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Healthy Ageing for All? A Health Growth Incidence Curve Approach

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ABSTRACT

We propose and apply a framework that analyses the distributional impact of episodes of overall health growth or decline. We use local smoothing to model the relationship between health outcomes and relative income rank and we introduce Health Growth Incidence Curves (HGIC) to graph the rate of change of health outcomes across the income distribution. We illustrate our framework with an analysis of the distributional dynamics of health and well-being among those aged 60–85 in the years 2004 and 2015 using pooled SHARE data for selected European countries. Overall we observe a pattern that favours individuals with higher socioeconomic status, with a pro-rich distribution of improvements in outcomes. Only cognitive capacity growth has been uniform across income groups.

JEL Classification: I12, I14

1 | Introduction

Over the past 50 years, high-income countries have experienced an extraordinary increase in life expectancy. This has been possible thanks to the improvement in healthcare technologies, the uptake of vaccination, the diffusion of information on healthy lifestyles as well and the greater availability of medical treatments [1]. Life expectancy at birth has reached 80 years across OECD countries, corresponding to a gain of more than 10 years since 1960.[1] However, in recent years, this trend has faltered, amplified by the COVID-19 pandemic. More generally, society may be affected by events that either increase or decrease average population health and, at the same time, have impacts that are unequally distributed across socioeconomic groups. Consider for instance positive events such as large-scale technological change or mass vaccination campaigns, or, negative events, such as pandemics and natural disasters. Identification of the losers and gainers from these episodes of health growth or decline is important for both health and economic policy since it can contribute to the normative assessment of policy intervention and to the targeting of compensating policies.

The classic approach to measuring income-related inequalities in health has been to use rank-dependent indices that are built on the concentration curve and associated concentration index and its variants [2, 3]. When applied to cross-sectional data, these provide a snapshot of the level of income-related health inequality at a point in time. The concentration curve provides a non-parametric visual representation of the concentration of health outcomes across the distribution of income and gives a partial ranking of distributions. By imposing a particular set of weights that reflect the degree of inequality aversion, the concentration index provides a point estimate of income-related inequality that can provide a complete ranking of different distributions. Analysis of changes in the level of income-related inequality over time has focused primarily on the decomposition of concentration indices. The starting point is to compare the differences in the levels of the cross-sectional indices at two points in time. Reference [4] assume a linear model to capture the relationship between the level of health outcomes and associated factors, from this, they derive a regression-based decomposition of the level of concentration index by factors. This can be extended to decompose the difference between cross-sectional measures of health inequalities over time [4, 5].

Longitudinal data, that track the same group of people over time, opens up the possibility of cohort-decompositions that disentangle the evolution of inequalities within a cohort of individuals. Reference [6] focus on longitudinal data where health outcomes and income-rank are observed for multiple periods for a balanced panel of individuals. By comparing the concentration index for the "long-run" average of health outcomes with the weighted average of the cross-sectional concentration indices, they derive a measure of health-related income mobility. They show that the concentration index for long-run health can be written as the sum of the weighted average of the short-run measures plus a term that captures the correlation between income (rank) mobility over time and levels of health outcome. Given a linear model for health outcomes, these terms can be further decomposed by factors. Reference [7] also take differences over time in the standard concentration index as their starting point and decompose this into two components that relate to income-related changes in health and health-related changes in income. Subsequent analysis has extended this decomposition to other rank-dependent inequality indices, clarified their normative implications, and taken account of selective mortality among the cohort [8–10]. Reference [11] begin with the difference between concentration indices at two points in time for a given cohort of individuals and, following [4], assume a linear model for health outcomes. Their decomposition focuses on the nature of income growth over time. The [11] approach has been adapted and reinterpreted to use the [12] corrected version of the concentration index which is robust when the health outcome is bounded and which focuses on absolute rather than relative inequalities [13, 14]. This provides a decomposition of the difference in concentration indices into the relative contributions of income growth, the evolution of income inequality, income mobility, and the evolution of non-income factors.

In this article, our focus is on the distributional impact of healthy/unhealthy ageing across cohorts. So, rather than a cohort approach, we focus on comparable age groups (those aged 65–80) at two points in time (2004 and 2015). This implies that we are not taking a life course perspective of the kind enabled by cohort or panel data analysis [15]. We do not adopt the specific normative assumptions that justify the use of concentration indices and their extensions. Nor do we assume a parametric linear model for health outcomes. As a consequence, our approach does not offer the detailed decompositions that can be derived from those assumptions. Instead, in the spirit of analysis of concentration curves, our approach offers a simple non-parametric visual method that shifts the emphasis from cross-sectional levels of inequality to a direct focus on health gains or losses over time and how these are distributed across the income distribution. This limits the scope of our analysis to the evolution of income-related inequalities rather than other dimensions of social, economic, and political relations [16]. To paraphrase [17] we aim to assess the extent that overall health improvements have been "pro-poor". The analysis reflects the association between the health outcomes and income rank and should not be interpreted as causal analysis or a directional relationship [18].

We propose and apply a framework that analyses the distributional effects of episodes of health growth or decline from a novel perspective. We estimate local linear regressions to model the relationship between health outcomes and relative income rank—a variant of Pen's Parade—and we introduce Health Growth Incidence Curves (HGIC) to graph the health changes between periods across the income distribution. We build on the concept of the Growth Incidence Curve (GIC) developed by [17] and we extend it to the domain of health inequalities. The Growth Incidence Curve (GIC) is used to describe the distributional effects of income growth between two periods. It consists of a graphical representation of the growth rate of income plotted against income percentiles. So far, the literature on pro-poor growth has mainly focused on the income dimension. In fact, while non-income indicators of well-being and the multidimensionality of poverty have received increasing attention in poverty measurement no attempts have been made to measure pro-poor growth using non-income indicators. This framework allows us to evaluate the health growth for specific groups of the population and to find out which groups are the gainers and which are the losers.

