NBER WORKING PAPER SERIES

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Working Paper 35165
http://www.nber.org/papers/w35165

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 2026

This paper is part of the National Bureau of Economic Research's International Social Security (ISS) project. This phase of the ISS Project is supported by the Sloan Foundation (G-2019-12578), the National Institute on Aging (grants P01 AG012810 and P30-AG012810) and by the U.S. Social Security Administration through grant 5-RRC08098400-10 to the National Bureau of Economic Research as part of the SSA Retirement Research Consortium. Malene Kallestrup-Lamb gratefully acknowledge financial support from the Pension Research Centre (PeRCent) at Copenhagen Business School. Paul Bingley is grateful for financial support from Independent Research Fund Denmark | Social Sciences (grant code 0219-00004). The findings and conclusions expressed are solely those of the authors and do not represent the views of the Sloan Foundation, SSA, any agency of the Federal Government, or the National Bureau of Economic Research. The authors thank the other members of the ISS Project for their methodological contributions, particularly Luca Salerno and Frederik Fetze, for their assistance with the Stata code used in this study.

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JEL No. I14, J14

ABSTRACT

Using Danish SHARE data from 2004–2022, we examine income gradients in health among retirees ages 60–79 across functional, diagnosed, comprehensive, mental, and cognitive domains. Higher-income retirees are healthier across all dimensions, but the evolution of inequality differs across measures. Functional and comprehensive health gaps narrow over time because lower-income retirees improve, whereas mental health gaps remain large and persistent. Diagnosed and cognitive health show smaller, less stable gradients. Overall, health inequality at older ages is substantial but not uniform: physical health disparities compress, while mental health disparities show no sign of convergence.

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1 Introduction

Over the past two decades, the dynamics of health inequalities have attracted growing attention in public health, economics, and social policy research (Marmot, 2005). While the existence of socioeconomic gradients in health is well documented, less is known about how these disparities evolve over time and across different health domains (Mackenbach et al., 2016). Understanding whether inequalities are widening, narrowing, or shifting in character is particularly important in aging societies, where longer working lives and policy reforms may interact with health trajectories in complex ways.

Denmark provides a valuable case study for filling this knowledge gap. Since the mid-2000s, a series of pension reforms have gradually increased the statutory retirement age and restricted access to early pension benefits. The 2006 Welfare Agreement (Ministry of Finance - Denmark, 2006) linked the pension age to life expectancy, while the 2011 Retirement Reform accelerated this timeline and shortened the voluntary early-retirement period from five to three years (Ministry of Finance - Denmark, 2011). The state pension age reached 67 by 2024–25 and is legislated to rise to 68 in 2030, 69 in 2035, and 70 in 2040, while new targeted early-exit pathways were introduced for individuals with long employment histories or reduced work capacity. These reforms primarily affect the duration of working life rather than direct medical costs, as Denmark's universal, tax-financed health system ensures relatively low out-of-pocket expenses (approx. 13% of total health care expenditure). An important question, therefore, is whether longer work exposure and delayed retirement have altered patterns of health inequality among older Danes.

This study examines the evolution of income-related health inequalities among residents of Denmark aged 60–79 between 2004 and 2022, using data from the Survey of Health, Aging and Retirement in Europe (SHARE) (Börsch-Supan et al., 2022). By exploiting measures of health, socioeconomic status, and demographic characteristics for the sample, our analysis traces temporal changes in the socioeconomic gradient of health. We consider five dimensions of health: functional, diagnosed, comprehensive, mental, and cognitive. First, we calculate the proportions reporting good or very good health by income decile and examine how the socioeconomic gradient in health changes over time. Second, we transform observed level differences in health into a metric directly comparable across health measures and easily interpretable as corresponding to age-related health decline. Finally, we use concentration curves, analogous to the Gini coefficient, to assess inequality over time.

We find that while functional and comprehensive health initially display wide gaps across the income distribution, equivalent to more than a decade of additional good health for higher-income individuals, these disparities narrow substantially over time, largely due to improvements among lower-income groups. By contrast, diagnosed and cognitive health exhibit more modest

and shifting gradients, often concentrated asymmetrically around the median of the income distribution. Mental health emerges as the most unequal domain, with persistent and substantial disparities translating into the longest catch-up times in terms of equivalent age-related decline. These results show that income-related health inequality evolves differently across domains: gaps in functional and comprehensive health narrow over time, while disparities in mental health remain large.

To complement these findings, we also employ concentration curves and concentration indices to provide a distributional perspective on health inequality. These concentration measures reveal that poor health is disproportionately concentrated among lower-income individuals, with the greatest inequality observed in functional and comprehensive health. However, the concentration indices show little systematic change over time, indicating stability in inequality patterns despite important domain-specific dynamics.

The remainder of the paper is organized as follows. In Section 2 we describe data and the methodical approach. Section 3 shows the main results. Section 4 provides a discussion, while Section 5 concludes.

2 Data and Methods

We analyze data from the Danish subsample of SHARE, a large, biennial longitudinal survey collecting detailed health, socioeconomic, and social information from individuals aged 50 and older across Europe (Börsch-Supan et al., 2013). Our primary sample includes retired respondents aged 60–79 at the time of interview across eight waves (1, 2, 4–9) spanning the years 2004–2022. Wave 3 is excluded as it contains retrospective rather than contemporaneous information on the variables of interest. Individuals may contribute multiple observations if they satisfy the age and retirement criteria in more than one wave. All analyses employ SHARE-provided cross-sectional weights to maintain representativeness.

We construct five distinct health indicators, each standardized such that higher values consistently reflect better health outcomes. This coding approach ensures comparability across measures and facilitates a more intuitive interpretation of results, as improvements in any indicator correspond to improvements in overall health status.

- **Functional Health**: We combine counts of Activities of Daily Living (ADL) proposed by Katz et al. (1963) and Instrumental Activities of Daily Living (IADL) (Lawton and Brody, 1969) where respondents report the number of limitations due to physical, mental, emotional, or memory problems. ADLs measure basic self-care and complex daily tasks: (1) dressing, (2) walking across a room, (3) bathing or showering, (4) eating, (5) getting in or out of bed, (6) using the toilet, (7) using a map to figure out how to get around in a strange place, (8)

preparing a hot meal, (9) shopping for groceries, and (10) making telephone calls. IADLs capture physical functioning and mobility: (1) walking 100 meters, (2) sitting for two hours, (3) getting up from a chair, (4) climbing several flights of stairs, (5) climbing one flight of stairs, (6) stooping, kneeling, or crouching, (7) reaching or extending arms above shoulder level, (8) pulling or pushing large objects, (9) lifting or carrying weights over 5 kilos, and (10) picking up a small coin from a table. Since each domain contains 10 items, we construct our measure as 20 minus the total number of reported limitations, yielding a range of 0–20, with higher scores reflecting greater functional independence.

- **Diagnosed Health**: We construct a measure of disease-free status using doctor-diagnosed chronic conditions from a standardized list consistently available across all survey waves. Respondents report whether a doctor has ever diagnosed them with any of the 11 conditions: (1) heart attack, (2) high blood pressure or hypertension, (3) high blood cholesterol, (4) stroke, (5) diabetes or high blood sugar, (6) chronic lung disease, (7) cancer, (8) stomach or duodenal ulcer or peptic ulcer, (9) Parkinson's disease, (10) cataracts, and (11) hip fracture or femoral fracture. We deliberately exclude conditions with inconsistent availability across waves, specifically asthma, arthritis, osteoporosis, other fractures, Alzheimer's disease/dementia, benign tumors, affective/emotional disorders, rheumatoid arthritis, osteoarthritis, and chronic kidney disease, to ensure temporal comparability. Thus, the variable counts the number of conditions the respondent does *not* have (11 minus the number of reported conditions), so higher values indicate better health status.
- **Comprehensive Health**: Constructed following the deficit accumulation approach (Mitnitski et al., 2001), comprehensive health is the ratio of the number of health deficits absent to the total number of possible deficits considered. Deficits are drawn from a broad set of SHARE health indicators, including functional limitations, chronic conditions, sensory impairments, and self-rated health, each coded as 0–1. In our case, the index is constructed from 45 variables available in SHARE, as described in Abeliansky and Strulik (2019) and Börsch-Supan et al. (2021). Comprehensive health thus ranges from 0 (maximum deficits observed in the dataset) to 1 (no deficits), with higher values indicating better overall health.
- **Mental Health**: Measured using the 12-item EURO-D depression scale, which captures depressive symptoms, for example, sadness, pessimism, irritability, loss of interest, and fatigue. Each symptom is coded as present (=0) or absent (=1), and the total score ranges from 0 (all symptoms present) to 12 (no depressive symptoms). Higher values indicate better mental health. The EURO-D has been validated cross-culturally and is widely used in gerontological research.
- **Cognitive Health**: We measure cognitive functioning using a continuous 0–30 (Cog30)

index based on Harris and Dowson (1982). The index aggregates respondent performance across four standardized SHARE cognitive tasks: immediate word recall, delayed word recall, verbal fluency (animal naming), and numeracy (arithmetical problem-solving). Higher scores reflect better cognitive health.

Next, we construct income deciles as our measure of socioeconomic position using equivalized household income that aggregates all individual income components.[1] The decile construction follows a multi-step procedure designed to ensure consistent socioeconomic positioning while accounting for SHARE's complex panel structure and missing income data. Each respondent receives their permanent income decile assignment based on their position within the income distribution of their first sample appearance wave. We compute deciles within each wave using all respondents present in that wave to ensure that income positions reflect the full-sample distribution, rather than being influenced by the characteristics of new entrants. [2]

To address the common problem of missing income data in surveys of older adults, SHARE employs multiple imputation, generating five complete datasets with plausible values for the missing income components. We perform the entire decile construction procedure separately for each of the five imputation datasets, yielding five distinct decile assignments for each respondent. A respondent's final income decile is the average of their decile assignments across the five imputation datasets, rounded to the nearest integer. This approach ensures that each respondent maintains consistent income-group membership throughout their panel participation, reflects wave-specific economic conditions, and properly handles missing income information through multiple-imputation inference.

As a robustness check, we re-estimate our results on an alternative sample defined by age only, including all respondents aged 65–79 regardless of labor market status. This broader sample allows us to assess whether our results are sensitive to the restriction to retirees and to address potential selection effects related to retirement timing.

[1] Equivalization applies a linear equivalence scale with the formula $0.5 + 0.5 \times$ household size, where each additional household member contributes 0.5 to the equivalence factor.

[2] For example, someone first appearing in Wave 4 receives the decile corresponding to their position among all Wave 4 participants. Special adjustments accommodate SHARE's survey design features. Wave 1 entrants have their positions determined using the average of the Wave 1 and Wave 2 equivalized incomes, when both are available. Deciles are calculated among all respondents participating in both waves; those participating in only one wave receive deciles from that wave's distribution. Wave 7 entrants use Wave 8 income data (or Wave 9 if Wave 8 is unavailable) because the substantially reduced standard interview sample in Wave 7, resulting from SHARELIFE retrospective interviews.

2.1 Summary Statistics

Table 1, Panel A presents descriptive statistics for our analytical sample of 40,353 observations from retirees aged 60-79 across eight SHARE waves spanning 2004-2022. Panel A illustrates the effectiveness of our sampling approach in creating a relatively homogeneous comparison group across waves. Despite the 18-year observation window, the demographic and health characteristics remain remarkably stable. Mean ages vary narrowly between 69.2 and 71.8 years, while gender composition fluctuates modestly around 54-56% female. Most importantly, health outcomes exhibit consistent patterns across waves: functional health clusters tightly around 18.5-18.8, comprehensive health remains stable at 0.88-0.89, and mental health scores vary minimally between 10.1 and 10.4. This stability suggests that our restriction to retired individuals aged 60-79 successfully isolates a comparable population across the observation period, mitigating concerns about compositional changes that could confound temporal analysis.

The observed variation in mean income deciles, from 5.2 to 6.8 across waves, poses challenges for our analytical framework, as this pattern may reflect differential sample composition rather than within-individual changes. The modest variation in diagnosed health from 9.8 to 8.9 is similarly notable. However, both differences lie well within the standard deviations around these means, suggesting they are not practically significant.

Panel B reveals modest but systematic socioeconomic gradients across all health dimensions. The differences, while consistent in direction, vary considerably in magnitude across measures. For functional health, individuals in the lowest income decile score 18.1 on the scale compared to 19.1 for the highest decile. This difference, while representing less than half a standard deviation, could translate into meaningful limitations in daily activities for affected individuals. Diagnosed health shows minimal variation across income groups (9.1 vs. 9.4 doctor visits), consistent with Denmark's universal healthcare system, which ensures equitable access to medical services regardless of socioeconomic status.

More pronounced gradients emerge for other health metrics. Comprehensive health spans 0.06 points between the bottom and top deciles (0.85 vs. 0.91). In contrast, mental health differences are evident in EURO-D scores (10.1 vs. 10.7), suggesting higher rates of depressive symptoms among lower-income retirees. The largest absolute difference appears in cognitive health, where the bottom decile scores 2.7 points lower than the top decile (17.4 vs. 20.1). However, when viewed against the substantial within-group variation—standard deviations ranging from 1.5 to 4.6 across measures—these between-group differences become statistically insignificant. This pattern suggests that, among retirees, socioeconomic health gradients exist in the expected direction, but remain compressed relative to the overall variation in health in the population, highlighting the importance of our longitudinal approach for detecting subtle yet policy-relevant changes in health inequality over time.

