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Live longer, work longer? An investigation of the health capacity to work at older ages in Denmark using combined register and survey data

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Abstract

Publicly funded pension systems are facing the challenge of remaining financially sustainable without lowering pensions. Raising the statutory retirement age gradually in line with the increase in life expectancy has been a key measure to solve the problem. The implicit assumption is that the additional years of life are lived in good health, or as a minimum that health status is compatible with work. However, some individuals may not have the ability to work. Furthermore, a uniform retirement age ignores the different exposures to morbidity and mortality risks across social groups. Consequently, it is important to examine whether the health of older individuals will allow them to continue working and whether there is significant heterogeneity in the ability to work. Combining the Survey of Health, Ageing and Retirement in Europe (SHARE) with data from the Danish registers enables us to create a composite health index that includes an extensive range of health indicators. Utilising the health capacity to work approach, we estimate the health capacity to work among Danes aged 55 and above. We divide health capacity into physical and mental health. We investigate heterogeneity in health capacity across educational and occupational attainment. Substantial additional work capacity is found for older Danes. Depending on the type of health index applied, the health capacrk varies. There is evidence of a socio-economic gradient in work capacity. Results thereby show that policies that intend to utilise the additional work capacity should consider heterogeneity in health.

Highlights

- We provide new evidence of the health capacity work in Denmark.
- The combination of survey and register data allow for comprehensive health indices.
- There is substantial additional health capacity to work.
- There is variation across health indices.
- There is variation across educational and occupational attainment.

Keywords Retirement, Work capacity, Health, Heterogeneity, SHARE, Denmark

JEL Classification E24, I14, J14, J21, J26

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1 Introduction

The population of most developed countries is 'turning increasingly grey' as a result of low levels of fertility and increased life expectancies. This development could potentially endanger the financial sustainability of publicly funded pension systems if pensions remain unchanged. Therefore, policy makers are compelled to consider redesigning pension systems to retain older individuals in the workforce. This has led to a range of retirement reforms that link retirement age to life expectancy, as seen in countries such as Denmark, Finland, Italy, the Netherlands, Portugal, and the Slovak Republic (OECD 2017). The purpose is to allocate some of the life years gained to employment rather than to retirement. This requires that the additional years of life are lived in good health, or at a minimum, that the health status during these added years is compatible with work. However, some individuals may not have the ability to work. Furthermore, a uniform retirement age ignores the different exposures to morbidity and mortality risks across social groups. To improve our understanding of the health capacity to work, we aim to investigate whether the health of older individuals will allow them to continue working and whether there is significant heterogeneity in the ability to work.

The impact of health on retirement decisions (and vice versa) has gained significant attention from researchers over the past decades (Deschryvere 2005). Whereas this literature has focused on the nexus of health and retirement, research attempting to quantify the health capacity to work has been limited. To our knowledge, only two methods have been used to estimate the health capacity to work. These methods rely on sound evidence that poor health increases the risk of exiting the labour market and of early retirement (e.g., Christensen & Kallestrup-Lamb 2012; Disney et al. 2006). The first approach, based on Milligan and Wise (2015), compares current and past employment rates given the same level of mortality. The second approach, following Cutler et al. (2013), compares the employment of older cohorts with that of younger counterparts in similar health. This latter method is preferred to the former as it includes detailed health information, thus incorporating morbidity and not just mortality. Both methods have been utilised in the International Social Security project's seventh phase, where the twelve countries (Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, the UK and the US) participating found additional work capacity amongst the older populations (see Wise (2017) for details). Similar results have been seen in South Korea (Kim 2019), China (Hou et al. 2021), Latin America (De Souza et al. 2019), and across Europe (Vandenberghe 2021).

A concern with pension reforms that link statutory retirement age and cohorts' life expectancy is that they reflect population averages, which may disguise significant heterogeneity in the ability to work. Studies have demonstrated persistent social inequality in (healthy) life expectancy across education, occupation, and income (Brønnum-Hansen et al. 2017, 2020; Head et al. 2019; Lallo & Raitano 2018). A common concern is that individuals with low socio-economic status, often in more physically demanding jobs, may be less able to delay their exit from the labour market due to health reasons. Furthermore, their employment opportunities may be more sensitive to health status, leaving them with less flexibility to remain employed. These hypotheses are supported by studies showing a significant correlation between higher educational attainment and higher employment rates (OECD 2012), and that workers with low socio-economic status exit the labour market earlier than those with a higher social status due to poorer health (Carr et al. 2018; De Breij et al. 2020). Additionally, individuals with higher socio-economic status are more likely to recover from health shocks (Mackenbach et al. 2008). Therefore, there may be a great socio-economic inequality in the ability to extend working lives. Individuals with low socio-economic status not only live fewer years in good health before retirement and have fewer years in retirement, but the implications of socio-economic inequalities are also amplified when retirement age is linked with life expectancy (Alvarez et al. 2021).

This study contributes to the limited literature investigating health capacity to work of older individuals. We provide up-to-date measurements of older individuals' health capacity to work in a high-income country with an extensive welfare system. Specifically, we expand on the previous analyses performed on Danish data (Bingley et al. 2017) in the following ways. First, we utilise a unique dataset obtained by linking data from the Survey of Health, Ageing and Retirement in Europe (SHARE) with data from the rich Danish registers. This allows us to address some of the limitations of the previous study, which relied solely on self-reported survey data. Second, we improve upon previous work by creating a more comprehensive health index based on a wide range of health indicators. Moreover, the vividness of the data allows us to divide health capacity into physical and mental health. We do this to get a better understanding of what defines health capacity to work. Lastly, we explore heterogeneity in work capacity. We use education quartiles to account for the upward trend in the population's educational attainment. We also estimate work capacity across occupational groups. We do this to better understand whether increased retirement age could lead to socio-economic inequality in expected years after the transition into retirement.

