Population-based estimates of healthy working life expectancy in England at age 50 years: analysis of data from the English Longitudinal Study of Ageing

Marty Parker, Milica Bucknall, Carol Jagger, Ross Wilkie

Summary

Background Retirement ages are rising in many countries to offset the challenges of population ageing, but people's capacity to work for more years in their later working life (>50 years) is unclear. We aimed to estimate healthy working life expectancy in England.

Methods This analysis included adults aged 50 years and older from six waves (2002–13) of the English Longitudinal Study of Ageing (ELSA), with linked mortality data. Healthy working life expectancy was defined as the average number of years expected to be spent healthy (no limiting long-standing illness) and in paid work (employment or self-employment) from age 50 years. Healthy working life expectancy was estimated for England overall and stratified by sex, educational attainment, deprivation level, occupation type, and region by use of interpolated Markov chain multi-state modelling.

Findings There were 15 284 respondents (7025 men and 8259 women) with survey and mortality data for the study period. Healthy working life expectancy at age 50 years was on average 9·42 years (10·94 years [95% CI 10·65–11·23] for men and 8·25 years [7·92–8·58] for women) and life expectancy was 31·76 years (30·05 years for men and 33·49 years for women). The number of years expected to be spent unhealthy and in work from age 50 years was 1·84 years (95% CI 1·74–1·94) in England overall. Population subgroups with the longest healthy working life expectancy were the self-employed (11·76 years [95% CI 10·76–12·76]) or those with non-manual occupations (10·32 years [9·95–10·69]), those with a tertiary education (11·27 years [10·74–11·80]), those living in southern England (10·73 years [10·16–11·30] in the South East and 10·51 years [9·80–11·22] in the South West), and those living in the least deprived areas (10·53 years [10·06–10·99]).

Interpretation Healthy working life expectancy at age 50 years in England is below the remaining years to State Pension age. Older workers of lower socioeconomic status and in particular regions in England might benefit from proactive approaches to improve health, workplace environments, and job opportunities to improve their healthy working life expectancy. Continued monitoring of healthy working life expectancy would provide further examination of the success of such approaches and that of policies to extend working lives.

Funding Economic and Social Research Council.

Correspondence to:
Marty Parker, School of Primary, Community and Social Care, Keele University, Newcastle under Lyme ST5 5BG, UK
m.e.parker@keele.ac.uk

Introduction

There is an increasing expectation for people to remain healthy and in work for longer. Rising life expectancy and worsening dependency ratios have fostered policies to defer retirement age in efforts to mitigate against the high costs of population ageing; for example, France, Germany, and Spain will increase the State Pension age to 67 years between 2023 and 2029 and the UK will increase the State Pension age to 68 years after 2037.[1] The success of such policies depends on the willingness and ability of a substantial proportion of the population to work for longer. Health is a particularly strong driver of work outcomes among individuals aged 50 years and older.[2] Physical and mental health conditions increase the risk of absenteeism, presenteeism, work disability, early retirement, and increased employer costs.[3] These issues create a greater need for financial support from the state for disability or unemployment.[2] Poor health and reduced work capacity, as well as socioeconomic inequalities in health and life expectancy, make it difficult to determine whether policies to extend working life can be successful.[4] Levels of employment, job opportunities, and the inability to change jobs in response to poor health might prevent people from working for longer[5] or lead to premature exit from employment.[2] This issue underlines the additional need for policies that encourage the provision of employment opportunities, in addition to a population approach to measuring the feasibility and success of extensions to working life.

To date, there are no clear estimates that can determine whether a sufficient proportion of the UK population can extend their working life (ie, stay healthy and in work) in line with plans to increase the State Pension age.[6] Although estimates of work participation such as employment rate

Research in context

Evidence before this study

Retirement ages are rising in many countries to manage the challenges of population ageing and increasing life expectancy. In the UK, the State Pension age will increase to 67 years by 2028, with further increases planned. However, recent gains in life expectancy are disproportionately unhealthy and there are inequalities in health and mortality within the UK. Poor health and a lack of appropriate job opportunities are a major reason for early retirement, work absence, and reduced productivity. On Jan 30, 2019, we searched nine databases (Embase, Allied and Complementary Medicine Database, MEDLINE, Health Management Information Consortium, Social Sciences Citation Index and Science Citation Index Expanded, AgeLine, CINAHL, PsycINFO, and the grey literature database Open Grey) for publications containing references to healthy life expectancy ("active life expectancy", "disability free life expectancy", "disability adjusted life year(s)", "healthy life year(s)," "health expectancy", "healthy life expectancy", "work(ing) life expectancy", and "population indicator") as well as references to employment, retirement, or health-related work outcomes ("occupation(s)", "(un)employed", "(un)employment", "retire(ment)", "pension", "absenteeism", "presenteeism", "workers compensation", "productivity", "work capacity", and "workplace"). Four relevant studies were identified: two from Finland, one from Bulgaria, and one done in various European countries. Population-level estimates of time spent healthy and in work from age 50 years were lower than 10 years in all studies. Available subpopulation estimates indicated

differences by sex and by occupation (in Bulgaria and Finland). We identified no recent estimates of healthy working life expectancy in England.

