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Social inequalities in Healthy Life Expectancy

ALTERNATIVE METHODS OF ESTIMATION IN THE ABSENCE OF THE NATIONAL CENSUS

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1. General introduction

1.1 Background

Life expectancy has long been used as an indicator ofpopulation health. This indicator represents the average number of years a person can expect to live, if in the future they experience the current age-specific mortality rates in the population.It has often been used to compare population health across countries and across different points of time. This is largely because on one hand reliable and comparable mortality data are available in many countries, and because on the other hand mortality was thought to reasonably describe the state of population (ill-)health. This is a sensible assumption while infectious diseases were the main cause of death. However, now that chronic diseases have replaced, or are progressively replacing, infectious diseases, and the risk of becoming ill is not solely linked to the risk of dying, monitoring the increase in life expectancy is no longer sufficient to infer population health(Sihvonen et al., 2009).

Using morbidity data solely to describe the health of the population is also problematic for two reasons. First,there are problems associated with the availability, reliability and comparability of data on the prevalence of diseases or disabilities. However, this issue is being seriously tackled, especially in the context of the development of European level surveys such as the Health Interview Survey (EU-HIS). The other problem is that morbidity data describe those people who are alive at a certain age. The older the age group concerned the smaller and more select that group will be as mortality increases as age increases.

To overcome the above mentioned limitations, a number of summary measures of population health have been developed to take into account mortality and morbidity simultaneously. Among these measures are the indicators of health expectancies that have became widely used recently. Health expectancies are a measure of population health that combine length and quality of life into a single measure.

1.2 What are health expectancies?

The concept of health expectancies as health indicators was proposed by Sanders (1964) andthe first example was published in a report of the US Department of Health Education and Welfare(Sullivan, 1971). This report contained preliminary estimates of "Disability-Free Life Expectancy"calculated using a method devised by Sullivan and applicable to any state of health definition.

Health expectancy reflects the current health of a real population adjusted formortality levels and independent of the age structure.It is defined as the number of remaining years spent in a health state from a particular age assuming current rates of mortality and morbidity. For example in 2004 the female life expectancy at birth in Belgium was 81.4 years, so a baby girl born in 2004 could expect to live to age 81 years, assuming the conditions of 2004 prevailed over her whole life. By considering not only mortality but also ill-health at particular ages we can divide this remaining number of years into years spent in good and bad health – these are then health expectancies. Health expectancies add a quality dimension to the quantity of life lived (Robine, 2006).

Health expectancy is a generic term referring to an entire class of indictors expressed in terms of life expectancy in a given state of health. Therefore, as there are many dimensions of health, there are many health expectancies. Healthy Life Years (HLY) is the HE based on limitations in daily activities and is therefore a disability-free lifeexpectancy. This indicator is one of the most common health expectancies reported(Robine et al., 2003). Others examples of health expectanciesindicators include healthy life expectancy (based on the self-rated health question: ‘How is your health in general?) and life expectancy free of specific diseases, for instance dementia-free life expectancy(Roelands et al., 1994).

Health expectancies have many advantages compared to other morbidity and mortality measures. Health expectancy indicators are considered as important population health outcome measures (Stiefel et al., 2010).They are more intuitive and meaningful measure of health to which policy makers can relate due to the measurement in expected years of life. Also, the indicator is already age standardized so comparison are possible without further adjustment between population with different age distributions and among subgroups that make uppopulations such as the different genders, socio-economic categories,regions and countries.

1.3Use of the health expectancies indicators

Health expectancies is becoming a standard summary measure of population health that is used for different purposes at the international and regional levels. For instance, it has been used to study health inequalities, to target resources for health promotion, to evaluate the impact of health policies, and to plan health, social, and fiscal policy (Stiefel et al., 2010).

Health expectancies havealso been widely used to explore the future course of mortality and morbidity in developed countries. Three scenarios have been examined in different countries(Doblhammer & Kytir, 2001; Graham et al., 2004).The “compression of morbidity” theory purports that the increase in life expectancy is accompanied by a decrease in unhealthy life years (Fries, 1980). In contrast, the “expansion of morbidity” scenario suggests that the increase in life expectancy is achieved mainly through improvements in medical care and secondary prevention strategies extending the life of people with illness and disability(Gruenberg, 1977). The dynamic equilibrium is an intermediate scenario where an increase in unhealthy life years is offset by a decrease in the severity of illness and disability (Manton, 1982). It is important for the planning of future medical and care services to determine which scenario is unfolding as these three scenarios imply different pressures on health services and systems.

A large and growing number of European Member States estimate health expectancies periodically.Moreover, in 2004 the European Union has selected the health expectancy and more specifically, the disability free life expectancy(DFLE) at birth (also termed Healthy Life Years) and at age 50 years as one of the structural indicators to be monitored annually as a key economic outcome measure for social policies related to retirement age and spending for health and long term care for the aging population (EC 2009). It has to benoted that the health expectancy is the only health indicator among thestructural indicators. The importance given by the EU to the health expectancy indicatoris evident by the fact that it figures on the shortlist of the European Community

Health Indicators (ECHI), that it isincluded in the list of sustainable development indicators (DFLE at birthand at age 65) and that it is one of the 18 so-called Laeken indicators for social inclusion, adopted at the European Council in Laeken, Belgiumin 2001.

1.4 Social inequalities in health expectancies

The inverse association between health expectancy and socioeconomic status has been widely documented internationally (Bronnum-Hansen & Baadsgaard, 2008; Matthews et al., 2006).Also, social inequalities in HE have been found in Belgium. Bossuyt and colleagues have found that in 1997 those with a low level of education have shorter lives than people with a higher level of education. (Bossuyt et al., 2004)They also have fewer years in good health, and can expect more years in poor health in their shorter lives. For instance, in 1990s, among males aged 25 years the difference in health expectancy between the highest and lowest levels of education can be up to 17 years. This difference is substantially greater than the difference in life expectancy, which is a maximum of 5.23 years. Among females this difference is 11.42 years, while the difference in life expectancy is, at most, 3.22 years (Deboosere et al., 2008; Van Oyen et al., 2011).