2 Institutional setting

The Danish pension system, the world's second-oldest, is a multi-pillar system that combines public and labour market pensions (OECD 2019). The first pillar comprises of public basis schemes, including the old age pension and minor early retirement schemes. The second pillar includes mandatory defined contribution labour market pension schemes, which are regulated through collective agreements and cover roughly 90% of the employed labour force. Self-employed workers, while not covered, can establish similar schemes. The last pillar consists of private individual pension savings schemes.

In response to the demographic challenge of an ageing population, the Danish government introduced a welfare reform in 2006 that prompted a gradual increase in the statutory retirement age in line with the increase in life expectancy (Additional file 1: Table S1). Denmark was the first country to implement such policies (Whitehouse 2007). The aim is to ensure a life expectancy of 14.5 years after the statutory retirement age. The rise in life expectancy increases the retirement age by the same amount, with a 15-year delay and a maximum of 1 year every 5 years. This implies an increase in retirement age from the current 67 years to 74 years for individuals entering the labour market now (the highest statutory retirement age among OECD countries (OECD 2017)).

3 Data

We use the comprehensive Danish register data from Statistics Denmark, in conjunction with SHARE. Survey data is gathered from the Danish part of SHARE for the waves 1, 2, 4, 5, and 6 collected in 2004, 2006/2007, 2011, 2013, and 2015, respectively (Börsch-Supan 2018a, 2018b, 2018c, 2018d, 2018e) (for methodological details see Börsch-Supan et al. (2013) and www-share-project.org). This results in 3,761 unique individuals (14,502 year observations) that can be linked with corresponding longitudinal data from the Danish registers. We outline the variables used from both data sources below. We exclude individuals younger than 50 years and older than 79 years, as well as those with missing information on key variables, including personal identification number (see exclusion in Additional file 1: Table S2). The final sample consists of 1,521 men (3,627 year observations) and 1,638 women (3,849 year observations).[1]

[1] 96 year observations are missing information on whether they are self-employed or an employee in their latest-held job and are thus excluded in those analyses.

3.1 Measures from SHARE

The variables obtained from SHARE contain essential health information not available in the registers. These include self-assessed health, quality of life measured by CASP, depression caseness, functional limitations such as problems with activities of daily living (ADL) and instrument activities of daily living (IADL), physical limitations, low grip strength, mobility limitations, and lifestyle (smoking and BMI).

3.2 Measures from the registers

From the registers, we extract information on gender, age, ethnicity, marital status, area of residence, education, occupation, specific diagnoses, chronic illnesses, comorbidities, and healthcare utilisation. An individual's highest achieved education is defined by education quartiles based on the individual's year of birth and gender. This enables us to account for the general improvement in educational attainment over time (Bound et al. 2015). We measure labour market attachment and occupational characteristics annually. The current or latest-held occupational group is defined according to the International Standard Classification of Occupations (ISCO) (IOL 2012). Due to limited statistical power, we aggregate occupational groups into four categories. Individuals whose most recent occupation falls under ISCO major groups 1, 2, or 3 were classified as white-collar workers. This includes managers, professionals, technicians and associate professionals. Pink-collar workers are defined as clerical support workers and service and sales workers (ISCO levels 4 and 5). We assign individuals as blue-collar workers if they work within skilled agricultural, forestry, fishery, craft and related trades, or as plant and machine operators, and assemblers (ISCO levels 6, 7, and 8). Lastly, low-skilled workers are classified as those within elementary occupations (ISCO level 9). For a small number of respondents, the latest-held occupation is identified from SHARE. We also categorise the most recent occupation in terms of whether the individual is self-employed or an employee. Using an algorithm from The Danish Health Data Authority (Sundhedsdatastyrelsen 2019), we identify eight common chronic illnesses: asthma, COPD, rheumatoid arthritis, osteoporosis, type 1 diabetes, or type 2 diabetes. This entails contact with a hospital or a prescription related to one of the illnesses within the last 10 years before the interview. We ascertain 31 physical and psychiatric diagnoses including heart attack, arthritis, cancer, depression, and substance abuse. The diagnoses should have been made within 10 years prior to the interview. We construct the Elixhauser van Walraven Comorbidity Index (van Walraven et al. 2009) over a ten-year period. Finally, we identify healthcare utilisation in the year preceding the interview. This includes the prescription drug use, visits to general practitioners, psychologists, psychiatrists, chiropractors and physiotherapists, as well as somatic and psychiatric inpatient and outpatient admissions.

4 Methods

4.1 Estimating work capacity

The method by Cutler et al. (2013) consists of two stages. First, we estimate the relationship between employment and health (controlling for other characteristics) for those aged 50–54 using a linear probability model. This younger age range is chosen because their employment decision is not influenced by the availability of early retirement. This is crucial as non-health-related retirement could introduce a downward bias in the estimated effect of health on retirement. The estimated model is:

$$E_i^{50-54} = \beta_0 + \beta_1 H_i^{50-54} + \beta_2 X_i^{50-54} + \varepsilon_i \quad (1)$$

where E_i is a binary variable indicating whether the individual is employed or not, H_i is the individual's health status, and X_i is other characteristics (ethnicity, marital status, area of residence, education level, and time dummies). ε_i represents the error term. We apply cluster-robust standard errors at the individual level. Regressions are performed separately for men and women due to differences in their employment and health outcomes.

In the second stage, the estimated regression coefficients from Eq. (1) are used to predict the work capacity for older cohorts. We do this by combining the estimated effect of health on employment for the younger age group with the actual health of those aged 55 and above:

$$\widehat{E}_i^a = \widehat{\beta}_0^{50-54} + \widehat{\beta}_1^{50-54} H_i^a + \widehat{\beta}_2^{50-54} X_i^a \quad (2)$$

where $\widehat{E}_i^a$ is the predicted employment rate of individual i at age group a. H_i^a and X_i^a are health indicators and other characteristics at age group a, respectively. $\widehat{\beta}_0^{50-54}$, $\widehat{\beta}_1^{50-54}$ and $\widehat{\beta}_2^{50-54}$ are the estimated coefficients from Eq. (1). The second stage yields counterfactual estimates for the older age groups' employment rates. The difference between the counterfactual and actual employment rate is defined as additional work capacity. Unlike most other literature estimating the effect of health on retirement, the objective is not the find the most accurate description of the observed age-work profile, but rather to find the best possible description of individual health related to work in order to estimate the most plausible counterfactual (Vandenberghe 2021).

