001**
Age [4]	−0.82	−0.90 to −0.75	**<0.001**
Age [5]	−0.30	−0.44 to −0.17	**<0.001**
Age [6]	−1.43	−1.53 to −1.32	**<0.001**
North East England	−0.12	−0.18 to −0.06	**<0.001**
North West England	−0.09	−0.13 to −0.04	**<0.001**
Yorkshire	−0.22	−0.26 to −0.17	**<0.001**
East Midlands	−0.20	−0.24 to −0.15	**<0.001**
West Midlands	−0.13	−0.17 to −0.08	**<0.001**
East of England	−0.06	−0.11 to −0.02	**0.004**
South East England	−0.05	−0.09 to −0.01	**0.012**
South West England	−0.15	−0.20 to −0.11	**<0.001**
Wales	−0.04	−0.09 to 0.02	0.178
Scotland	0.03	−0.02 to 0.08	0.277
n	16,185		
N	82,168		
R^2	0.747		

in the professional and intermediate subgroups. That is, arthritis reduced earnings by approximately 5 percentage point in the professional subgroup, yet had no effect in the routine work subgroup. Results from the logistic regressions of hours worked conditional on employment are given in Appendix 7. They indicated that for all three subgroups there were few differences in the hours worked between the arthritis and non-arthritis groups amongst males. Yet, in the professional subgroup for females, a gap is observed and is particularly prominent at ages 40 and above.

3.4.2.2. Employer-type subgroups. The regression models show the effect of arthritis on employment (equation 1) appears to be greatest in the small private company subgroup (Table 5 and Fig. 6). For instance, a 63 year old male (the median age in our dataset) who had most recently been employed in a small private company had an 80% probability of being in work if they did not have arthritis, after controlling for the selected variables, whereas those with arthritis had a 60% probability of being in work. This equates to a 20 percentage point reduction in the likelihood of being in work. In contrast, there was a smaller 9 percentage point reduction in the likelihood of being in work that was associated with arthritis among 63 year old males who had most recently been employed by a large, non-private employer. This difference appears to be greater in older age. For example, for 55 year old males who had most recently worked in a small private company, there was only a one percentage point reduction in the likelihood of being in work when living with arthritis compared to people without arthritis. Yet, the equivalent reduction for 65 year old males was 23 percentage points. Our regression models where earnings was an outcome (equation 2) showed that, for people in work, there was no statistically significant relationship between having arthritis and earnings by the type of employer (Table 5 and Fig. 6).

4. Discussion

4.1. Summary of main findings

Our results showed that arthritis was associated with an overall reduction of around 3 percentage points in people's probability of being employed. Yet this overall figure hides a large amount of heterogeneity both in terms of an individuals' characteristics and the nature of their employment and workplace. The effect size varies over people's life course as well as being larger amongst women, people without a degree, and those in routine or intermediate type occupations. In contrast, arthritis seemed to have less impact on men, people with a degree, or those in professional type occupations. People with arthritis were more likely to be out of work if they had previously worked for small private companies, compared to large private companies and non-private employers.

We have demonstrated that (among those in work) arthritis was also associated with reduced earnings, although again there was heterogeneity present. For example, men without a degree and women earned the same (if they were employed) whether they had arthritis or not. On the other hand, men with a degree earned less if they had arthritis, as did those in professional occupations. This latter effect was particularly acute among women over 40, and there were indications that it was driven by a reduction in hours worked.

4.2. Implications

The prevalence of arthritis is rising, due in part to an ageing population. There are also increasing levels of arthritis and multimorbidity, defined as the co-occurrence of arthritis with one or more mental or physical long-term health conditions. How to help individuals with arthritis manage their condition(s) is thus a substantial and growing societal challenge (Versus Arthritis, 2017). Our results complement previous findings in the literature. For example, they support the findings of Sorensen et al. (2021), who highlight the interplay between employment and health, suggesting that the ageing population in developed economies further complicates individual and societal issues about workforce participation. Our conclusions demonstrate the importance of considering how long term health conditions such as arthritis affect labour market outcomes (Salis et al., 2021).

Arthritis is more common amongst women and lower socio-economic groups. This, combined with our findings of sometimes substantial

Table 5
Results (RQ2: The role of work-type and employer-type in explaining differences in labour market outcomes).

Employment (equation 1)					Inflation adjusted annual earnings (equation 2)			
By work-type (NS-SEC category)					**By work-type (NS-SEC category)**			
	Routine	Intermediate	Professional		Routine	Intermediate	Professional	
Arthritis status	0.62 (<0.001) CI (0.55 to 0.70)	0.64 (<0.001) CI (0.55 to 0.75)	0.69 (<0.001) CI (0.58 to 0.82)		0 (>0.10) CI (−0.02 to −0.03)	−0.05 (<0.05) CI (−0.09 to −0.00)	−0.05 (<0.01) CI(-0.09 to −0.02)	
R^2 or pseudo R^2	0.40	0.38	0.47		0.21	0.08	0.15	
N	63,473	40,133	42,773		22,737	14,874	23,049	
n	9030	5402	5796		6116	4189	5723	
By employer-type					**By employer-type**			
	Large private	Small private	Large public	Small public	Large private	Small private	Large public	Small public
Arthritis status	0.56 (<0.01) CI (0.40 to 0.79)	0.37 (<0.001) CI (0.30 to 0.47)	0.67 (>0.05) CI (0.45 to 1.01)	0.51 (<0.01) CI (0.35 to 0.75)	−0.01 (>0.1) CI (−0.04 to 0.02)	−0.05 (<0.01) CI (−0.08 to −0.01)	−0.00 (>0.1) CI (−0.03 to 0.03)	−0.04 (>0.1) CI (−0.09 to 0.01)
R^2 or pseudo R^2	0.33	0.33	0.38	0.36	0.24	0.19	0.16	0.14
N	23,626	29,984	20,900	15,536	16,324	19,159	14,706	10,147
n	4012	4925	3312	2727	3770	4617	3152	2583

•Table shows odds ratio (LHS), coefficient (RHS), 95% confidence intervals (CI) and p-values (in brackets) for the arthritis variable in fully adjusted models.
•Values for all other covariates and the full regression outputs are shown in Appendix 5.

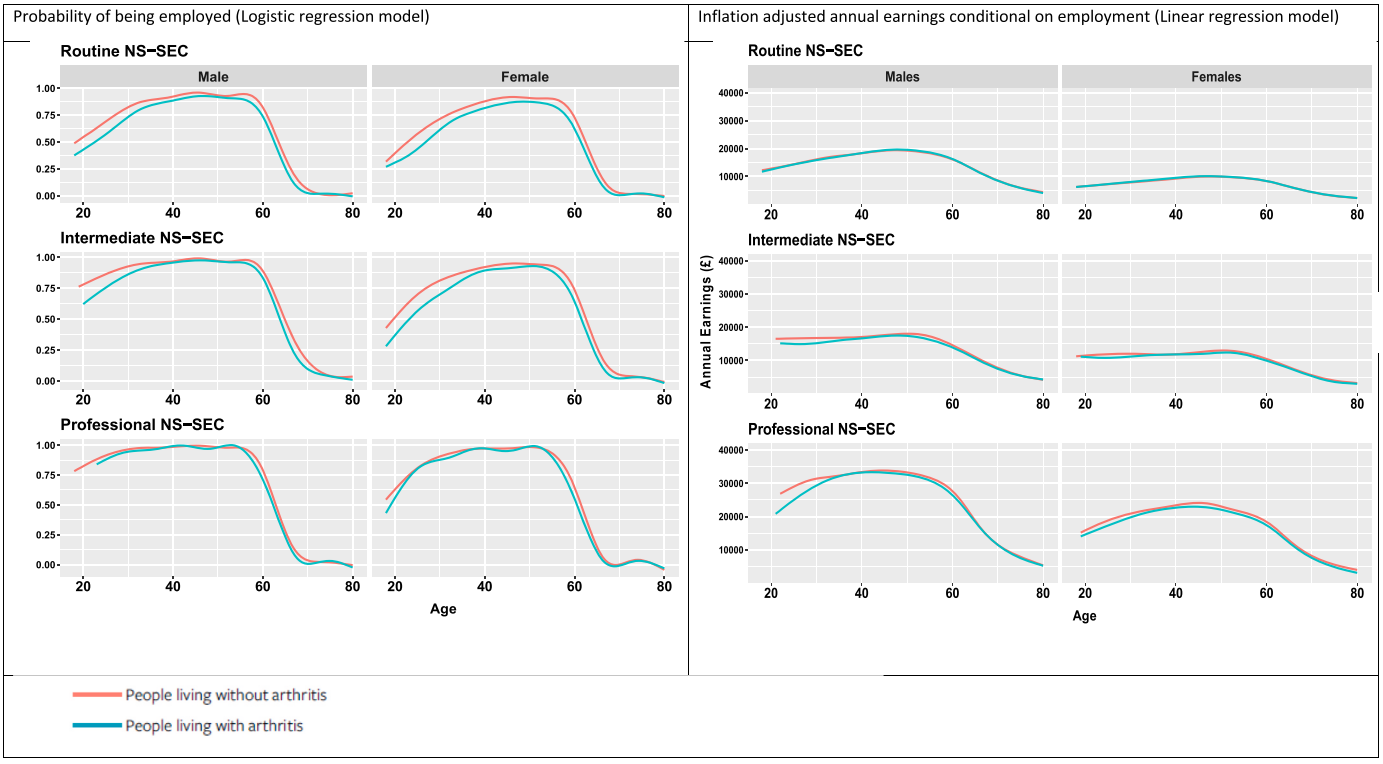


Fig. 5. Employment and earnings conditional on employment, by work-type (NS-SEC category), arthritis group, age and gender (RQ2).

