Health expectancy indicators: What do they measure?

Abstract

Introduction. Health expectancy indicators aim at capturing the quality dimension of the total life expectancy. However, the underlying approach, definition of health and information source differs considerably among the indicators available. This work aims to (1) review the main concepts and approaches to estimating health expectancies focusing on two widely used health indicators for the European case (HALE and HLY); and (2) to identify underlying differences in results yielded by these two indicators. **Methods**. Statistical differences between HALE and HLY by sex at ages 50,60 and 70 are tested through pairwise and global Student´s t-tests and z-scores based on the standard deviation. Data is for 29 European countries from the European Health Expectancy Monitoring Unit Information System (EHEMU) and the WHO-GBD study for year 2016. **Results**. HALE estimates are smoother across European countries than HLY, have a narrower gender gap in morbidity, present higher z-scores compared to the average distribution across Europe, being less sensitive to cross-country variations. **Conclusion** HALE estimates indicate a compression of morbidity for both sexes while HLY suggests a compression of morbidity for males and expansion for females, while also being more sensitive to cross-country characteristics. Because HALE measures are weighted by the severity level of diseases, the estimates are more correlated to mortality, while HLY captures more the health dimension, irrespective of mortality. These results imply that one should be cautious when using the different health expectancy indicators available, especially when investigating the relationship between health and mortality.

Key-words: HALE; HLY; Sullivan; Health Expectancy; Morbidity

1. Introduction

The idea of combining health and mortality in a summary measure was first proposed in the 1960s (1) and later developed in the 1970s by Sullivan, whose name became a synonym of the method (2). Sullivan combined population health state prevalence data with mortality data to generate estimates of expected years of life lived in various health states. This measure was called the disability-free life expectancy (DFLE) and it was first calculated for a set of countries in the 1980s and later in the 1990s. In the same decade, the REVES (Réseau Espérance de Vie en Santé) network was established with the aim of promoting the use of healthy life expectancy as a tool for monitoring health and policy making. In 1993, the disability-free life expectancy (DFLE) was included among the health indicators in the OECD. The REVES network then started to systematically assess the comparability and stability of health indicators across countries, health dimensions, age and time, with a focus in Europe (3–6). REVES developed a series of research project that aimed at adding the quality dimension of life lived to the quantity dimension of European populations. In their first project (2004-2007), called the European Health Expectancy Monitoring Unit (EHEMU), supported by the Public Health Programme of the European Union, several summary measures and methods of population health were developed, most particularly, healthy life expectancies free from chronic disease, disability and in good perceived health (7,8). They also developed survey instruments that were included in the European Statistics on Incomes and Living Conditions (EU-SILC) and on

the Survey on Health, Ageing and Retirement in Europe (SHARE) (7,9). In the second project (2007-2010), called EHLEIS, they monitored the results provided by the instrument and indicators constructed in the previous project (10). In the last more recent project JA EHLEIS (2011-2014), the group consolidated these measures and survey instruments, tested their comparability, and broadened the EHLEIS Information System (11–13). Resulting from this joint effort throughout the three projects, the group suggested a harmonized and comparable indicator of healthy life expectancy in the European context called the healthy life years (HLY) indicator. HLY is a disability-free life expectancy measure based on the GALI instrument, included in the EU-SILC survey and estimated using the Sullivan method (more details on this measurement below). In 2004, as part of the Lisbon Strategy, the European Union national states (EU) selected HLY to be one of the European structural indicators to be monitored annually. It was regarded as a key economic outcome measure for social policies related to retirement age and spending for health and long-term care for its rapidly aging population (14). Later in 2006, the European Commission (EC) sponsored a study by RAND Europe to assess the uptake of the healthy life years (HLY) structural indicator in the EU and ministries in member states (15). The EC concluded from this study that the HLY indicator is relevant to guide policy making and monitoring regarding labor force participation, pensions, health conditions, and lifestyles. As a result, since 2004 the European Union (EU) monitors the HLY of its member countries, based on a standard set of questions from the Statistics on Income and Living Conditions Survey (EU-SILC) (9,14).

However, other research show that because DFLE indicators are estimated using a dichotomous weighting scheme (healthy versus unhealthy), they do not take into account

varying levels of severity, making them more sensitive to the definition of disability. On an effort to tackle this issue, in year 1999 the World Health Organization published the first estimates for 191 countries of the disability-adjusted life expectancy (DALE), a measure they deemed more sensitive to disability severity levels (16). DALE measures the number of years of life that one expects to live in full health, by weighting the severity of disability prevalence of disease and injury burden. In the following year, the Global Burden of Disease Study (GBD) updated these WHO estimates including different measurement approaches and cross-population comparable survey data from 63 surveys in 55 countries (17). On this new set of estimates, they incorporated a disease-specific approach to estimate the disability and loss of healthy years associated to an exhaustive set of health conditions and derive what they called the health-adjusted life expectancy (HALE). In addition to HALE, another health indicator used by WHO and GBD is the disability-adjusted life year (DALY). DALY is the sum of years of life lost due to mortality (YLL) and healthy years lost due to disability (YLD). Contrary to healthy life expectancy indicators, which quantify how much of total life expectancy is lived in good health, DALY is a gap measure that assesses the distance between a population´s actual health and some desired goal or target to reach (17,18). Because the components of DALY (both YLL and YLD) are used in the construction of the health state valuation weights in the estimation process of HALE, both HALE and DALY are the current health indicators used by WHO and the GBD study (17,19).

Despite the common aim in estimating healthy life expectancies, the underlying approach, definition of health and information source employed by HALE and HLY are different. This affects how one evaluates and interprets the overall health status of

populations. This work particularly addresses those differences and their consequences for health and mortality research.