4.1.1 Heterogeneity in health capacity to work

The analyses, which reflect population averages, may disguise significant heterogeneity in the ability to work. Therefore, we re-estimate the employment regressions by educational attainment and occupational group. This allows the health-employment relationship to vary across socio-economic status. We then predict the employment rate for the older cohorts given their educational and occupational attainment. We also re-estimate the employment regression by whether the individual is self-employed or an employee. The self-employed are not subject to the mandatory and labour market pension schemes. Therefore, their retirement decisions may differ from those of employees. Moreover, the self-employed have greater job flexibility and autonomy.

4.2 Health indices

To overcome multicollinearity among health indicators, we follow Poterba et al. (2013) and construct a health index based on a principal component analysis of the health indicators. The first principal component is converted into a percentile score for each individual, where a higher score indicates better health.

Our base case health index consists of 56 health indicators including self-assessed health, quality of life, functional and physical limitations, low grip strength, 31 diagnoses, use of prescription drugs, primary and secondary healthcare utilisation, chronic illnesses, and comorbidities (Additional file 1: Tables S3 and S4). The loadings from the first principal component are shown in Table S5 (Additional file 1). All loadings are positive for the base case health index, meaning that higher values of the first principal component represent poorer health. It can be seen that the index gives the highest weights to GALI (Global Activity Limitation Indicator), self-assessed health, quality of life, mobility limitations, and somatic admissions whereas less weight is given to specific diagnoses. The mean percentiles of the indies are presented in the descriptive statistics (Additional file 1: Tables S3 and S4). For instance, can be seen that for (wo)men aged 50–54 the mean percentile is 64.7 (55.4), while it for (wo)men aged 75–79 is 38.2 (34.4). The index effectively captures the fact that health is worse for women and declines with age, as seen in Fig. 1. Thus, the health index captures the expected developments in health.

To better understand what defines health capacity to work, we divide the health index into a mental and a physical health index. The former consists of mental disorders, visits to psychologists and psychiatrists as well as psychiatric inpatient and outpatient admission, while the latter entails smoking, BMI, physical and mobility limitations, somatic diagnoses, visits to chiropractor and physiotherapist as well as somatic inpatient and outpatient visits. We exclude health indicators such as self-assessed health, quality of life, visits to GP and comorbidities as they contain elements of both types of

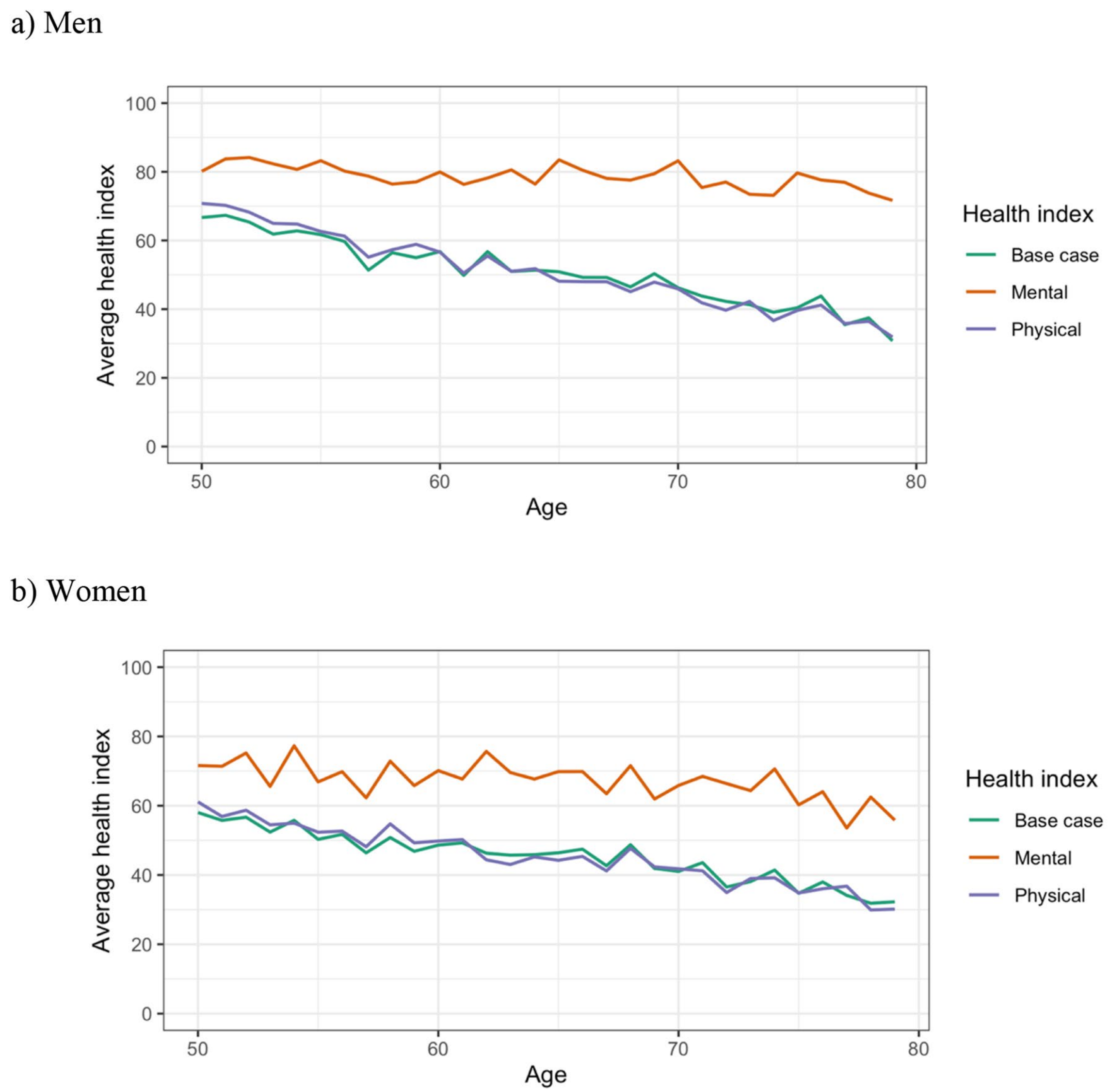

Fig. 1 Average health index percentile by age, gender and health index. The figure displays mean percentiles by age across gender and health indices

health. Specifications and loadings of the health indices can be seen in Table S5 (Additional file 1).