differences in how different groups' labour market outcomes are affected by arthritis, means the condition is potentially a major contributor to socio-economic inequalities in both health and work. The trend towards older retirement ages can only exacerbate these problems. Inequalities in labour market outcomes due to ill health have also been highlighted by the COVID-19 pandemic. For example, Bell and Blanchflower (2020) have provided evidence that the effects of the pandemic on labour market outcomes have been unequally distributed across age groups, gender and ethnicity.

There have been several studies examining interventions designed to help working-age people with arthritis with employment (Faisting and de Oliveira Sato, 2019; Holland and Clayton, 2020; National Institute for Health and Care Excellence, 2019; Palmer et al., 2012; Skamagki et al., 2018; Wainwright et al., 2022). This includes, for example, investment in ergonomic and other job design adjustments, the use of assistive technology and personalised case management. The latter is an intervention that is typically led by an occupational health practitioner to encourage constructive dialogue between employees, healthcare practitioners, and employers. However, they are not generally targeted at particular groups. Our results suggest that due to heterogeneity in who is most likely to be impacted by an arthritis diagnosis, it may be advantageous to focus on

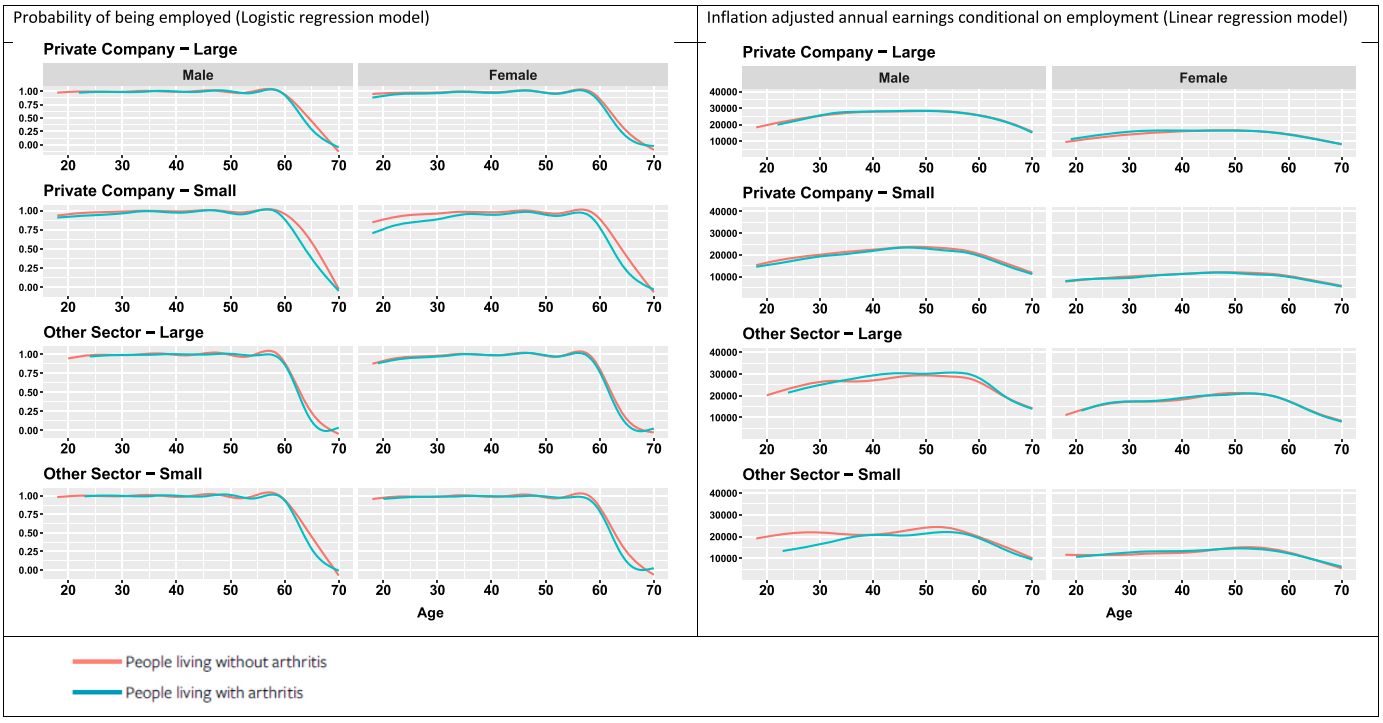


Fig. 6. Employment and earnings conditional on employment, by employer-type, arthritis group, age and gender (RQ2).

different groups when developing and trialling policies and interventions. Our results also suggest that it may be beneficial to focus on outcomes in different sectors. For example, with routine work it may be better to target staying in employment. In contrast, with professional work there is greater potential for benefit in supporting people reach their earnings potential, as arthritis does not appear to affect employment in this sector. In addition, our results indicate that people employed by smaller private firms may especially benefit from support. This is possibly due to such firms having fewer resources available, and/or less scope to transfer people with arthritis to alternative roles.

4.3. Strengths and weaknesses

Our study has several strengths. The datasets we used availed us of a large sample size, which enabled us to explore individual-level heterogeneity and ensures that the matching procedure is well supported. Individuals in our datasets were followed for long periods of time and, compared to previous literature, these datasets had a reduced risk of recall bias, as interview intervals were short (one year for BHPS/UKHLS, two years for ELSA). A previous Australian study by Majeed et al. (2017), for example, relied on retrospective life-history data collected through questionnaires and interviews with a small sample of participants aged over 60 (n = 1261). The study reported that arthritis was associated with a lower probability of being in full time work for men, but not women. However, this data would be at high risk of recall bias because participants were required to recall details of their health, living conditions, education and employment throughout their lifetime.

Our large sample size also compares favourably to other previous studies. For example, Barrett et al. (2000) used the Norfolk Arthritis Register to show that people with arthritis were 32 times more likely to stop work on health grounds, but relied on a sample size of under 300 from a single area of England. Analyses of survey data by Conaghan et al. (2015) showed that 15% of people with osteoarthritis had taken early retirement on average 7.8 years earlier than planned, but had responses from only 2001 people. Finally, Syddall et al., 2020 examined data on 5143 older workers (aged 50–64 years at baseline) who participated in the Health and Employment after Fifty (HEAF) cohort study. After two years, 297 participants had reported exiting work for any health-related reason. Although only a subsample of these were living with arthritis, the study examined differences by job type. The study found that women who had worked in teaching, education, nursing, midwifery or caring roles, and men who had worked in vehicle trades or as road transport drivers, were more likely than average to have exited work for health-related (versus non-health-related) reasons.

Few other large datasets have collected information on both arthritis and labour market outcomes. One exception is the UK's Labour Force Survey which reports the number of working days lost to sickness due to musculoskeletal conditions (HSE, 2021). However, this data does not assess arthritis independent of other musculoskeletal conditions. A further exception is the UK Biobank dataset. However, studies using this dataset may be limited by selection bias, given the relative health and age of UK Biobank participants. One recent study using UK Biobank data did not identify any associations between arthritis and income or employment outcomes among White British people aged between 39 and 72 years (n = 336,997). However, the authors suggest that there may be a lack of statistical power to detect effects (Harrison et al., 2020). This may be partly due to the study relying on a subsample of people who are more genetically prone to arthritis, rather than observed cases of an arthritis diagnosis. Our study also has several weaknesses. Our measure of arthritis was based on self-report, thus it could be that it includes other musculoskeletal conditions that respondents interpreted as arthritis. (Though note that all three surveys ask whether respondents have been given a formal diagnosis by a medical professional.) The datasets (particularly BHPS and UKHLS) did not allow us to distinguish between severity or the type of arthritis, both of which would likely be important factors in determining the impact of arthritis on labour

market outcomes. For these reasons, inclusion of questions related to those factors could be considered for inclusion in future data collection. We compared outcomes for people with and without arthritis using propensity score matching. While this technique is useful in controlling for confounding factors, it does not provide definitive proof of causal inference (Garrido et al., 2014; Rosenbaum and Rubin, 1983).