In our empirical analysis, we apply the HGIC to analyse the distributional dynamics underlying healthy or unhealthy ageing. The low mortality rate observed in recent decades has resulted in a growing share of the population aged 65 and above. Between 2000 and 2015, the share of the population aged 65+ years in the OECD countries increased by 27% and it is expected to rise by a further 39% by 2030.[2] A key issue linked to the phenomenon of an ageing population is the risk of an overall reduction in population health status. In fact, over recent years the prevalence of chronic diseases and the incidence of disabilities have been growing within developed countries. Is the decline in mortality rates among the older population also accompanied by an increase in healthy years of life? The 'failure of success' hypothesis, argues that mortality declines arise from higher survival rates of individuals with health problems, resulting in the worse overall health of the elderly population [19]. In contrast, 'the success of success' hypothesis states that the same forces that resulted in decreased mortality also postpone the onset of disability among the elderly, resulting in more people living longer with better health than previously [20]. We contribute to this debate by analysing changes in indicators of healthy ageing: Physical health, disability, cognitive capacities, and quality of life (the CASP-19 index). Our analysis focuses on changes in these measures between 2004 and 2015 within an elderly population (65–80 years old) across Europe.

The remainder of the article is organised as follows: In Section 2 we briefly describe the theory behind the GIC and introduce our adaptation, the HGIC. Section 3 presents the data and reports the results of our empirical analysis. Finally, we draw conclusions and policy implications in Section 4.

2 | The Health Growth Incidence Curve

The standard graphical approach to summarise a static view of income-related inequalities in health outcomes is to present concentration curves and generalised concentration curves. The former captures relative income-related inequalities and the latter also captures the average level of the outcome. These are rank-dependent functions with the graphs plotted against relative income ranks. In this section, we depart from the Growth Incidence Curve (GIC), introduced by [17], which is also a rank-dependent approach, and we extend this framework to the domain of health by defining a Health Growth Incidence Curve (HGIC). The foundation for growth incidence curves is the quantile function, or Pen's parade, which plots absolute levels of income at each quantile of the income distribution. The GIC takes this a step further and plots the rate of growth of income between two periods at each percentile. This reveals how the change in outcome is distributed across different income groups, For example, whether the growth is equally distributed or whether there are relative winners and losers.

We adapt the GIC to income-related inequalities in health outcomes, focusing on the relationship between percentiles of income and the level and rate of change of health outcomes. For each health outcome, we present a series of graphs. The first, which are shown in the Appendix, are the generalised concentration curves. These summarise the absolute income-related inequalities in the outcome, scaled by the mean outcome which appears on the right-hand vertical axis. Graphs are presented for the initial period (2004) and the end period (2015).

In the main text, we present graphs that are analogous to the quantile function, or Pen's parade, for health outcomes. To capture the expected health outcome at varying percentiles of the income distribution these are estimated by kernel-weighted local polynomial smoothing of the bivariate relationship between health outcome and relative income rank. The smoothed values that are derived to plot the quantile functions are saved $H_t(p)$. Quantile functions for 2004 and 2015 are presented separately to show the differences between the level of outcome at each income percentile and are shown with 95% confidence bands.

The final graphs illustrate the distributional dynamics through the growth incidence curves. The HGIC plots the rate of change of the outcome between 2004 and 2015 at each percentile of income:

$$g_t(p) = 100 \times \left(\frac{H_t(p)}{H_{t-1}(p)} - 1 \right) \qquad (1)$$

These rates of change are computed using the fitted values from the quantile functions and these are plotted against the baseline (2004) percentiles.

This reveals how the overall rate of change of the outcome is distributed across different levels of initial income. Regions of the plot with negative values imply that there has been a decline in average outcomes for that part of the income distribution and positive values imply an improvement in average outcomes. The HGIC focuses on relative growth rates for the outcomes. To gauge whether a focus on absolute rather than relative changes affects the interpretation of our findings we propose plotting the absolute change in outcome against the percentiles of income:

$$a_t(p) = H_t(p) - H_{t-1}(p) \qquad (2)$$

We refer to these plots as absolute growth incidence curves (AGIC). The script used to derive and plot the HGIC and AGIC is available at https://zenodo.org/records/14615633.

3 | Empirical Analysis

3.1 | Data and Variables

We use data from the Survey of Health, Ageing and Retirement in Europe (SHARE). SHARE is a multidisciplinary and cross-national longitudinal survey that has been conducted biannually since 2004. By collecting data on health, socioeconomic status, and social and family networks from individuals aged 50+ contributes to the understanding of the ageing process in Europe. Although SHARE has a panel component, we maintain the largest possible sample size by treating the data as repeated cross-sections. In this article, we use waves 1 and 6 and obtain a dataset at the individual level between 2004 and 2015.[3] Our sample includes all individuals aged between 65 and 80. Thus, we exclude the younger and older portion of the population to focus only on older adults, for which an increase in health outcomes is reasonably expected within each age cohort compared over calendar time. By comparing individuals within the same age-cohort over the years, we make sure that our results are not led by the underlying ageing process. Finally, we include only those countries that have been part of the survey since the first wave in the analysis. This means that our population of interest pools the residents of Austria, Belgium, Denmark, France, Germany, Italy, Spain, Sweden and Switzerland.[4] This implies that our focus is on the evolution of income-related inequalities within this pooled population, rather than being analysed country-by-country. Implicitly, we are assuming that the measured outcomes are comparable across the pooled sample and our point of reference is an individual's position in the income distribution for the pooled population.