4.3 Robustness checks

To test the empirical strategy, we perform numerous robustness analyses, all of which are included in Additional file 1.

In one robustness check, we re-estimate the employment regressions using the individuals aged 55–59. Like the younger cohort, they too are not eligible for non-health-related early retirement and may allow for a better interpretation of the older cohorts as they are closer in age. In another, we exclude education as a covariate in the employment regressions as it may capture additional health information but also include non-health-related information, i.e., education is likely to affect retirement both directly and indirectly through health. For the same reason, we also estimate the employment regressions with health index and time dummies as the only covariates. Because social norms and other factors have kept women away from the labour market in the past, we also predict women's health capacity to work given the male regression coefficient estimates. Furthermore, we estimate the employment regression with a health index separately computed for men and women (a health index by gender). Loadings can be seen in Table S5 (Additional file 1). We also include changes in health indices between waves as an additional covariate. We do this to examine the extent to which changes in health, and not just health status, impact work capacity.[2] Previous studies have shown that health shocks increase the likelihood of exiting the labour market (Bound et al. 1999; Trevisan & Zantomio 2016), and health shocks could also change preferences (Simonsen & Kjær, 2021). This could explain why people exit the labour market despite having the health to continue working. We explore the impact of a negative change in health on the capacity to work by including the change in health index as a covariate in the employment regression. Lastly, several studies suggest that self-reported health could be susceptible to measurement errors that are systematically related to employment status. Specifically, Bound (1991) conjectures that non-working individuals may justify this by reporting worse health status leading to an upward bias. Therefore, to overcome the justification bias, we also compute the health index based solely on objective (not self-assessed) measures, which include health indicators such as grip strength, diagnoses, healthcare utilisation, and comorbidities. Specifications and loadings can be seen in Table S5 (Additional file 1).

5 Results

5.1 Sample characteristics

Descriptive statistics are presented in Tables S3 and S4 (Additional file 1) for men and women, respectively. Employment outcomes are always higher for men than for women. However, they decrease substantially around the early 60s (around the eligibility age for old age pension and early retirement pension) for both genders and continue to fall. Overall, these statistics show that men work more, women are generally experiencing poorer health, and health decreases with age.

5.2 Predicted health capacity to work

From the stage one employment regressions, we find that health has a positive effect on employment. The health coefficients are statistically significant and have large effects, as seen in Fig. 2.[3] When comparing the health indices, the mental health index has the smallest impact on employment, while physical health impacts more. Moreover, as expected, we observe an educational and occupational gradient in the magnitude of the association between health and employment. The smallest positive coefficient is for the highly educated and those with white-collar jobs (see Additional file 1: Figures S1, S2).

Figure 3 displays the actual and estimated additional work capacity for men and women by health indices. There exists considerable additional work capacity among the older individuals irrespective of which health index is applied. The large additional work capacity is explained by a substantial reduction in the actual employment rate of individuals beyond 60 years of age. Both actual and predicted employment rates (which is the sum of the actual employment rate and the additional work capacity) are higher for men than for women across all ages. However, women's additional work capacity is higher because their actual employment rate is lower. As expected, the predicted employment rate declines with age and is below 100%, i.e., some individuals are not able to work given their health. Moreover, we see that additional health capacity to work varies by health indices. The mental health index displays higher additional work capacity compared to the physical health index, around a 10 percentage points difference. Importantly, although additional work capacity is relatively similar across the health indices at the aggregated level, health capacity to work at the individual level varies substantially (results not shown). This is supported by the correlations between the health indices, which vary in strength (Table S6, Additional file 1). For instance, the correlation between physical and mental health is weak. Results for all health indices at the average level, across education and occupation can be found in Tables S7 and S8 (Additional file 1) for men and women, respectively.

5.3 Heterogeneity in the predicted health capacity to work

5.3.1 Education

Figure 4 displays the actual employment rate and estimated additional work capacity for men and women.[4] It can be seen that the actual employment rate differs across educational attainment. Additional work capacity is fairly similar until the age of 65–69 for women and 70–74 for men. After this, the education gap between the lower and higher educated becomes substantial, with more than a 20 percentage points difference between the 1st and the 4th education quartile. The education gradient goes beyond what can be explained by differences in actual employment rates. It can also be seen

[2] Sample sizes are reduced when negative changes in health are included as a covariate in the employment regressions.

[3] For example, a ten-percentage point increase in the base case health index (e.g., being at the 70th rather than the 60th percentile of health) raises the likelihood of working by 4.9 percentage points for men and 5.0 percentage points for women.

[4] Most health indices are statistically significant in the re-estimated employment regressions, but a few are not. For women in the 4th education quartile the mental and physical indices are not significant, for men the same goes for the mental health index. This suggests that the health indices do not contain employment-determining health conditions for this group of workers, and these results should therefore be interpreted with greater caution.