Table 1: Sample Characteristics and Health Outcomes

Panel A: Descriptive Statistics by Survey Wave

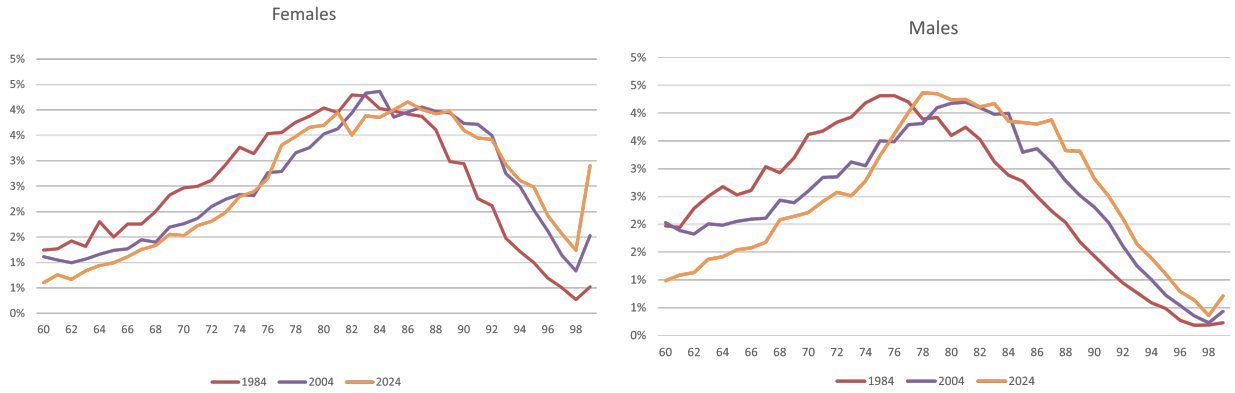
Wave	Year	Obs.	Female (%)	Age	Income Decile	Functional Health	Diagnosed Health	Comp. Health	Mental Health	Cognitive Health
1-9	04-22	40,353	54.5	70.2 (5.0)	6.2 (2.9)	18.7 (2.5)	9.2 (1.5)	0.89 (0.10)	10.3 (1.8)	19.1 (4.1)
1	2004	3,142	53.6	69.2 (5.7)	5.2 (2.9)	18.5 (2.5)	9.8 (1.2)	0.88 (0.10)	10.4 (1.8)	–
2	2007	4,773	53.9	69.4 (5.4)	5.6 (2.9)	18.6 (2.6)	9.5 (1.4)	0.89 (0.10)	10.3 (1.8)	–
4	2011	3,974	54.4	69.5 (5.1)	6.3 (2.8)	18.8 (2.3)	9.3 (1.4)	0.89 (0.10)	10.4 (1.7)	18.9 (4.4)
5	2013	7,812	53.3	69.6 (4.8)	6.0 (2.9)	18.7 (2.5)	9.3 (1.4)	0.89 (0.10)	10.4 (1.8)	18.9 (4.0)
6	2015	7,194	53.7	70.1 (4.7)	6.3 (2.8)	18.6 (2.7)	9.1 (1.5)	0.88 (0.11)	10.3 (1.7)	19.2 (4.2)
7	2017	3,401	57.7	70.8 (4.6)	6.7 (2.8)	18.6 (2.7)	8.9 (1.6)	0.88 (0.11)	10.2 (1.8)	19.2 (4.0)
8	2020	5,077	54.9	71.3 (4.4)	6.7 (2.8)	18.8 (2.3)	9.0 (1.5)	0.89 (0.10)	10.3 (1.8)	19.2 (4.1)
9	2022	4,980	56.2	71.8 (4.3)	6.8 (2.8)	18.7 (2.3)	8.9 (1.5)	0.88 (0.10)	10.1 (1.9)	19.4 (4.1)

Panel B: Descriptive Statistics by Income Decile

Decile	Obs.	Female (%)	Age	Functional Health	Diagnosed Health	Comprehensive Health	Mental Health	Cognitive Health
1-10	40,353	54.5	70.2 (5.0)	18.7 (2.5)	9.2 (1.5)	0.89 (0.10)	10.3 (1.8)	19.1 (4.1)
1 low	3,141	60.1	71.4 (4.9)	18.1 (3.2)	9.1 (1.6)	0.86 (0.12)	10.1 (1.9)	18.3 (4.4)
2	2,661	57.9	72.0 (4.8)	17.9 (3.2)	9.0 (1.6)	0.85 (0.12)	9.9 (1.9)	17.4 (4.6)
3	3,180	60.3	71.4 (4.8)	18.1 (3.2)	9.0 (1.6)	0.86 (0.12)	10.0 (2.0)	18.1 (4.3)
4	3,508	58.8	71.0 (4.8)	18.4 (2.5)	9.1 (1.5)	0.87 (0.10)	10.1 (1.9)	18.4 (4.2)
5	3,530	57.3	70.5 (4.8)	18.6 (2.4)	9.2 (1.5)	0.88 (0.10)	10.2 (1.9)	18.3 (4.1)
6	3,966	54.5	70.4 (4.8)	18.8 (2.1)	9.3 (1.5)	0.89 (0.09)	10.3 (1.7)	19.0 (4.1)
7	4,251	52.5	70.1 (4.9)	18.9 (2.1)	9.2 (1.4)	0.89 (0.09)	10.4 (1.7)	19.7 (3.8)
8	4,550	53.1	69.4 (4.9)	18.8 (2.2)	9.4 (1.4)	0.89 (0.09)	10.4 (1.7)	19.5 (3.9)
9	5,324	52.8	69.4 (4.7)	19.1 (1.9)	9.3 (1.5)	0.90 (0.09)	10.4 (1.7)	19.7 (4.0)
10 high	6,221	48.2	68.9 (4.7)	19.1 (2.2)	9.4 (1.4)	0.91 (0.09)	10.7 (1.5)	20.1 (3.8)

Notes: Sample from SHARE waves 1, 2, and 4–9 (2004, 2007, 2011–2022). Wave 3 is excluded since information/questions on health were not recorded in this wave. All health measures are coded such that higher values indicate better health: (1) Functional health measures functional independence in Activities of Daily Living, with higher scores indicating fewer limitations in basic daily tasks; (2) Diagnosed health counts doctor visits using reverse-coded measure where higher values reflect lower healthcare utilization; (3) Comprehensive health is a composite measure (0-1 scale) capturing absence of chronic conditions and physical impairments; (4) Mental health uses the EURO-D Score from the European Depression scale reverse-coded so higher values indicate fewer depressive symptoms; (5) Cognitive health measures performance on cognitive tests (30-point scale) with higher scores reflecting better cognitive functioning. Cognitive scores are not available for waves 1 and 2. Income decile represents the mean household income decile position (1=lowest, 10=highest). Observations with missing income deciles are excluded. All statistics use sample weights.

Figure 1: Deaths by Age, Sex, and Birth Cohort



(a) Females (b) Males

Note: From the Human Mortality Database (HMD, 2025) we present the conditional distribution of percentage deaths by age and sex, given survival to age 60 for birth cohorts 1984, 2004, and 2024.

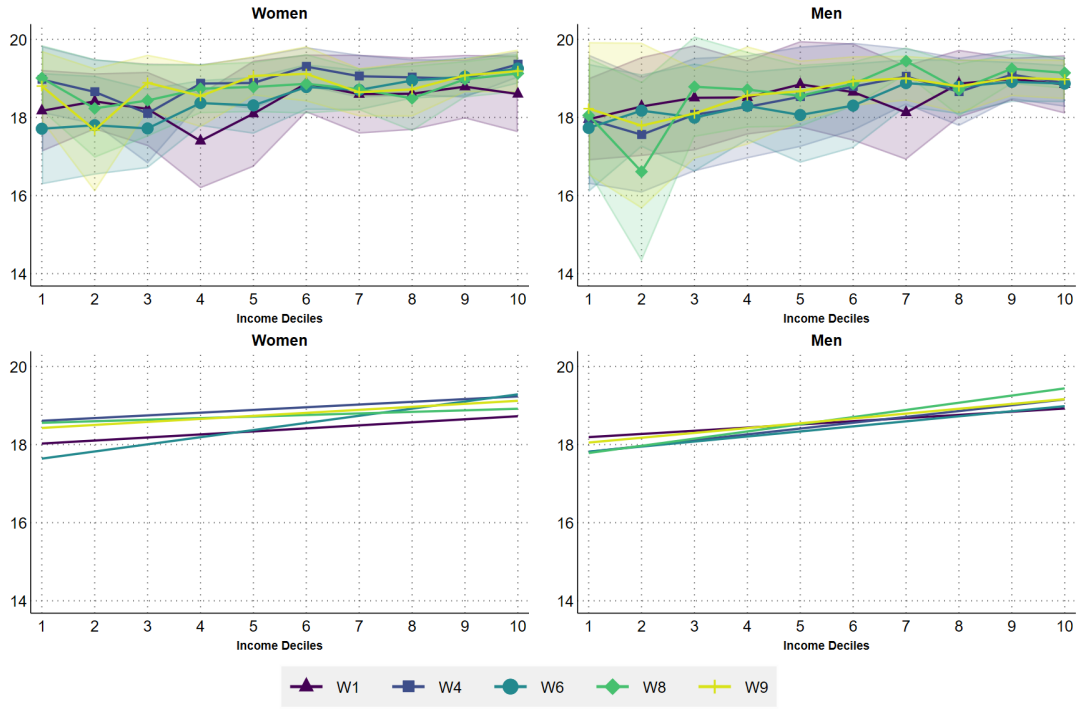
3 Results

Using data from the Human Mortality Database (HMD, 2025), we examine mortality patterns among retired Danes across three distinct cohorts (1984, 2004, and 2024). Figures 1a and 1b display the conditional distribution of deaths by age and sex, given survival to age 60. The results reveal pronounced shifts in the age-at-death profile over time, with mortality becoming increasingly compressed at older ages. In earlier cohorts (1984), deaths were more widely distributed across ages 70 to 90, while in later cohorts (2004 and especially 2024), deaths cluster more tightly around ages 78 to 85, suggesting an expansion of longevity and a narrowing of variation in survival. Sex differences remain evident: women show a more even mortality distribution and persistently higher survival probabilities into advanced ages compared to men, though both sexes experience similar temporal trends. These figures highlight not only improvements in life expectancy but also changing patterns of health inequality within the retired population, as later cohorts experience both delayed and more concentrated mortality.

Next, we examine health inequalities among retirees using SHARE data. Our analysis focuses on five distinct health measures across income deciles to capture the socioeconomic gradient in health outcomes and its evolution over time among the retired population aged 60-79. For our primary analysis, we calculate the mean health measure by income decile and investigate how the socioeconomic gradient in health changes over time.

Functional Health: Figure 2 presents the combined measure of Activities of Daily Living and Instrumental Activities of Daily Living by household income decile across survey waves. The results reveal a consistent but modest socioeconomic gradient in functional independence

Figure 2: Functional Health



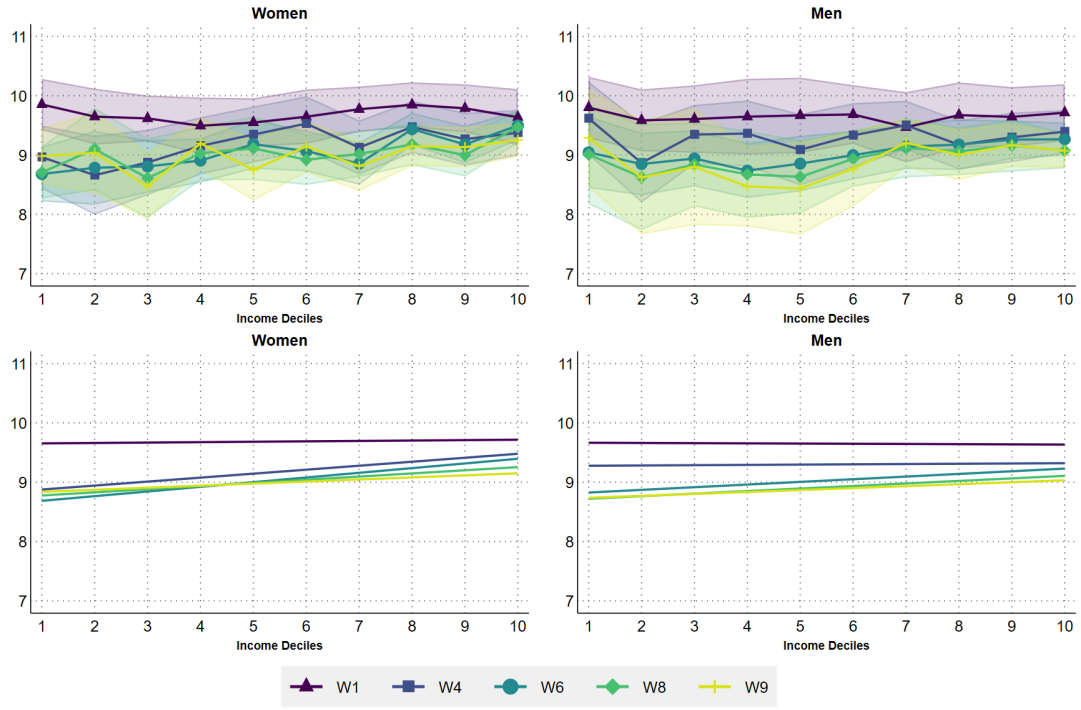
Note: The upper panes show health outcomes by income decile, with 95% confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across income deciles by wave. Higher scores indicate better functional independence (fewer limitations). Sample restricted to retired individuals aged 60-79. All estimates use SHARE sampling weights.

among retirees. Individuals in the lowest income deciles consistently report lower functional independence scores, indicating more limitations in basic and complex daily activities.