2. Objectives

This work aims to: (1) review the main concepts and approaches to estimating health expectancies focusing on two widely used health indicators for the European case (HALE and HLY). (2) Identify underlying differences in results yielded by these two indicators and address its impact on policy making and health research.

3. Material and Methods

A conceptual overview of the framework underlying health expectancies is performed in order to address objective (1). In order to address objective (2) an empirical application to 29 European countries for year 2016 follows to underline the difference in results by age, sex and health indicator. The application focuses on this selected group of European countries because HLY is the indicator used by the European Union. The healthy life years (HLY) and total life expectancy (LE) are retrieved from the EUROHEX database from the European Health Expectancy Monitoring Unit Information System, for year 2016 (http://www.ehemu.eu). Health-adjusted life expectancy (HALE) estimates are retrieved from the WHO-GBD study website (http://ghdx.healthdata.org/gbd-results-tool). The information is available by age and sex. Both health indicators are readily available in the data sources described above. Descriptive analyses show the differences in country ranking by total life expectancy and proportion of total life expectancy spent in unhealthy states for both HLY and HALE, by sex, at ages 50, 60 and 70. Statistical differences

between HALE and HLY by sex and age cutoffs are tested through pairwise and global Student´s t-tests, since they come from two independent different samples. (38). For further discussing differences between HLY and HALE, z-scores based on the standard deviation are estimated, since HLY and HALE are not directly comparable. The z-scores estimated represent the number of standard deviations that each indicator lies above or below its mean distribution. To calculate the z-score, the mean from each of the individual data points is subtracted and divided by the standard deviation (39). Despite still not enabling a direct comparison in terms of magnitude, this allows for analyzing the relationship between mortality and health underlying HLY and HALE. It also allows for evaluating how European countries perform in terms of proportion of total life expectancy spent in healthy states at age 50 and by sex.

4. Results

4.1. A review of healthy life expectancy indicators

4.1.1. The concept of healthy life expectancy

There is a set of health indicators and healthy life expectancy measures that are used by different institutions. In the European case, healthy life years (HLY) is the official structural indicator for assessing and monitoring health. In the case of the World Health Organization (WHO) and the Global Burden of Disease Study (GBD), health-adjusted life expectancy (HALE) and disability-adjusted life year (DALY) are used. Despite being differently estimated, they have in common the underlying conceptual framework of

survival and how to slice the survival curve into different parts that represent the health states. Let $S_{(x)}$ be the survivorship curve for a population at any given point in time t and over ages a, ranging from α until ω, where ω is the last age where there are survivors left. The grey shaded area α is the area under the curve $S_{(x)}$ and its integral yields the total life expectancy e_x, as depicted on **panel a** in **Figure 1**. To the right, on **panel b**, the same survivorship curve $S_{(x)}$ is divided into health states I to IV, where state I is the state of full health. In theory, those health states are a continuum, but in practice they are generally conceptualized and measured as a set of mutually exclusive and exhaustive discrete states, ordered on one or more dimensions. A gap measure such as DALY, contrary to a healthy life expectancy indicator, does not refer to the area α under curve, but instead measures the distance between a population´s actual health and some desired goal or target to reach, which in refers to area β. From a theoretical perspective, the ideal goal would be the distance from S to a complete rectangularization of the curve. In practical terms, researchers use a limit function or threshold age.

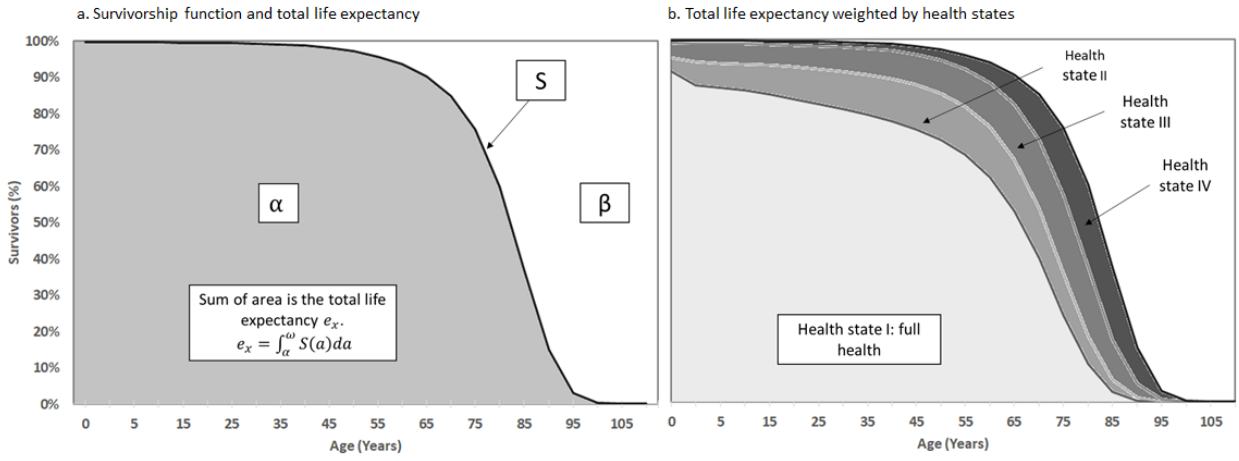

Figure 1. A scheme of total life expectancy and healthy life expectancy

Source: Own elaboration adapted from Murray et al (2002)

Healthy life expectancy indicators aim at taking into account the specific areas under the survival curve as years of life lived in less than full health, in order to quantify how much of total life expectancy is lived in good health. What distinguishes the various healthy life expectancy indicators from one another are mainly the approach or methodology employed, the source of health data and how the information is incorporated. HLY is within the category of disability-free life expectancy estimates (DFLE). In this case, health expectancy gives a weight of 1 to states of health with no disability and a weight of 0 to states of health with any level of disability above a given threshold (Other types of health expectancy not discussed here also use this approach, like active life expectancy and independent life expectancy (20–22)). This approach is called dichotomous, since there are only two mutually exclusively health states defined. This means that the indicator is usually defined in terms of two shaded areas under curve $S_{(x)}$, with or without a given health state. The definition of health can be various (e.g with/without chronic morbidity, good/bad self-rated health, with/without dementia), and in the case of the HLY the dimension of health analysed is activity limitation, based on the GALI instrument, as shown in more detail below.