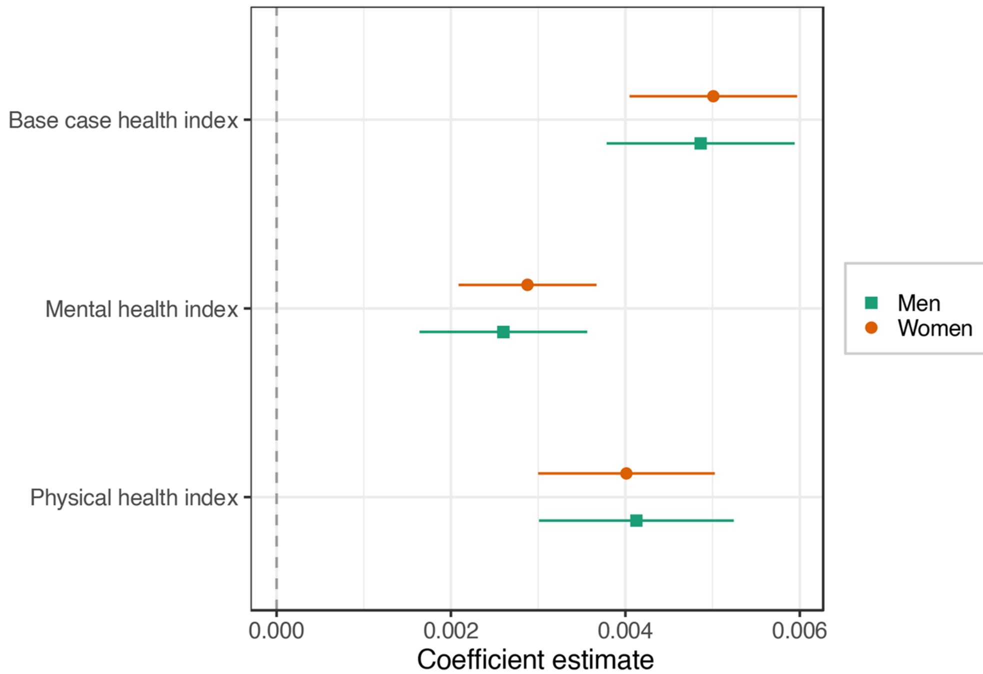

Fig. 2 Employment regression coefficients for the different health indices by gender. The figure displays regression coefficients and their 95% confidence intervals (cluster robust standard errors). We regress a variable for being employed on each health index for the age group of 50–54-year-olds. Specifications include the covariates: Education (4 dummies), married (1 dummy), being born in Denmark (1 dummy), area of residence (4 dummies), and wave (5 dummies)

that some individuals work more than their health permits; additional work capacity is negative for men in the 1st quartile and women in the 3rd quartile among the 55–59-year-olds. The education gradient is more evident for the physical health index.

5.3.2 Occupation

Figure 5 displays the actual and estimated additional work capacity across age groups, health indices and occupation groups. Low-skilled and blue-collar workers retire earlier than others for men and women, respectively. There is substantial additional work capacity for ages 60–64 and above. For the age group 55–59, some individuals continue to work despite their poor health. Additional work capacity is negative for low-skilled, blue-collar and pink-collar male workers, and much so for blue-collar female workers. As with education, we see an occupational gradient beyond what can be explained by differences in actual employment rates. The occupation gradient is greater among women. For men, it is pink-collar workers that have the lowest additional work capacity, while it for women is blue-collar workers.

5.3.3 Employee versus self-employed

Tables S7 and S8 (Additional file 1) show the results separately for self-employed and employees for men and women, respectively.[5] Self-employed retire earlier (55–59-year-olds), but also continue working longer (70 years and above for men, 65 years and above for women). The additional work capacity is greater for the self-employed compared to the employees among women, for men, the opposite occurs.

5.4 Robustness checks

We conduct several robustness checks to test our empirical strategy, as shown in Tables S7-S12 (Additional file 1). Reassuringly, we see the same tendencies. When we include a negative change in the health index as a covariate in the employment regression,[6] the results remain fairly unchanged (Tables S13 and S14, Additional file 1). However, some small changes are observed for the mental health index among women.

[5] The mental health index is not statistically significant for men, while none of the health indices are significant for women. The estimated additional work capacity should be interpreted with caution.

[6] The negative change for men for the mental health index is insignificant. This suggests that the changes in health index do not contain health information that shape employment, and estimated additional work capacity should therefore be interpreted with caution. Moreover, the mental health index is insignificant for women.