We analyse a set of six indicators that span different aspects of physical health, cognitive performance, and well-being in later life and are available in SHARE [21]. The first two outcomes of interest are the ADL (Activities of Daily Living) and IADL (Instrumental Activities of Daily Living). They measure the extent to which people experience difficulty in carrying out activities that are essential to independent living—difficulties in performing activities of daily living (ADL), and/or instrumental activities of daily living (IADL). These are frequently used as measures of disability and information on ADLs and IADLs is often used as part of assessments for eligibility of welfare benefits and social care [16]. ADL functions are essential for an individual's self-care (e.g., to wash and dry your whole body and get on and off the toilet). The version of ADL used in SHARE includes six activities. For comparability with the other outcomes used here, we scale this as a measure of positive health attainment. So, the ADL score ranges from 0 to 6 with higher scores indicating fewer difficulties and better mobility [22]. IADL functions are more concerned with self-reliant functioning in a given environment (e.g., to prepare dinner and or do the shopping) [23]. ADL disability represents a more severe form of disability than IADL disability. The scale used in SHARE includes nine activities. We have scaled this to range from 0 to 9 which higher scores indicating fewer difficulties and better mobility.

The third outcome is the maximum grip strength. Lower grip strength is associated with higher disability prevalence, suggesting that age-related loss of muscle mass and strength can be a cause as well as a consequence of physical disability [24]. In SHARE grip strength is measured by a dynamometer held in each hand with two measurements taken for each hand. Higher values indicate a better outcome, noting that grip strength varies with gender, height, and weight.

We also include two indicators of cognitive function: Word recall (WLLST) and fluency in speaking. Cognitive decline in old age is associated with a range of adverse health consequences, including disability and death. The 10-words recall test is an indicator of cognitive impairment and dementia [25]. The test includes verbal registration and recall of a list of 10 words and the score ranges from 0 to 10 depending on the number of words that are recalled. Higher values imply better memory. In SHARE verbal fluency is measured using the category or semantic verbal fluency test in which respondents are given a minute to recall the name of as many "animals" as possible. Higher values imply greater cognitive function [26].

Finally, we use the CASP-12 index, which is a revised 12-item version of the CASP-19 scale developed by [27]. This is a subjective measure of well-being derived from an explicit theory of human need that spans four life domains: Control, autonomy, self-realisation, and pleasure. The index is regarded as a good proxy for the general quality of life and well-being among older people (see [28]). The 12 items are presented as questions or statements with responses on a four-point Likert scale from 1 to 4. The overall CASP-12 score therefore ranges from 12 to 48 with higher scores indicating better quality of life.

It should be noted that, while grip strength is based on measurements and the measures of cognitive performance are based on well-defined tasks, these outcomes reflect subjective responses [21]. These may be affected by differences in reporting across and within countries. It is likely that these will be less of a concern than using measures of self-assessed health but they should be borne in mind and would be problematic if the measurement errors were associated with different levels of income.

We use total household disposable income as a measure of living standards. It is calculated as the sum of all incomes from all

TABLE 1 | Descriptive statistics.

		Wave 1		Wave 6	
Variable	**Description**	**Mean**	**N**	**Mean**	**N**
Age	Age in years	71.54	8190	71.58	17,296
Income	Total household disposable income: Euros per annum	34,209.49	8190	36,605.07	17,296
ADLs	Activities of daily living: Count from 0 to 6 with higher values indicating higher mobility	5.76	8152	5.78	17,266
IADLs	Instrumental activities of daily living: count from 0 to 9 with higher values indicating higher mobility	8.60	8152	8.58	17,266
Grip	Maximum grip strength: Measured by hand-held dynamometer with high values indicating better physical health	31.37	7546	32.31	16,009
CASP	Control, Autonomy, Self-realization and Pleasure index: Count from 12 to with 48 higher values indicating higher quality of life	37.11	4775	38.45	16,375
WLLST	10-words recall test for cognitive impairment: Count from 0 to 10 with higher values indicating better cognitive performance	2.83	8190	3.83	17,296
Fluency	Verbal fluency test: Number of responses in 60 s with higher values indicating better cognitive performance	17.62	8190	19.80	17,296

sources earned by the household components during the financial year. This is measured in Euros per annum and no adjustments are made for purchasing power parity. Note that income enters our analysis as a relative rank so we only make use of the cross-sectional and ordinal variation in income across individuals. Table 1 provides the main descriptive statistics of all the variables used for the initial period (wave 1 relative to 2004) and the last period covered (wave 6 relative to 2015) in our analysis. The first line indicates that the two samples are balanced with respect to age, which is very useful for our analysis because it allows us to exclude the effect of the natural ageing process. There is also an observed increase in average household income during the analysis period, by almost 2000 on average. This reflects both real and nominal growth in income. Regarding health outcomes, there is a significant average increase in health levels for all dimensions analysed, consistent with the ongoing process of healthy ageing. The only exception is represented by IADL limitations, which show a slight increase during the analysed period, as we will see in greater detail in Section 3.2. Finally, there is a substantial increase in the number of available observations in wave 6 compared to the survey's launch wave, which is a result of developments in the SHARE sample and the refreshments conducted over the years.