These inequalities are not static overtime. Studying the evolution of inequalities in healthy life years from 1997 to 2004, Van Oyen and colleagues (2011) found that the social gap has increased during this period. For instance, at 25 years, the difference in HLY between men in the lowest and highest educational categories was 17 years in 1997 and became 18.58 years in 2004. For women, this difference was 11.42 years in 1997 and became 18.18 years in 2004. This highlights the importance of identifying the appropriate databases and methods to monitor inequalities in such an important indicator.

1.5Estimation of health expectancies by social positionin Belgium

To estimate social inequalities in health expectancy, two different types of data are used. First, information is needed about the prevalence of health status by socioeconomic category. This information is usually extracted from surveys. For instance the Belgian studies mentioned above have used data from the Belgian Health Interview Survey, while the EU uses the

Statistics on Income and Living Conditions Survey (EU-SILC). Second, information is needed about mortality rate by SES category. In Belgium, this information has been extracted from the mortality follow up of the census. For instance, the above studies linked the 1991 and the 2001 censuses to the National Register data on mortality and emigration in 1991–1994 and 2001–2004. The record linkage was based on a unique identifier present in both the census andregister files. As a consequence, socio-demographic characteristics in the censuswere unambiguously matched to migration and mortality data in the populationregister in a follow-up period of three years after each census.

The method described above is based on what is called “linked data”. Another method to estimate HLY by SES is to use “unlinked data”. This entails that information on deaths, including the SES of the deceased, is coming from death certificates while population data, including their SES, is coming from the census or census based population estimates. Such data can be potentially biased due to the lack of comparability of the SES information on the death certificate (reported by a proxy informant usually a relative of the deceased) with that of the census (self reported by the person); this is the so called numerator denominator bias. That is why it has been recognized that the most reliable data for group-specific (e.g. SES groups) estimations are provided by linked record studies as individual data linkage avoids inconsistencies between the numerator and the denominator(Valkonen, 1993).

This makes the census and its mortality follow up an important tool for estimating health expectancies by SES in Belgium. However, as there is no planned census after the 2001 census, other approaches must be identified to estimate HE by SES.

1.6 Objectives of the project

In this context, the overall objective of this project is the development of a methodology to estimate and updatehealthy life expectancy by socio-economic status (SES).This is an important endeavor as this project will contribute through its recommendations to the establishment of a system to monitor the HLY by SES in Belgium.

The aim of this report is to explore the different possible methods as alternative to the census to be used in Belgium to estimate HLY by SES. As described above, one possible method is the use of cross-sectional, unlinked studies. This method involves the use of mortality rates by SES generated from two different cross-sectional datasets: one providing the number of death by SES and the other the distribution of the population by SES. Chapter 2 describes this approach and its limitations in the Belgian context. The other possible method is the use of linked record studies other than the census. Using this approach, health expectancies by SES can be estimated based on mortality rates generated from the follow up of a number of surveys such as the Health Interview Survey or the EU-SILC that include information on the participants' socioeconomic status, health and functional limitations. Chapter 3 describes the criteria used to select the appropriate surveys to be used in this second approach. Chapter 4 presents the estimations done based on the surveys selected. Chapter 5 examines the approaches used in other European member states to estimate mortality rate by SES. Finally, chapter 6 presents the recommendations for the establishment of a system in Belgium to estimate and updatehealthy life expectancy by socio-economic status.

This project is funded by the Belgian Science Policy (Contract # AG/00/155), in the context of the AGORA program. This project was initiated in January 2010 and has ended in June 2011. Researchers from two institutions collaborate on this project: the Scientific Institute of Public Health (IPH) that is also the coordinator, and the VrijeUniversiteitBrussel (VUB).

2. Mortality and social inequalities. Comparison between the linked and the unlinked method

Sylvie Gadeyne, Patrick Deboosere

Opmerking [SG1]: Komen er ooknamenonder de anderehoofdstukken, wantvoorlopiggeennaamvermeldingbijanderestukken Is dan eenbeetjegek om het hier wel te doen ??

2.1 Introduction

The healthy life expectancy can be calculated in various ways.One of the possibilities is the Sullivan method, which applies, for example,the prevalence of people in good health to the mortality table. This technique can be differentiated on the basis of the educational level, in order to calculate the healthy life expectancy by educational level. A mortality table is classically drawn up on age-specific probabilities of dying. Generally, these are not observed directly, but derived from age-specific mortality rates. The numerator of these ratesconsists of the number of deaths by educational level, the denominator of the number of person-years lived in each educational group.

In Belgium, healthy life expectancy can be calculated on the basis of various data sources. The prevalence of people in good health (or in 'less than good health') can be derived from the subsequent health surveys or from the census 2001, which also contain information on the educational level of the respondents.

The other component of healthy life expectancy, the mortality table and the derived life expectancy by educational level, can be calculated in various ways, at least for the Brussels Capital Region (C.R.). The data available atInterface Demography allow to calculate mortality rates by educational level for the Brussels C.R. on the basis of a linked dataset and on the basis of an unlinked dataset. This allows us to examine the magnitude of the error when unlinked data instead of linked data would be used to calculate mortality rates by educational level. Because denominators and numerators come from two independent unlinked data sources, the risk of errors in the calculation of the mortality rates by educational level increases.

2.2 Linked and unlinked data

The linkage of the data of the census of 1/10/2001 tothe register data on mortality and emigration for the period 1/10/2001 - 31/12/2004 allows to directly calculate mortality rates by educational level for the period concerned. The linkage is deterministic, which means that the linked information regards the same person in both databases. This is possible because both the census and the register contain the national number. In other words, the national number functions as a unique identification key on the basis of which both databases can be linked correctly. The linked database contains census information on the demographic and socio-economic characteristics of each individual as well as register information concerning the date of death or emigration.The database allows to make a correct estimation of the mortality rates by educational level, provided that mortality and educational level have been measured correctly.