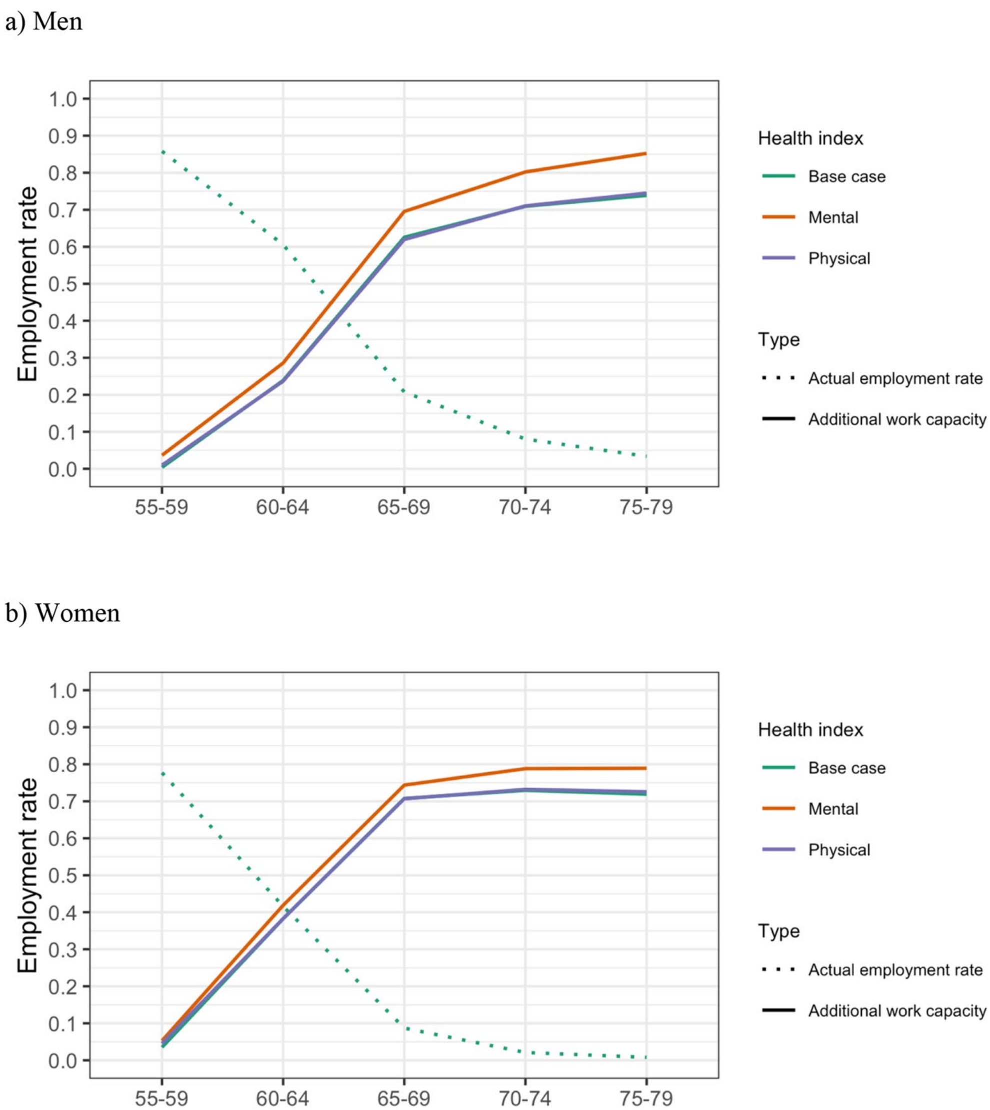

Fig. 3 Actual employment rate and estimated additional work capacity by age group, gender and health index. The figure displays men's (upper panel) and women's (lower panel) actual employment rates and estimated additional work capacity across health indices. Results are plotted across age groups on the x-axis and employment rates on the y-axis. Predicted employment rate equals actual employment rate plus additional work capacity

6 Discussion

A major strength of this study is the combination of rich data sources that allow us to overcome some shortcomings of previous research relying solely on self-reported measures. We obtain reliable socio-demographic and health information from the Danish registers, while the survey data allows us to include detailed information regarding self-assessed mental and physical functioning.

The results of our heterogeneity analyses question the fairness of pension reforms that index the statutory retirement age on average life expectancy. We find that those in the worst health (those in the lowest 10% of the health index) are less likely to be married, have lower education, are low-skilled or pink-collar workers, and are less employed (Additional file 1: Table S15). Estimates for additional work capacity reflect these statistics as we see a socio-economic gradient in health capacity to work. Results demonstrate that highly educated individuals, despite their greater exposure to work, are capable of working longer and thus are more likely to retire due to reasons other than ill health. Our results confirm previous findings that health capacity to work differs across educational and occupational attainment, especially at older ages, where individuals with higher education and

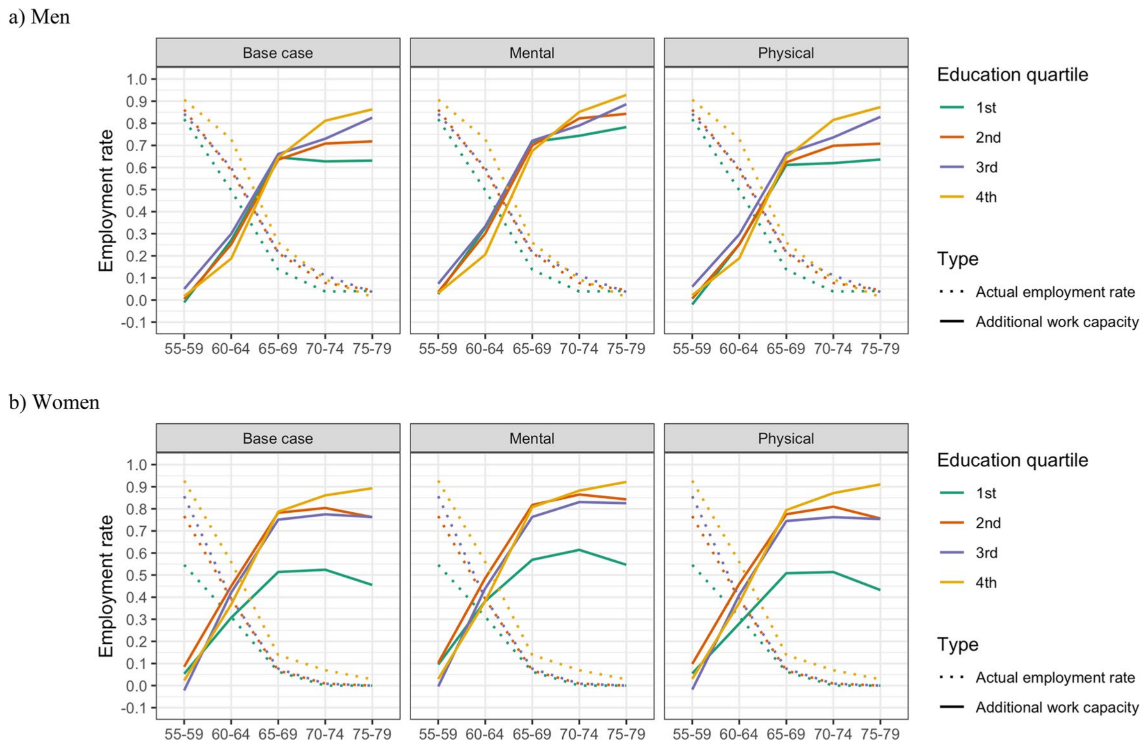

Fig. 4 Actual employment rate and estimated additional work capacity by education quartile. The figure displays men's (upper panel) and women's (lower panel) actual employment rates and estimated additional work capacity across education quartiles and health indices. Results are plotted across age groups on the x-axis and employment rates on the y-axis. Predicted employment rate equals actual employment rate plus additional work capacity