The gradient spans approximately 1-1.5 points on our 20-point scale between the lowest and highest income deciles. The 95% confidence intervals shown in the upper panes indicate reasonable precision in our estimates, although some uncertainty exists, particularly for the highest and lowest deciles where sample sizes are smaller. Results from a simple linear regression of mean health on income decile by wave (lower pane) highlight the remarkable stability of temporal trends across waves, with parallel lines suggesting that functional health inequalities among retirees have remained essentially unchanged over the 18-year observation period. Sex differences are evident but modest, with women showing slightly steeper gradients in some waves.

Diagnosed Health: Figure 3 displays the average number of chronic conditions absent (reverse-coded) by income decile and wave. The socioeconomic gradient in chronic disease burden among retirees is notably shallow, with the difference between income deciles amounting to less than one condition on average. The confidence intervals in the upper panes show con-

Figure 3: Diagnosed Health

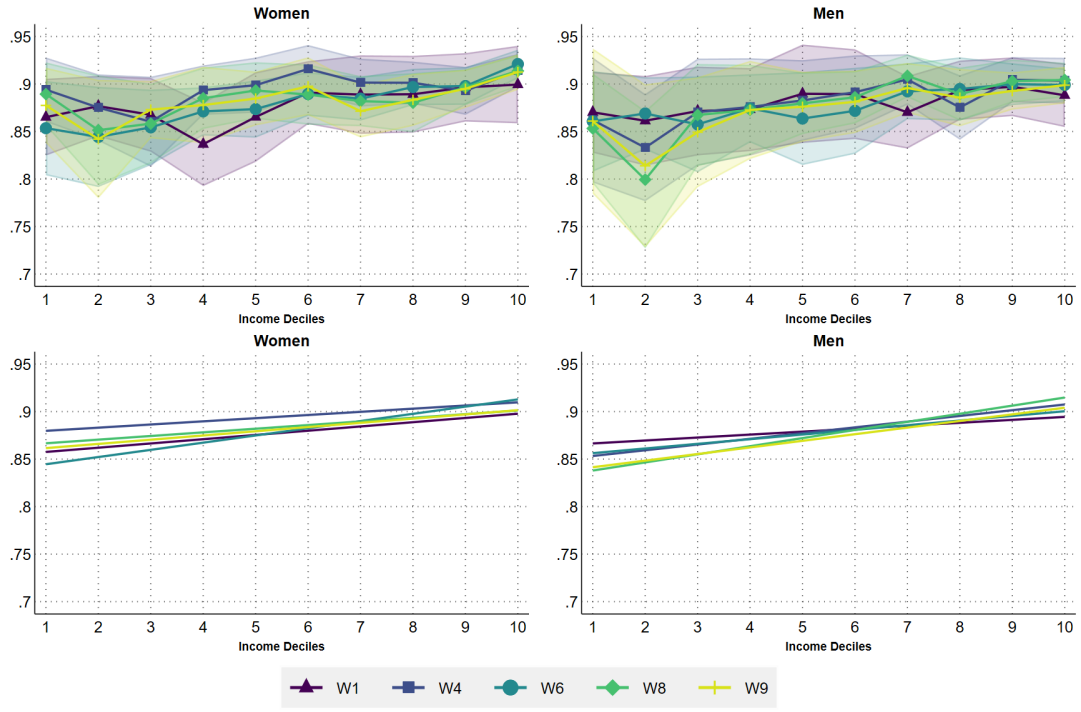


Note: The upper panes show health outcomes by income decile, with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across income deciles by wave. Higher scores indicate fewer chronic conditions (better health). Chronic conditions include heart attack, hypertension, cholesterol, stroke, diabetes, lung disease, cancer, ulcer, Parkinson's, cataracts, and hip fracture. Sample restricted to retired individuals aged 60-79. All estimates use SHARE sampling weights.

siderable overlap across income deciles, indicating substantial uncertainty around the gradient estimates for this health measure. Temporal patterns reveal interesting dynamics: while early waves (W1, W4) exhibited virtually flat gradients with wide confidence intervals, more recent waves show slightly steeper relationships between income and chronic disease burden; however, the overlapping confidence bands indicate that the differences are insignificant.

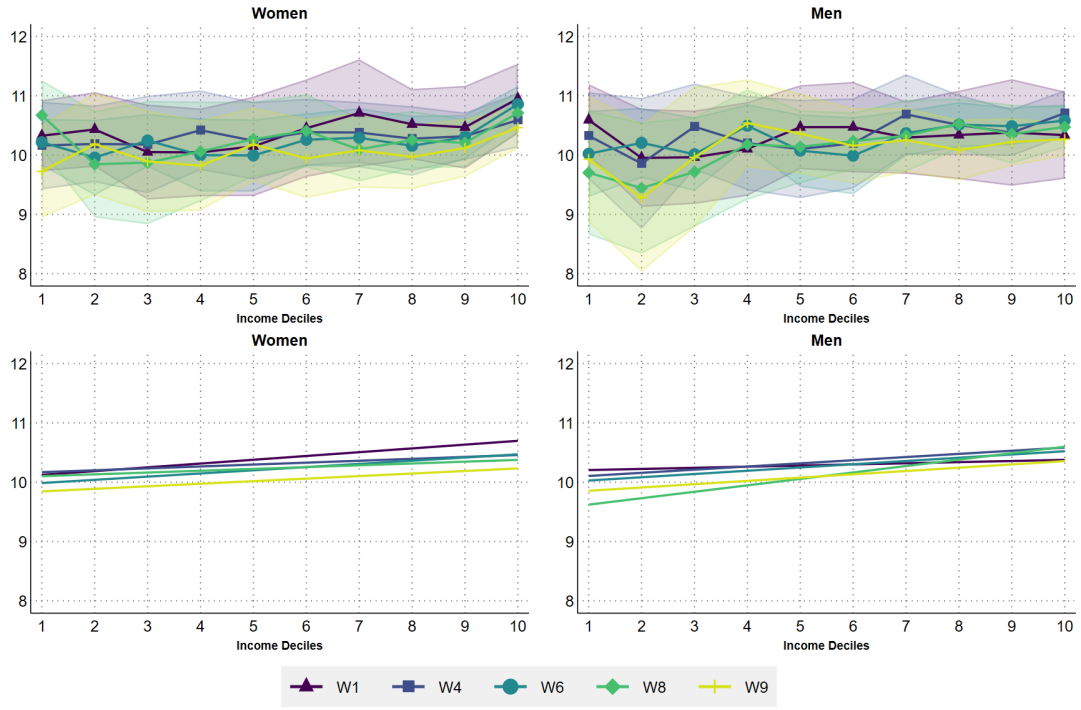
Comprehensive Health: Constructing a health deficiency index from 45 health variables provides the most comprehensive measure of health status in our analysis. Figure 4 demonstrates a clear socioeconomic gradient that has remained stable over time. The confidence intervals are notably tighter than those for other health measures, reflecting the comprehensive nature of this composite index; however, they typically overlap. Higher-income retirees consistently score approximately 0.05 to 0.06 points higher on the index compared to their lower-income counterparts, indicating fewer health deficits. The gradient shows remarkable temporal stability, with parallel trends across income groups, providing evidence for persistent health inequalities among retirees throughout the observation period.

Figure 4: Comprehensive Health



Note: The upper panes show health outcomes by income decile, with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across income deciles by wave. Health Deficiency Index ranges from 0 to 1, with higher scores indicating fewer health deficits (better overall health). Index constructed from 45 health variables following the deficit accumulation approach. Sample restricted to retired individuals aged 60-79. All estimates use SHARE sampling weights.

Figure 5: Mental Health

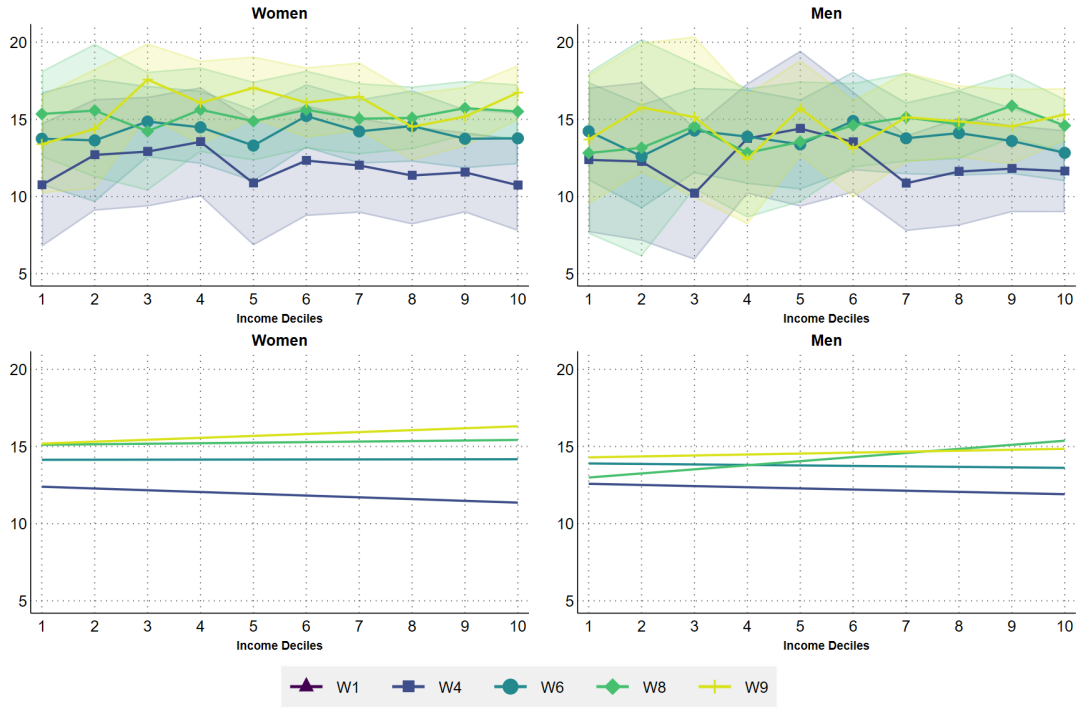


Note: The upper panes show health outcomes by income decile, with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across income deciles by wave. EURO-D scale ranges from 0-12, with higher scores indicating better mental health (fewer depressive symptoms). Scale captures symptoms including sadness, pessimism, irritability, loss of interest, and fatigue. Sample restricted to retired individuals aged 60-79. All estimates use SHARE sampling weights.

Mental Health: Figure 5 presents mental health outcomes, as measured by the EURO-D depression scale, across income deciles. The socioeconomic gradient for mental health among retirees is modest but persistent, with higher-income individuals reporting consistently better mental health outcomes. However, the confidence intervals show considerable overlap across middle-income deciles, suggesting that differences between the highest and lowest deciles may primarily drive the gradient. The gradient spans approximately 0.5 to 0.8 points on the EURO-D scale between the lowest- and highest-income deciles. Temporal trends indicate relative stability across waves, although substantial uncertainty remains in the observed fluctuations, particularly among low- and middle-income groups.

Cognitive Health: Cognitive functioning, measured by the COG-30 index, presents the most complex and inconsistent pattern among all health measures examined. Figure 6 reveals substantial instability in the socioeconomic gradient across waves, with gradients frequently reversing direction and showing little consistent relationship between income and cognitive performance.