Added value of this study

This study provides, to the best of our knowledge, the first estimates of healthy working life expectancy in adults at age 50 years in England, overall and by sex, socioeconomic status, occupation, and region. We found that, from age 50 years, people in England are expected to spend an average of 9·42 years (95% CI 9·19–9·66) of their remaining life healthy and in work (29·7% of 31·76 years of life expectancy) and 1·84 years (1·74–1·94) unhealthy and in work. Subgroup analyses highlighted inequalities in healthy working life expectancy in England by socioeconomic status (captured through education level and area-level deprivation), and to an extent by occupation and region.

Implications of all the available evidence

Adults aged 50 years in England have an average healthy working life expectancy lower than the number of years to the State Pension age (equalised for men and women at age 65 years and approaching 66 years by September, 2020). Our findings suggest that achieving policy objectives to extend working life will be challenging. A variety of interventions (economic, social, political, and workplace structures and factors) that aim to tackle widening inequities and improve population health are likely to be key to extending healthy working life.

or working life expectancy[7,8] are key indicators, in this context they do not capture the health or work capacity required for a sustainable extension to working life. Similarly, estimates of healthy life expectancy do not consider work status, which is important if extensions to working life are to be realised. Healthy working life expectancy has been proposed as a population indicator that takes account of both health and work states and provides an indication of whether extensions to working life are achievable.[6,9] Healthy working life expectancy at age 50 years is the average number of years a person is expected to be healthy and in work from age 50 years, with these years not necessarily lived consecutively (health and work states can be exited and re-entered) but at any time between age 50 years and end of life.[9] Although there is much literature on the geographical and socioeconomic inequalities in health expectancy,[4] healthy working life expectancy has not yet been used to monitor inequalities by geographical region or in population subgroups. This study used data from the English Longitudinal Study of Ageing (ELSA), a nationally representative sample of adults aged 50 years and older in England, to examine how long older workers are healthy and in work for to meet the demands for extending working life. We aimed to provide the first estimates of healthy working life expectancy in

adults aged 50 years in England overall and by sex, socioeconomic status, occupation, and region.

Methods

Study design and participants

Full details of the study design, methods, and response rates of the ELSA have been published.[10] Briefly, self-reported data were collected via interviews in a representative sample of community-dwelling adults aged 50 years and older in England every 2 years. Data collected in ELSA survey waves 1 to 6 (2002–3 to 2012–13) were used, including refreshment samples at waves 3 and 4 to maintain representativeness of the data despite survey attrition, cohort ageing, and deaths. Participants in the ELSA sample who responded to at least one wave were included. Mortality-linked (year of death) data (available up to the end of wave 6) were obtained from the UK Data Service. Months of death were imputed on the basis of 2010 monthly death rates in England and known vital status at the interview date in the year of death.

Assessment of health and work states

Health and work states were self-reported in each survey wave. Health was defined by the presence or absence of

limiting long-standing illness, obtained from a combination of two survey items: "Do you have any long-standing illness, disability or infirmity?" and, if so, "(Does this/Do these) illness(es) or disability(ies) limit your activities in any way?".

Work was defined as participation in paid work or self-employment within the month preceding the interview.

At each survey wave, respondents were classified as dead or into one of four alive health and work states (healthy and in work, healthy and not in work, not healthy and in work, and not healthy and not in work; figure 1).

Identifiers of population subgroups
Subpopulations by sex, socioeconomic status, occupational status, and region were identified. Sex (male or female) was identified by use of self-reported data. Individual (educational attainment) and area-level (Index of Multiple Deprivation [IMD] quintile) indicators of socioeconomic status were used. Educational attainment was identified from the earliest response, which was categorised with the ELSA simplification of 1997 International Standard Classification of Education (ISCED-97) codes: less than secondary education, upper secondary education, tertiary education (education level more advanced than upper secondary), or other (where education level [eg, foreign qualifications] could not be classified).[11] Data on educational attainment were missing in 411 cases. IMD data, categorised by quintile, were obtained via the UK Data Service and defined by the earliest record of quintile, coded 1 (least deprived quintile of England) to 5 (most deprived quintile).

Occupation type was identified from the earliest response to ELSA's National Statistics Socio-economic Classification survey items about current (or recent or upcoming) main occupation and categorised as non-manual, manual, or self-employed.[12] Occupation was not recorded at wave 1 and was unknown for individuals who did not respond to follow-up interviews. Healthy working life expectancy by occupation was therefore estimated with waves 2–6 to minimise potential bias. Healthy working life expectancy for the group with unknown occupation (2322 respondents, of whom 1959 were not interviewed in any of waves 2–6) could not be analysed as the statistical method was based on observed transitions between healthy working life expectancy states.

Healthy working life expectancy by region was examined according to government office region (North East, North West, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, South East, and South West). The region was classified as missing for individuals who occupied multiple regions during the study period (n=356).

Statistical analysis
Healthy working life expectancy was estimated with interpolated Markov chain multi-state modelling of
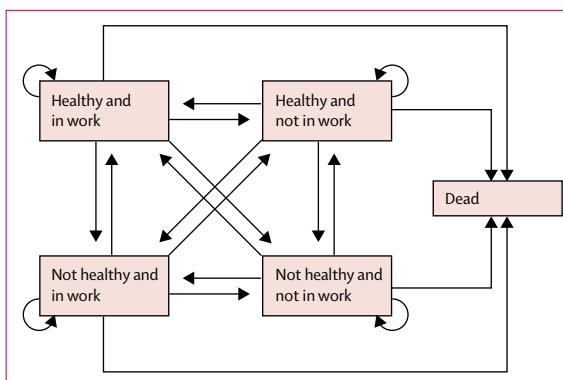

Figure 1: **Multi-state model of healthy working life expectancy**
Permitted transitions shown with arrows.

cross-longitudinal survey data (panel data from repeated cross-sectional surveys of a cohort). A multi-state model was defined (figure 1).