3.2 | Results

In this section, we report the results of our analysis through distributional plots. Table 1 shows the means of the outcomes in Wave 1 and in Wave 6. In the Appendix, we graph the generalised concentration curves comparing the initial (2004) and the last period of analysis (2015), respectively. This depicts the evolution of the mean outcome and income-related inequalities for each health outcome. In the upper panels of Figures 1–6, we display the quantile functions for the first and last period to trace the evolution

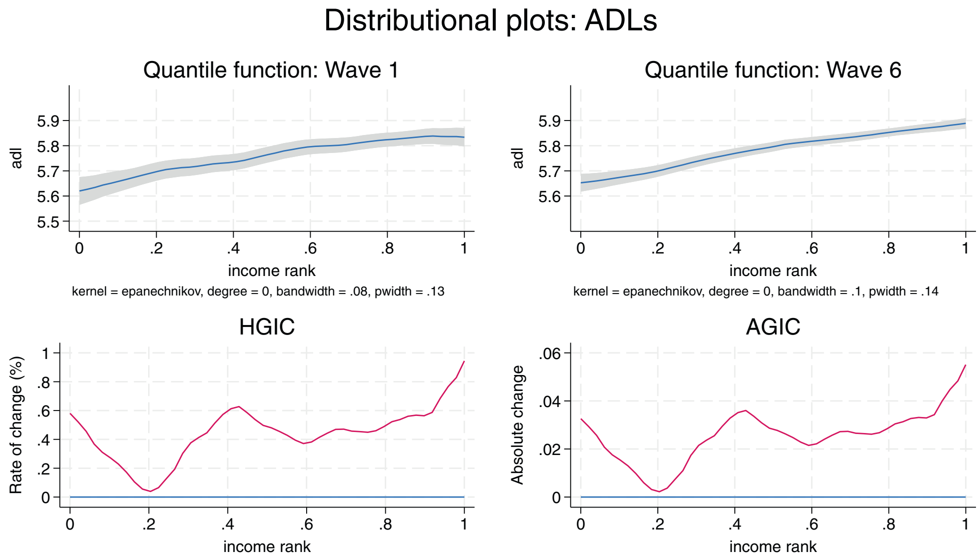

FIGURE 1 | ADL. [Colour figure can be viewed at wileyonlinelibrary.com]

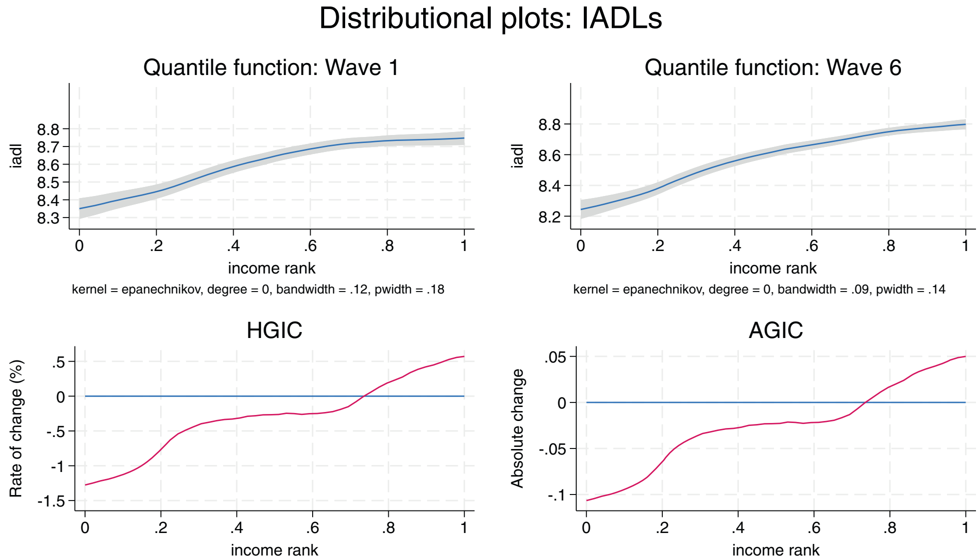

FIGURE 2 | IADL. [Colour figure can be viewed at wileyonlinelibrary.com]

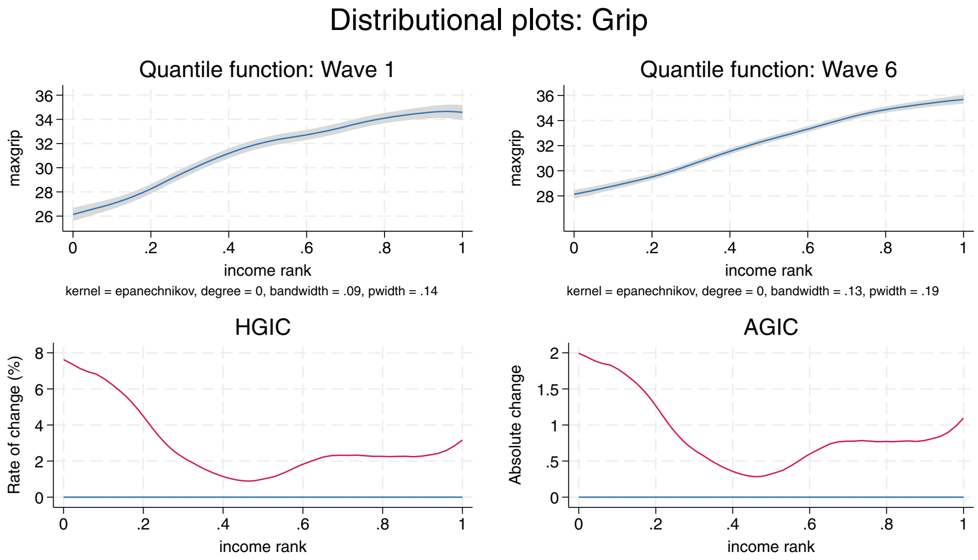

FIGURE 3 | Muscle strength. [Colour figure can be viewed at wileyonlinelibrary.com]