Figure 6: Cognitive Health



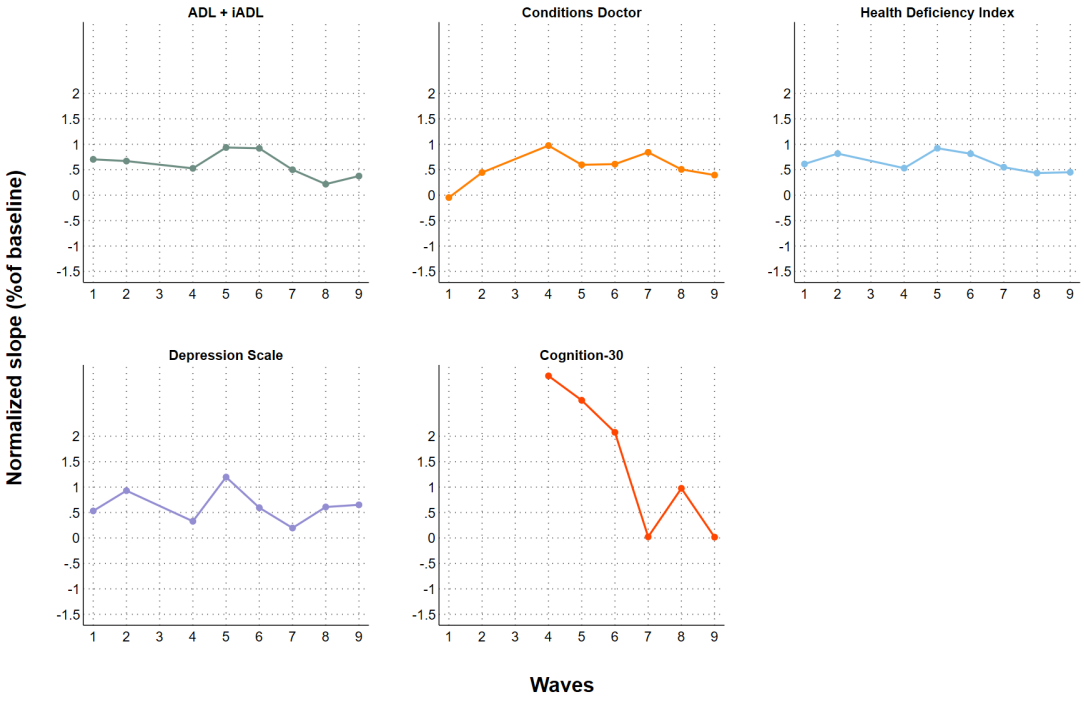
Note: The upper panes show health outcomes by income decile, with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across income deciles by wave. COG-30 index ranges from 0 to 30, with higher scores indicating better cognitive functioning. Index combines immediate word recall (0-10), delayed word recall (0-10), verbal fluency (0-10), and numeracy tasks. Cognitive data not available for Waves 1 and 2. Sample restricted to retired individuals aged 60-79. All estimates use SHARE sampling weights.

The upper panes demonstrate extensive overlap in confidence intervals across income deciles, indicating high uncertainty in the estimates and limited statistical power to detect meaningful differences. Most notably, several waves exhibit counterintuitive patterns in which lower-income deciles outperform higher-income groups, contradicting the expected socioeconomic gradients. The fitted linear trends in the lower panes highlight this instability, with slopes that vary dramatically across waves and even change sign between survey periods.

This erratic pattern suggests that cognitive functioning among retirees may be less systematically related to income than other health measures, possibly due to measurement challenges, small sample sizes for cognitive assessments, or genuine heterogeneity in cognitive aging processes that are not well captured by simple income-based stratification. The lack of a consistent gradient across waves makes it difficult to draw reliable conclusions about socioeconomic inequalities in cognitive health based on this sample.

To summarize the evolution of the slope of the health-income gradient across health metrics, we graph the slopes of the regression lines from the income-health profiles for women and men

Figure 7: Income-Health Gradient for Women across Waves



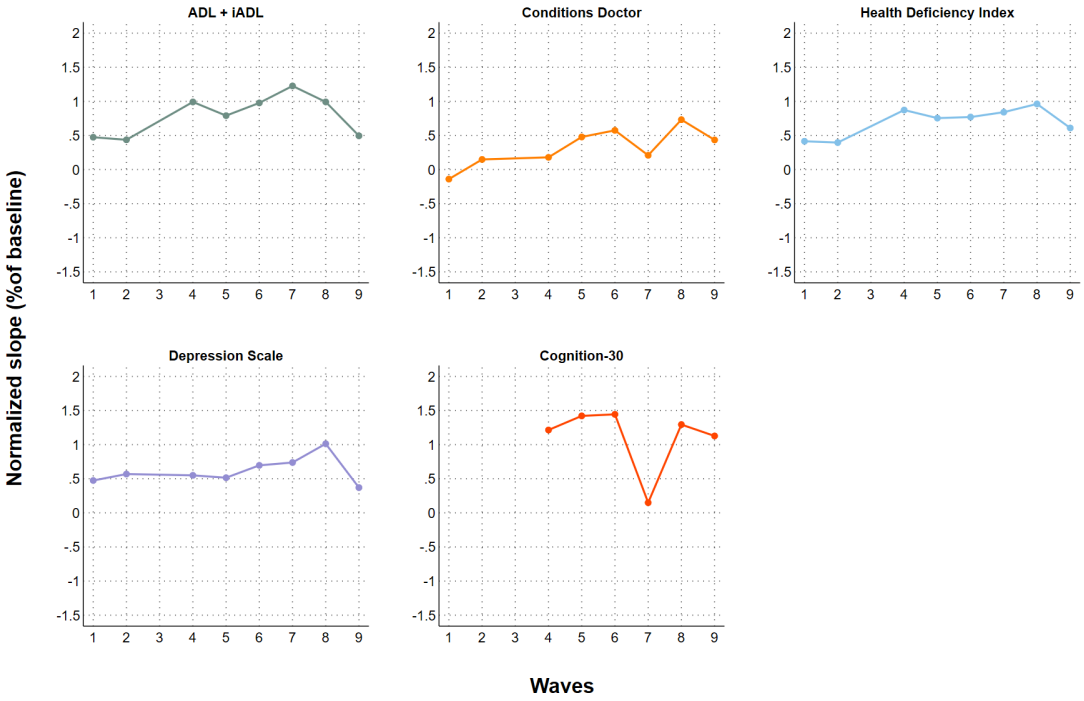
Note: Authors' own calculations based on SHARE release 9.0.0, with sampling weights applied. Slopes of income-health gradients from the regression lines for the metrics presented in Figures 2 through 6. The mean health outcome for each metric in wave nine normalizes the slopes. Numbers on the horizontal axes represent survey waves.

in Figures 7 and 8, respectively. Except for female cognitive health, there is no discernible trend in income health gradients across health metrics for men or women. The cognitive-health-income gradient for women declines sharply from wave four (the first wave in which it is assessed) to wave seven; however, cognitive health exhibited the most inconsistent pattern across the income distribution of all health metrics, and this development over time may be an artifact of these inconsistencies.

3.1 Income-Health Gradients in terms of Age-Related Decline

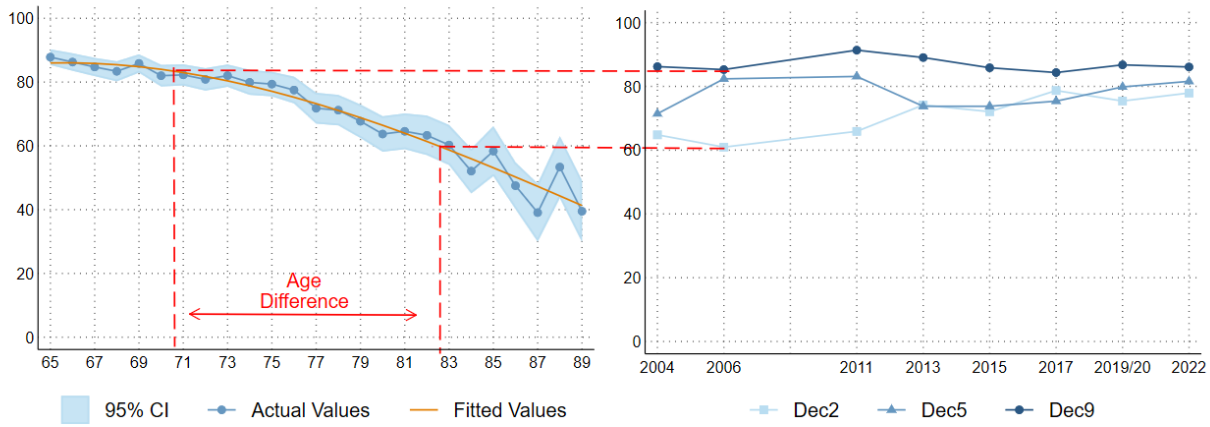
In this subsection, we transform observed differences in subjective health levels into a metric directly comparable across health measures and interpretable in real-world terms. Figure 9, based on functional health, illustrates the approach. Here, we define "good or very good" functional health as having a score above the 60th percentile in the overall distribution of individuals aged 65 to 89 in Wave One (2004). The left pane of the figure shows that the percentage of individuals with good or very good functional health decreases with age, while the right pane shows changes in this percentage over time for the second, fifth, and ninth income deciles.

Figure 8: Income-Health Gradient for Men across Waves



Note: Authors' own calculations based on SHARE release 9.0.0, with sampling weights applied. Slopes of income-health gradients from the regression lines for the metrics presented in Figures 2 through 6. The mean health outcome for each metric in wave nine normalizes the slopes. Numbers on the horizontal axes represent survey waves.

Figure 9: Functional Health by Age, Year and Income Decile

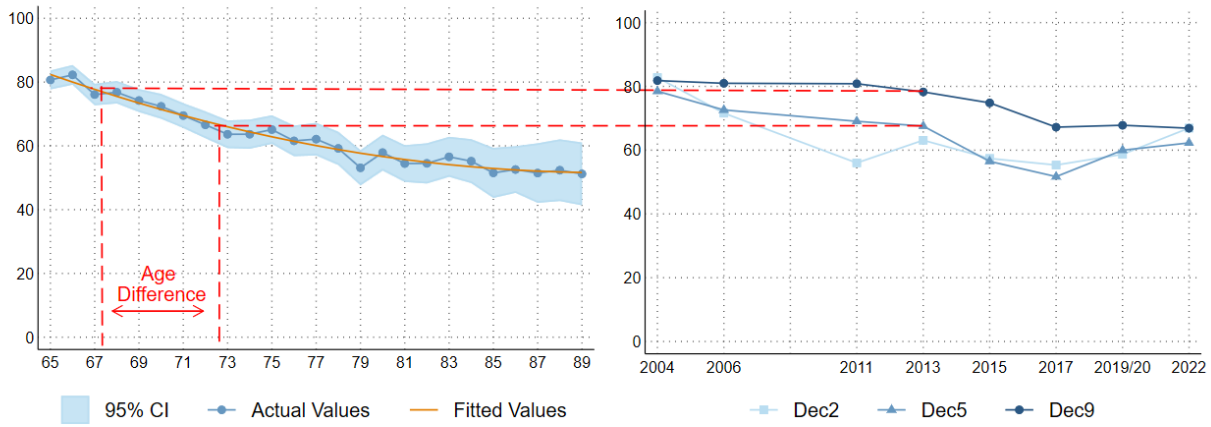


Note: Authors' own calculations based on SHARE release 9.0.0, with sampling weights applied. The left pane reports the proportion of individuals in good or very good health—defined as the top 40 percent of the functional health distribution in 2004, disaggregated by age. The right-hand pane shows the share of respondents reporting good or very good health across three income groups over time. The concept of catch-up time is illustrated in the 2006 data by comparing the health gap between income deciles 9 and 2: the red lines translate this gap into the equivalent number of years of aging required for lower-income individuals to reach the health level observed among higher-income individuals.

To interpret these differences across the income distribution, we translate the income-related variation in the right pane into an equivalent measure expressed in years of age, as shown in the left pane. In other words, we calculate how much earlier an individual in the second income decile reaches the same health status as an individual in the ninth income decile. We refer to this measure as "catch-up time," which represents the number of years a poorer individual would need to bridge to attain the same health level as a higher-income counterpart. In Figure 9, Wave 2 (2006) shows that individuals in the ninth income decile report an approximately 24 percentage-point higher probability of having good or very good functional health compared to those in the second decile, as shown in the right pane of Figure 9. Interpreted through the left pane, this gap corresponds to an additional 12 years spent in good or very good health for the higher-income group.

Catch-up time between the second and ninth income deciles remains constant from 2004 to 2011, then gradually narrows to about three years in 2022, corresponding to an eight percentage-

Figure 10: Diagnosed Health by Age, Year and Income Decile



Note: Authors' own calculations based on SHARE release 9.0.0, with sampling weights applied. The left pane reports the proportion of individuals in good or very good health—defined as the top 40 percent of the distribution of diagnosed health in 2004 —disaggregated by age. The right-hand pane shows the share of respondents reporting good or very good health across three income groups over time. The concept of catch-up time is illustrated in the 2013 data by comparing the health gap between income deciles 9 and 5: the red lines translate this gap into the equivalent number of years of aging required for lower-income individuals to reach the health level observed among higher-income individuals.

point difference in the sample proportions with good or very good health. This reduction in catch-up time has been due to a growing proportion of good or very good functional health in income decile two, whereas the corresponding proportion in decile nine has remained fairly constant. Splitting the income distribution at the median reveals that almost all of the narrowing of the overall gap was due to decile two improving functional health compared to decile five; indeed, from 2013 to 2022, the functional health of income deciles two and five is indistinguishable.

Figure 10 performs the same exercise of translating health differentials, now for diagnosed health, between income deciles in the cross-section into age-related decline. The figure shows the percentage of the sample with diagnosed health as good or very good. Wave 5 (2013) shows that individuals in the ninth income decile report an approximately 12 percentage-point higher probability of having good or very good diagnosed health compared to those in the fifth decile, as shown in the right pane of Figure 10. Interpreted through the left pane, this gap corresponds to an additional five years spent in good or very good health for the higher-income group.