HALE, on the other hand, is within the category that employs polychotomous or continuous weights. These weights are based on health state valuations which are defined in terms of severity-weighted disability prevalence. The weight of 1 is attributed to years of good health and non-zero weights to some states of less than good health. WHO and GBD argue that dichotomous weighting such as the one employed by the HLY

measurement is not sensitive to differences in the severity distribution of disability, since time spent in any health state categorized as disabled is assigned a weight of zero (16).

4.1.2. How is healthy life expectancy estimated?

The three most usual ways to estimate healthy life expectancy are: 1. Sullivan, 2. Multistate, and 3. Double decrement method. The Sullivan method essentially combines life table information on survivorship with prevalence rates by age. It requires a population life table and prevalence data for the health state or states of interest. The prevalence data is usually derived from cross-sectional surveys. Because of its parsimony and tested consistency, it is the most often used approach (23,24). The Multistate approach is a generalization of the life table (which can be conceived as a single state life table), where it is possible to estimate the transition probability matrix for the various non-absorbing states of health before death, including remission states and recovery. This allows for calculating health expectancies for specific health states of a selected population subgroup, while prevalence-based Sullivan provides only the average health expectancy for the entire population at a given age. It is based on incidence measures representing current health transitions, and it allows death rates to differ by health state (25–27). However, it requires detailed health information, usually derived from longitudinal studies (25,26). The double decrement method is a special case of the multistate method, where the only possible transition is from disability to death, and so the probability of remission in a given health state is zero (28). This method is appropriate when the disability state is

considered either irreversible (e.g. senile dementia) or when probabilities of recovery are negligible. Other currently less used approaches are microsimulation, grade of membership (GoM) approach, and Bayesian approach. For more details and a brief introduction on these methods see (26). An alternative, not often used approach to indirectly measure healthy life expectancy is the intercensal method, where age-specific proportions of healthy persons at two successive and independent cross-sectional health surveys are combined with mortality information to generate a set of transition probabilities (29). This indirect estimation of health expectancy relies on a multistate approach, but uses widely available data. The method has been proven suitable to estimate healthy life expectancy in contexts where nationally representative longitudinal health studies are limited, precluding HLE estimates for the population as a whole (30). This work focuses on the specific characteristics of the Sullivan method, because it is the one used to estimate both HLY and HALE.

4.1.3. The Sullivan method and its use to estimate HLY and HALE

Sullivan partitions the total number of person-years lived from the life table into disability and disability-free life expectancy, based on the proportion of the population disabled at each age, as shown in **Figure 1** (2). This means it can use period health data from surveys and period life tables to derive its estimate. Due to its simplicity and parcimony, as well as ease in interpretation, the method has been used to estimate DFLE in many populations and according to different definitions of disability (24,31), racial and regional disparities (32,33), educational levels (21), gender (34), and time (35), only to cite a few. Additionaly, it is the approach used by many of the international health organizations, governments, and research groups, including the World Health

Organization (WHO), the U.S. National Center of Health Statistics (CDC-NCHS), Eurostat, and the Global Burden of Disease Study, performed by the Institute for Health Metrics and Evaluation (IHME-GBD) (19,36).

4.1.4. The dichotomous health measure, HLY

Eurostat's HLY is a composite indicator that combines mortality data with health status data based on the GALI - Global Activity Limitation Instrument foreseen in the annual EU-SILC survey question: "For at least the last 6 months have you been limited in activities people usually do, because of a health problem?". The GALI instrument has been thoroughly tested and its robustness rigoursly assessed for the European context (7,9,10,26).

Consider that L_x is the number of years lived between ages x and $x+5$ from the life table, and that $prev_x$ is the prevalence rate of a given health dimension retrieved from a particular survey. Then, the number of years lived in state H between ages x and $x+5$ is given by: $YH_x = L_x * prev_x$. Where the equivalent $YWH_x = L_x * (1 - prev_x)$ provides the number of years lived without state H. This shows the dichotomous nature of this measure. In order to estimate healthy life expectancy free from state H, it is necessary to sum YWH_i from age $i = x$ until the last open-ended age interval in the life table ω and divide it by the number of life table surivors at age x (l_x), as shown in **Equation 1**.

$$DFLE_x = \sum_{i=x}^{\omega} YWH / l_x \quad (1)$$

In order to estimate the health expectancy for the given health state H, one must subtract $DFLE$ from the total life expectancy. This procedure can be done for any dimension of health considered. The REVES network estimated this indicator for chronic morbidity, self-reported health and activity limitation. After thorough analyses the network concluded that activity limitation was the most appropriate dimension of health to capture overall health conditions. This one particular healthy life expectancy is called Health Life Years (HLY) and is the indicator used by Eurostat (7,9–13,26).