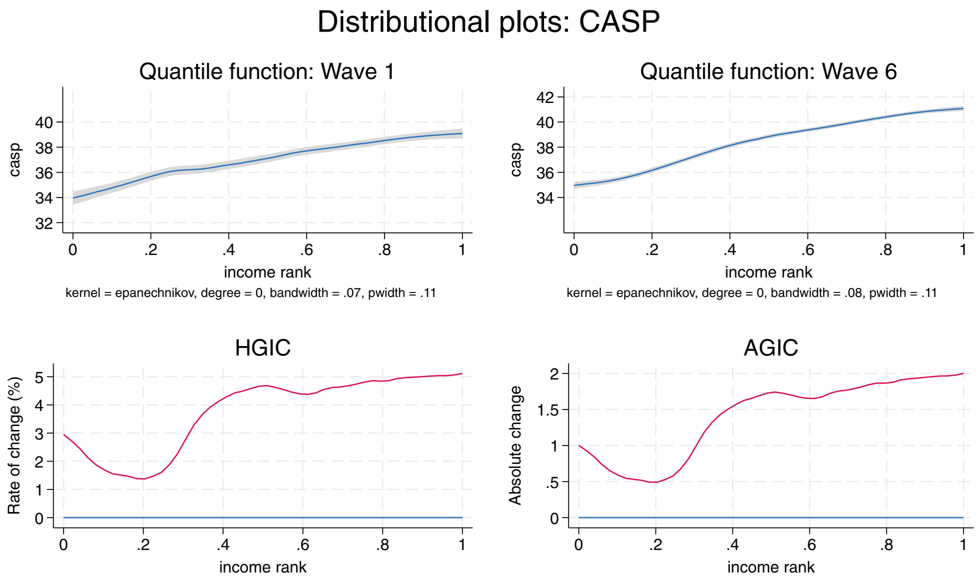

FIGURE 4 | CASP. [Colour figure can be viewed at wileyonlinelibrary.com]

of the variation in the health outcome across individuals ranked by their income. On the left side of the lower panel, we plot the HGIC. This is built as follows: on the horizontal axis we report the relative income rank (percentile) and on the vertical axis the growth rate between 2004 and 2015 at each percentile. The lower right panel focuses on the absolute growth of each outcome and shows the AGIC

Table 1 shows that there was a very small improvement in the mean of ADLs between the two periods from 5.76 to 5.78. In Figure 1, the quantile plots show that outcomes improve for those on higher incomes at both waves. The HGIC and AGIC show that the modest improvement in outcomes, both relative and absolute, was more concentrated among those with higher income ranks. Table 1 shows there was a negligible decline in the mean IADL from 8.60 to 8.58. Like ADLs, there has been a small increase in income-related inequalities. In Figure 2 the HGIC shows asymmetric health dynamics across income levels. Indeed, for the least affluent 80%, there is a decline in mobility, offset by an improvement for the most affluent 20%. Distributional plots for muscle strength (Figure 3) and CASP (Figure 4) show a very similar pattern to each other. There are small improvements in the mean outcomes and little difference in income-related inequalities between 2004 and 2018. Given these small overall changes, the HGIC and AGICs display a quite heterogeneous pattern. A U-shaped pattern for muscle strength, with a relatively worse situation for the middle-income deciles, contrasted by a pro-rich growth for CASP. Finally, Figures 5 and 6 report results for the two indicators of cognitive function: Word recall and fluency in speaking. With respect to word recall, there are no significant differences in income-related inequality over time but a quite large increase in the mean levels of the outcome, which appears to be slightly pro-poor (50% for the poorest and 40% for the richest). The improvement in verbal fluency has been evenly distributed across income levels.

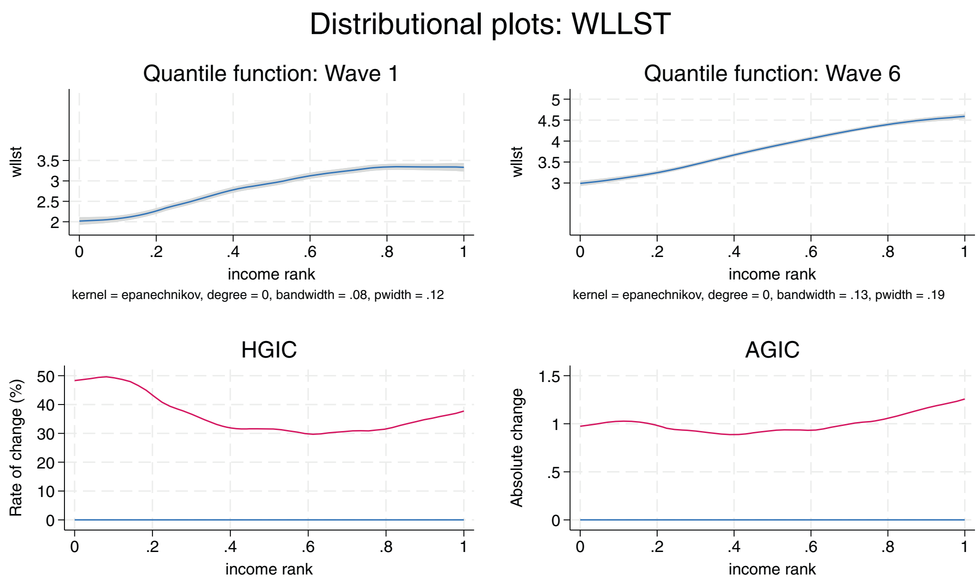

FIGURE 5 | Word recall. [Colour figure can be viewed at wileyonlinelibrary.com]