The percentage of the sample in good or very good diagnosed health falls gradually over the sample period, from about 80 percent in 2004 to 65 percent in 2022. The income-diagnosed-health gradient begins in 2004 at a modest three percentage points and ends in 2022 at a similar level, but the gradient increases before declining during the intervening years. Except for 2011 (when there is a 12 percentage-point difference in the proportion in good or very good health), diagnosed health is similar across the fifth and second income deciles; the income-diagnosed-health gradient is observed primarily in the upper half of the income distribution.

In Figure 11, we translate comprehensive health differentials between income deciles in the cross-section into age-related decline. The figure shows the percentage of the sample with comprehensive health rated as good or very good. Wave 7 (2017) shows that individuals in the ninth income decile report an approximately 16 percentage-point higher probability of having good or very good comprehensive health compared to those in the fifth decile, as shown in the right pane of Figure 11. Interpreted through the left pane, this gap corresponds to an additional 8 years of good or very good comprehensive health for the higher-income group.

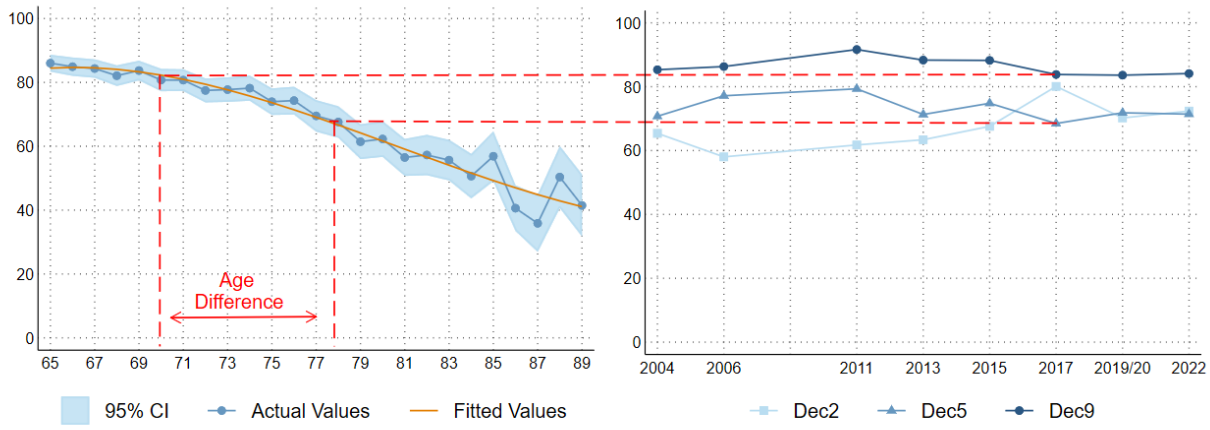
During the sample period, catch-up time for comprehensive health between income deciles five and nine remains fairly stable, with the percentages in good or very good comprehensive health rising by about ten percentage points to 2011 for both deciles, before falling back. The greatest change in comprehensive health across the income distribution is in decile two, with the catch-up time to decile five decreasing over the sample period and reaching zero by 2019. Hence, the reduction in the overall health-income gradient is driven by improvements in health at the bottom of the income distribution.

Figure 12 translates mental health differentials between income deciles in the cross-section into age-related decline. The figure depicts the percentage of the sample with good or very good mental health. Wave 7 (2017) shows that individuals in the ninth income decile report an approximately 18 percentage-point higher probability of having good or very good mental health compared to those in the fifth decile, as shown in the right pane of Figure 12. This gap corresponds to an additional 19 years spent in good or very good health for the higher-income group. For all of the health metrics we consider, income inequality translates into the longest catch-up time for mental health because of the more gradual decline in mental health with age than with other measures of health.

Over the sample period, the difference in percentages between income deciles two and nine for good or very good mental health remains fairly constant at 20 percentage points (80-60). There are no evident asymmetries in the income-mental-health gradient above or below the median.

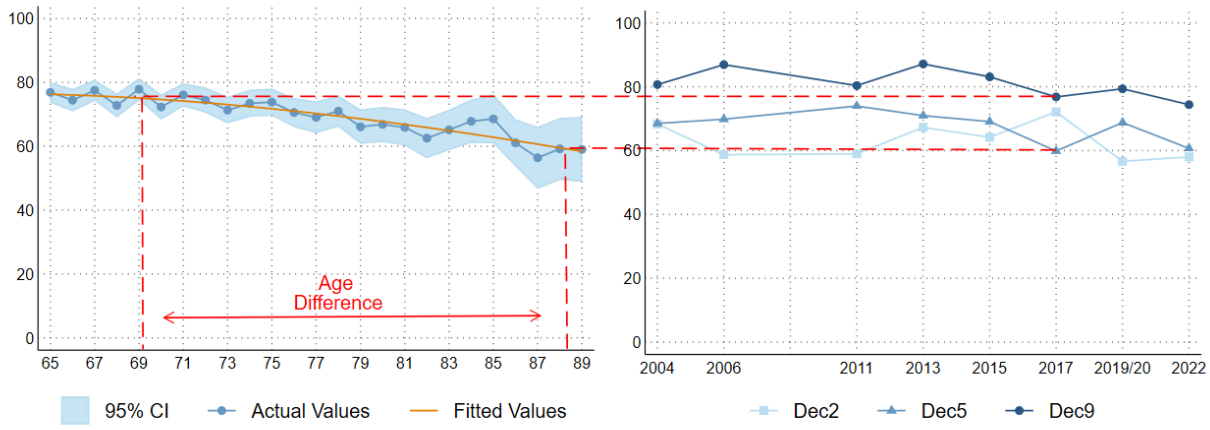
In Figure 13, we translate cognitive health differentials between income deciles in the cross-section into age-related decline. The figure illustrates the percentage of the sample with cognitive

Figure 11: Comprehensive Health by Age, Year and Income Decile



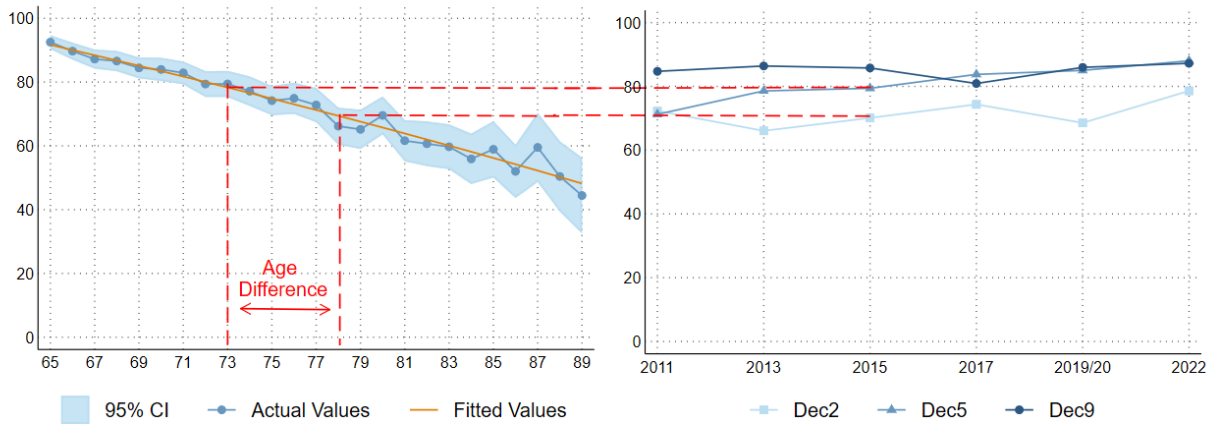
Note: Authors' own calculations based on SHARE release 9.0.0, with sampling weights applied. The left pane reports the proportion of individuals in good or very good health—defined as the top 40 percent of the comprehensive health distribution in 2004, disaggregated by age. The right-hand pane shows the share of respondents reporting good or very good health across three income groups over time. The concept of catch-up time is illustrated in the 2013 data by comparing the health gap between income deciles 9 and 5: the red lines translate this gap into the equivalent number of years of aging required for lower-income individuals to reach the health level observed among higher-income individuals.

Figure 12: Mental Health by Age, Year and Income Decile



Note: Authors' own calculations based on SHARE release 9.0.0, with sampling weights applied. The left pane reports the proportion of individuals in good or very good health—defined as the top 40 percent of the mental health distribution in 2004, disaggregated by age. The right-hand pane shows the share of respondents reporting good or very good health across three income groups over time. The concept of catch-up time is illustrated in the 2013 data by comparing the health gap between income deciles 9 and 5: the red lines translate this gap into the equivalent number of years of aging required for lower-income individuals to reach the health level observed among higher-income individuals.

Figure 13: Cognitive Health by Age, Year and Income Decile



Note: Authors' own calculations based on SHARE release 9.0.0, with sampling weights applied. The left pane reports the proportion of individuals in good or very good health—defined as the top 40 percent of the cognitive health distribution in 2011, disaggregated by age. The right-hand pane shows the share of respondents reporting good or very good health across three income groups over time. The concept of catch-up time is illustrated in the 2015 data by comparing the health gap between income deciles 5 and 2: the red lines translate this gap into the equivalent number of years of aging required for lower-income individuals to reach the health level observed among higher-income individuals.

health rated as good or very good. Wave 6 (2015) shows that individuals in the fifth income decile report an approximately 10 percentage-point higher probability of having good or very good cognitive health compared to those in the second decile, as shown in the right pane of Figure 13. Interpreted through the left pane, this gap corresponds to an additional 5 years of good or very good cognitive health for the higher-income group.

Over the sample period, the proportion of respondents reporting good or very good cognitive health increases slightly. While the ninth-second income decile difference in the percentage with good or very good cognitive health remains relatively consistent at around ten percentage points, the difference between deciles five and nine narrows, becoming indistinguishable from 2017 onwards. Hence, the cognitive-health-income gradient is evident only below the median income in the second half of the observation period.

The analysis shows that translating health disparities into age-related terms clarifies the extent of income-based inequality. Functional and comprehensive health initially shows large

gaps between high- and low-income groups, equivalent to more than a decade of additional good health. Still, these differences narrow substantially over time as lower-income groups improve. This catch-up dynamic suggests that inequality in certain aspects of physical health has decreased, primarily due to gains among the lower-income deciles.

In contrast, other domains reveal more persistent disparities. Diagnosed and cognitive health show modest, shifting income gradients that are asymmetric around median income, while mental health stands out as the most unequal, with broad and stable gaps translating into the longest catch-up times. Overall, income-related health gaps at older ages are not uniform across outcomes: physical health disparities narrow over time, but mental health disparities remain persistent.

3.2 Health Concentration Indices

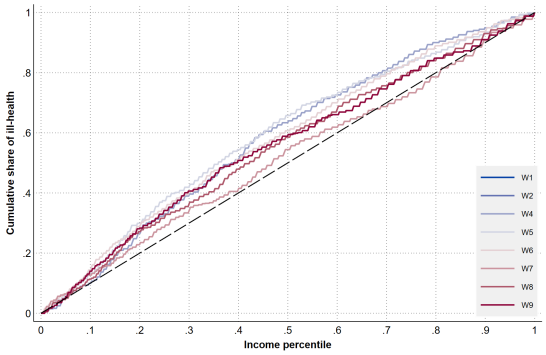
Another widely used approach to quantifying inequality relies on the *concentration curve*, which is conceptually related to the Lorenz curve but incorporates socioeconomic ranking into the analysis. Figure 14, panes a through e, presents the concentration curves constructed for each survey wave of the SHARE dataset. These curves depict the cumulative proportion of individuals reporting poor health status, ranked by income percentiles, against the cumulative distribution of the population. The 45-degree line serves as the line of equality, representing a hypothetical scenario in which poor health is distributed uniformly across the income distribution. Deviations from this benchmark indicate the degree of socioeconomic-related health inequality. Specifically, the farther the concentration curve lies above and to the left of the line of equality, the greater the concentration of poor health among individuals in the lower-income percentiles. Conversely, curves closer to the line of equality suggest a more even distribution of health outcomes across the income spectrum.

While there are no discernible differences in health concentration between waves, as demonstrated by the largely overlapping curves, the greatest health inequality by income is evident for functional and comprehensive health, as shown by the daylight between the lines of equality and all the concentration curves in panes d and e.