Interpolated Markov Chain software, IMaCh version 0.99r19, was used to estimate healthy working life expectancy with standard errors.[13] This approach uses multinomial logistic regression to model the probabilities of transition from and to each healthy working life expectancy state (or transition from alive to dead vital state) over small discrete time intervals (interpolation steps) based on the transitions observed in the data, where the analysed time intervals are typically briefer than the time between data time points. Maximum likelihood estimates of transition probability model parameters were found by evaluating the product of the transition probabilities for each step contained within each observed transition (health and work states at consecutive observed time points) or sequence of transitions (where more than one transition was observed for an individual). Healthy working life expectancy was estimated according to the health and work state occupied at age 50 years and averaged (weighted by the observed prevalence of occupying each health and work state at age 50 years) to estimate healthy working life expectancy for the population. Further details of the methodology and an investigation into changes in healthy working life expectancy over time are provided in the appendix (pp 2,10).

Health expectancies were also estimated for those classified as healthy and not in work, those not healthy and in work, and those not healthy and not in work. Life expectancy was estimated as the sum of all four health expectancies. Additionally, life expectancy was estimated with the life table method to assess whether the (summed) health expectancy estimates were consistent with mortality rates among respondents. Healthy life expectancy was estimated by summing healthy working life expectancy and the expected time spent healthy and not in work. Working life expectancy was estimated by summing healthy working life expectancy and expected time spent not healthy and in work.
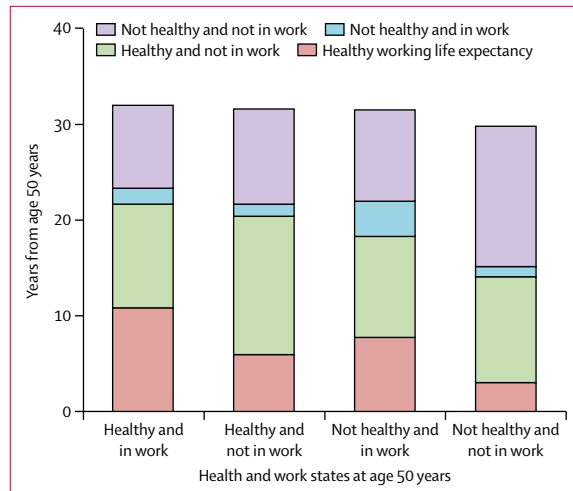
See **Online** for appendix

Figure 2: Health expectancies according to starting state at age 50 years in England

Age was included in the transition probability models. Age was measured in years from the midpoint of year of birth (taken as month 6; June) to the month and year of death. Transition probabilities were assumed to be constant over time within each year of age and not to be affected by any history of previous state occupation (the Markov property).

Initially, healthy working life expectancy was calculated overall for England and then by sex, educational attainment, IMD quintile, occupational status, and region. Individuals with missing data in the identifiers of population subgroups were excluded from the study population, which was then stratified to estimate healthy working life expectancy by population subgroup. The number of observed transitions for each analysed dataset are provided in the appendix (p 12).

Monthly transition probability models (interpolation step size of 1 month) were developed to estimate healthy working life expectancy for England overall and by sex. Annual transition probability models were developed for education, IMD, occupation, and region (step size of 12 months) because of smaller sample sizes. Sensitivity analyses were done by estimating healthy working life expectancy for England overall and by sex with yearly transition probability models, and by estimating healthy working life expectancy for England overall including respondents who were excluded from main analyses because of missing covariate data.

Further sensitivity analyses were done by estimating healthy working life expectancy overall by use of alternative health definitions: self-assessed health and difficulties with activities of daily living. Self-assessed health was defined as good if respondents reported good, very good, or excellent general health and poor if respondents reported fair, bad, very bad, or poor general health (question phrasing varied across waves). Health based on activities of daily living was defined as good if

there were no difficulties with activities of daily living and poor if difficulty was reported with at least one activity from bathing, dressing, eating, getting in and out of bed, and walking across a room.

Role of the funding source
The funder had no involvement in any aspect of the study. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results
The study sample comprised 15 284 respondents (8259 women and 7025 men; appendix p 4).

In England overall, life expectancy at age 50 years was estimated to be 31·76 years. Healthy working life expectancy was 9·42 years (95% CI 9·19–9·66; table); that is, from age 50 years, people in England on average are expected to spend 9·42 years healthy and in work (29·7% of life expectancy at age 50 years).

Healthy working life expectancy varied by starting state occupied at age 50 years (figure 2). People who were healthy and in work at age 50 years had a healthy working life expectancy of 10·81 years, 33·8% of their life expectancy (32·01 years from age 50 years). Healthy people who were not working at age 50 years had a healthy working life expectancy of 5·92 years, 18·7% of their life expectancy (31·62 years). People who were not healthy and in work at age 50 years had an expected healthy working life expectancy of 7·72 years, 24·5% of their life expectancy (31·52 years). Healthy working life expectancy for people who were neither healthy nor in work at age 50 years was 2·99 years, 10·0% of their life expectancy (29·84 years).