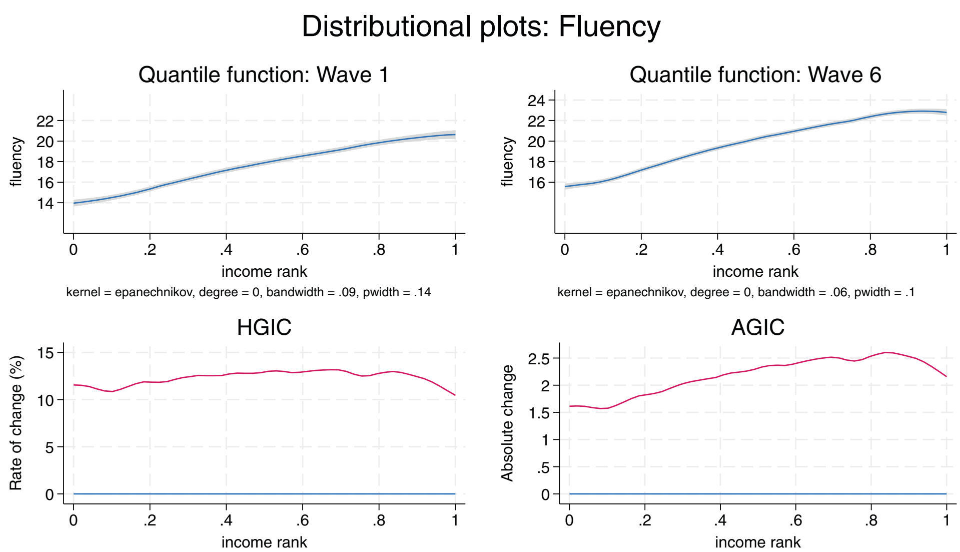

FIGURE 6 | Fluency. [Colour figure can be viewed at wileyonlinelibrary.com]

4 | Conclusion

Societal well-being can be influenced by both positive and negative events that alter average population health, impacting various socioeconomic groups differently. In this article, we introduce a framework to study how general health changes are distributed across income levels based on local linear regressions and Health Growth Incidence Curves (HGIC). We use this framework to study the ageing process of the European elderly and how this is distributed across socioeconomic groups. We compare the distributions of relevant outcomes for those aged 65 to 80 in 2004 and in 2015. There is a very small improvement in average mobility measured by Activities of Daily Living (ADL) but a small worsening when measured by Instrumental Activities of Daily Living (IADL). We find an improvement in the remainder of the average outcomes and in particular a large increase in the measures of cognitive function such as word recall and verbal fluency (e.g., [29]; [30]). We take a further step, analysing to what extent the improvement and the worsening of the ageing features have been equally distributed across income groups. We present a set of Health Growth Incidence Curves (HGIC) plotting the rate of health outcome changes across the income distribution. This shows that the improvement in ADLs was more concentrated among those with higher incomes and that the increased prevalence of more severe disability (IADLs) was concentrated disproportionately among low-income groups, with those on the highest incomes experiencing an improvement. The growth of cognitive capacities was fairly evenly spread across income groups while the improvement in overall health utility (CASP-19) was greater for those with higher incomes (Figures A1–A6).

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Endnotes

[1] https://www.oecdbetterlifeindex.org/topics/health/.

[2] https://www.oecdbetterlifeindex.org/topics/health/.

[3] The 3rd wave is known as *SHARELIFE* and contains information on people's histories (e.g., childhood/health/accommodation histories). Thus, the 3rd wave is not part of the panel.

[4] The Netherlands has been part of the survey since wave 1. Nevertheless, we exclude it from our sample as in wave 6 the Netherlands did not participate in the regular SHARE wave but conducted an experiment using an online survey (CAWI) or telephone interviewing (CATI) instead of face-to-face interviews like in the rest of the countries participating in SHARE Wave 6.

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Appendix A

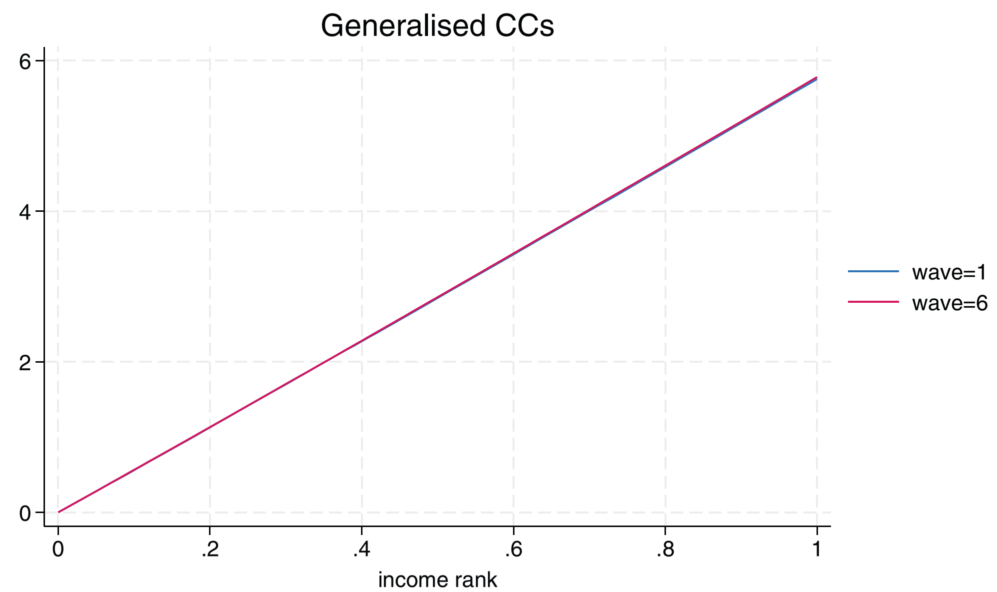

FIGURE A1 | ADL. [Colour figure can be viewed at wileyonlinelibrary.com]