4.4. Future research

The large impact that arthritis has on society means that it is important to quantify its effects on individuals, and to examine how these effects differ for different sectors of society. It is hoped that our findings will be useful for future research, for example by guiding which types of interventions and policies should be evaluated in order to better support those groups identified in our study as most in need. Our results may also be useful in assessing their long-term cost-effectiveness, given that evaluation studies of the interventions described in Section 4.2 are often limited by necessity to relatively short follow-up periods. Future research ought also to identify the reasons why arthritis has a different impact on certain groups of people, including by gender, age group or work-type. For example, whilst our study indicates that people living with arthritis who work in lower NS-SEC categories are less able than those in professional roles to remain in work and to reduce their working hours, finding out why this is the case would be valuable in terms of designing appropriate support for these groups. Reasons might include the possibility that such work is less compatible with the symptoms of arthritis due to it being more physically demanding (e.g. manual work) or because of fewer prospects to work remotely or flexibly. It is likely that future research in this area would require qualitative interviews with people whose working lives have been affected by arthritis, rather than analysis of large-scale surveys of the kind used in this study.

Future research could also fruitfully explore the complex links and causal relationships between arthritis and some co-morbidities, for example obesity or mental health (Mujica-Mota et al., 2015). For people living with co-morbidities, some of the labour market outcomes attributed in our study to arthritis may in fact be due to other conditions. Alternatively, when lived in combination with other conditions, the labour market outcomes attributed to arthritis might be larger than identified in this study.

Finally, it has been a tacit assumption throughout that differences in labour market outcomes for people with arthritis represents a problem to be solved. The result for research question 2 especially suggests that arthritis can lead to complex changes to the labour-leisure trade-off, and it is plausible that being diagnosed with a life-long condition may lead to changes in priorities. This could include a desire to spend more time with family or other interests including leisure activities or voluntary work, for example. While it is undoubtedly true that many people's opportunities are unjustly limited by arthritis, it is not clear that equalising the labour market outcomes of people with and without arthritis would necessarily maximise people with arthritis' quality of life. Thus it is vital that future research should go beyond labour market outcomes to examine how arthritis and the labour market interacts with quality of life, as well as investigating why people with arthritis make the labour market decisions they do.

5. Conclusion

Our study has provided evidence that arthritis has an effect on labour market outcomes, with the condition leading to a lower probability of being employed, and lower earnings for those who are employed. We have also shown that different groups are affected more than others.

Credit author statement

Nasir Rajah: Conceptualization, Methodology, Software, Formal analysis, Writing- Reviewing and Editing, Visualisation. **Adam Martin**: Conceptualization, Methodology, Software, Formal analysis, Writing-Reviewing and Editing. **Edward J.D. Webb:** Methodology, Formal analysis, Writing- Reviewing and Editing. **Claire Hulme:** Conceptualization, Writing- Reviewing and Editing, Supervision. **Robert West:** Conceptualization, Supervision, Methodology, Formal analysis. **Sarah R Kingsbury:** Writing- Reviewing and Editing, Conceptualization.

Data availability

Data will be made available on request.

Acknowledgements

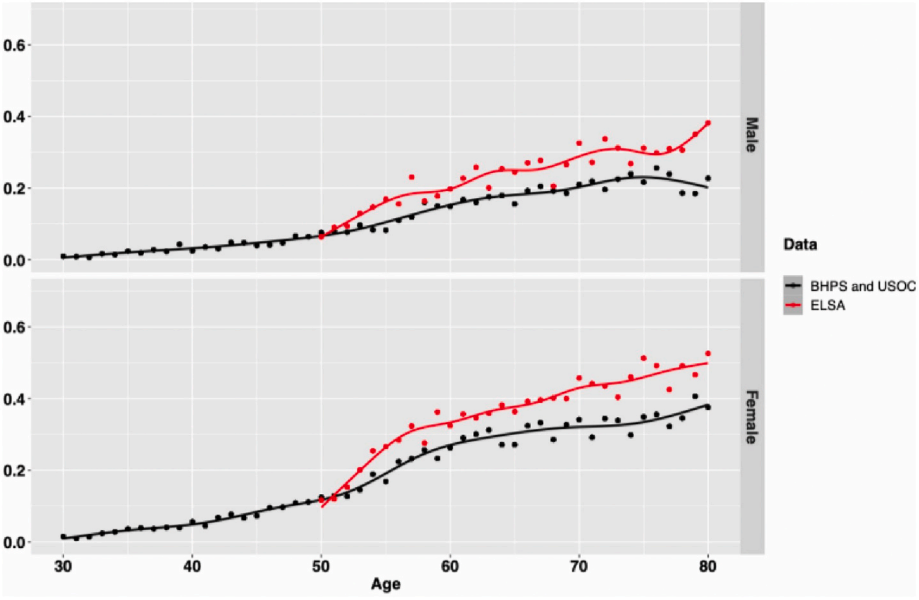
This work was funded by the Nuffield Foundation's Oliver Bird Fund (OBF/44005). Members of the investigator team for this project were: AM (Principal Investigator), Professor Philip G. Conaghan (Leeds Institute of Rheumatic and Musculoskeletal Medicine), CH, SRK, Dr Theresa Munyombwe (Leeds Institute of Cardiovascular and Metabolic Medicine) and RW. PGC and SRK were also supported, in part, through the National Institute for Health Research (NIHR) Leeds Biomedical Research Centre (BRC). NR was also supported, in part, by the Economic and Social Research Council (ESRC) (ES/M001660/1, Centre for Longitudinal Studies, Resource Centre 2015–20).

We are grateful to our Patient and Public Involvement and Engagement group, including Mrs. Gill Bowskill and Mr. Christopher McIlveen, and to our Project Advisory Group for their invaluable input throughout this project. We also wish to thank those who provided feedback on earlier versions of this work including participants at meetings facilitated by the Department for Work and Pensions (DWP), Versus Arthritis' National Musculoskeletal Health Data Group, and the International Health Economics Association.

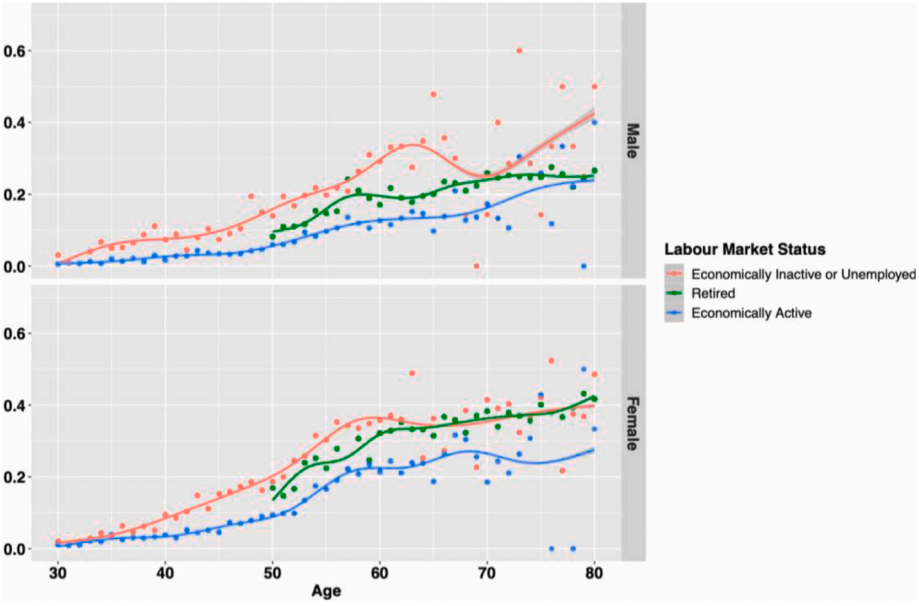
The research data used in this project was distributed by the UK Data Service. The UKHLS ('Understanding Society') is an initiative funded by the ESRC and various Government departments, with scientific leadership by the Institute for Social and Economic Research, University of Essex, and survey delivery by NatCen Social Research and Kantar Public. The English Longitudinal Study of Ageing (ELSA) was developed by a team of researchers based at University College London, NatCen Social Research, the Institute for Fiscal Studies, the University of Manchester and the University of East Anglia. The data were collected by NatCen Social Research. The funding is currently provided by the National Institute on Aging (Ref: R01AG017644) and by a consortium of Government departments: Department for Health and Social Care; Department for Transport; DWP, which is coordinated by the NIHR (Ref: 198–1074). Funding has also been provided by the ESRC.