high-skilled workers are predicted to work longer given their health (Wise 2017). These results underline the strong relation between socio-economic status, health, and employment outcome. We also see different work abilities among self-employed and employees. For men, self-employed individuals have lower additional health capacity to work, while the opposite is true for women. This seems to suggest that autonomy may have an impact on retaining individuals in the labour market, although occupational selection bias should not be neglected, i.e., it is certain types of men or women that choose those types of work. There could be systematic differences in measurement error across socio-economic groups (Bago d'Uva et al. 2008). It is also possible that individuals with lower socio-economic position are more likely to utilise less healthcare and be diagnosed later than those with higher socio-economic status (Currie & Madrian 1999). This would overestimate the ability to work among the lower socio-economic groups. It is also worth mentioning that respondents in SHARE are more socio-economically advantaged than the general population (Brønnum-Hansen et al. 2015), why educational and occupational gradients may be more pronounced in 'real life.'

Predicted ability to work differs across health indices with larger additional work capacity estimated for mental health than for physical health. This aligns with the findings of Vandenberghe (2021) and Blundell et al. (2023), who find that cognition has limited explanatory power in predicting work capacity. One interpretation for the observed difference in indices could be that mental health constitutes less of a barrier to prolonged working life than physical health and that individuals adapt to their mental health condition over time and thus are more likely to be able to continue working. Yet, this interpretation should be made with caution. By definition, our results are driven by the profile of the 50–54-year-olds. Mental health is likely to manifest over time (i.e., a chronic condition), whereas physical health is likely to occur as sudden changes in health (i.e., a health shock). The physical health index is thus more exogenous, and the estimates for the mental health index are most likely overestimated. In addition, retirement due to mental illness may be delayed as a result of the late manifesting, implying that the predicted work capacity for the reference group (ages 50–54) is overestimated if individuals are first worn out later in life. Moreover, there is substantial social stigma associated with mental illness, which

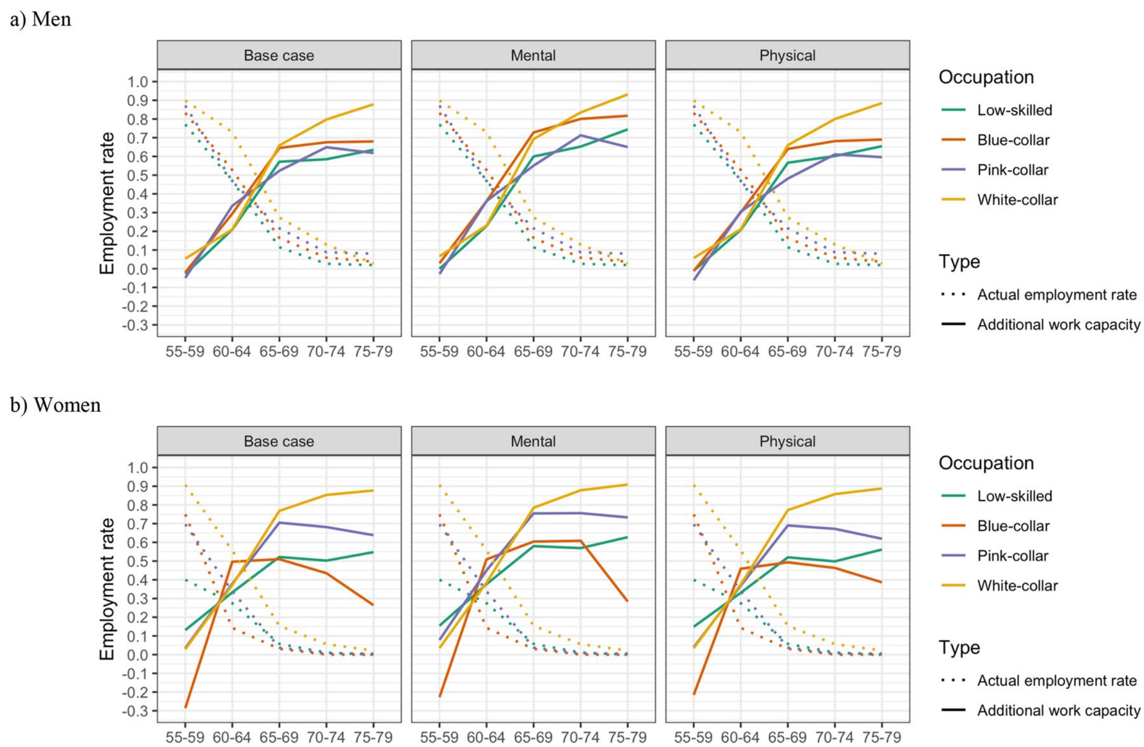

Fig. 5 Actual employment rate and estimated additional work capacity by occupation group. The figure displays men's (upper panel) and women's (lower panel) actual employment rates and estimated additional work capacity across occupation groups and health indices. Results are plotted across age groups on the x-axis and employment rates on the y-axis. Predicted employment rate equals actual employment rate plus additional work capacity

could make it more difficult to obtain early retirement (disability pension). The choice of health indicators could also play a role. If individuals have a well-managed mental illness, they are unlikely to be in contact with psychiatric hospitals and/or psychologist. As a results, their illness would not be reflected in the health index. This is supported by the relatively low rates of mental illnesses and use of psychiatric care in the primary and secondary care, which remain low across age groups (Additional file 1: Tables S3 and S4). Lastly, individuals with mental illnesses are perhaps less inclined to participate in surveys. Thus, it is likely that the mental health capacity to work is overestimated. This is affirmed by Avendano et al. (2019) and Plana-Ripoll et al. (2023) who have established that poor mental health is a major source of work disability and early retirement among older individuals. Moreover, we see substantial differences in predicted estimates at the individual level across the three health indices. While our results might seem unsurprising, they emphasise the challenge in accounting for workforce diversity and defining fair requirements for early retirement.