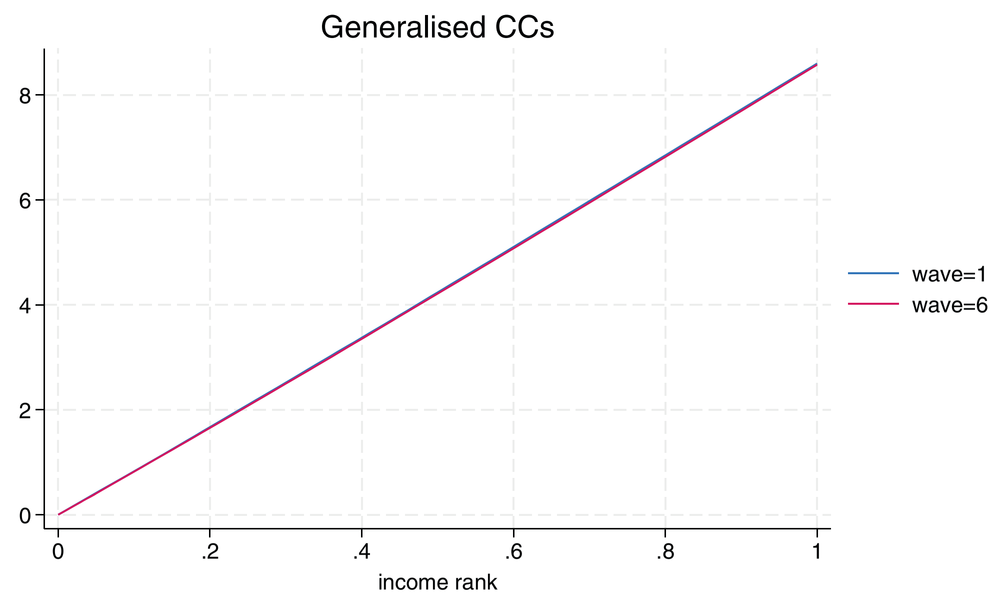

FIGURE A2 | IADL. [Colour figure can be viewed at wileyonlinelibrary.com]

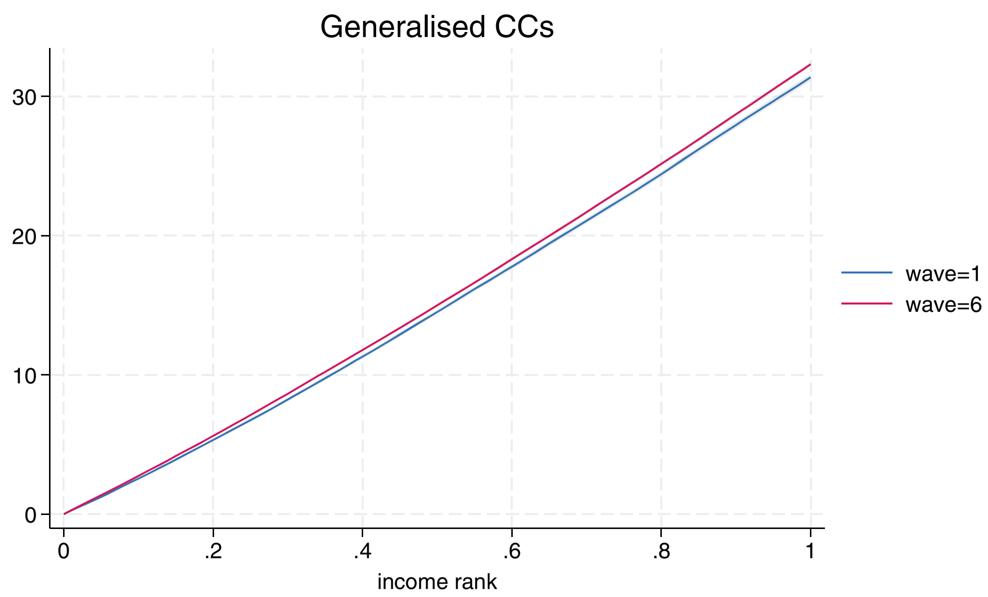

FIGURE A3 | Muscle strength. [Colour figure can be viewed at wileyonlinelibrary.com]