This paper presents independent research. The views expressed are those of the authors and not necessarily those of our funders or any Government department.

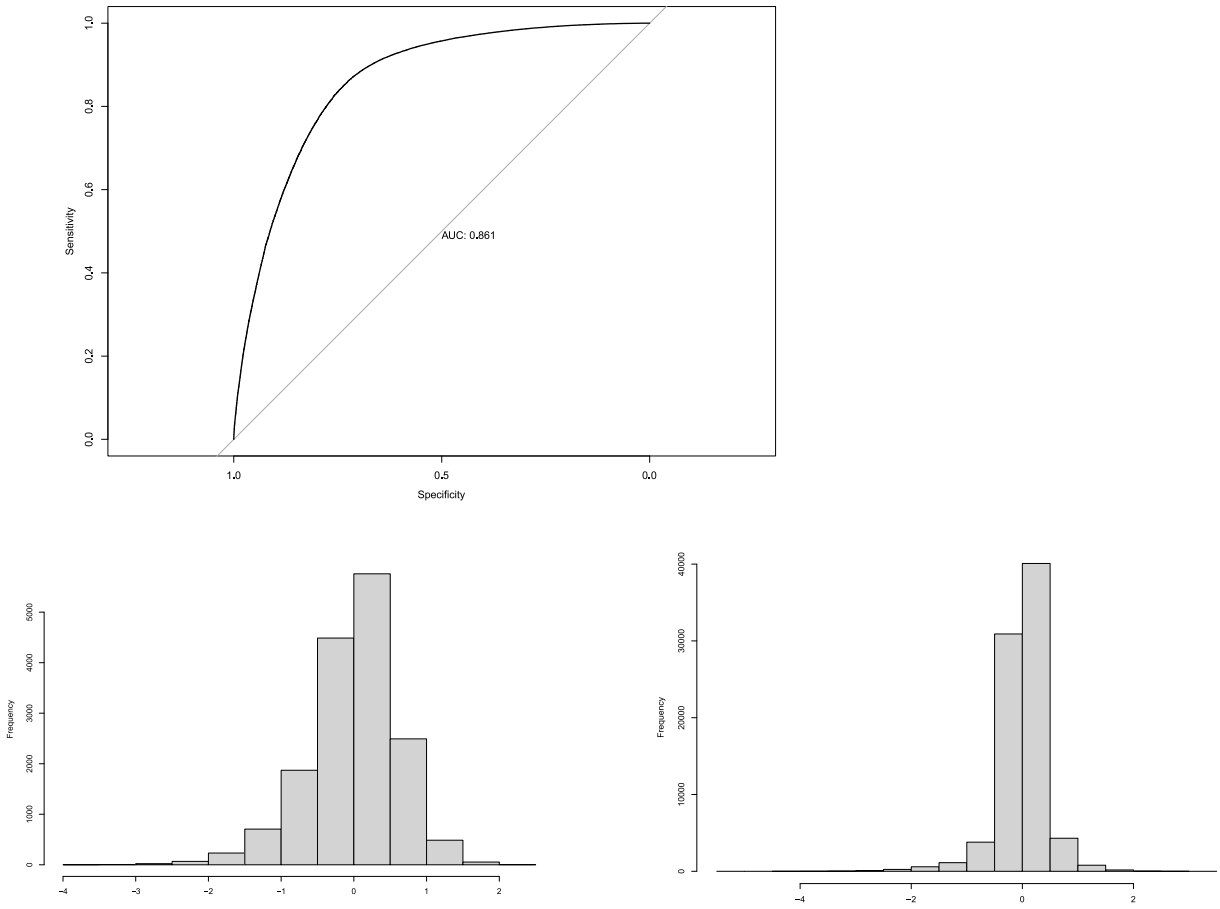
Appendix 1. Proportion of participants reporting an arthritis diagnosis at wave of entry to cohort, by age, gender and source dataset



Appendix 2. Proportion of participants reporting an arthritis diagnosis at wave of entry to cohort, by age, gender and labour market status



Appendix 3. Regression model diagnostics



The top panel shows the receiver operating characteristic (ROC) curve for the employment status regression model (equation 1, RQ1, see Table 3). The lower panel shows histograms of the level 1 (LHS) and level 2 (RHS) residuals for the inflation adjusted annual earnings regression model (equation 2, RQ1, see Table 4)

Appendix 4. Results (RQ1), split by source dataset

Results (RQ1, equation 1: Employment), split by source dataset

	BHPS and UKHLS			ELSA		
Predictors	Odds Ratios	95% confidence interval	p-value	Odds Ratios	95% confidence interval	p-value
Intercept	3.19	1.94 – 5.26	**<0.001**	5.34	2.05 – 13.92	**0.001**
Gender	0.29	0.25 – 0.35	**<0.001**	0.47	0.42 – 0.53	**<0.001**
Ethnicity	0.76	0.67 – 0.87	**<0.001**	0.54	0.38 – 0.76	**0.001**
Arthritis status	0.45	0.40 – 0.51	**<0.001**	0.53	0.48 – 0.59	**<0.001**
Children in household	0.54	0.48 – 0.60	**<0.001**	1.09	0.99 – 1.20	0.070
Marital status	1.43	1.23 – 1.66	**<0.001**	1.44	1.15 – 1.80	**0.002**
Degree-level education status	4.00	3.31 – 4.83	**<0.001**	1.31	1.11 – 1.54	**0.001**
Age[1]	21.07	14.59 – 30.42	**<0.001**	0.39	0.16 – 0.91	**0.030**
Age[2]	1.94	1.29 – 2.90	**0.001**	0.05	0.02 – 0.13	**<0.001**
Age[3]	0.01	0.01 – 0.02	**<0.001**	0.01	0.01 – 0.04	**<0.001**
Age[4]	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.01	**<0.001**
Age[5]	0.01	0.00 – 0.02	**<0.001**	0.02	0.00 – 0.13	**<0.001**
Age[6]	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
North East England	0.72	0.48 – 1.06	0.098	0.57	0.42 – 0.76	**<0.001**
North West England	1.14	0.87 – 1.51	0.347	0.65	0.50 – 0.83	**0.001**
Yorkshire	0.88	0.65 – 1.20	0.431	0.62	0.48 – 0.80	**<0.001**
East Midlands	1.43	1.05 – 1.94	**0.024**	0.79	0.61 – 1.01	0.061
West Midlands	1.41	1.05 – 1.91	**0.024**	0.75	0.58 – 0.97	**0.029**
East of England	2.37	1.77 – 3.17	**<0.001**	0.94	0.74 – 1.20	0.619
South East England	2.15	1.65 – 2.80	**<0.001**	0.98	0.78 – 1.24	0.896
SouthWest England	2.08	1.55 – 2.80	**<0.001**	0.79	0.62 – 1.02	0.066
Wales	0.96	0.71 – 1.29	0.789	0.56	0.18 – 1.75	0.323
Scotland	1.23	0.91 – 1.66	0.179	0.49	0.10 – 2.34	0.369
n	25254			10773		
N	189293			56466		
Psuedo R^2	0.928			0.762		

Results (RQ1, equation 2: Inflation adjusted annual earnings), split by source dataset