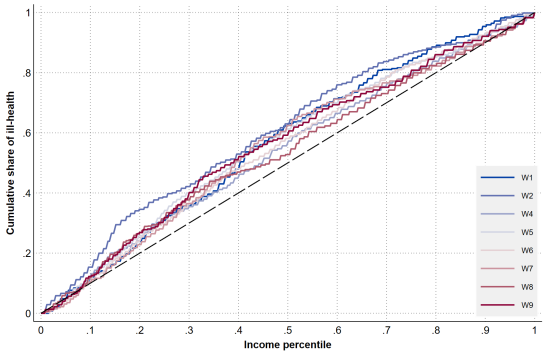
A summary measure derived from these curves is the *concentration index* (CI), directly comparable in interpretation to the Gini coefficient. Formally, the CI is defined as:

$$CI = \frac{1}{n\,\bar{h}} \sum_{i=1}^{n} h_i\,(2R_i - 1), \tag{1}$$

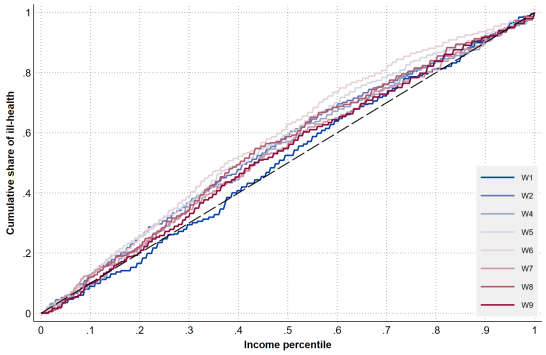
where h_i denotes the health status of individual i, $\bar{h}$ represents the mean health status across the sample, and R_i is the fractional rank of individual i in the income distribution (scaled between 0 and 1). A concentration index of zero denotes no inequality, whereas increasingly



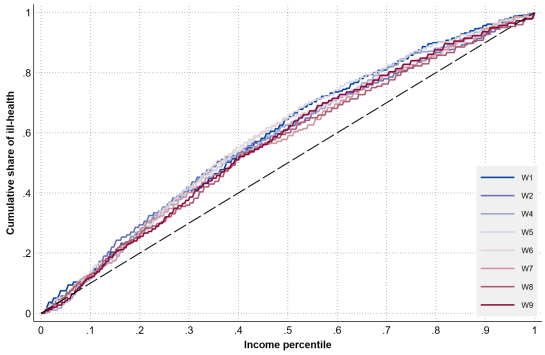
(a) Cognitive Health



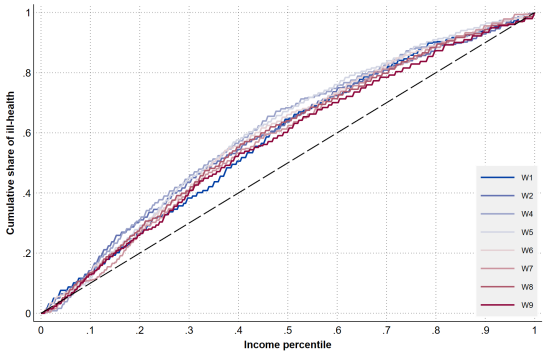
(b) Mental Health



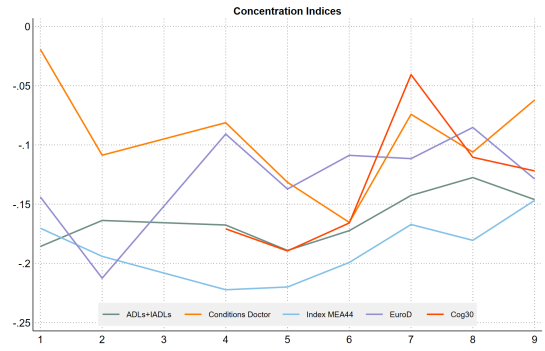
(c) Diagnosed Health



(d) Functional Health



(e) Comprehensive Health



(f) Health Concentration Indices

Figure 14: Health Concentration Curves

Note: Authors' own calculations based on SHARE release 9.0.0, with weights applied. The concentration curves depict the cumulative proportion of individuals reporting poor health across the income distribution. Equality in health outcomes would correspond to the 45-degree line; deviations to the left of this line indicate increasing inequality. The health concentration indices are summary measures of the concentration curves as defined in Equation 1. They are reported over time in pane f by health outcome, where lower values reflect greater inequality.

negative values indicate greater inequality, reflecting stronger disparities in health associated with income rank.

Pane f of Figure 14 presents health concentration indices over time for each of the five health metrics. While health concentration is mostly lowest for diagnosed health, there is no clear pattern across waves in any of the health metrics.

This subsection applies the concentration curve and the corresponding CI to assess income-related health inequalities. The concentration curves illustrate that poor health is disproportionately concentrated among individuals with lower incomes, with the greatest inequality observed for functional and comprehensive health measures. However, the curves largely overlap across waves, indicating stability in inequality patterns over time. The CI, formally analogous to the Gini coefficient, provides a scalar summary of these distributions: values close to zero indicate equality, whereas increasingly negative values indicate greater inequality. Consistent with the curves, the indices reveal no clear time trend across waves and the lowest degree of concentration for diagnosed health.

4 Discussion

Our main analysis demonstrates robustness across alternative sample definitions and socioeconomic measures, illustrated in Online Appendix A.1. When we expand our sample to include all individuals aged 65-79, regardless of retirement status, the patterns of modest, stable health inequalities persist, suggesting that our restriction to retirees does not artificially constrain the observed gradients. Similarly, replacing household income with net household wealth as our measure of socioeconomic position yields comparable results, with wealth-based deciles showing similar magnitudes and temporal stability in health disparities. This consistency across socioeconomic indicators is particularly noteworthy, given that income and wealth capture different aspects of economic resources, with wealth potentially reflecting longer-term economic security, whereas income represents current economic flows.

Retirement reforms legislated in the mid-2000s and implemented since 2011 have gradually increased both the early and normal retirement ages. The effects of postponing retirement on health are, in general, complex and mixed (see e.g., Kuhn (2018)). A priori, it is not clear how the reforms in Denmark have affected health inequalities. One study investigating the effect of the 2011 retirement reform on health and healthcare use finds a modest increase in GP visits around the early retirement age and an increase in antidepressant use after, but small and insignificant effects on comorbidities, painkillers, and cardiovascular disease medication. However, there is little heterogeneity in these impacts when the data are split by education (Borgbjerg et al., 2024).

A 2007 reform consolidating the municipality structure reduced the number of municipalities

from 271 to 98. It concentrated specialized care into five broad regions, rather than 14, potentially reducing access to care for individuals living in rural areas. It also incentivized municipalities to avoid referrals to regional specialized hospitals. Pedersen (2007) reports evidence of only a modest substitution of about 2-5% referrals that were avoided as a result of the reform. There is little evidence on socioeconomic differences in the referrals avoided, although it is likely that older individuals (e.g., those residing in assisted living centers) and those with chronic illnesses are least likely to be referred. On the other hand, because the regions no longer had to levy income and property taxes for financing healthcare and, from 2007, received block grants from the government, this may have had an equalizing effect on access to care. In any case, according to Pedersen (2007), substituting municipal health care services for acute care under this reform is unlikely to have a substantial effect.

Another relevant reform during this period is the plan to construct 16 "super hospitals" (university hospitals) dedicated to state-of-the-art, specialized care for complex diseases. Since 2010, this construction has cost eight billion euros in 2023 prices (Danish Ministry of Health, 2025). Six of these super hospitals were constructed between 2012 and 2022. While a comprehensive evaluation of this program has not been undertaken, some have raised equity concerns due to the increased distances to health care for rural populations after the centralization and the possible exclusion of marginalized groups such as the elderly and those with low health literacy, due to a greater reliance on digital health solutions (Eriksen et al., 2023).

Finally, the five cancer package reforms (In Danish: kræftpakke) enacted since 2000 have enforced a maximum waiting time of 14 days between a GP referral and assessment. Khan et al. (2023) conduct a before-and-after analysis on matched samples and find positive impacts on survival from breast cancer and a reduced risk of early retirement. While they find some evidence of lower income among patients observed after the reform compared to before, they caution that their findings may be influenced by survivor bias. Thus, there is currently little evidence that recent reforms to either the pension or healthcare systems have significantly improved or worsened socioeconomic inequalities in health in Denmark.

5 Conclusion

We provide evidence on the evolution of health inequalities among retirees in Denmark from 2004 to 2022, utilizing income and subjective health data from SHARE. By examining five distinct dimensions of health—functional, diagnosed, comprehensive, mental, and cognitive—across income deciles, the analysis provides insight into socioeconomic gradients and their persistence over time. The findings highlight that, while certain physical health measures, such as functional and comprehensive health, have seen narrowing disparities owing to improvements

among lower-income groups, mental health remains the domain with the most pronounced and enduring inequalities.

Temporal analysis reveals that the overall structure of health inequality is stable, with concentration indices showing little systematic change despite notable domain-specific dynamics. This stability suggests that recent pension and healthcare reforms in Denmark, including adjustments to pensionable ages and the expansion of specialized medical care, have not fundamentally altered patterns of socioeconomic health inequality among older adults. Moreover, the universal nature of Denmark's tax-financed health system continues to ensure minimal differences in healthcare utilization across income groups, supporting the notion that observed health gradients largely reflect broader socioeconomic factors rather than differential access to services.

Our study contributes to the literature by translating observed health disparities into interpretable, real-world terms using catch-up time, which measures inequality as the number of years of health-related aging required for individuals in lower-income groups to match the health status of higher-income peers. This metric indicates that the gap in physical health outcomes has notably decreased. In contrast, gaps in mental health persist, requiring nearly two decades of additional healthy years to bridge the difference in some cases. Unlike the other health domains, cognitive health shows no stable relationship with income over time, which may reflect both measurement noise and heterogeneous aging processes.

Robustness checks confirm the persistence of socioeconomic health gradients across alternative specifications, including analyses using wealth-based deciles and samples not restricted to retired individuals. These supplementary results strengthen confidence in the generalizability of the main findings, indicating that the conclusion holds across different operationalizations of socioeconomic position and population groups.

The policy implications of these findings are clear. While Denmark's welfare and healthcare system provides a strong foundation for reducing physical health disparities, targeted interventions addressing mental health could be prioritized to achieve greater equity in health outcomes. The persistent gap in mental health suggests that there is scope for enhanced focus on psychosocial support, preventive mental health strategies, and accessible care for older adults, particularly among the socioeconomically disadvantaged. Further, continued monitoring of health gradients is warranted as future pension and healthcare reforms unfold in an aging population.

In summary, our study highlights significant trends and persistent challenges in health inequality among older adults, revealing both progress and remaining barriers to achieving equitable health across socioeconomic groups. The multidimensional approach offers valuable insights into the evolution of disparities within Denmark's policy context, emphasizing the need for ongoing attention to mental health and the varying trajectories of health domains as societies navigate demographic change.

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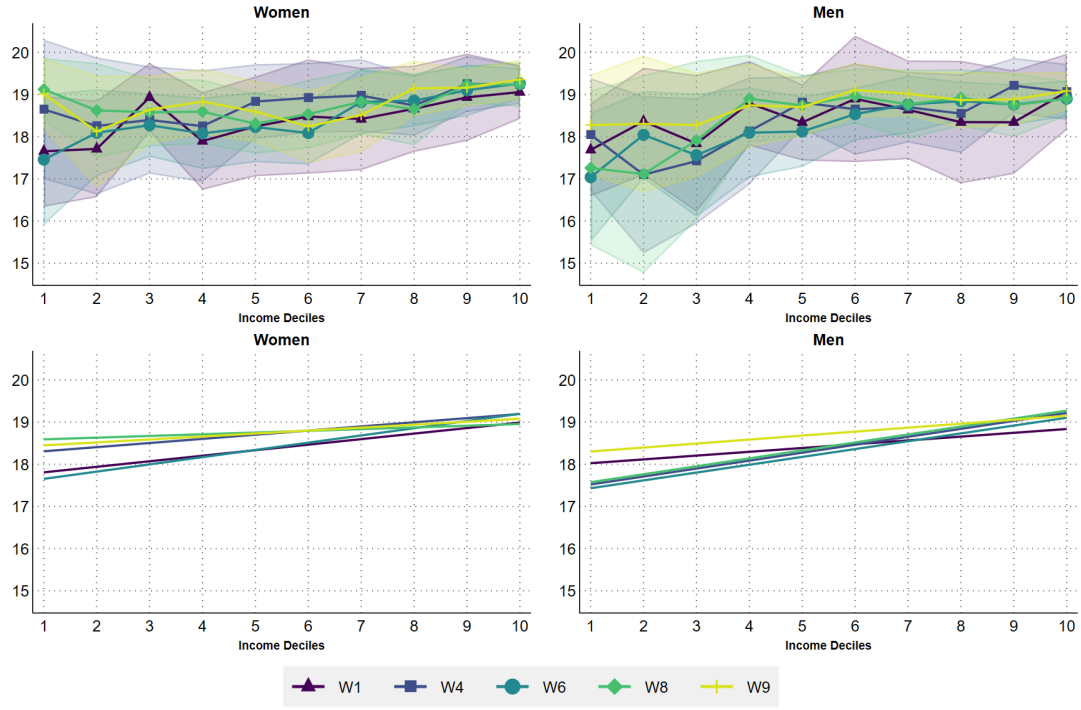
A Online Results Appendix

A.1 Robustness: Alternative Sample Definitions and Socioeconomic Measures

To test the robustness of our findings, we examine health gradients under two alternative specifications. First, we extend the sample to include all individuals aged 65-79 regardless of retirement status (Figures A1 to A5). Second, we replace household income with net household wealth as our measure of socioeconomic position among retirees aged 60-79 (Figures A6 to A10).