4.1.5. The continuous or polychotomous health measure, HALE

For estimating health-adjusted life expectancy the basic estimation of **Equation 1** holds, but the number of years lived in state H is replaced by a weighted sum of the years lived across all health states defined. The sum of the prevalences across all states 0 to S is 1. On a scale from 0 to 1 where 1 is equal to good health, there will be several weights measured on this scale. Consider the weights w_0, w_1, $w_2 \ldots w_s$ and the prevalences $prev_1$, $prev_2 \ldots prev_s$. The years lived in good health between age x and $x+5$ is $YGH_x = L_x * \sum_{s=0}^{S} w_s * (prev_{si})$ and the health-adjusted life expectancy is:

$$HALE_x = \sum_{i=x}^{\omega} YGH_i \, / l_x \qquad (2)$$

The difference between **Equation 1** and **Equation 2** is the fact that the numerator of **Equation 2** is a weighted sum of all health states (S) defined. In graphical terms, this means to take the health states as described in **panel b** of **Figure 1** and attribute to each one of them a specific severity-weighted prevalence. Considering the 4 states schematically drawn in **Figure 1**, this makes $HALE$ additively decomposable into $HALE = HE_{1,0} + HE_{2,0} * w_2 + HE_{3,0} * w_3 + HE_{4,0} * w_4$, where HE are the health expectancies. The issue that is widely debated in this approach is how the w_s severity-weighted prevalences of disability are estimated (37). These values are derived from the years of life lived with disability (YLD) estimated by the GBD study. The YLD is a componenent of the $DALY$ measure.

4.2. An empirical application

4.2.1. Healthy life years (HLY): the Eurostat indicator

Figure 2 shows how EU countries are ranked according to total life expectancy at age 50 (left) and proportion of total life expectancy spent in health life years (right). The ranking is based on estimates for males. It is evident how women live longer than men on all countries, with contrasting differences, but also spend a higher proportion of their total life expectancy in poorer health, on all countries.

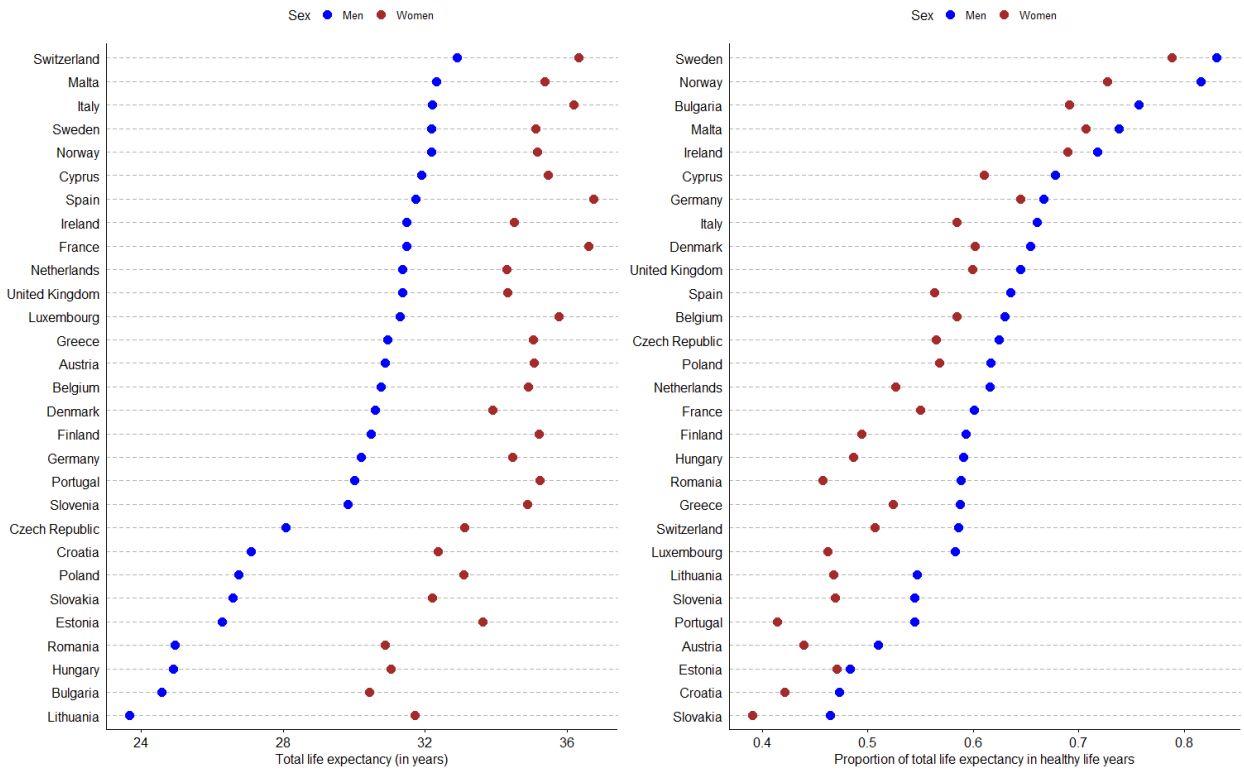

Figure 2. Total life expectancy (LE) and proportion of total life expectancy in healthy life years (HLY/LE) at age 50 by sex, selected EU countries, 2016

Source: Statistics on income and living conditions (EU-SILC); European Health Expectancy Monitoring Unit Information System (EHLEIS)

This phenomenon is called in the literature the male-female health-survival paradox (40) and has been explored in the European context through both the HLY indicator and other health dimensions (12,13,41,42).

4.2.2. Health-adjusted life expectancy (HALE): the WHO and GBD indicator

As regards the HALE indicator in **Figure 3**, the scenario of the gender paradox is not universal across all countries as it is for the HLY indicator, as shown by the overlap or even reversal in the proportion of total life expectancy spent in equivalent good years by

gender (right side of the figure). HLY and HALE are not directly comparable, but when we compute the proportion within the same indicator, it was expected that the pattern seen in **Figure 2** would reappear in **Figure 3**. Noteworthy that in **Figure 3**, the countries are ranked according female total life expectancy, but that should also not change the pattern observed.