	BHPS and UKHLS			ELSA		
Predictors	Estimates	95% confidence interval	p-value	Estimates	95% confidence interval	p-value
Intercept	10.14	10.06 to 10.22	**<0.001**	10.23	9.90 to 10.55	**<0.001**
Gender	-0.54	-0.57 to -0.52	**<0.001**	-0.52	-0.57 to -0.48	**<0.001**
Ethnicity	-0.08	-0.10 to -0.06	**<0.001**	-0.03	-0.17 to 0.10	0.633
Arthritis status	-0.05	-0.07 to -0.03	**<0.001**	-0.04	-0.08 to 0.00	0.073
Children in household	-0.10	-0.11 to -0.08	**<0.001**	0.05	0.02 to 0.09	**0.005**
Marital status	-0.02	-0.04 to 0.00	0.082	-0.03	-0.12 to 0.05	0.474
Degree-level education status	0.43	0.40 to 0.46	**<0.001**	0.39	0.33 to 0.45	**<0.001**
Age[1]	0.60	0.55 to 0.66	**<0.001**	0.06	-0.23 to 0.34	0.699
Age[2]	0.44	0.37 to 0.50	**<0.001**	-0.53	-0.85 to -0.21	**0.001**
Age[3]	-0.01	-0.08 to 0.05	0.742	-0.79	-1.10 to -0.48	**<0.001**
Age[4]	-0.66	-0.73 to -0.58	**<0.001**	-1.43	-1.69 to -1.17	**<0.001**
Age[5]	-0.04	-0.18 to 0.10	0.568	-1.31	-1.94 to -0.68	**<0.001**
Age[6]	-1.10	-1.21 to -0.98	**<0.001**	-1.91	-2.18 to -1.64	**<0.001**
North East England	-0.05	-0.11 to 0.02	0.179	-0.16	-0.27 to -0.05	**0.005**
North West England	-0.02	-0.07 to 0.02	0.337	-0.16	-0.26 to -0.07	**0.001**
Yorkshire	-0.14	-0.19 to -0.09	**<0.001**	-0.24	-0.34 to -0.14	**<0.001**
East Midlands	-0.13	-0.18 to -0.08	**<0.001**	-0.21	-0.31 to -0.11	**<0.001**
West Midlands	-0.07	-0.12 to -0.02	**0.009**	-0.15	-0.25 to -0.05	**0.003**
East of England	0.03	-0.02 to 0.08	0.224	-0.12	-0.22 to -0.03	**0.011**
South East England	0.01	-0.03 to 0.06	0.539	-0.09	-0.18 to 0.00	0.055
South West England	-0.10	-0.15 to -0.05	**<0.001**	-0.15	-0.25 to -0.05	**0.002**
Wales	-0.07	-0.13 to -0.02	**0.005**	-0.50	-1.21 to 0.21	0.165
Scotland	-0.02	-0.07 to 0.03	0.447	-1.29	-2.21 to -0.37	**0.006**
n	11383			4802		
N	66912			15256		
R^2	0.774			0.549		

Appendix 5. Results (RQ2: The role of work-type in explaining differences in labour market outcomes)

Employment (equation 1)

	Routine			Intermediate			Professional		
Predictors	Odds Ratios	95% confidence interval	p-value	Odds Ratios	95% confidence interval	p-value	Odds Ratios	95% confidence interval	p
Intercept	1.82	1.10 – 3.03	**0.021**	6.48	2.98 – 14.09	**<0.001**	7.56	3.24 – 17.64	**<0.001**
Gender	0.57	0.50 – 0.66	**<0.001**	0.34	0.29 – 0.42	**<0.001**	0.43	0.35 – 0.52	**<0.001**
Ethnicity	0.91	0.76 – 1.09	0.306	0.83	0.64 – 1.07	0.152	1.12	0.83 – 1.51	0.467
Arthritis status	0.62	0.55 – 0.70	**<0.001**	0.64	0.55 – 0.75	**<0.001**	0.69	0.58 – 0.82	**<0.001**
Children in household	0.57	0.51 – 0.64	**<0.001**	0.57	0.49 – 0.67	**<0.001**	0.55	0.47 – 0.65	**<0.001**
Marital status	1.05	0.87 – 1.26	0.632	1.36	1.03 – 1.79	**0.031**	1.20	0.93 – 1.54	0.161
Degree-level education status	2.19	1.69 – 2.84	**<0.001**	1.36	1.08 – 1.72	**0.010**	1.34	1.11 – 1.61	**0.002**
Age[1]	25.81	17.01 – 39.16	**<0.001**	26.46	13.76 – 50.90	**<0.001**	38.20	18.15 – 80.40	**<0.001**
Age[2]	15.11	9.62 – 23.75	**<0.001**	7.25	3.59 – 14.65	**<0.001**	3.14	1.42 – 6.95	**0.005**
Age[3]	1.66	1.07 – 2.58	**0.023**	0.48	0.24 – 0.94	**0.033**	0.23	0.11 – 0.51	**<0.001**
Age[4]	0.01	0.01 – 0.01	**<0.001**	0.01	0.01 – 0.02	**<0.001**	0.00	0.00 – 0.00	**<0.001**
Age[5]	0.34	0.13 – 0.85	**0.022**	0.46	0.11 – 1.95	0.288	0.18	0.03 – 0.98	**0.047**
Age[6]	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
North East England	0.54	0.39 – 0.75	**<0.001**	0.40	0.26 – 0.63	**<0.001**	0.28	0.17 – 0.46	**<0.001**
North West England	0.60	0.46 – 0.78	**<0.001**	0.73	0.52 – 1.03	0.075	0.56	0.39 – 0.80	**0.002**
Yorkshire	0.55	0.42 – 0.73	**<0.001**	0.54	0.37 – 0.79	**0.001**	0.37	0.25 – 0.56	**<0.001**
East Midlands	0.63	0.48 – 0.83	**0.001**	0.52	0.36 – 0.74	**<0.001**	0.78	0.53 – 1.15	0.206
West Midlands	0.63	0.48 – 0.83	**0.001**	0.77	0.53 – 1.10	0.153	0.59	0.40 – 0.87	**0.008**
East of England	0.83	0.63 – 1.09	0.173	0.81	0.58 – 1.13	0.216	0.86	0.60 – 1.23	0.398
South East England	0.89	0.68 – 1.16	0.379	0.83	0.60 – 1.14	0.250	0.75	0.54 – 1.05	0.091
South West England	0.85	0.64 – 1.13	0.256	0.67	0.48 – 0.95	**0.023**	0.57	0.39 – 0.83	**0.003**
Wales	1.13	0.80 – 1.59	0.484	1.44	0.88 – 2.34	0.144	1.49	0.91 – 2.45	0.117
Scotland	1.97	1.38 – 2.82	**<0.001**	2.62	1.63 – 4.22	**<0.001**	1.06	0.66 – 1.71	0.803
n	9030			5402			5796		
N	63473			40133			42773		
Pseudo R^2	0.809			0.813			0.856		

Inflation adjusted annual earnings (equation 2)

	Routine			Intermediate			Professional		
Predictors	Estimates	95% confidence interval	p-value	Estimates	95% confidence interval	p-value	Estimates	95% confidence interval	p-value
Intercept	10.10	9.96 to 10.25	**<0.001**	10.18	9.91 to 10.44	**<0.001**	10.47	10.30 to 10.64	**<0.001**
Gender	-0.67	-0.71 to -0.63	**<0.001**	-0.34	-0.40 to -0.28	**<0.001**	-0.41	-0.45 to -0.37	**<0.001**
Ethnicity	0.07	-0.00 to 0.13	0.051	-0.08	-0.19 to 0.03	0.145	-0.04	-0.11 to 0.04	0.364
Arthritis status	0.00	-0.02 to 0.03	0.701	-0.05	-0.09 to -0.00	**0.048**	-0.05	-0.09 to -0.02	**0.001**
Children in Household	-0.10	-0.12 to -0.07	**<0.001**	-0.13	-0.18 to -0.08	**<0.001**	-0.08	-0.11 to -0.06	**<0.001**
Marital Status	-0.04	-0.08 to 0.00	0.070	-0.07	-0.15 to 0.00	0.056	0.02	-0.03 to 0.07	0.393
Degree-level education status	0.17	0.10 to 0.24	**<0.001**	0.03	-0.04 to 0.11	0.397	0.21	0.17 to 0.24	**<0.001**
Age[1]	0.49	0.37 to 0.61	**<0.001**	0.21	-0.02 to 0.44	0.077	0.37	0.22 to 0.52	**<0.001**
Age[2]	0.41	0.28 to 0.54	**<0.001**	0.02	-0.24 to 0.27	0.892	0.28	0.13 to 0.44	**<0.001**
Age[3]	0.13	0.00 to 0.26	**0.049**	-0.23	-0.48 to 0.02	0.069	0.08	-0.08 to 0.23	0.319
Age[4]	-0.66	-0.78 to -0.54	**<0.001**	-0.93	-1.14 to -0.72	**<0.001**	-0.96	-1.09 to -0.83	**<0.001**
Age[5]	-0.21	-0.48 to 0.07	0.138	-0.82	-1.35 to -0.28	**0.003**	-0.67	-1.01 to -0.33	**<0.001**
Age[6]	-1.32	-1.47 to -1.17	**<0.001**	-1.38	-1.65 to -1.11	**<0.001**	-1.79	-2.00 to -1.58	**<0.001**
North East England	0.00	-0.09 to 0.10	0.952	-0.20	-0.35 to -0.05	**0.010**	-0.13	-0.23 to -0.02	**0.016**
North West England	-0.07	-0.15 to 0.01	0.079	-0.20	-0.31 to -0.09	**<0.001**	-0.08	-0.15 to -0.00	**0.038**
Yorkshire	-0.13	-0.21 to -0.05	**0.001**	-0.28	-0.41 to -0.16	**<0.001**	-0.25	-0.33 to -0.16	**<0.001**
East Midlands	-0.13	-0.21 to -0.05	**0.001**	-0.29	-0.41 to -0.17	**<0.001**	-0.21	-0.29 to -0.13	**<0.001**
West Midlands	-0.11	-0.19 to -0.03	**0.006**	-0.23	-0.35 to -0.11	**<0.001**	-0.10	-0.18 to -0.02	**0.017**
East of England	-0.06	-0.14 to 0.02	0.149	-0.10	-0.21 to 0.02	0.091	-0.06	-0.13 to 0.02	0.135
South East England	-0.08	-0.16 to -0.00	**0.039**	-0.14	-0.25 to -0.04	**0.008**	-0.02	-0.09 to 0.05	0.589
South West England	-0.09	-0.17 to -0.01	**0.034**	-0.23	-0.34 to -0.11	**<0.001**	-0.17	-0.25 to -0.09	**<0.001**
Wales	-0.01	-0.10 to 0.08	0.813	-0.08	-0.22 to 0.06	0.267	-0.08	-0.17 to 0.02	0.118
Scotland	0.14	0.05 to 0.23	**0.003**	-0.10	-0.24 to 0.04	0.167	0.03	-0.06 to 0.12	0.510
n	6116			4189			5723		
N	22737			14874			23049		
R^2	0.791			0.605			0.713		