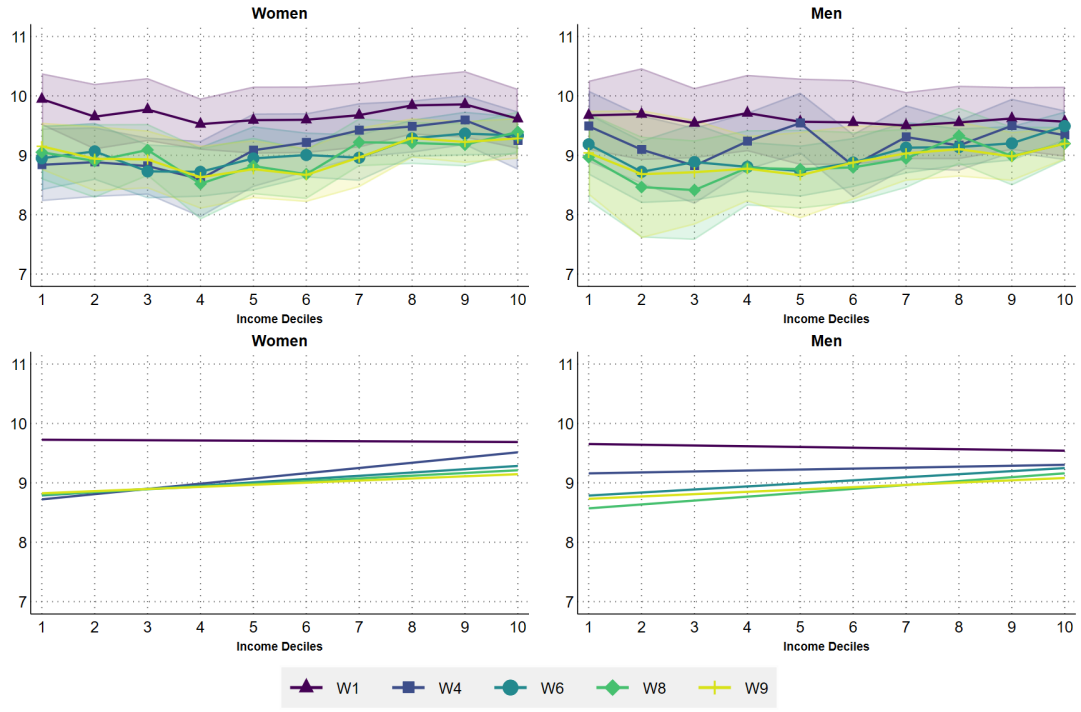
Both robustness checks confirm our main findings. The age-based sample shows similar patterns of health inequality across income deciles, suggesting that restricting to retirees does not drive our results. Using wealth instead of income reveals comparable socioeconomic gradients, indicating that our findings are not sensitive to the specific measure of economic resources. The persistence of health inequalities across these alternative specifications strengthens confidence in our core conclusions about the evolution of socioeconomic health disparities among older adults.

Figure A1: Functional Health



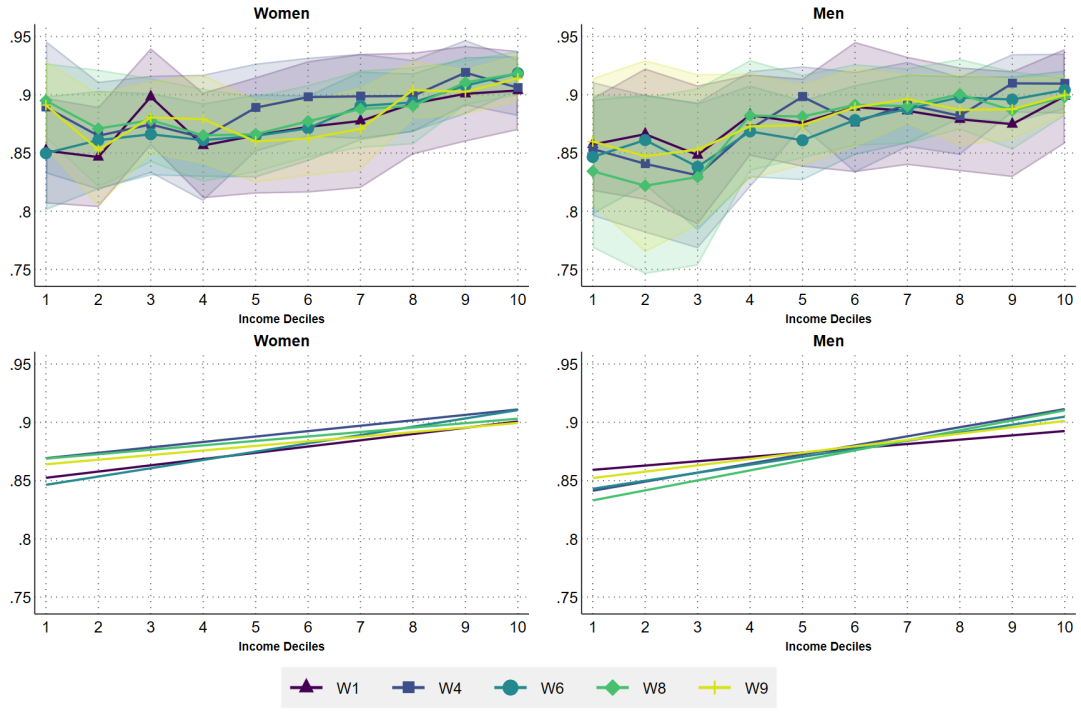
Note: Upper panes show health outcomes by income decile with 95% confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across income deciles by wave. Higher scores indicate better functional independence (fewer limitations). Sample restricted to individuals above age 65-79. All estimates use SHARE sampling weights.

Figure A2: Diagnosed Health



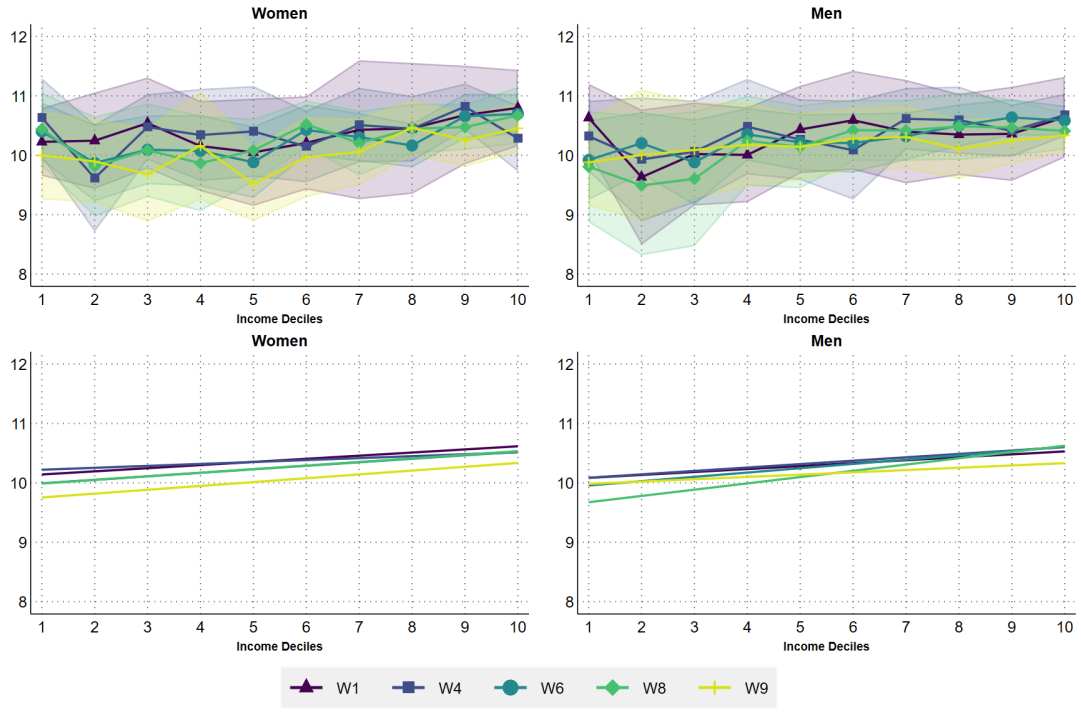
Note: Upper panes show health outcomes by income decile with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across income deciles by wave. Higher scores indicate fewer chronic conditions (better health). Chronic conditions include heart attack, hypertension, cholesterol, stroke, diabetes, lung disease, cancer, ulcer, Parkinson's, cataracts, and hip fracture. Sample restricted to individuals above age 65-79. All estimates use SHARE sampling weights.

Figure A3: Comprehensive Health



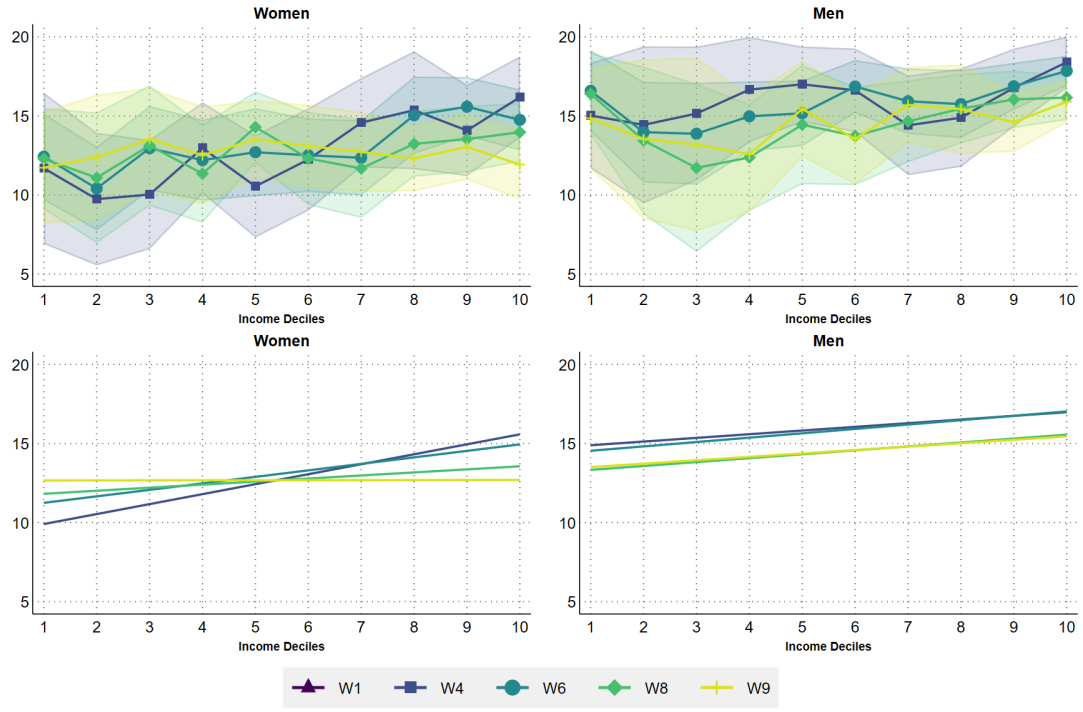
Note: Upper panes show health outcomes by income decile with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across income deciles by wave. Health Deficiency Index ranges from 0 to 1, with higher scores indicating fewer health deficits (better overall health). Index constructed from 45 health variables following deficit accumulation approach. Sample restricted to individuals above age 65-79. All estimates use SHARE sampling weights.

Figure A4: Mental Health



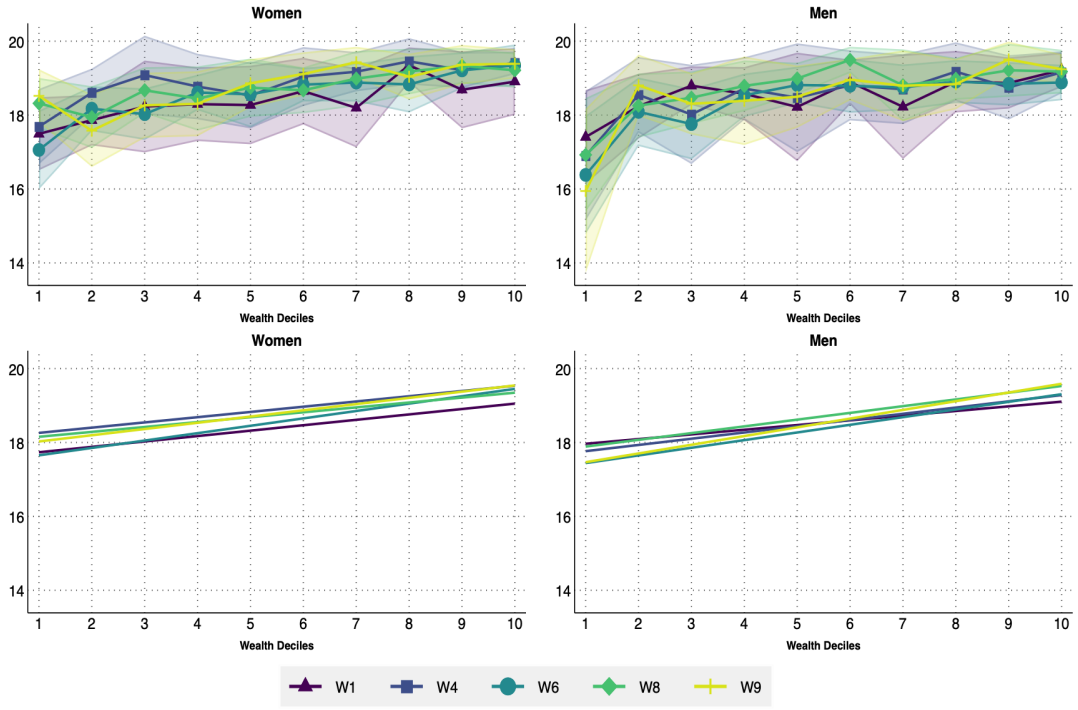
Note: Upper panes show health outcomes by income decile with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across income deciles by wave. EURO-D scale ranges from 0-12, with higher scores indicating better mental health (fewer depressive symptoms). Scale captures symptoms including sadness, pessimism, irritability, loss of interest, and fatigue. Sample restricted to individuals above age 65-79. All estimates use SHARE sampling weights.