The magnitude of the differences in **Figure 2** and **Figure 3** are shown in **Table 1**. For all European countries considered, SILC sex ratios indicate a considerably better scenario for males in terms of their total life expectancy spent in good health, relative to their female counterpart. Portuguese and Romenian males expect to spend 30% more healthy life years compared to females at age 50. On the other hand, HALE sex ratios are not always indicative of male advantage as regards equivalent years spend in good health, and the sex ratios hover around 1, with Eastern European countries presenting ratios a little below 1 (Croatia, Czech Republic, Poland, Slovakia and Slovenia).

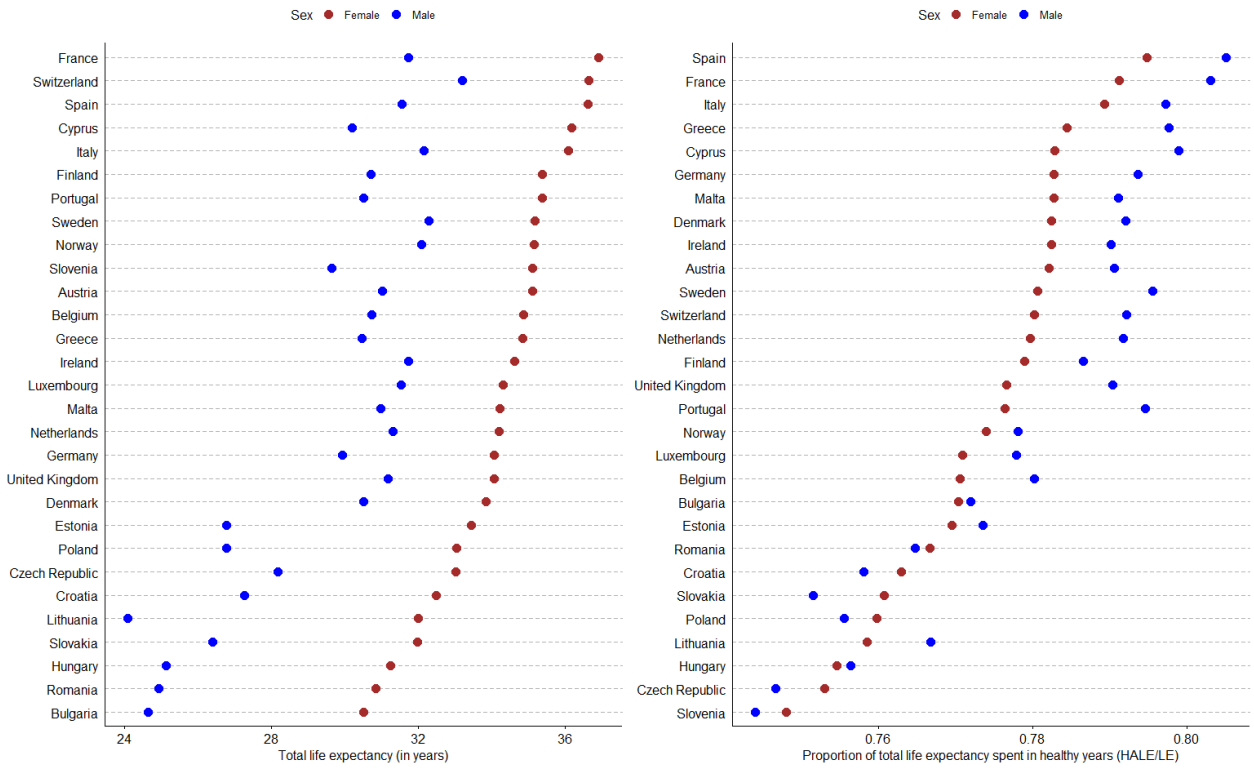

Figure 3. Total life expectancy (LE) and proportion of equivalent healthy life years (HALE/LE) at age 50 by sex, selected EU countries, 2016

Source: Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018

1.1.1. Eurostat x GBD: What do they measure?

Figure 4 shows boxplots of HALE against HLY by sex and different ages for European countries in absolute years. The scattered dots around the boxplot are the countries. The HALE indicator from the GBD provides a higher level of health expectancy compared to HLY, on all ages and sex considered. In addition, the distribution of their estimates is less dispersed throughout countries, with HLY being the only indicator to present outliers. The named countries represent the higher end of the distribution (i.e the best performers in terms of health).

Table 1. Proportion of total life expectancy spent in good health at age 50, by indicador, sex, and sex ratio, selected EU countries, 2016