In addition to the linked dataset, a dataset containing the cause of each death registered during the follow-up period 2001-2004 is also available for the Brussels C.R(the certificates). When the cause of death is registered, occupation and educational level of the deceased person are recorded as well. The database thus allows to calculate the numerators of the mortality rates – the number of deaths by educational level. These can then be divided by the number of person-years lived by educational level as registered in the census. These mortality rates – based on an unlinked data – can be biasedby a so-called numerator-denominator problem, i.e. the lack of correspondence of the educationalinformation on the death certificate and the educational informationin the census.

2.3 Mortality rates on the basis of linked and unlinked data: significant differences?

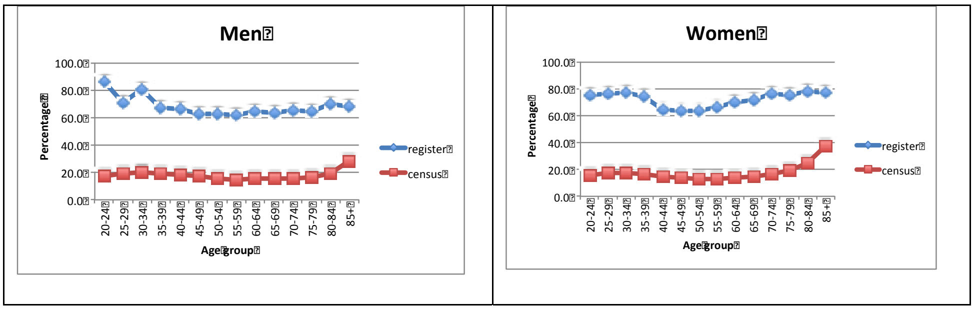
In order to assess the error resulting from the use of unlinked data, the mortality rates for the Brussels C.R. are calculated on the basis of the unlinked data (unlinked method) and then compared to the rates calculated on the basis of the linked dataset (linked method).

First, the quality of the variables is examined. The quality of the registration of demographic variables in the register is very good. It can thus be assumed that sex, age and age atdeath are recorded correctly in the register. The date of birth and the sex are taken over on the census form, which means that there is a perfect match between both databases at this level. As already mentioned, the register data on date of death are linked on the basis of a unique identifier – the national number – which means that there is anunambiguous or perfect match too.

An important difference between the census and the certificates regards the quality of the socio-economic variables such as educational level. For the three youngest age groups, the census does not contain information on the educational level. Moreover, the eventual educational level of an individual can only be determined as from the age of 20-24. Consequently, the analyses are limited to the population aged 20-24 and older. In this population, the percentage of missing values for the educational level variable in the census amounts to 17.1%, with a slightly lower percentage for women than for men (16.6% against 17.6%). In the certificates, the percentages amount to no less than 71.1% for the entire population, 75.5% for women and 65.9% for men. In other words, information on educational level is missing in the certificates for three quarters of the women. This will most certainly have consequences for the numerators of the mortality rates (number of deaths by educational level) calculated on the basis of the register data.

Figure 1 shows the percentage of missing values by age. In the census data, an increasing percentage by age can be observed for men as well as for women. For the certificates, the pattern differentiates by sex. Among men, a higher percentage is observed for the younger generations, followed by a stabilisation and a slight increase as from the age of 75-79. Also among women, the highest percentage is observed in the youngest age groups, but after a first decrease, there is a progressive increase in the number of missing values, up to about 80% in the oldest age group.

Figure 2.1: Percentage of missing values for the educational level by age and sex: comparison between the data from the certificates and the census data (own calculations)



It is obvious that such high levels of missing values will have an important impact on the mortality rates. In the unlinked method, the numerator of the mortality rate is calculated on the basis of the certificate data, the denominator on the basis of the census data. In the linked method, the numerator as well as the denominator are calculated on the basis of the census data. The annex contains the tables with the mortality rates by educational level, calculated according to both methods. These mortality rates arethe basis for the production of mortality tables. Table 1 shows the life expectancy at age 20by educational level according to both methods, as well as the difference between both methods. Various conclusions can be drawn.

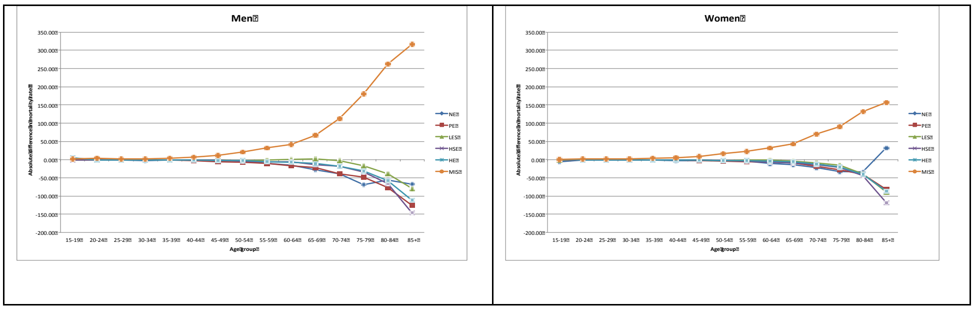
Mortality is clearly underestimated on the basis of the unlinked method, resulting in a significantly higher life expectancy at the age of 20. The differenceappears to be at its highest among the higher educational levels, although the relation is not linear and is depending on sex. Among women, the smallest differenceis observed for unqualified women, whose life expectancy at age 20 is 'only' 8 years higher in the unlinked method. The largest difference is observed for women with a higher secondary education, i.e. a difference of not less than 38 years.For men, differences are smaller. The smallest deviation, almost 2.5 years, is observed formen with a lower secondary education. This underestimation of mortality among the various educational groups is explained by the much higher mortality of respondents with a missing value for educational level in the certificates. Their life expectancy is 32 years lower for men and 21 years lower for women, compared to the category with a missing value for educational level in the census. The underestimation of mortality is thus partly due to the lack of information on the educational level of the deceased persons.