Appendix 6. Results (RQ2: The role of employer-type in explaining differences in labour market outcomes)

Employment (equation 1)

	Private Large			Private Small			Other Large			Other Small		
Predictors	Odds Ratios	95% confidence interval	p-value	Odds Ratios	95% confidence interval	p-value	Odds Ratios	95% confidence interval	p-value	Odds Ratios	95% confidence interval	p-value
Intercept	234.88	66.52 – 829.28	**<0.001**	36.76	14.12 – 95.66	**<0.001**	39.63	7.20 – 218.26	**<0.001**	343.43	41.10 – 2869.47	**<0.001**
Gender	0.32	0.21 – 0.48	**<0.001**	0.39	0.29 – 0.53	**<0.001**	0.45	0.27 – 0.75	**0.002**	0.30	0.16 – 0.56	**<0.001**
Ethnicity	1.21	0.81 – 1.81	0.347	1.46	1.10 – 1.93	**0.009**	1.46	0.94 – 2.29	0.095	0.83	0.53 – 1.29	0.401
Arthritis status	0.56	0.40 – 0.79	**0.001**	0.37	0.30 – 0.47	**<0.001**	0.67	0.45 – 1.01	0.054	0.51	0.35 – 0.75	**0.001**
Children in household	0.39	0.28 – 0.54	**<0.001**	0.50	0.39 – 0.65	**<0.001**	0.42	0.28 – 0.63	**<0.001**	0.41	0.27 – 0.62	**<0.001**
Marital status	3.29	2.23 – 4.84	**<0.001**	3.04	2.15 – 4.30	**<0.001**	3.75	2.07 – 6.79	**<0.001**	3.23	1.67 – 6.26	**<0.001**
Degree-level education status	1.15	0.68 – 1.94	0.604	1.78	1.19 – 2.65	**0.005**	0.67	0.42 – 1.07	0.092	1.05	0.60 – 1.85	0.864
Age[1]	5.48	2.13 – 14.09	**<0.001**	6.31	3.00 – 13.29	**<0.001**	76.77	20.04–294.09	**<0.001**	3.41	0.61 – 19.15	0.163
Age[2]	1.60	0.58 – 4.43	0.365	3.47	1.53 – 7.89	**0.003**	11.44	2.68 – 48.88	**0.001**	1.29	0.20 – 8.18	0.790
Age[3]	0.58	0.22 – 1.54	0.278	1.05	0.48 – 2.28	0.909	1.27	0.32 – 5.03	0.736	0.05	0.01 – 0.33	**0.001**
Age[4]	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
Age[5]	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.01	**<0.001**	0.00	0.00 – 0.02	**<0.001**	0.00	0.00 – 0.01	**<0.001**
Age[6]	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**	0.00	0.00 – 0.00	**<0.001**
North East England	0.81	0.29 – 2.26	0.691	0.56	0.27 – 1.16	0.117	0.38	0.13 – 1.10	0.075	0.41	0.12 – 1.34	0.139
North West England	0.57	0.27 – 1.23	0.154	1.20	0.70 – 2.08	0.508	0.67	0.31 – 1.43	0.297	0.86	0.36 – 2.05	0.728
Yorkshire	0.78	0.35 – 1.76	0.557	0.89	0.49 – 1.61	0.701	0.96	0.41 – 2.27	0.933	1.61	0.63 – 4.15	0.323
East Midlands	0.70	0.30 – 1.62	0.403	0.77	0.43 – 1.38	0.379	0.81	0.33 – 1.96	0.638	0.61	0.24 – 1.55	0.303
West Midlands	1.06	0.45 – 2.48	0.893	1.26	0.70 – 2.28	0.434	1.29	0.52 – 3.18	0.587	1.13	0.47 – 2.73	0.778
East of England	1.72	0.80 – 3.71	0.165	1.78	1.01 – 3.17	**0.048**	0.58	0.26 – 1.29	0.180	1.35	0.54 – 3.39	0.521
South East England	1.06	0.52 – 2.17	0.862	1.63	0.98 – 2.70	0.060	1.56	0.73 – 3.31	0.249	1.45	0.66 – 3.20	0.360
South West England	1.15	0.50 – 2.66	0.736	2.08	1.17 – 3.69	**0.013**	0.87	0.39 – 1.97	0.744	2.05	0.84 – 5.01	0.114
Wales	0.43	0.20 – 0.95	**0.037**	0.58	0.33 – 1.02	0.061	0.65	0.29 – 1.48	0.306	0.65	0.27 – 1.53	0.320
Scotland	0.84	0.38 – 1.88	0.679	0.85	0.48 – 1.49	0.568	0.51	0.23 – 1.13	0.099	1.35	0.56 – 3.25	0.509
n	4012			4925			3312			2727		
N	23626			29984			20900			15536		
Psuedo R^2	0.915			0.882			0.921			0.919		

Inflation adjusted annual earnings (equation 2)