Country	Men		Women		M/F Ratio	
	SILC	HALE	SILC	HALE	SILC	HALE
Austria	0.5100	0.7906	0.4390	0.7821	1.16	1.01
Belgium	0.6300	0.7802	0.5847	0.7706	1.08	1.01
Bulgaria	0.7568	0.7720	0.6911	0.7704	1.10	1.00
Croatia	0.4732	0.7581	0.4214	0.7630	1.12	0.99
Cyprus	0.6777	0.7990	0.6101	0.7829	1.11	1.02
Czech Republic	0.6242	0.7467	0.5647	0.7531	1.11	0.99
Denmark	0.6542	0.7921	0.6019	0.7825	1.09	1.01
Estonia	0.4833	0.7736	0.4704	0.7695	1.03	1.01
Finland	0.5927	0.7866	0.4938	0.7790	1.20	1.01
France	0.6006	0.8031	0.5499	0.7912	1.09	1.01
Germany	0.6664	0.7937	0.6445	0.7828	1.03	1.01
Greece	0.5877	0.7977	0.5236	0.7845	1.12	1.02
Hungary	0.5908	0.7565	0.4865	0.7547	1.21	1.00
Ireland	0.7173	0.7902	0.6897	0.7825	1.04	1.01
Italy	0.6600	0.7973	0.5841	0.7894	1.13	1.01
Lithuania	0.5467	0.7667	0.4672	0.7585	1.17	1.01
Luxembourg	0.5828	0.7779	0.4621	0.7709	1.26	1.01
Malta	0.7382	0.7911	0.7067	0.7827	1.04	1.01
Netherlands	0.6159	0.7918	0.5265	0.7798	1.17	1.02
Norway	0.8160	0.7781	0.7270	0.7740	1.12	1.01
Poland	0.6168	0.7555	0.5678	0.7598	1.09	0.99
Portugal	0.5442	0.7946	0.4144	0.7764	1.31	1.02
Romania	0.5881	0.7648	0.4573	0.7667	1.29	1.00
Slovakia	0.4645	0.7516	0.3904	0.7608	1.19	0.99
Slovenia	0.5444	0.7441	0.4692	0.7480	1.16	0.99
Spain	0.6354	0.8051	0.5633	0.7948	1.13	1.01
Sweden	0.8310	0.7956	0.7879	0.7807	1.05	1.02
Switzerland	0.5856	0.7922	0.5065	0.7802	1.16	1.02
United Kingdom	0.6448	0.7904	0.5990	0.7767	1.08	1.02

Source: Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018, Statistics on income and living conditions (EU-SILC)

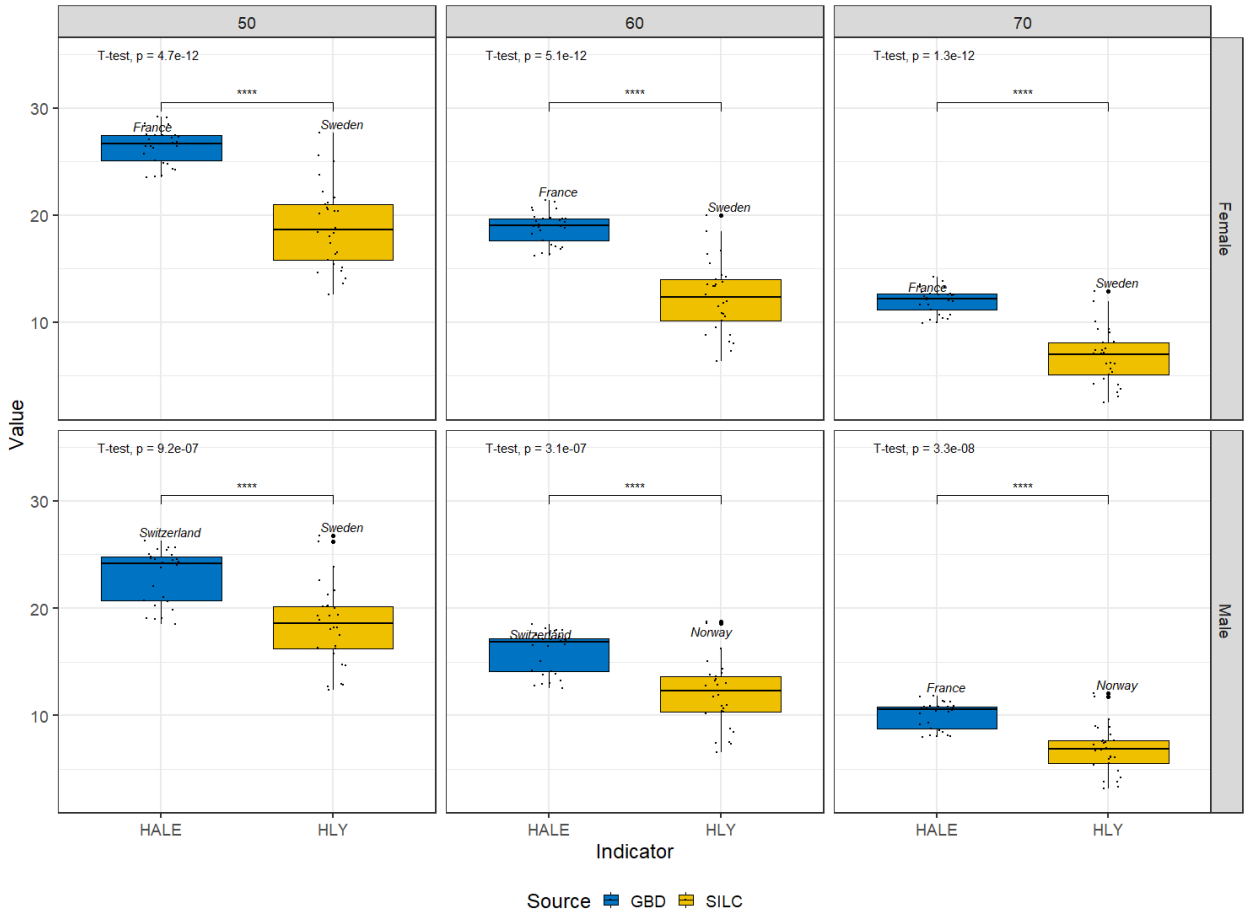

Figure 4. Absolute differences in years between HALE and HLY, by age and sex

Source: Statistics on income and living conditions (EU-SILC); European Health Expectancy Monitoring Unit Information System (EHLEIS). Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018

The t-tests indicate that the absolute differences observed between the means of the two distributions are significant, both for the pairwise comparison and the global one. The forerunner countries are the same for females on every age, but differ between indicators, with HALE estimating France to be the healthiest and HLY Sweden. For males, there are differences for both ages and indicator considered. While HALE estimates males from Switzerland to be the healthiest at ages 50 and 60, at age 70 the French take the

lead. HLY estimate Swedish males to be the forerunners at age 50, but their Scandinavian counterpart Norway takes over at ages 60 and 70.