Table 2.1: Life expectancy at the age of 20 by educational level and sex according to the unlinked and the linked method (own calculations)

	Total	Men	Women
No education			
unlinked	68.9	69.6	68.7
linked	58.3	55.4	60.7
difference	10.5	14.1	8.0
PE			
unlinked	71.5	67.3	73.6
linked	56.7	53.0	59.9
difference	14.8	14.4	13.7
LES			
unlinked	65.4	56.3	74.6
linked	58.0	53.9	61.4
difference	7.3	2.4	13.2
HSE			
unlinked	84.4	69.2	99.6
linked	59.1	55.6	61.9
difference	25.3	13.6	37.7
HE			
unlinked	80.2	74.1	92.4
linked	61.3	59.1	64.6
difference	18.9	15.1	27.8
Missing			
unlinked	22.5	17.0	34.0
linked	52.3	49.4	55.3
difference	-29.8	-32.4	-21.3

In order to studyage patterns, the age-specific mortality rates calculated on the basis of the linked method are compared with theage-specific mortality rates calculated on the basis of the unlinked method. Figure 2 shows the absolute differences between both series of ratesfor men and women separately.

Figure 2.2: Absolute differencesbetween the age-specific mortality rates calculated on the basis of the linked data and the age-specific mortality rates calculated on the basis of the unlinked data, men and women (own calculations)



Absolute differences are relatively smallin the young age groups, which is quite logic, as mortality rates are low atthese ages. Differences become larger with increasing age, and especially the oldest age groups show considerable differences. The figure clearly illustrates the underestimation of mortality in the various educational groups.Patterns are similar formen and women, but differences aregenerally somewhat higher among women. For the group with missing information, absolute differences arelarger among men, especially among the oldest age groups. Moreover, for this group with missing information,differences between the linked and non-linked methodarealready visibleat a relatively young age, for both men and women.

Figure 2.3: Relative differencesbetween the age-specific mortality rates calculated on the basis of the linked data and the age-specific mortality rates calculated on the basis of the unlinked data, men and women (own calculations)

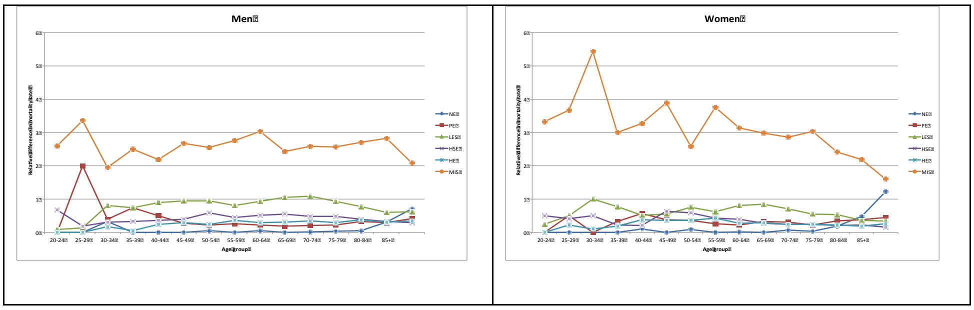
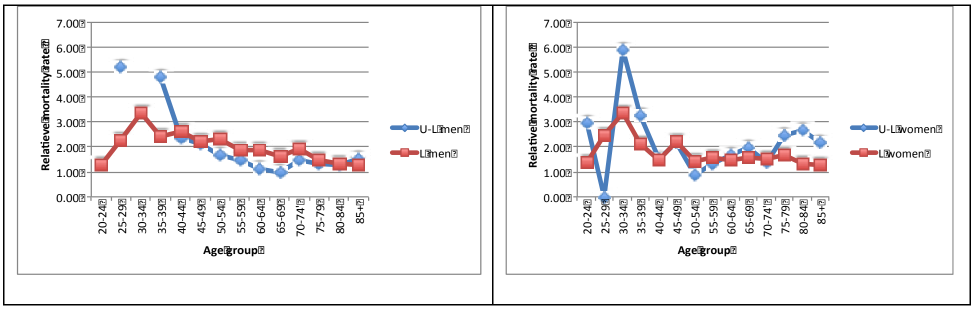


Figure 3 presents the relative differencesbetween the mortality rates calculated according to both methods. As from a young age, mortality rates of personswith a missing value for education are much higher on the basis of the unlinked data: up to 3 times higher for men and up to more than 5 times higher for women.For persons with a known educational level, the relative differences smaller than the unit valueonce again show that mortality is underestimated. The smallest relative differencesare found for the lower secondary education group, for both men and women. For persons with a primary education, the figures calculated on the basis of the linked data are 1.9 times higher at the age of 30-34 and up 4.5 times higher at the age of 75-79 (total population). Among persons with higher secondary educationlargedifferences are found atyoung age (7.75 higher at the age of 20-24), which then decline at older ages (1.1 to 1.5). Persons withhigher secondary education and higher education again show ratesthat are mostly three to four times higher in the linked method.

2.4 Relative differences in mortality by education on the basis of linked and unlinked data

An important issue is the error that occurs when unlinked data are used for calculating social inequalities in mortality. Figure 4 shows the ratio between the mortality rate of the primary educated and the mortality rate of the tertiary educated, on the basis of the linked (L) and the unlinked (U-L) method, for men and women.

Figure 2.4: Relative mortality differencesby educational level (PE/HE) calculated on the basis of the linked data and on the basis of the unlinked data, men and women



For men, the curve calculated on the basis of the unlinked data is 'interrupted'. At age 20-24, the relative differencebetween the lower and higher educated group cannot be calculated because the mortality of the higher educated group is zero. At age 30-34, the relative difference is not less than 45.8, which is the result of the extremely low mortality among higher educated men (0.02 pro mille).

Not taking into account these 'outliers', figure 4 shows a clear trend for men. In the young age groups, social inequalities between lower and higher educated persons areoverestimated by a factor of about 2.5 when the unlinked data are used instead of the linked data (relative difference of about 5 against about 2). As from the age group 45-49, there is no longer an overestimation but an underestimation until age 70-74. At older ages, 75-79 and older, results of both methods correspond relatively well.