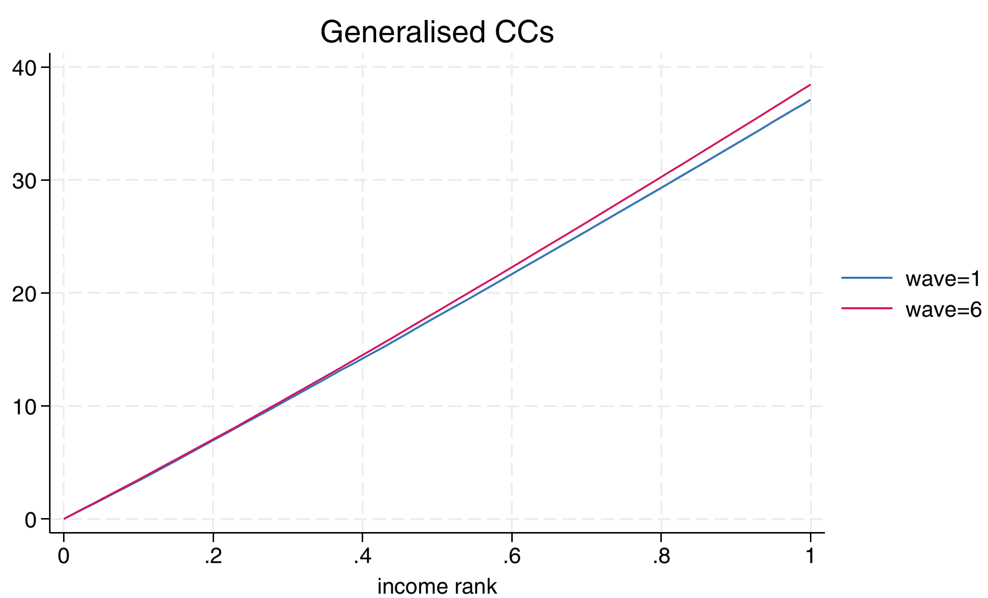

FIGURE A4 | CASP. [Colour figure can be viewed at wileyonlinelibrary.com]

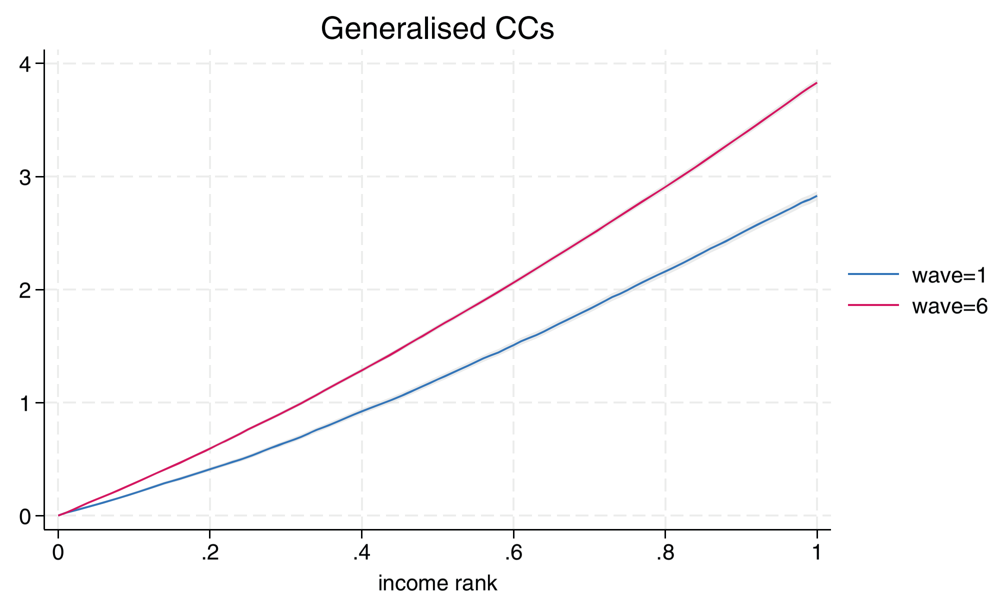

FIGURE A5 | Word recall. [Colour figure can be viewed at wileyonlinelibrary.com]

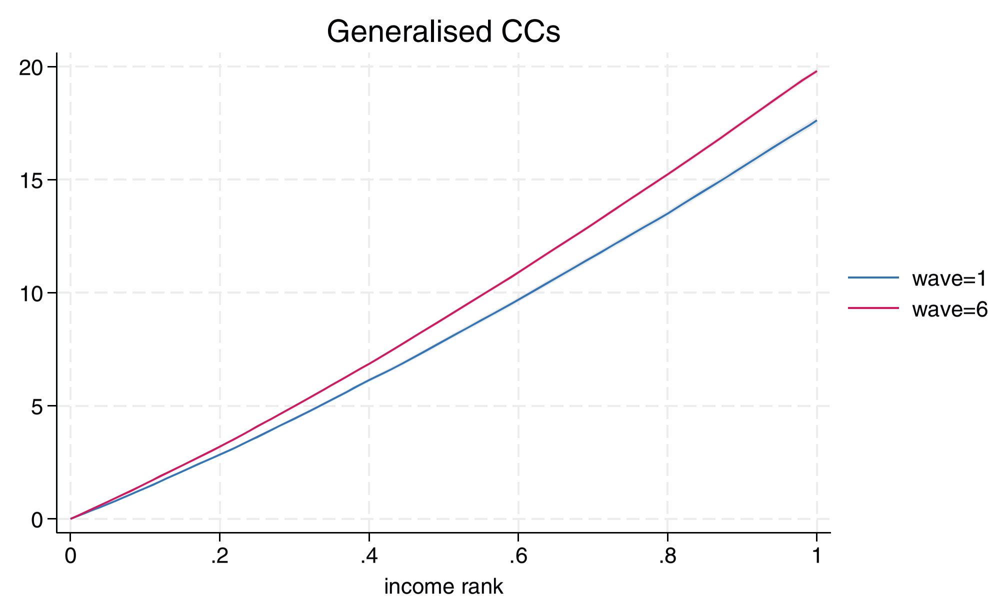

FIGURE A6 | Fluency. [Colour figure can be viewed at wileyonlinelibrary.com]