Figure A5: Cognitive Health



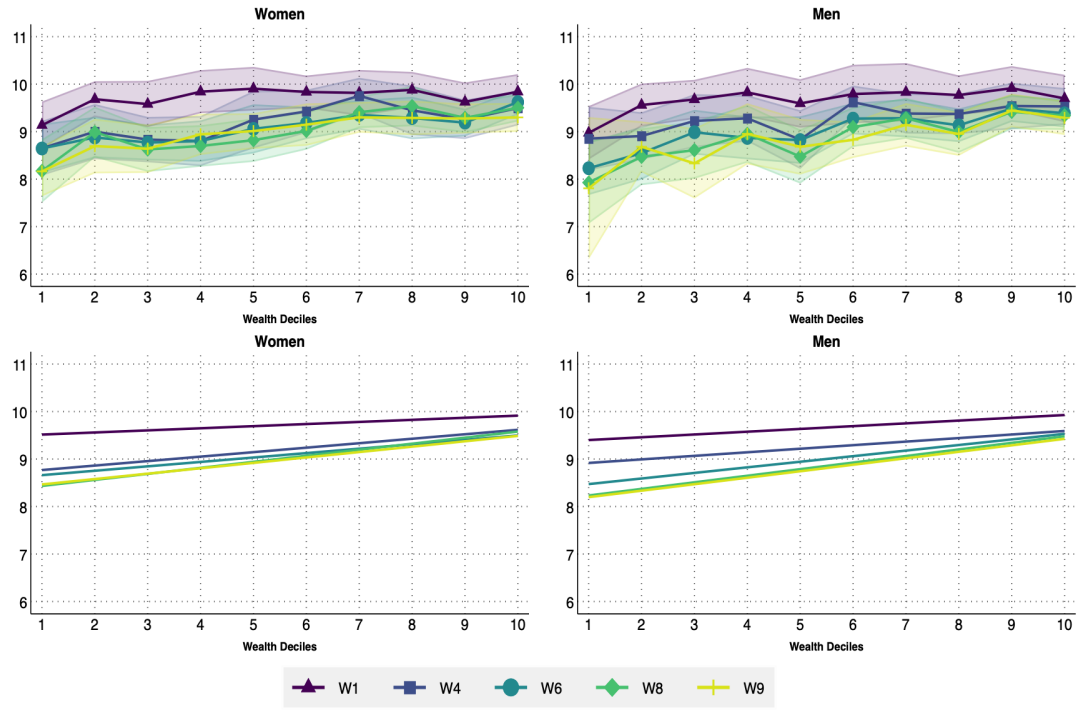
Note: Upper panes show health outcomes by income decile with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across income deciles by wave. COG-30 index ranges from 0-30, with higher scores indicating better cognitive functioning. Index combines immediate word recall (0-10), delayed word recall (0-10), verbal fluency (0-10), and numeracy tasks. Cognitive data not available for Waves 1 and 2. Sample restricted to individuals above age 65-79. All estimates use SHARE sampling weights.

Figure A6: Functional Health



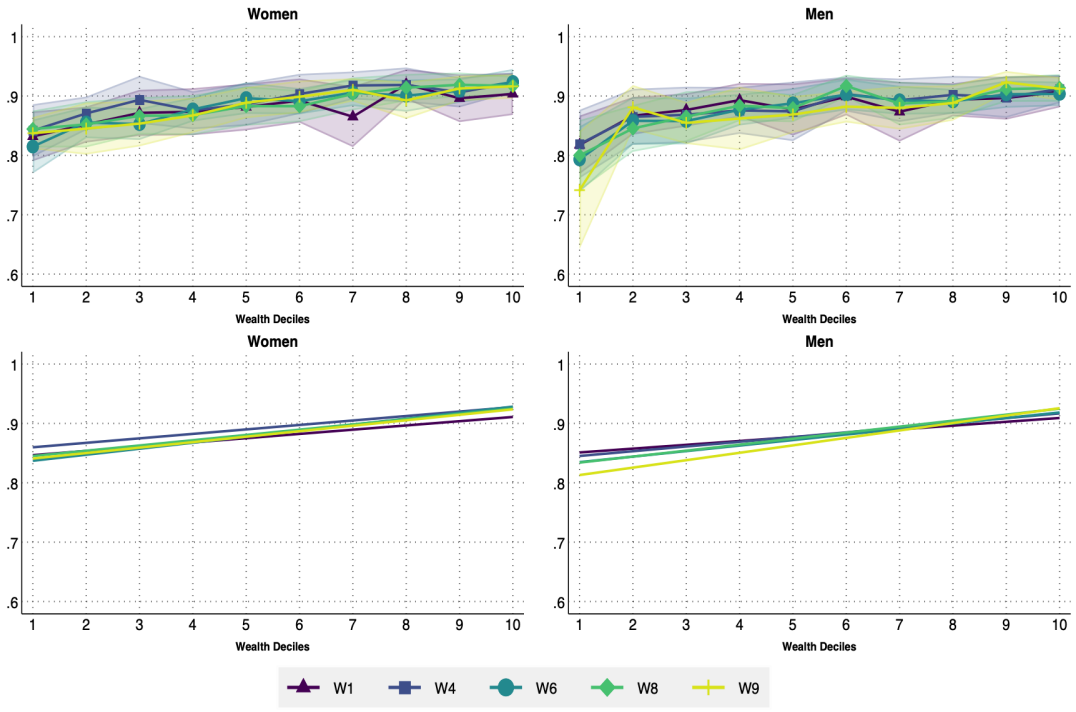
Note: Upper panes show health outcomes by wealth decile with 95% confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across wealth deciles by wave. Higher scores indicate better functional independence (fewer limitations). Sample restricted to retired individuals above age 60-79. All estimates use SHARE sampling weights.

Figure A7: Diagnosed Health



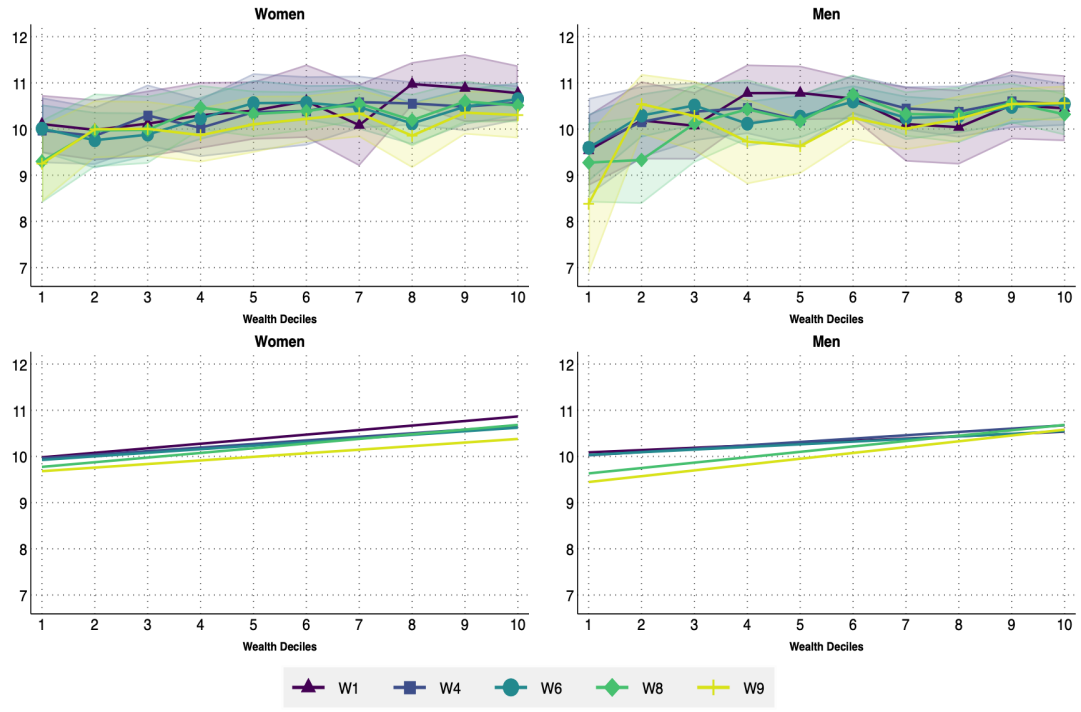
Note: Upper panes show health outcomes by wealth decile with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across wealth deciles by wave. Higher scores indicate fewer chronic conditions (better health). Chronic conditions include heart attack, hypertension, cholesterol, stroke, diabetes, lung disease, cancer, ulcer, Parkinson's, cataracts, and hip fracture. Sample restricted to retired individuals above age 60-79. All estimates use SHARE sampling weights.

Figure A8: Comprehensive Health



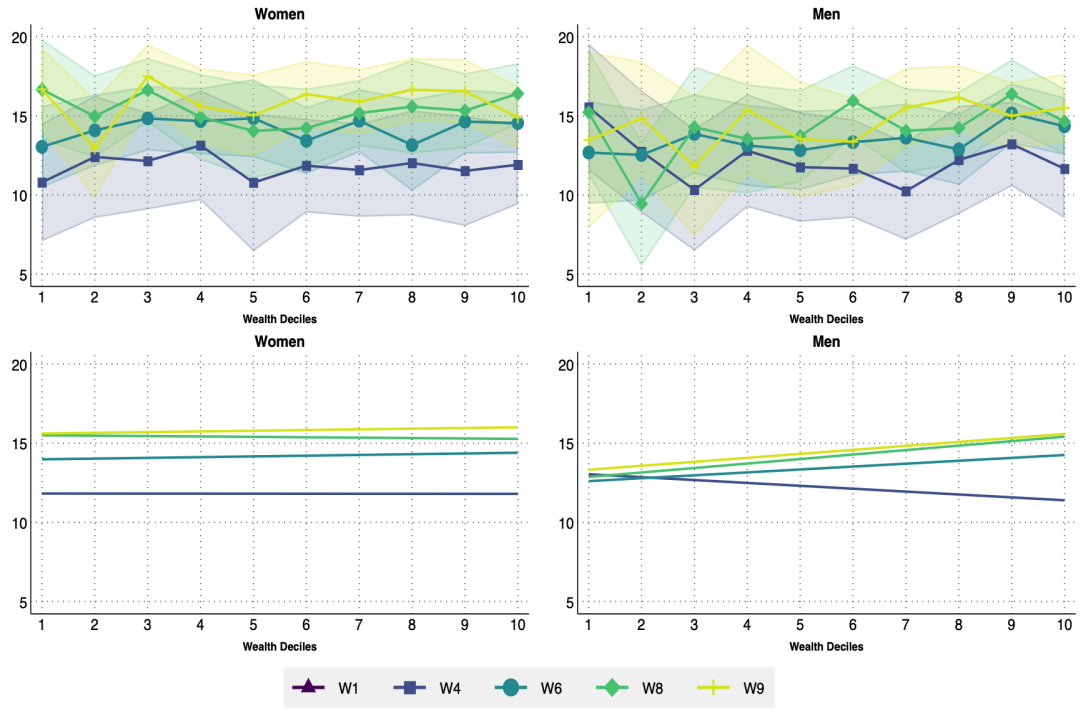
Note: Upper panes show health outcomes by wealth decile with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across wealth deciles by wave. Health Deficiency Index ranges from 0 to 1, with higher scores indicating fewer health deficits (better overall health). Index constructed from 45 health variables following deficit accumulation approach. Sample restricted to retired individuals above age 60-79. All estimates use SHARE sampling weights.

Figure A9: Mental Health



Note: Upper panes show health outcomes by wealth decile with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across wealth deciles by wave. EURO-D scale ranges from 0-12, with higher scores indicating better mental health (fewer depressive symptoms). Scale captures symptoms including sadness, pessimism, irritability, loss of interest, and fatigue. Sample restricted to retired individuals above age 60-79. All estimates use SHARE sampling weights.

Figure A10: Cognitive Health



Note: Upper panes show health outcomes by wealth decile with confidence intervals for women (left) and men (right). Lower panes display fitted linear trends across wealth deciles by wave. COG-30 index ranges from 0-30, with higher scores indicating better cognitive functioning. Index combines immediate word recall (0-10), delayed word recall (0-10), verbal fluency (0-10), and numeracy tasks. Cognitive data not available for Waves 1 and 2. Sample restricted to retired individuals above age 60-79. All estimates use SHARE sampling weights.