The comparison forthe other educational levels, shows that inequalitiesare generally overestimated when the unlinked method is used. For the lower secondary level, the differenceislargestat young age (inequalitiesthat are 4.7 times higher when using the unlinked method) and somewhat smaller at older age (factor 3 at age 70-74 and factor 2 subsequently). For the higher secondary and higher education levels, differencesbetween both methods are somewhatmore irregular. Nevertheless, there is a trend towards an overestimation for the younger age groups and an underestimation for the older age groups (cf. primary education).

For women, figure 4 demonstratesan overestimation of inequalitiesby educational level in the youngest age groups, a relative good correspondence in the age groups 40-44 to 70-74 and again an overestimation in the oldest age groups. For the lower secondary education level, like for men, there is a systematic overestimation of inequalities when using the unlinked method, mostly of about factor 1.5 to 2.5. For the higher secondary education level, both series correspond relatively well as from the age 55-59, inequalities being somewhat overestimated (mostly of about factor 1.5).

2.5 Conclusion

It is clear that using unlinked data results in a significant errorwhen calculating mortality rates and derived indicators, such as mortality probabilitiesand life expectancy. The use of unlinked data results in a significant underestimation of mortality in the various educational groups for both women and men. The error seems partly related to the large number of missing values for the education variable in the certificates (on the basis of which the numerators – the number of deaths by educational level – are calculated) compared to the census (on the basis of which the denominators – the number of person-years lived by educational level – are calculated). The mortality rate of this group with a missing value for education is clearly higher when the unlinked method is used.

Social mortality inequalities between the educational levels (relative inequalities), on the other hand, are most often overestimated in the unlinked method compared to the linked method.

These conclusions have a number of important implications. If mortality andsocial inequalitiesby educational level have to be examined on the basis of unlinked data, educational level should be registered in a correct and exhaustive wayin the certificates. Mortality and mortality inequalitiescannot be correctly assessed if the educational level of almost three quarters of the populations is unknown. Alternatively, the respondents for whom educational level is unknown in the certificates could be redistributed according to the frequency distribution of education observed in the census, or educational level could be inputted on the basis of other variables (e.g. age or occupation). However, these methods do not provide any certitude as regards the correctness of the educational level ofrespondents.

Even if the educational level would be registered fully correctly, errors could still occur when using two different data sources for the calculation of the numerator and the denominator of the mortality rates by educational level (different registration of education, technical problems, errors in the registration of deaths). The best option is that both datasets – the general mortality registered in the national register or the cause of death registered in the certificates (for the numerators) and the census (for the denominators) – can be linked. By means of a unique identification number – such as the national number – that is contained in both databases or by means of an identification key on the basis of a number of variables, it can be assumed with a relatively high degree of certitude that the linked information refers to the same person, so that the mortality rates by educational level can also be calculated relatively correctly. The 2001 census was the last 'classic census' that was held in Belgium. As from 2011, it is replaced by an administrative census. It is not yet sure that this administrative census will register the educational level for everyone. That means that this new census will not allow to monitor the social inequalities in mortality comprehensively or exhaustively either.

Annex

Totale bevolking

	geen onderwijs		**LO**		**LSO**		**HSO**		**HO**		**Ontbrekende waarde**	
	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt
20-24	0.00	0.62	0.80	0.64	0.16	0.84	0.11	0.44	0.06	0.48	3.46	1.00
25-29	0.16	0.63	0.21	0.94	0.64	0.76	0.24	0.61	0.06	0.40	2.76	1.11
30-34	0.00	1.46	0.70	1.32	0.47	0.62	0.20	0.68	0.05	0.39	3.91	1.48
35-39	0.09	1.34	0.64	1.21	1.15	1.54	0.41	1.34	0.15	0.52	5.35	2.12
40-44	0.00	1.70	0.84	2.78	2.02	2.59	0.95	1.94	0.43	1.30	9.41	3.12
45-49	0.21	2.97	1.39	5.19	3.93	4.45	1.87	3.18	0.65	2.31	16.92	6.61
50-54	0.00	3.82	1.81	6.86	5.31	7.16	2.38	5.39	1.44	3.60	27.64	9.02
55-59	0.30	7.44	2.23	9.85	7.84	8.87	3.84	8.16	1.61	5.66	40.75	13.26
60-64	0.00	12.20	3.35	14.08	11.32	11.62	4.75	11.31	2.60	8.39	59.52	22.61
65-69	0.63	20.94	4.63	18.95	16.28	17.63	6.50	17.31	4.08	12.88	86.11	32.03
70-74'	0.86	30.00	7.37	33.23	20.57	27.23	9.20	24.87	5.97	21.20	134.77	48.63
75-79	6.29	51.83	17.44	51.62	28.55	43.96	11.99	38.28	12.67	38.06	196.37	77.53
80-84	30.35	70.64	27.19	77.60	32.60	71.69	18.82	69.92	17.96	67.52	284.31	118.70
85+	175.31	162.45	70.03	159.21	64.21	150.78	31.83	156.63	44.86	143.18	449.38	264.78

Mannen

	geen onderwijs		**LO**		**LSO**		**HSO**		**HO**		**Ontbrekende waarde**	
	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt
20-24	0.00	0.80	1.31	0.66	0.18	1.29	0.12	0.62	0.00	0.52	4.70	1.40
25-29	0.35	1.05	0.44	1.09	1.01	1.24	0.22	0.70	0.08	0.48	3.49	1.79
30-34	0.00	2.04	0.94	1.25	0.54	0.73	0.32	0.98	0.02	0.37	4.83	1.93
35-39	0.00	0.97	0.82	1.64	1.58	1.77	0.59	1.61	0.17	0.68	5.84	2.67
40-44	0.00	1.53	1.11	4.04	2.79	2.94	0.97	2.46	0.47	1.55	10.94	4.09
45-49	0.18	3.38	1.53	6.90	5.75	6.08	2.37	4.02	0.73	3.08	19.58	7.68
50-54	0.00	4.78	2.35	8.96	7.75	9.53	3.40	7.62	1.42	3.89	32.18	11.69
55-59	0.53	11.02	2.91	13.11	11.69	12.59	5.82	11.13	1.98	6.93	48.53	16.01
60-64	0.00	14.82	3.76	19.90	17.72	16.72	7.88	14.10	3.32	10.50	70.37	28.89
65-69	0.30	28.47	5.58	27.60	27.77	25.68	11.87	24.75	5.83	16.83	109.55	42.53
70-74'	1.13	40.18	10.85	48.94	38.79	41.82	16.88	35.29	7.46	25.28	184.77	72.09
75-79	3.31	72.43	24.51	72.96	53.00	68.99	22.83	56.36	18.57	49.01	286.81	106.22
80-84	25.89	82.48	32.55	109.78	59.11	98.20	30.90	95.97	25.59	83.80	405.35	143.18
85+	161.15	228.61	91.12	216.41	128.65	207.71	59.72	206.02	59.74	170.98	606.77	290.40