Healthy working life expectancy was higher for men (10·94 years [95% CI 10·65–11·23]) than for women (8·25 years [95% CI 7·92–8·58]; table). Healthy working life expectancy decreased with decreasing educational attainment, from 11·27 years (95% CI 10·74–11·80) for those with a tertiary education to 7·68 years (7·23–8·14) for those with less than a secondary education (figure 3; table). Healthy working life expectancy was inversely related to area-level deprivation, with healthy working life expectancy highest in the least deprived quintile (10·53 years [95% CI 10·06–10·99]), which was 1·5 times higher than in the most deprived quintile (6·8 years [6·18–7·43]). For occupation, healthy working life expectancy was highest for self-employed people (11·76 years [95% CI 10·76–12·76]), followed by those with non-manual occupations (10·32 years [9·95–10·69]), and lowest for people with manual occupations (8·72 years [8·25–9·20]).

Healthy working life expectancy by region ranged from 7·34 years (95% CI 6·47–8·20) in the North East to 10·73 years (10·16–11·30) in the South East (table 1, figure 3). The median regional healthy working life expectancy was 8·93 years (Yorkshire and the Humber; table, figures 3, 4).
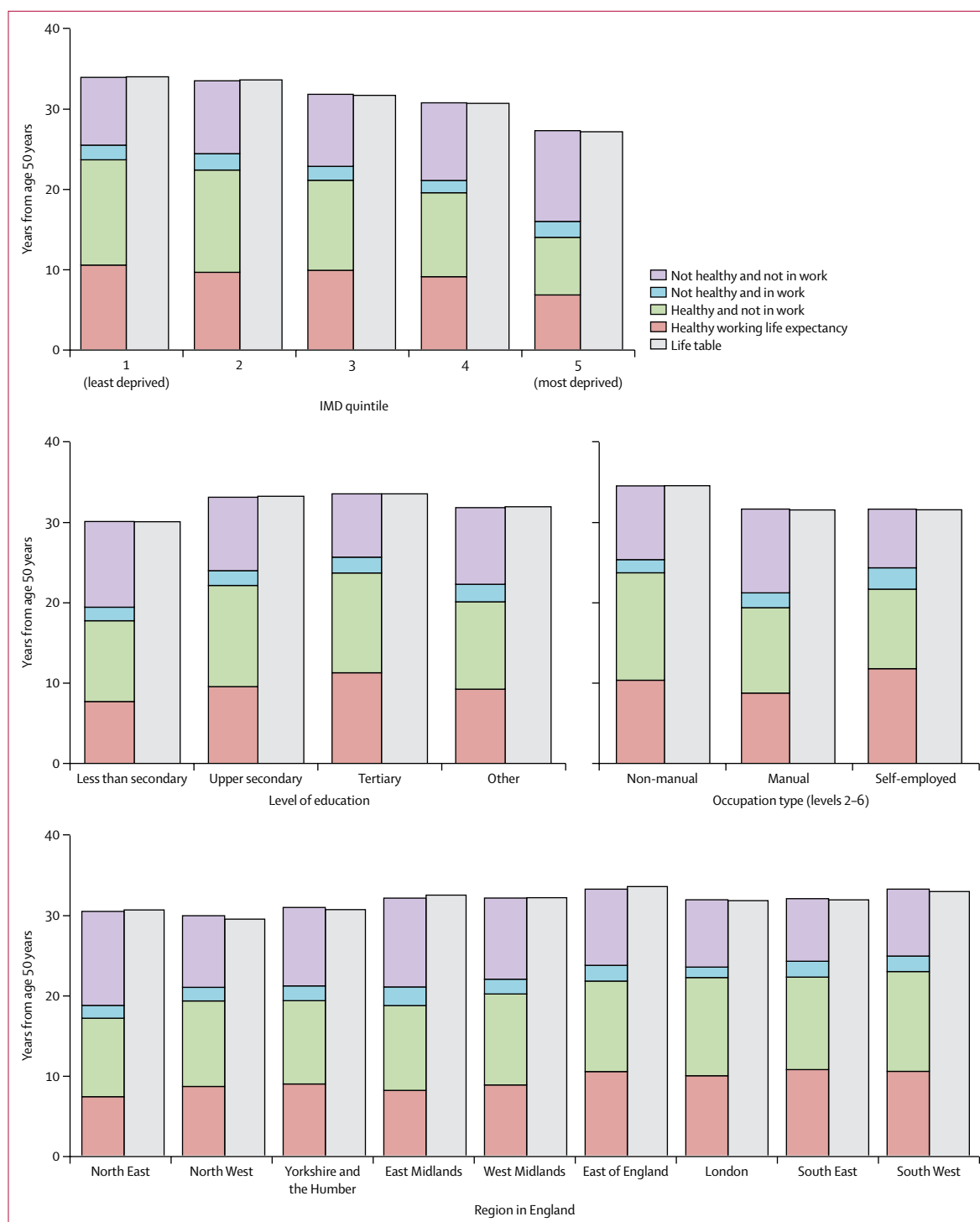
Figure 3: Health expectancies by educational attainment, IMD quintile, occupation, and region, with total life expectancy estimates from life tables
IMD=Index of Multiple Deprivation.

Estimates of healthy working life expectancy for England through modelling monthly transitions (9·42 years; 95% CI 9·19–9·66) and yearly transitions (9·43 years; 9·19–9·66) were similar (appendix pp 7–9), indicating that estimates were insensitive to interpolation step size (1 month or 12 months).