Figure 5 shows how country rankings in terms of proportion healthy by sex at age 50 are very different when considering SILC source (HLY) or GBD source (HALE). Despite the pattern of difference in rankings being similar for both sexes, it is still overwhelming how the rankings differ by indicator.

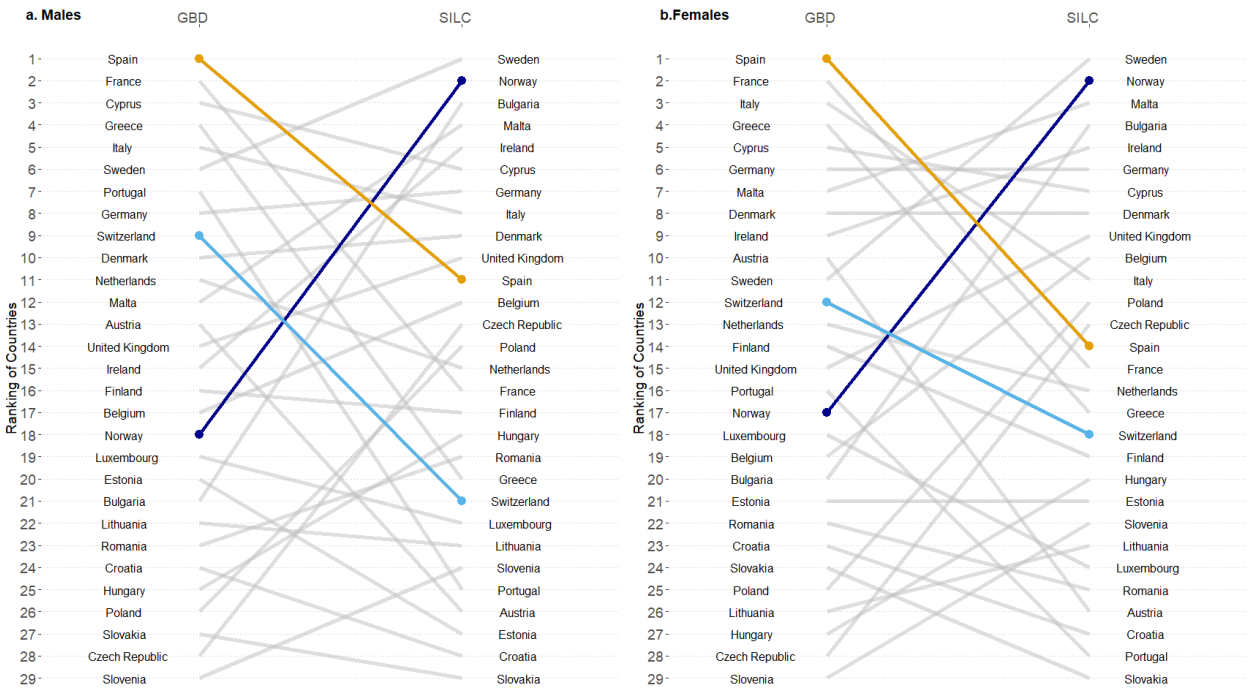

Figure 5. Proportion of total life expectancy spent in healthy state at age 50, by sex, SILC and GBD.

Source: Statistics on income and living conditions (EU-SILC); European Health Expectancy Monitoring Unit Information System (EHLEIS). Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018

Since it is not possible to directly compare magnitude differences in HLY and HALE, sex ratios of both indicators, proportion healthy and z-scores are used to show the extent to which each indicator establishes a relationship between mortality and health. **Figure 6** shows on **panel a** the sex ratio distribution of both HALE and HLY in terms of proportion of total life expectancy lived in good or equivalent healthy years. The most striking aspect is how smooth HALE is compared to HLY. The ratio throughout European countries barely deviates from 1 for HALE, while the HLY is much more sensitive and is for all countries well above 1, indicating the health advantage that males experience relative to their female counterparts at age 50. **Panel b** shows a different facet of the same aspect highlighted in **panel a**, but now the boxplot distributions are shown, with the two endpoints being males on the top end and females on the bottom end of the boxplot. This highlights the variance between sexes within the countries for each indicator. The GBD indicator presents lower variance between sexes, with the gap between women and men barely existing. In addition, the fact that the proportion of healthy life according to the GBD indicator is much higher than the SILC-EU indicator suggests that the GBD health indicator is much more correlated to the mortality dimension. Since their weighting scheme accounts for the levels of severity of diseases it is possible that their indicator of health mirrors mortality. Since higher levels of severity are correlated to higher probabilities of dying, this suggests that HALE probably reflects more the mortality aspect than the health aspect. In order to briefly assess this latter aspect, we computed z-scores for each indicator and expressed the results in terms of lower and higher sex ratio. Results of zero show the point and the mean equal. A result of one indicates the point is one standard deviation above the mean and when data points are below the mean, the Z-score is negative.