	Private Large			Private Small			Other Large			Other Small		
Predictors	Estimates	95% confidence interval	p-value	Estimates	95% confidence interval	p-value	Estimates	95% confidence interval	p-value	Estimates	95% confidence interval	p-value
Intercept	10.53	10.40to– 10.65	**<0.001**	10.38	10.23 to 10.52	**<0.001**	10.32	10.15 to 10.50	**<0.001**	10.20	9.95 to 10.45	**<0.001**
Gender	-0.62	-0.66 to -0.58	**<0.001**	-0.67	-0.71 to -0.63	**<0.001**	-0.40	-0.45 to -0.35	**<0.001**	-0.44	-0.51 to -0.36	**<0.001**
Ethnicity	-0.09	-0.13 to -0.05	**<0.001**	-0.09	-0.13 to -0.05	**<0.001**	-0.06	-0.10 to -0.02	**0.001**	-0.05	-0.10 to 0.00	0.070
Arthritis status	-0.01	-0.04 to 0.02	0.440	-0.05	-0.08 to -0.01	**0.010**	-0.00	-0.03 to 0.03	0.824	-0.04	-0.09 to 0.01	0.106
Children in household	-0.07	-0.09 to -0.04	**<0.001**	-0.11	-0.14 to -0.08	**<0.001**	-0.12	-0.15 to -0.09	**<0.001**	-0.13	-0.17 to -0.09	**<0.001**
Marital status	0.03	-0.01 to 0.07	0.135	0.02	-0.03 to 0.06	0.475	-0.03	-0.07 to 0.02	0.246	0.01	-0.05 to 0.07	0.732
Degree status	0.46	0.41 to 0.51	**<0.001**	0.34	0.29 to 0.40	**<0.001**	0.38	0.33 to 0.42	**<0.001**	0.45	0.39 to 0.52	**<0.001**
Age[1]	0.45	0.36to– 0.55	**<0.001**	0.43	0.32 to 0.54	**<0.001**	0.53	0.40 to 0.66	**<0.001**	0.27	0.08 to 0.46	**0.006**
Age[2]	0.43	0.33to– 0.54	**<0.001**	0.32	0.20 to 0.44	**<0.001**	0.46	0.32 to 0.60	**<0.001**	0.25	0.04 to 0.46	**0.021**
Age[3]	0.35	0.24 to 0.45	**<0.001**	0.26	0.15 to 0.38	**<0.001**	0.40	0.26 to 0.53	**<0.001**	0.10	-0.11 to 0.31	0.342
Age[4]	-0.16	-0.25 to -0.06	**0.002**	-0.43	-0.54 to -0.33	**<0.001**	-0.39	-0.51 to -0.27	**<0.001**	-0.68	-0.84 to -0.51	**<0.001**
Age[5]	-0.21	-0.45 to 0.02	0.074	-0.30	-0.55 to -0.05	**0.020**	-0.36	-0.66 to -0.05	**0.021**	-0.78	-1.22 to -0.34	**0.001**
Age[6]	-1.24	-1.45 to -1.04	**<0.001**	-1.12	-1.29 to -0.96	**<0.001**	-1.29	-1.53 to -1.05	**<0.001**	-1.20	-1.45 to -0.96	**<0.001**
North East England	-0.09	-0.20 to 0.01	0.089	-0.05	-0.16 to 0.06	0.394	-0.11	-0.23 to 0.00	0.059	0.06	-0.10 to 0.23	0.435
North West England	-0.08	-0.16 to 0.00	0.060	-0.04	-0.12 to 0.04	0.338	-0.11	-0.20 to -0.02	**0.017**	-0.03	-0.14 to 0.08	0.602
Yorkshire	-0.19	-0.28 to -0.11	**<0.001**	-0.09	-0.18 to 0.00	0.059	-0.24	-0.33 to -0.15	**<0.001**	-0.09	-0.21 to 0.04	0.173
East Midlands	-0.15	-0.23 to -0.07	**<0.001**	-0.08	-0.17 to 0.01	0.076	-0.25	-0.34 to -0.15	**<0.001**	-0.17	-0.30 to -0.04	**0.009**
West Midlands	-0.10	-0.19 to -0.02	**0.021**	-0.09	-0.18 to -0.00	**0.046**	-0.19	-0.28 to -0.09	**<0.001**	-0.10	-0.22 to 0.02	0.102
East of England	-0.05	-0.13 to 0.03	0.241	0.07	-0.02 to 0.15	0.150	-0.11	-0.19 to -0.02	**0.019**	-0.13	-0.25 to -0.01	**0.037**
South East England	-0.06	-0.13 to 0.01	0.115	-0.01	-0.09 to 0.07	0.835	-0.08	-0.16 to 0.00	0.052	-0.15	-0.26 to -0.03	**0.011**
South West England	-0.13	-0.22 to -0.04	**0.003**	-0.05	-0.13 to 0.04	0.301	-0.17	-0.26 to -0.07	**0.001**	-0.18	-0.31 to -0.06	**0.005**
Wales	-0.15	-0.23 to -0.07	**<0.001**	-0.14	-0.23 to -0.05	**0.003**	-0.21	-0.30 to -0.12	**<0.001**	-0.05	-0.16 to 0.07	0.426
Scotland	-0.06	-0.15 to 0.02	0.139	-0.07	-0.16 to 0.02	0.104	-0.11	-0.20 to -0.02	**0.015**	-0.04	-0.15 to 0.06	0.448
n	3770			4617			3152			2583		
N	16324			19159			14706			10147		
R^2	0.796			0.763			0.784			0.810		

Appendix 7. Results: Relationship between arthritis status and working hours, by work-type

Results (equation 2 where log odds of working full time ($\geq$ 35 h/week) is compared to working less than full time (>0 and < 35 h)), by work-type

	Routine			Intermediate			Professional		
Predictors	Odds Ratios	95% confidence interval	p-value	Odds Ratios	95% confidence interval	p-value	Odds Ratios	95% confidence interval	p-value
Intercept	584.95	207.04 – 1652.64	**<0.001**	189.18	54.75 – 653.74	**<0.001**	3151.59	991.51 – 10017.59	**<0.001**
Gender	0.02	0.01 – 0.02	**<0.001**	0.09	0.06 – 0.12	**<0.001**	0.08	0.06 – 0.10	**<0.001**
Ethnicity	1.01	0.65 – 1.57	0.965	0.93	0.57 – 1.53	0.780	0.94	0.58 – 1.54	0.819
Arthritis status	0.93	0.74 – 1.17	0.554	0.92	0.71 – 1.19	0.535	0.84	0.67 – 1.06	0.150
Children in household	0.33	0.25 – 0.42	**<0.001**	0.36	0.27 – 0.48	**<0.001**	0.35	0.27 – 0.44	**<0.001**
Marital status	0.82	0.60 – 1.13	0.229	0.65	0.44 – 0.94	**0.023**	0.85	0.61 – 1.18	0.338
Degree-level education status	1.67	1.02 – 2.75	**0.043**	0.96	0.65 – 1.41	0.831	0.78	0.60 – 1.02	0.067
Age[1]	2.80	1.20 – 6.57	**0.018**	1.90	0.67 – 5.37	0.228	0.71	0.27 – 1.86	0.485
Age[2]	1.57	0.61 – 4.05	0.355	0.73	0.23 – 2.34	0.599	0.15	0.05 – 0.44	**0.001**
Age[3]	0.32	0.12 – 0.84	**0.022**	0.17	0.05 – 0.53	**0.002**	0.04	0.01 – 0.11	**<0.001**
Age[4]	0.00	0.00 – 0.01	**<0.001**	0.01	0.00 – 0.02	**<0.001**	0.00	0.00 – 0.00	**<0.001**
Age[5]	0.03	0.00 – 0.26	**0.002**	0.04	0.00 – 0.46	**0.010**	0.00	0.00 – 0.00	**<0.001**
Age[6]	0.00	0.00 – 0.02	**<0.001**	0.02	0.00 – 0.07	**<0.001**	0.00	0.00 – 0.00	**<0.001**
North East England	1.27	0.61 – 2.66	0.519	0.61	0.28 – 1.30	0.199	0.95	0.45 – 2.02	0.895
North West England	1.03	0.59 – 1.80	0.921	0.86	0.50 – 1.48	0.580	0.80	0.47 – 1.34	0.390
Yorkshire	0.71	0.39 – 1.28	0.258	0.58	0.31 – 1.10	0.097	0.53	0.29 – 0.98	**0.042**
East Midlands	1.13	0.63 – 2.04	0.684	0.57	0.31 – 1.07	0.078	0.48	0.28 – 0.84	**0.010**
West Midlands	0.86	0.49 – 1.53	0.615	0.70	0.39 – 1.27	0.244	0.66	0.38 – 1.15	0.140
East of England	1.09	0.59 – 2.01	0.782	0.65	0.37 – 1.15	0.140	0.79	0.47 – 1.33	0.374
South East England	1.07	0.61 – 1.89	0.816	0.93	0.54 – 1.60	0.786	0.73	0.45 – 1.18	0.201
South West England	0.84	0.45 – 1.56	0.576	0.65	0.36 – 1.17	0.152	0.79	0.44 – 1.39	0.411
Wales	0.78	0.42 – 1.46	0.444	1.28	0.66 – 2.47	0.459	0.70	0.38 – 1.28	0.245
Scotland	1.10	0.60 – 2.03	0.754	0.88	0.46 – 1.67	0.689	0.74	0.41 – 1.34	0.322
n	4526			3493			4325		
N	19800			14547			21078		
Pseudo R^2	0.855			0.821			0.839		

References

Austin, P.C., 2011. Optimal caliper widths for propensity-score matching when estimating differences in means and differences in proportions in observational studies. Pharmaceut. Stat. 10 (2), 150–161.

Barrett, E.M., Scott, D.G.I., Wiles, N.J., Symmons, D.P.M., 2000. The impact of rheumatoid arthritis on employment status in the early years of disease: a UK community-based study. Rheumatology 39 (12), 1403–1409.

Bartley, M., Sacker, A., Clarke, P., 2004. Employment status, employment conditions, and limiting illness: prospective evidence from the British Household Panel Survey 1991–2001. J. Epidemiol. Community Health 58 (6), 501–506.