Defining health as the absence of difficulty with activities of daily living (appendix pp 7–9) led to higher

	Sample size (%)	Total life expectancy, years	Healthy working life expectancy, years (95% CI)	Health expectancy, in years, at age 50 years in various work states (95% CI)			Healthy life expectancy, years	Working life expectancy, years
				Healthy and not in work	Not healthy and in work	Not healthy and not in work		
England*	15 284 (100%)	31·76	9·42 (9·19–9·66)	11·18 (10·88–11·47)	1·84 (1·74–1·94)	9·32 (9·06–9·58)	20·60	11·26
Sex								
Male*	7025 (46%)	30·05	10·94 (10·65–11·23)	9·58 (9·18–9·97)	2·00 (1·85–2·16)	7·52 (7·19–7·85)	20·52	12·94
Female*	8259 (54%)	33·49	8·25 (7·92–8·58)	12·57 (12·14–13·00)	1·70 (1·56–1·83)	10·97 (10·57–11·36)	20·82	9·95
Level of education								
Less than secondary†	6205 (41%)	30·14	7·68 (7·23–8·14)	10·08 (9·59–10·57)	1·69 (1·50–1·89)	10·69 (10·21–11·16)	17·76	9·38
Upper secondary†	6176 (40%)	33·16	9·54 (9·21–9·86)	12·62 (12·09–13·14)	1·85 (1·70–1·99)	9·16 (8·72–9·60)	22·15	11·38
Tertiary†	1940 (13%)	33·59	11·27 (10·74–11·80)	12·45 (11·53–13·37)	1·97 (1·74–2·21)	7·90 (7·02–8·77)	23·72	13·24
Other†	963 (6%)	31·86	9·22 (8·14–10·30)	10·90 (9·79–12·00)	2·19 (1·59–2·78)	9·56 (8·43–10·68)	20·11	11·40
Occupation								
Non-manual (waves 2–6)†	6254 (41%)	34·54	10·32 (9·95–10·69)	13·39 (12·85–13·94)	1·64 (1·49–1·80)	9·19 (8·74–9·64)	23·71	11·96
Manual (waves 2–6)†	5624 (37%)	31·66	8·72 (8·25–9·20)	10·64 (10·10–11·18)	1·85 (1·63–2·07)	10·44 (9·94–10·95)	19·37	10·58
Self-employed (waves 2–6)†	1084 (7%)	31·64	11·76 (10·76–12·76)	9·91 (8·69–11·12)	2·66 (2·16–3·17)	7·31 (6·30–8·32)	21·67	14·42
Unknown‡	2322 (15%)	··	··	··	··	··	··	··
Region								
North East†	974 (6%)	30·49	7·34 (6·47–8·20)	9·81 (8·65–10·96)	1·60 (1·11–2·09)	11·75 (10·56–12·93)	17·14	8·94
North West†	2023 (13%)	29·96	8·62 (7·93–9·31)	10·69 (9·87–11·52)	1·70 (1·40–1·99)	8·95 (8·26–9·64)	19·32	10·32
Yorkshire and the Humber†	1673 (11%)	31·00	8·93 (8·22–9·65)	10·41 (9·56–11·26)	1·85 (1·55–2·14)	9·80 (8·99–10·61)	19·35	10·78
East Midlands†	1529 (10%)	32·16	8·13 (7·43–8·82)	10·60 (9·71–11·48)	2·33 (1·99–2·68)	11·10 (10·20–12·00)	18·72	10·46
West Midlands†	1676 (11%)	32·16	8·81 (8·04–9·58)	11·37 (10·45–12·28)	1·85 (1·52–2·17)	10·14 (9·26–11·01)	20·17	10·65
East of England†	1801 (12%)	33·27	10·48 (9·83–11·13)	11·31 (10·46–12·16)	1·97 (1·66–2·28)	9·52 (8·74–10·30)	21·79	12·45
London†	1391 (9%)	31·95	9·96 (9·19–10·74)	12·27 (11·22–13·32)	1·31 (1·02–1·60)	8·41 (7·57–9·25)	22·23	11·27
South East†	2502 (16%)	32·08	10·73 (10·16–11·30)	11·56 (10·82–12·29)	1·98§	7·82 (7·26–8·38)	22·29	12·71
South West†	1715 (11%)	33·28	10·51 (9·80–11·22)	12·47 (11·53–13·41)	1·94 (1·59–2·29)	8·36 (7·66–9·06)	22·98	12·45
IMD quintile								
1 (least deprived)†	3473 (23%)	33·99	10·53 (10·06–10·99)	13·16 (12·51–13·82)	1·83 (1·63–2·04)	8·47 (7·93–9·01)	23·69	12·36
2†	3555 (23%)	33·56	9·63 (9·15–10·10)	12·78 (12·13–13·44)	2·05 (1·82–2·28)	9·10 (8·56–9·63)	22·41	11·68
3†	3151 (21%)	31·87	9·88 (9·34–10·42)	11·25 (10·60–11·89)	1·74 (1·53–1·96)	9·00 (8·46–9·55)	21·13	11·62
4†	2787 (18%)	30·81	9·08 (8·54–9·62)	10·49 (9·81–11·16)	1·54 (1·32–1·77)	9·70 (9·09–10·31)	19·57	10·62
5 (most deprived)†	2318 (15%)	27·33	6·80 (6·18–7·43)	7·20 (6·56–7·83)	1·99 (1·69–2·29)	11·34 (10·56–12·13)	14·00	8·79

IMD=Index of Multiple Deprivation. *Health expectancies from monthly transition probability models were estimated by use of interpolation steps of size 1 month. †Health expectancies from yearly transition probability models were estimated by use of interpolation steps of size 12 months. ‡Health expectancies and total life expectancy not calculated for unknown occupation subgroup (see main text). Sample size percentages of totals might not sum to 100% due to rounding. §Uncertain 95% CI due to poor covariance matrix estimate for this model (due to infrequently observed transitions).