We find that the additional work capacity is similar for regressions that include a negative estimate of changes in the health index, suggesting that detriments in health do not significantly affect the capacity to work. This is somewhat surprising as others have found that acute health shocks greatly affect the probability of exiting the labour market (e.g., Trevisan & Zantomio 2016). However, the predicted employment rate is slightly smaller when negative changes in mental health are included, implying that mental health shocks do affect the capacity to work. Our result could be explained by differences in types of health changes across age groups and the fact that the ability to cope with health changes declines with age. If health shocks have little impact on early retirement among the 50–54-year-olds, this will translate into high work capacity among the older cohorts. Moreover, it is likely that the perception and/or consequences of a similar estimated change in health are dependent on health state and thus change with age as health deteriorates.

The estimates are likely to reflect the upper bounds of the 'true' health capacity to work. This is for several reasons. First, while the inclusion of self-reported (subjective) health measures allows us to account for some of the variation in the burden of disease, these data might be subject to justification bias (Bound 1991). We test for this by only including objective health measures and find similar results for additional work capacity, suggesting limited justification bias as aligned with findings from Vandenberghe (2021). Second, it is likely that health conditions have a smaller effect on employment for younger (50–54-year-olds) than for older cohorts. In a robustness check, we re-estimate the employment regressions using the 55–59-year-olds (who are closer in age to the older cohorts) and find no notable differences in estimates. Third, we cannot rule out the possibility that reverse causality impacts our results. If retirement has a positive effect health (as found by, e.g., Rose (2020)), we are likely to overestimate the ability to work given health. Fourth, we assume that health capacity is not a function of years of work. However, if health is endogenous and individuals wear out at a faster rate in older age (i.e., after more years of work), health capacity to work would be overestimated. Furthermore, some illnesses, such as dementia, have a late onset (the are age-related), and therefore the effect of these conditions on the ability to work is not appropriately captured by the model, resulting in an upward bias.

7 Policy implications and conclusion

Population ageing and financial sustainability concerns have forced many countries to link retirement age to life expectancy. The aim has been to reduce the incentive for early retirement and to extend the working lives of older individuals. However, when designing pension systems, it is important to think about what creates welfare in a society. Our results indicate that there is an extensive work capacity among older individuals and that many will be able to work for a longer period than they currently do. Thus, results confirm that pension reforms can extend the working life of the general population as intended. This is promising. Yet, two important questions remain unanswered: are there negative welfare consequences of such reforms and how do we ensure that those who legitimately are worn out are given the possibility for early retirement?

The reforms could result in negative welfare effects if the opportunity costs such as, e.g., the disutility from labour, are greater than the benefits of labour market attachment. Moreover, a concern with the current Danish model is that an extra year of life is fully transferred to an additional year of work. How additional years of life should be divided between work and retirement should be debated, and it may create higher welfare if some of the additional years were translated into retirement. For example, in Sweden and Finland, a year of additional life expectancy is translated into an additional eight months of work and 4 months of retirement.

Our results suggest that a differential statutory retirement age would be fairer because there is a social and systematic disparity in work conditions, life expectancy and health at older ages, which a uniform pension scheme ignores. In contrast, a system where the retirement age differs in a way that equalises additional health capacity across citizens could be considered more equitable. Unfortunately, our results also demonstrate that this is not easy to operationalise in practice. Health capacity differs greatly at the individual level not only by socio-economic status but also across health indices which demonstrate the complexity of measuring and defining 'good' health and thus the eligibility criteria for early retirement. In conjunction with this, Baurin (2021) concludes that socio-economic status poorly predicts lifespan, and he argues against a differential retirement age based on socio-economic gradients because there is great individual heterogeneity within socio-economic groups. Individual case management could be a solution, but it is costly. Another solution could be to give financial incentives for workers to remain in the workforce. However, this may be distorting. A more viable solution is to encourage individuals to extend their working lives voluntarily by, e.g., promoting physical and psychosocial working conditions, increasing older individuals' workplace flexibility, or offering training and vocational rehabilitation programmes. Our findings suggest that autonomy is an important factor in individuals' decision to remain in the workforce.

It should also be considered that with delayed retirement, the labour force may experience more age-related health shocks during their working years. From a policy perspective, it is of great interest to explore how health state and health shock affect employment rate and what the implications of increased retirement age are. Moreover, it is also of political interest to know whether work is of the same quality at older ages and whether older workers maintain their productivity.

The trends in predicted work capacity can likely be generalised to other OECD countries with comparable healthcare systems. Yet, the magnitude of the additional health capacity to work may differ substantially across pension systems due to, e.g., differences in age at which citizens can retire, and which disability pensions are available (Börsch-Supan et al. 2009). In the future, the statutory retirement age will be 74 years in Denmark, and 71.3 years in Italy and the Netherlands (OECD 2017). Wise (2017) shows that the predicted employment rate is almost the same in the three countries, but that the additional work capacity is substantially larger in Italy and the Netherlands due to the lower actual employment rates.

We would like to point out that our analyses are not normative, and as such do not indicate that individuals *should* continue to work in accordance with the additional work capacity found (it is an upper bound estimate). Rather they give a hint that individuals are capable of working longer if they want to and are not restricted by other factors, e.g., labour demand, workplace environment, family responsibilities, or a preference for leisure. It is also important to stress that the estimates are averages, that age does not dictate one's health status, and that there is great individual variation.

Abbreviation
SHARE Survey of Health, Ageing and Retirement in Europe

Supplementary Information

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Additional file 1: Appendix.

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MSA: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data Curation, Writing—Original Draft, Writing—Review and Editing, Visualization, Project administration. JTL: Conceptualization, Methodology, Data Curation, Writing—Review and Editing, Supervision. TK: Conceptualization, Methodology, Writing—Review and Editing, Supervision, Funding acquisition.

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Availability of the data and materials
Due to Danish Data Protection Legislation, only Danish research environments can be granted authorisation to Danish administrative registers. However, SHARE data is available from www.share-project.org but restrictions apply.

Declarations

Competing interests
The authors declare no conflict of interest.

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