Vrouwen

	geen onderwijs		**LO**		**LSO**		**HSO**		**HO**		**Ontbrekende waarde**	
	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt	niet-gelinkt	gelinkt
20-24	0.00	0.51	0.32	0.63	0.144	0.29	0.112	0.27	0.105	0.46	2.18	0.59
25-29	0.00	0.29	0.00	0.81	0.196	0.20	0.249	0.50	0.035	0.33	1.95	0.36
30-34	0.00	0.88	0.46	1.39	0.392	0.50	0.077	0.34	0.078	0.41	2.78	0.93
35-39	0.17	1.66	0.46	0.80	0.661	1.27	0.218	1.05	0.139	0.37	4.73	1.44
40-44	0.00	1.82	0.59	1.56	1.213	2.22	0.922	1.46	0.389	1.06	7.57	1.94
45-49	0.23	2.70	1.25	3.47	2.218	2.90	1.444	2.48	0.577	1.57	13.71	5.32
50-54	0.00	3.09	1.26	4.78	3.169	5.09	1.568	3.62	1.456	3.31	22.46	5.97
55-59	0.13	4.77	1.57	6.75	4.700	5.83	2.338	5.91	1.194	4.26	32.48	10.34
60-64	0.00	9.79	2.98	8.93	6.668	7.92	2.572	9.38	1.785	5.98	48.81	16.42
65-69	0.92	14.30	3.95	12.81	8.794	12.39	2.982	12.43	1.981	8.12	67.03	23.49
70-74'	0.66	22.57	5.38	24.25	10.837	19.44	4.563	18.56	3.943	15.64	104.55	34.45
75-79	7.98	40.15	14.34	42.27	16.981	32.11	5.707	27.79	5.843	25.41	156.02	64.73
80-84	32.15	65.86	25.30	66.22	21.655	60.73	12.421	56.13	9.445	49.32	241.43	110.02
85+	178.77	146.31	65.74	147.58	47.030	135.60	22.692	140.46	30.144	115.69	415.69	259.30

Total population/men/women – no education – PE – LSE – HSE – HE – missing value – unlinked - linked

3. Inventory and evaluation of surveys as data sources to estimate HLE by SES

3.1 Evaluation criteria

To use surveys as source of data to estimate HLE by SES, it is necessary for the survey to have a number of essential characteristics. In the context of this study, these characteristics are: the health indicators included in the survey, the SES indicators included in the survey, the mortality follow up of the survey, and the design criteria of the survey.

3.1.1 Health indicators

To estimate HLE, it is important for the survey to include a number of health indicators. Examples of such indicators may include general self perceived health or reported chronic diseases or disabilities. As HLE are used to compare health of a particular country over time or across countries, it is important to use the same definitions of health states over time and across countries. For example, differences between health expectancies calculated for differentcountries can often be explained by differences in the measurement instruments used tocollect the prevalence data (Boshuizen & van de Water, 1994).

In order to allow comparable calculations of health expectancies across Europe, the Minimum European Health Module (MEHM) was designed. The MEHM has been implemented in several national and European surveys such as EU-SILC, SHARE, and EHIS(Robine et al, 2003). The objective of the MEHM is to obtain, with a short instrument, information comparable across Europe on three health domains: self perceived health, chronic long standing conditions, and long-term activity limitations (Cox et al., 2009).

Self perceived health (SPH) has become a conventional method for measuring health in populations in the last two decades. The utility of this measure derives from a number of factors. First, it is easily administered as it consists of asking individuals to rate their own health on a scale ranging from poor to excellent. Second, regardless of the semantic variations in the questions, this measure has been shown to be strongly and consistently predictive of mortality and of functional limitations. For instance, in a review of 27 studies comparing SRH and mortality, the authors concluded that in all but four of the 27 studies, general SRH reliably predicted survival in populations even after accounting for known risk factors (Idler & Benyamini, 1997). More recently, a meta-analysis between SRH and mortality was conducted(DeSalvo et al., 2006). The authors found that persons with poor SRH had a 2-fold higher mortality risk compared with persons with excellent SRH. Third, this measure provides a succinct way of addressing health from a broad perspective rather than assessing mortality or the absence of disease (Krause and Jay, 1994). It is suggested that this measure includes information about: diagnosed diseases and their severity as well as undiagnosed or early stage illness that might be missed by a physician, personal observation about functional status and performance in everyday life, sensation and perceptions about one's own body and mind (e.g. pain, tiredness), and individual understanding of their social and family history(Idler & Benyamini, 1997). The self perceived health item as part of the MEHM is based on the existing recommendations of the WHO.

The second item is a measure of the prevalence of chronic conditions. Reported longstanding diseases or conditions affect the health-related quality of life and are one of the major causes of utilisation of health services.

The third item is the global activity limitation indicator (GALI). Disability is a multifaceted phenomenon that can occur in a number of role and activities such as working, bathing, shopping, and socializing. To reflect this diversity, health surveys contain detailed items about limitations in specific activities. These multiple items are very informative but they also frustrate professionals and policy makers who often need brief summaries of population functioning and health (Verbrugge, 1997). Just as the SPH is one global generic health indicator, there has been a recent effort to create a single indicator of global disability: the global activity limitation indicator (GALI). It is an indicator that is able to identify subjects, in both general and/or specific populations, who perceive themselves as having long-standing, health related restrictions or limitations in their usual activities. In a French survey, it was found that the GALI is highly predictive of functional problems and that it captures more systematically severe levels of disability as it is most sensitive to personal care activities restrictions and less sensitive to functional limitations that are not associated with activity restrictions(Cambois et al., 2007). It is important to highlight that the healthy life years

(HLY) item, which is a structural indicator of the European community is calculated based on the GALI from SILC data.