Table: Health expectancy estimates for England

healthy working life expectancy estimates overall (10·62 years; 95% CI 10·39–10·85) and lower estimates for time spent not healthy and in work, with only 0·64 years (0·58–0·70) expected to be spent in this state. Overall healthy working life expectancy at age 50 years did not differ significantly when analysing self-assessed health (9·63 years; 95% CI 9·39–9·87). However, at each wave, 20–22% of respondents were classified into healthy working life expectancy states differently with this alternative definition.

For all analyses, estimates of life expectancy were similar to those obtained with the life table method, suggesting that health expectancy estimates were not overestimated or underestimated (figure 3; appendix p 7).

Plots displaying the primary results for England and by sex alongside results of the sensitivity analyses are given in the appendix (pp 7–9).

Discussion

Based on nationally representative data, this large observational study found that, from age 50 years, adults in England spend on average 9·42 years healthy and in work, 11·18 years healthy and not in work, 1·84 years unhealthy and in work, and 9·32 years unhealthy and not in work. These findings suggest that extending working life will be challenging because, on average, adults aged 50 years are not healthy and in work up to the current (and increasing) State Pension age. The time spent not

healthy and in work (almost 2 years) might indicate time spent with increased absenteeism and presenteeism or might also capture time spent when workers experience accommodations to enable them to remain in the workplace.[5] Some of the 11 years spent healthy and not in work might reflect a lack of (sufficient access to) good job opportunities, including loss of employment, but also some people's choice to retire. Differences in healthy working life expectancy by sex, socioeconomic status, and geographical region identify subpopulations who are target groups for interventions either to improve health or work opportunities and conditions (including initiatives to promote job availability and fair hiring practices, facilitate training and retraining opportunities for older workers, and encourage employer flexibility to adapt jobs and workplaces).

Women's lower healthy working life expectancy compared to men, by 2·69 years, reflects that State Pension age was lower for women than for men until late 2018 and women were less likely to be in work, but it might also reflect the higher prevalence of disability in women. The equalisation of State Pension age for men and women might reduce the difference in the coming years, as will the greater likelihood for women to work.[1] Our findings highlight inequalities in healthy working life expectancy in England by socioeconomic status, occupation, and geographical region, emphasising the link between socioeconomic status and health, life chances, and life expectancy.[14] Those who live for the longest in a healthy and working state, on average, are more likely to have a higher education, be self-employed, be in non-manual occupations, and live in less deprived areas or more affluent regions. Notably, healthy working life expectancy in the least deprived quintile of England's population was more than 1·5 times higher (3·73 more years) than that in the most deprived quintile, and healthy life expectancy was almost 10 years higher.

Analysis of healthy working life expectancy by region suggested a north–south divide. All regions of England contain areas of low and high deprivation, and further work is needed to investigate whether regional disparities in healthy working life expectancy persist within each deprivation quintile.[14] Regional variation might be due to geographical differences in health behaviours as well as in economic development between northern and southern parts of England.[14,15] The North East has higher unemployment rates and lower economic competitiveness than any other region in England, while the country's economic growth is driven by London and the South East.[16] There are also substantial regional differences in all-cause mortality, with persistent excess mortality in the north.[17] Geographical health gaps are widening, despite a redistribution of health resources to help tackle inequalities.[17–19]

The link between deprivation and poorer health occurs throughout the life course, from poor child health (through higher rates of low birthweight, infant mortality,
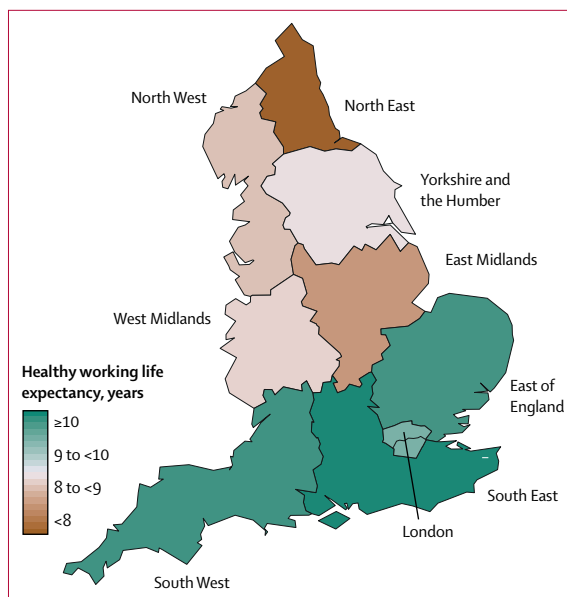

Figure 4: **Map of healthy working life expectancy by government office region in England**

and excess weight) to premature mortality from specific causes such as cancer and cardiovascular disease, with cardiovascular disease exacerbated by behavioural risk factors such as smoking, physical inactivity, and poor diet.[20] Higher healthy working life expectancy in individuals with higher levels of education could be a result of healthier lifestyles,[21] but it might also be due to greater access to employment opportunities. The nature of work undertaken is likely to be a key driver of healthy working life expectancy as workplace accommodations, job control, and support at work can remove barriers to participation and function in paid work (eg, barriers due to chronic health conditions).[22]