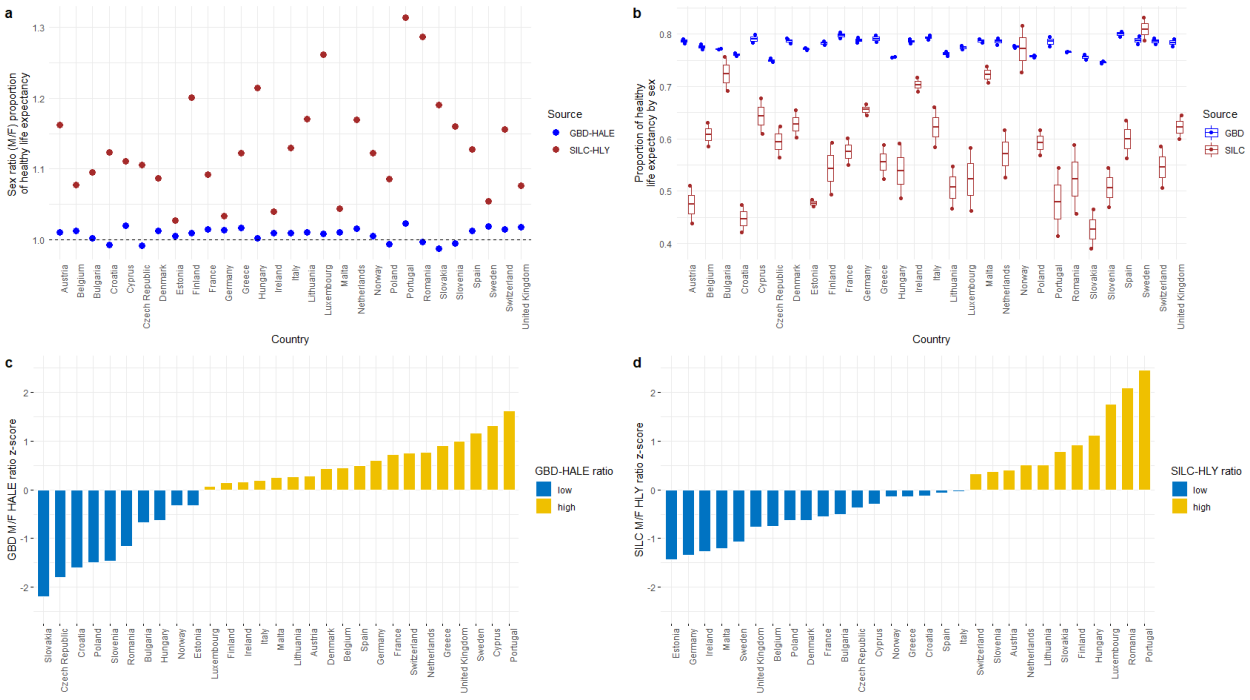

Figure 6. Male/Female ratios of proportion healthy and corresponding z-scores, SILC and GBD.

Source: Statistics on income and living conditions (EU-SILC); European Health Expectancy Monitoring Unit Information System (EHLEIS). Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018

First, there is striking difference between those countries that deviate positively and negatively between the two indicators. Second, the HALE measure has a higher proportion of z-scores that deviate positively from the mean of countries, so that the scenario is more optimistic for the selected European Countries. On the other hand, the ones that deviate negatively do so in a greater magnitude. The opposite is seen for HLY. The distribution has a more balanced pattern of both positive and negative deviations, with positive deviations being larger in magnitude.

5. Discussion

This work reviewed the main concepts and approaches to estimating health expectancies and focused on two widely used health indicators to stress the underlying differences between them and the impact this has on policy making and health research. HALE estimates are smoother across European countries than HLY, have a narrower gender gap in morbidity, and present higher z-scores compared to the average distribution across Europe. These results matter for understanding the relationship between health and mortality. One of the most important conceptual frameworks in health and mortality is whether increases in longevity imply a compression (43), expansion (44), or a dynamic equilibrium of morbidity (45). Health expectancies are attempts to assess how many of the life years gained are followed by an increase or decrease in healthy life years. On the one hand, HALE estimates indicate a compression of morbidity for both sexes, since the proportion of total life expectancy lived in healthy state is high. On the other hand, HLY suggests an overall expansion of morbidity, with a compression of morbidity for males and expansion for females. It also shows more influence of cross-country characteristics. This has important policy implications for decision makers, as they rely on the performance of the best standing countries to set targets, and it also has important implications for health researchers, who aim at assessing how mortality is correlated to morbidity. The sources for those differences are not the aim of this work, but previous research has shown that the health-valuation approach employed by the GBD study lacks parsimony, is often too complex and obscure (37,46). In addition, they incorporate more than 135 disease and injury categories and different disease stages, severity levels and sequelae. Many different data sources are used to calculate it, and an iterative process, combined with

bayesian approximations are used in estimating their indicator, with a heavy modelling of data (16). In the case of HLY, the source of information is mainly the SILC survey and the GALI instrument, so the sensitivity of this indicator is more easily assessed than HALE. On the other hand, HALE provides a health expectancy indicator for over 191 countries in the world, what has aided researchers in assessing health on a global perspective, while HLY is restricted to European countries.

Lastly, there is the issue that both indicators are estimated by the Sullivan method. Some authors contend that these indicators are not purely cross-sectional, because the prevalence rates are cumulative, and hence partly dependent on earlier health conditions of each age cohort. The prevalence of disability is a stock variable that depends on the past, while incidence of disability is a flow variable (23,47). Because of this mismatch between stock and flow of health variables, when sudden changes in population health occur, the Sullivan approach is not appropriate for detecting these changes, nor for monitoring the resultant change (23,48). However, other work shows that in cases where changes in transition rates are stable and smooth, Sullivan provides acceptable results for estimating trends in health expectancy (23,27).

In 2014, because of the emergence of a plethora of healthy life expectancy indicators that followed different guidelines and concepts of health, the World Health Organization (WHO) convened a working group (Guidelines for Accurate and Transparent Health Estimates Reporting - GATHER) that aimed at promoting good practice in defining and reporting health estimates. The guidelines were first published in 2016 through the Lancet and PLos Medicine channels. The effort was to have more consistent health results by incorporating a list of items that should be reported whenever health estimates are

published (49). However, despite following these protocols, health expectancy indicators still yield very different results, and this needs to be accounted for when measuring the health status of a population and deriving conclusions from it.

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