Bell, D.N., Blanchflower, D.G., 2020. US and UK labour markets before and during the Covid-19 Crash. National Institute Economic Review 252, R52–R69. https://www.niesr.ac.uk/wp-content/uploads/2021/10/US-and-UK-Labour-Markets-Before-and-During-the-Covid-19-Crash-4.pdf.

Booker, C.L., Andrews, L., Green, G., Kumari, M., 2020. Impacts of long-standing illness and chronic illness on working hours and household income in a longitudinal UK study. SSM-Popul. Health 12.

Bury, M., 1982. Chronic illness as biographical disruption. Sociol. Health Illness 4 (2), 167–182.

Clemens, S., Phelps, A., Oldfield, Z., Blake, M., Oskala, A., Marmot, M., Rogers, N., Banks, J., Steptoe, A., Nazroo, J., 2019. English Longitudinal Study of Ageing: Waves 0-8, 1998-2017, 30th Edition. UK Data Service, SN5050 doi:10.5255/UKDA-SN-5050-17.

Conaghan, P.G., Porcheret, M., Kingsbury, S.R., Gammon, A., Soni, A., Hurley, M., Rayman, M.P., Barlow, J., Hull, R.G., Cumming, J., Llewelyn, K., 2015. Impact and therapy of osteoarthritis: the Arthritis Care OA Nation 2012 survey. Clin. Rheumatol. 34 (9), 1581–1588.

Department for Work and Pensions (DWP), 2017a. Improving lives: the future of work, health and disability. https://www.gov.uk/government/publications/improving-lives-the-future-of-work-health-and-disability.

Department for Work and Pensions (DWP), 2017b. Thriving at work: a review of mental health and employers. https://www.gov.uk/government/publications/thriving-at-work-a-review-of-mental-health-and-employers.

Department for Work and Pensions (DWP), 2017. Fuller working lives: a partnership approach. https://www.gov.uk/government/publications/fuller-working-lives-a-partnership-approach.

Faisting, A.L.R.F., de Oliveira Sato, T., 2019. Effectiveness of ergonomic training to reduce physical demands and musculoskeletal symptoms-An overview of systematic reviews. Int. J. Ind. Ergon. 74.

Fortier, I., Burton, P.R., Robson, P.J., Ferretti, V., Little, J., L'heureux, F., Deschênes, M., Knoppers, B.M., Doiron, D., Keers, J.C., Linksted, P., et al., 2010. Quality, quantity and harmony: the DataSHaPER approach to integrating data across bioclinical studies. Int. J. Epidemiol. 39 (5), 1383–1393.

Fortier, I., Doiron, D., Burton, P., Raina, P., 2011. Invited commentary: consolidating data harmonization—how to obtain quality and applicability? Am. J. Epidemiol. 174 (3), 261–264.

Garrido, M.M., Kelley, A.S., Paris, J., Roza, K., Meier, D.E., Morrison, R.S., Aldridge, M. D., 2014. Methods for constructing and assessing propensity scores. Health Serv. Res. 49 (5), 1701–1720.

Goda, G.S., Streeter, J.L., 2021. Wealth trajectories across key milestones: longitudinal evidence from life-course transitions. National Bureau of Economic Research, Working Paper 29329.

Harrison, S., Davies, A.R., Dickson, M., Tyrrell, J., Green, M.J., Katikireddi, S.V., Campbell, D., Munafò, M., Dixon, P., Jones, H.E., Rice, F., 2020. The causal effects of health conditions and risk factors on social and socioeconomic outcomes: mendelian randomization in UK Biobank. Int. J. Epidemiol. 49 (5), 1661–1681.

Hastie, T., Tibshirani, R., Friedman, J., 2009. In: The elements of statistical learning: data mining, inference, and prediction, 2nd edition. Springer, New York, pp. 1–758.

Health and Safety Executive (HSE). Work-related musculoskeletal disorders statistics in Great Britain, 2021. https://www.hse.gov.uk/statistics/causdis/msd.pdf.

Holland, P., Clayton, S., 2020. Navigating employment retention with a chronic health condition: a meta-ethnography of the employment experiences of people with musculoskeletal disorders in the UK. Disabil. Rehabil. 42 (8), 1071–1086.

HM Treasury, 2019. Treasury GDP Deflator. https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-june-2019-quarterly-national-accounts.

Majeed, T., Forder, P.M., Mishra, G., Kendig, H., Byles, J.E., 2017. Exploring workforce participation patterns and chronic diseases among middle-aged Australian men and women over the life course. J. Aging Health 29 (2), 343–361.

Mujica-Mota, R.E., Roberts, M., Abel, G., Elliott, M., Lyratzopoulos, G., Roland, M., Campbell, J., 2015. Common patterns of morbidity and multi-morbidity and their impact on health-related quality of life: evidence from a national survey. Qual. Life Res. 24 (4), 909–918.

Palmer, K.T., Harris, E.C., Linaker, C., Barker, M., Lawrence, W., Cooper, C., Coggon, D., 2012. Effectiveness of community-and workplace-based interventions to manage musculoskeletal-related sickness absence and job loss: a systematic review. Rheumatology 51 (2), 230–242.

Parker, M., Bucknall, M., Jagger, C., Wilkie, R., 2020. Population-based estimates of healthy working life expectancy in England at age 50 years: analysis of data from the English Longitudinal Study of Ageing. Lancet Public Health 5 (7), e395–e403.

Pelkowski, J.M., Berger, M.C., 2004. The impact of health on employment, wages, and hours worked over the life cycle. Q. Rev. Econ. Finance 44 (1), 102–121.

Piper, A., Blanchflower, D.G., Bryson, A., 2023. Is pain associated with subsequent job loss? A panel study for Germany. Kyklos 76 (1), 141–158.

Rajah, N., Mattock, R., Martin, A., 2022. How do childhood ADHD symptoms affect labour market outcomes? Economics and Human Biology, 101189.

Reeve, J., Lloyd-Williams, M., Payne, S., Dowrick, C., 2010. Revisiting biographical disruption: exploring individual embodied illness experience in people with terminal cancer. Health 14 (2), 178–195.

Rosenbaum, P.R., Rubin, D.B., 1983. The central role of the propensity score in observational studies for causal effects. Biometrika 70 (1), 41–55.

Salis, S., Speckesser, S., Samek, L., Bivand, P., 2021. A study of work and health transitions: analysis of Understanding Society. https://www.gov.uk/government/publications/a-study-of-work-and-health-transitions-analysis-of-understanding-society.

Skamagki, G., King, A., Duncan, M., Wåhlin, C., 2018. A systematic review on workplace interventions to manage chronic musculoskeletal conditions. Physiother. Res. Int. 23 (4), e1738.

Sorensen, G., Dennerlein, J.T., Peters, S.E., Sabbath, E.L., Kelly, E.L., Wagner, G.R., 2021. The future of research on work, safety, health and wellbeing: A guiding conceptual framework. Social Science & Medicine 269, 113593.

Syddall, H.E., D'Angelo, S., Ntani, G., Stevens, M., Harris, E.C., Linaker, C.H., Walker-Bone, K., 2020. Work participation and risk factors for health-related job loss among older workers in the Health and Employment after Fifty (HEAF) study: evidence from a 2-year follow-up period. PLoS One 15 (9).

University of Essex, Institute for Social and Economic Research, 2020. Understanding Society: Waves 1-10, 2009-2019 and Harmonised BHPS: Waves 1-18, 1991-2009, 13th edition. UK Data Service, SN6614 doi:10.5255/UKDA-SN-6614-14.

Versus Arthritis, 2017. Musculoskeletal Conditions and Multimorbidity. Versus Arthritis. https://www.versusarthritis.org/media/2078/msk-conditions-and-multimorbidity-report.pdf (Accessed 29 November 2022).

Versus Arthritis, 2021. The State of Musculoskeletal Health 2021 (Arthritis and Other Musculoskeletal Conditions in Numbers). https://www.versusarthritis.org/about-arthritis/data-and-statistics/the-state-of-musculoskeletal-health/ (Accessed 2 November 2022).

Workplace health: long-term sickness absence and capability to work (Guideline NG146), 2019. https://www.nice.org.uk/guidance/ng146.

Wainwright, E., Bevan, S., Blyth, F.M., Khalatbari-Soltani, S., Sullivan, M.J., Walker-Bone, K., Eccleston, C., 2022. Pain, work, and the workplace: a topical review. Pain 163 (3), 408–414.

Young, V., Bhaumik, C., 2011. Health and wellbeing at work: a survey of employers. Department for Work and Pensions, London. Research Report 750. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/214525/rrep750.pdf.