Strengths of this study include the large sample size with six survey time points and the definition of health as a limiting long-standing illness. This approach adheres to the recommended global activity limitation indicator[23] as well as other harmonised statistical measures of disability, which enhances the comparability of healthy working life expectancy to other indicators. Restricting the definition of poor health to being limited by long-term conditions allows for individuals with managed long-term conditions (and who are therefore unlikely to be affected in work or other activities as a result) to be treated as healthy. Self-reported health status could be affected by biases with unclear directionality, although these might be insignificant at the population level.[24] The definition of work was inclusive and did not differentiate full-time workers from people who work part time or for low earnings, or both. Therefore, not all healthy and working years are spent contributing towards national budgets; some individuals counted as being in work might not earn enough to pay tax and might receive government financial support for maintenance.

Sensitivity analyses showed that healthy working life expectancy estimates were similar when self-assessed health was used to define health, despite this definition categorising the health status of almost a quarter of the population differently. If results of health research are used to guide targeted interventions, this study highlights the importance of defining health in line with the intended use of the indicator, even where estimates are comparable with alternative definitions. Poor health based on activities of daily living was a restrictive measure resulting in low numbers of years expected to be spent not healthy and in work; higher estimates of healthy working life expectancy based on this definition might arise from classifying people with other limiting health problems as healthy.

Despite the large study population, this study was limited by less common transitions being rarely observed. It was impossible to do all analyses with monthly transition probability models, leading to yearly models for analyses by educational attainment, IMD, occupation, and region. Monthly transition probability models are computationally intensive and can be weakly identifiable where health and work transitions are infrequently observed.[25,26] In this case the maximum likelihood estimation procedure can fail to converge on finite and consistent model parameter estimates.[26,27] Although sensitivity analyses of healthy working life expectancy for England overall and by sex did not indicate sensitivity of results to monthly or yearly transition probability models, the statistical assumption that people in the synthetic cohort transition between health states and work states once annually less closely approximates the continuous nature of the underlying process than monthly transition models.

Results for occupation were affected by the absence of an occupation measurement at ELSA wave 1, leading to the analysis being based on only waves 2–6. Observed transitions from wave 1–2 were therefore not analysed, leading to compromised comparability of the study sample with England overall and with subgroup analyses. The study was also limited by the absence of linked mortality data for more recent ELSA waves 7 and 8; healthy working life expectancy could be higher than estimated because of more recent policy changes encouraging longer working lives.

Finally, the ELSA sample is intended to be representative of the community-dwelling population in England but might be affected by recruitment and attrition bias as well as inherited bias from the Health Survey for England used as a representative sampling frame. Although ELSA recruits refreshment samples to maintain representativeness, descriptive statistics of the study population by IMD quintile indicate under-representation of the most deprived quintiles (table, appendix pp 5–6). In this case, actual overall healthy working life expectancy is likely to be lower than estimated.

Living for longer presents new opportunities for societal engagement and personal growth. Individuals who remain healthy as they age are assets to their communities and workplaces, and the physical and mental capabilities of older adults can be similar to those of young adults.[28] However, ageing trajectories are diverse and the results of this study demonstrate that, on average, adults in England are not living extended healthy working lives. Life course factors such as gender, education, psychological support, having the resources to meet basic needs, and the interaction between the environment and personal characteristics are key determinants of healthy ageing and functional ability.[29] There is also a need for provision of workplace accommodations, lifelong training opportunities, and inclusive hiring practices to facilitate increased work participation in later life.[22,30] Future research should identify specific drivers of healthy working life expectancy and investigate the effect of prevalent health conditions in later working life on healthy working life expectancy.

Although the average duration of healthy working life is likely to vary across countries, our healthy working life expectancy estimates for England demonstrate the designation and application of an indicator that provides a starting point for understanding whether planned policies and initiatives to extend working life will be realised. Targeted initiatives to promote health and good work opportunities in later working life must be initiated in populations most affected by deprivation and in different regional contexts as healthy working life expectancy within a population will improve if inequalities are reduced. Monitoring of healthy working life expectancy as the population continues to age and the State Pension age continues to rise will be crucial to detect changes in population behaviour due to policy or health interventions. A variety of interventions to tackle widening inequities and improve population health will be key to extending healthy working life.

References
1 Department for Work and Pensions. State Pension age review: final report. July 19, 2017. https://www.gov.uk/government/publications/state-pension-age-review-final-report (accessed May 7, 2020).

2 Reeuwijk KG, van Klaveren D, van Rijn RM, Burdorf A, Robroek SJW. The influence of poor health on competing exit routes from paid employment among older workers in 11 European countries. *Scand J Work Environ Health* 2017; **43:** 24–33.

3 Goetzel RZ, Long SR, Ozminkowski RJ, Hawkins K, Wang S, Lynch W. Health, absence, disability, and presenteeism cost estimates of certain physical and mental health conditions affecting U.S. employers. *J Occup Environ Med* 2004; **46:** 398–412.

4   Pongiglione B, De Stavola BL, Ploubidis GB. A systematic literature review of studies analyzing inequalities in health expectancy among the older population. *PLoS One* 2015; **10:** e0130747.

5   Wilkie R, Blagojevic-Bucknall M, Jordan KP, Pransky G. Onset of work restriction in employed adults with lower limb joint pain: individual factors and area-level socioeconomic conditions. *J Occup Rehabil* 2013; **23:** 180–88.