Box 1: The Minimum European Health Module

I would like now to talk about your health:
1. Self perceived health: How is your health in general?
1. Very Good
2. Good
3. Fair
4. Bad
5. Very Bad

2. Chronic conditions: Do you have any long standing illness or health problem?
1. Yes
2. No

3. Global activity limitation indicator: For at least the past 6 months, to what extent have you been limited because of a health problem in activities people usually do?
1. Severely limited
2. Limited but not severely
3. Not limited at all

3.1.2 SES indicators

The availability of a range of indicators reflecting individual or household social status is essential to monitor social inequalities in HLEusing surveys. The position of an individual within the social hierarchy may be determined by the dimensions of occupation, income and education. Each dimension relates to a specific aspect of social stratification, and therefore it is preferable to use all three instead of only one(Kunst & Mackenbach, 1994). Educational level differentiates people in terms of access to information and aptitude to benefit from new technologies. Income creates differences in access to scarce materials. Occupational status includes both these aspects and adds to them benefits derived from the exercise of specific jobs such as prestige, power and social and technical skills.

Among those indicators, education has a number of advantages. First, it applies to the adult population regardless of labour market position. Second, it affects potential earnings and access to material resources that influence health, and therefore shares some of the health effects with other indicators (occupation, income and wealth) and is strongly correlated with them (Galobardes et al., 2006). Third, as formal education is normally completed in young adulthood and partly reflects the characteristics of the family and community of origin, it is an indicator that measures early life socioeconomic position and that remains relatively stable over the life course from early adulthood onwards (Davey Smith et al., 1998).

3.1.3 Mortality follow-up

To study HLE, we need mortality data in addition to health data. One way to secure such data is to request information on the mortality follow up of the survey participants on the individual level. The duration of such mortality follow up depends on the size of the survey sample; the smaller the sample the longest the follow up period must be. In any case, the follow-up period must not be less than 2 to 3 years.

Obtaining individual mortality follow up data is a resource and time consuming process (see Appendix 1). Yet, the dataset obtained is very rich as it links health and socio-economic information with the vital status of each individual participating in the survey.

3.1.4 Representative sample

The survey sample should be representative of the Belgian population. An important tool to have a representative sample is the frame that refers to the list of units (eg, persons, households,etc) in the survey population. The selection of the sample is directly based on this list, and therefore the frame determines how well a target population is covered. In Belgium, the frame for national surveys is often the National Register. The National Register is the best and most complete population list in Belgium, yet it excludes some groups as the homeless who have no official address and those living illegally in the country.

As we are interested in deriving estimates for the general population, we will exclude surveys that are concerned with a specific subgroup of the population. For instance, the Survey of Health, Ageing and Retirement in Europe (SHARE) that includes a wide range of health and SES indicators will not be considered in this project as it pertains to people 50 years and older.

3.1.5 Accounting for design aspects

A main interest of surveys is the estimation of population parameters using the sample, often selected by complexschemes such as stratified multi-stage cluster sampling. Statistical methods for estimating populationparameters and their associated variances are based onassumptions about the characteristics of the underlying distribution of the observations. Among these are that the observationswere selected independently and have the sameprobability of being selected(Tibaldi et al., 2003). However surveys often violate these assumptions. Procedures need to be developed to account for complex sampling design in order to have correct estimations and variances. Therefore, surveys to be used need to include the sample weights and provide any other directives to adjust for the study design.

3.1.6 Sample size

Determining an appropriate sample size is an important task in study design. Sample size decision is primarily based on the desired analysis to be undertaken as the sample size influences the margin of error or degree of precision in estimation. Also, the size of the sample is based on the available budget and on efficiency that is about obtaining the same amount of information with as small a sample as possible. The surveys to be included must have a sample with sufficient size to allow estimation with an acceptable degree of precision.

3.1.7 Response rate

The quality and reliability of survey data can be significantly affected by the degree of response to a survey. A low participation rate is of concern as it may bias the results. That is why, it is important to compare respondents and non respondents on the variable of interest. Previous studies have shown that people in higher SES categories are more likely to participate in health surveys than those in lower SES categories (Goldberg et al., 2001; Purdie et al., 2002). Still, if the difference in participation rate between socio-economic groups is unrelated to the health outcome, then participation will not affect results in terms of socio-economic inequalities(Galea & Tracy, 2007; Lorant et al., 2007). A study conducted by Lorant and colleagues (2007) investigated if the SES difference in non-participation is related to health outcome by comparing the results of the 2001 Belgian census with the 2001 Belgian Health Interview Survey. They found that people in lower SES categories were less likely to participate in the survey, when they had a poor health status compared to people in higher educational categories. The authors hypothesized that this phenomenon may be related partly to an issue of privacy. People with low SES status have been found to engage in riskier health behaviors such as having a more sedentary lifestyle or being a smoker. For fear of stigma, these individuals may decline to participate in health surveys. If this is the case then health inequalities may be underestimated in surveys.

3.1.8 Periodicity

An important issue to consider when looking for a database to produce regular indicators is the periodicity of the database. For instance, the Labour Force Survey is a large survey with an interesting range of SES indicators. In 2002, the Labour Force Survey included a module on health. However, it would be problematic to recommend using this survey for regular HLE indicators as health module are not regular in the survey.

3.2 Evaluation of surveys in relation to theoretical criteria

As proposed in Section 3.1, we will compare the surveys based on a number of criteria. These are: availability of health indicators, availability of SES indicators, availability of an appropriate mortality follow up period, representative sample, survey design aspects accounted for, sample size, response rate, periodicity. Initially, we considered 4 surveys to be potentially interesting to estimate HLE by SES. These are: the Health Interview Survey (HIS), the Statistics on Income and Living Condition (SILC), Survey of Health, Ageing and Retirement in Europe (SHARE), and the Labor Force Survey (LFS). However, as SHARE pertains only to those 50 years and older and the LFS include health question only periodically, we have finally chosen to explore further only two national surveys: HIS and SILC.