6   Parker M, Bucknall M, Jagger C, Wilkie R. Extending working lives: a systematic review of healthy working life expectancy at age 50. *Soc Indic Res* 2020; published online Feb 28. DOI:10.1007/s11205-020-02302-1.

7   Loichinger E, Weber D. Trends in working life expectancy in Europe. *J Aging Health* 2016; **28:** 1194–213.

8   Pedersen J, Thorsen SV, Andersen MF, Hanvold TN, Schlünssen V, Bültmann U. Impact of depressive symptoms on worklife expectancy: a longitudinal study on Danish employees. *Occup Environ Med* 2019; **76:** 838–44.

9   Lièvre A, Jusot F, Barnay T, et al. Healthy working life expectancies at age 50 in Europe: a new indicator. *J Nutr Health Aging* 2007; **11:** 508–14.

10   NatCen Social Research. User guide to the main interview datasets waves 1 to 8. ELSA. May, 2018. http://doc.ukdataservice.ac.uk/doc/8375/mrdoc/pdf/8375_waves_1-8_interviewer_data_user_guide_v01.pdf (accessed May 7, 2020).

11   OECD. Classifying educational programmes: manual for ISCED-97 implementation in OECD countries. Paris: Organisation for Economic Co-operation and Development, 1999.

12   Hallqvist J, Diderichsen F, Theorell T, Reuterwall C, Ahlbom A. Is the effect of job strain on myocardial infarction risk due to interaction between high psychological demands and low decision latitude? Results from Stockholm Heart Epidemiology Program (SHEEP). *Soc Sci Med* 1998; **46:** 1405–15.

13   Lièvre A, Brouard N, Heathcote C. The estimation of health expectancies from cross-longitudinal surveys. *Math Popul Stud* 2003; **10:** 211–48.

14   Marmot M, Allen J, Goldblatt P, et al. The Marmot review: fair society, healthy lives. February, 2010. http://www.instituteofhealthequity.org/resources-reports/fair-society-healthy-lives-the-marmot-review/fair-society-healthy-lives-full-report-pdf.pdf (accessed May 7, 2020).

15   Ascani A, Iammarino S. Multinational enterprises, service outsourcing and regional structural change. *Cambridge J Econ* 2018; **42:** 1585–611.

16   Huggins R, Thompson P, Prokop D. UK competitiveness index 2019. Cardiff University, 2019. http://orca.cf.ac.uk/120234/1/R%20Huggins%202019%20UK%20competitive%20index%20report%20March2019.pdf (accessed May 7, 2020).

17   Hacking JM, Muller S, Buchan IE. Trends in mortality from 1965 to 2008 across the English north-south divide: comparative observational study. *BMJ* 2011; **342:** d508.

18   House of Commons Health Committee. Health inequalities: third report of session 2008–09. London: The Stationery Office, 2009. https://publications.parliament.uk/pa/cm200809/cmselect/cmhealth/286/28607.htm#a25

19   Jagger C. Trends in life expectancy and healthy life expectancy. Government Office for Science, 2015.

20   PHE. Health profile for England: 2018. Sept 11, 2018. https://www.gov.uk/government/publications/health-profile-for-england-2018 (accessed May 7, 2020).

21   Cutler DM, Lleras-Muney A. Education and health: evaluating theories and evidence. NBER Working Paper No. 12352. July, 2006. https://www.nber.org/papers/w12352 (accessed May 7, 2020).

22   Wilkie R. Musculoskeletal disorders: challenges and opportunities. In: Vickerstaff S, Phillipson C, Wilkie R, eds. Work, health and wellbeing: the challenges of managing health at work. Bristol: The Policy Press, 2012: 21–38.

23   Robine J-M, Jagger C, Euro-REVES Group. Creating a coherent set of indicators to monitor health across Europe: the Euro-REVES 2 project. *Eur J Public Health* 2003; **13:** 6–14.

24   Benítez-Silva H, Buchinsky M, Chan HM, Cheidvasser S, Rust J. How large is the bias in self-reported disability? *J Appl Econometrics* 2004; **19:** 649–70.

25   Cassarly C, Martin RH, Chimowitz M, Peña EA, Ramakrishnan V, Palesch YY. Assessing type I error and power of multistate Markov models for panel data-A simulation study. *Commun Stat Simul Comput* 2017; **46:** 7040–61.

26   Jackson CH, Sharples LD, Thompson SG, Duffy SW, Couto E. Multistate Markov models for disease progression with classification error. *J Royal Stat Soc D* 2003; **52:** 193–209.

27   Hutchinson RA, Valente JJ, Emerson SC, Betts MG, Dietterich TG. Penalized likelihood methods improve parameter estimates in occupancy models. *Methods Ecol Evol* 2015; **6:** 949–59.

28   WHO. World report on ageing and health. Sept 30, 2015. https://www.who.int/ageing/events/world-report-2015-launch/en/ (accessed May 7, 2020).

29   Allen J, Daly S. Older people and the social determinants of health. London: UCL Institute of Health Equity, 2016. http://www.instituteofhealthequity.org/resources-reports/inequalities-in-mental-health-cognitive-impairment-and-dementia-among-older-people/inequalities-in-mental-health-cognitive-impairement-and-dementia-among-older-people.pdf (accessed May 7, 2020).

30   Walker A. A strategy for active ageing. *Int Soc Secur Rev* 2002; **55:** 121–39.