The Health Interview Survey (HIS) provides information on the health status of the total Belgian population by means of interviews in a representative sample of the population. The specific aims of the HIS are: 1) identification of health problems, 2) description of the health status and health needs of the population, 3) estimation of prevalence and distribution of health indicators, 4) analysis of social (in)equality in health and access to the health services, 5) study of health consumption and its determinants, 6) study of possible trends in the health status of the population.

The SILC aims at studying poverty, social exclusion and living conditions on the basis of indicators that can be compared at the European level. The objective of this survey is to provide a framework for the production of updated data concerning the evolution of income and living conditions for Belgium. It is collecting on an annual basis timely and comparable multidimensional micro-data on income, housing condition, labour, education and health.

Health indicators

In the HIS, the individuals are questioned about a wide variety of health domains including general health perceptions, morbidity and functional status, use of health services, lifestyle and socio-economic factors. Also the questions of the MEHM are included in the survey.

Although the SILC studies essentially poverty, social exclusion and living conditions, it includes a number of health questions. These are the three questions of the Minimum European Health Module (MEHM). In both surveys there is an effort to provide indicators and concepts that are agreed upon on the European level and are therefore comparable with European level data. For the current study, we are interested to use the Global Activity Limitation Indicator (GALI). This will allow the estimation of the disability free life expectancy or Healthy Life Years.

SES indicators

The SILC collects a wide range of timely and comparable multidimensional data on income, housing condition, labour, and education. The choice of SES indicators is more restricted in the HIS, still this survey includes detailed SES information that is appropriate in this context. Especially, we are interested in using the educational level to reflect socioeconomic status and such information is widely available in both surveys.

Mortality follow-up

The process of obtaining mortality follow up information for both surveys is regulated by the Privacy Commission. A request was sent to the Commission and we were able to obtain the data. For the HIS, we have mortality follow up information for the waves of the years 1997 and 2001 until 31, December 2007. For the SILC, we obtained follow up information for the SILC 2004 until 31/12/2009. In the case of the SILC, the request process is described in Annex 1. For the His, the request was submitted 7 years ago, and meanwhile the process of submission has been modified. Therefore, the HIS follow up process will not be described here.

Representative sample

In both surveys the target population are all people with a residency in Belgium; that is all those registered in the National Register. There is no restriction on nationality or age. However the questions of interest in this study have been asked for those 15 years and older in the HIS and for those 16 years and older in the SILC. The sampling frame is the National Register, which allows identifying the administrative reference person of a household, the first study unit. The second study unit, the individual is identified at the level of the household. Data from the HIS are representative for the three regions, however this is not the case of the SILC where data are only representative of the Belgian population.

Design aspects accounted for

The participants of the HIS are selected from the National Register through a stratified multistage clustered sampling. Correct estimates can be obtained by re-weighting the data and accounting for clustering and stratification. Procedures have been developed to accurately estimate population parameters using HIS data(Tibaldi et al., 2003). The SILC has a stratified multistaged clustered sampling. To draw correct estimations we used the sample weight provided.

Sample size

For the HIS, the sample size is about 10.000 effective interviews per cycle, divided between the regions: 3500 in the Flemish community, 3500 for the Walloon Region and 3000 in the Brussels Region. For the SILC, the sample size is approximately 6000 households (about 11.000 individuals). So, the sample size is comparable in the examined surveys.

Response rate

For the HIS, the response rate is approximately 60%, and for the SILC it is about 64%.

Periodicity

The HIS takes place every 4-5 years. Already fourwaveshave been completed: 1997, 2001, 2004, and 2008.The SILC is an annual survey.

3.3 Conclusion

The HIS and the SILC have the required characteristics to correctly estimate social inequalities in healthy life years. Both surveys have the required variables and are of high quality concerning the study design. The advantage of the HIS is that the data are representative on the regional level, while this is not the case of the SILC. The SILC has the main advantage of being collected annually while the HIS is undertaken every 4 to 5 years.

4. Estimation of Healthy Life Years by educational level

4.1 Methods to estimate Healthy Life Years

In the last thirty years, there has been a significant increase in the number of Health Expectancies' calculations (Stiefel et al., 2010). Most of these calculations have been undertaken using the Sullivan method. This method starts from the mortality and survival life table that is based on age group specific mortality data for the population and time period concerned. The principle in calculating Sullivan health expectancies is that for each age range in the life table, total life years are divided between healthy and unhealthy years. For this, the data required are the age-specific prevalence (proportions) of the population in healthy and unhealthy states (often obtained from cross-sectional surveys), and age-specific mortality information taken from a period life table. The age-specific prevalence is directly applied to the person years of the life table: it provides the total number of years lived with disability; the total number of years lived without disability, and summing both, the total number of years lived. The concern about the Sullivan method is that it is based on current morbidity prevalence rates, and not current incidence rates. Also, it assumes the current mortality rates will prevail in future cohorts as they reach the same age. Therefore, it has been claimed that the Sullivan method produces biased estimates as it cannot reflect sudden changes in disability transition rates.

More recently, the multi-state method has been developed for estimating HE based on incidence morbidity rates instead of prevalence rates allowing the detection of changes in disability incidence over time (Khoman et al., 2008). However, this method is not used very frequently compared to the Sullivan method as its implementation requires longitudinal data which are not readily available n many countries including Belgium. Therefore, even with the drawback mentioned above, the Sullivan method is still the method of choice for estimating population health due to its simplicity, relative accuracy and ease of interpretation. Also, it has been suggested that the Sullivan method and multi-state method may produce similar results if transition rates are smooth and regular over time (Jagger et al., 2007).

In this context, we will use the Sullivan method for estimating HLY by SES based on an abridged life table where HLY are estimated by 5 year age groups. In this report we will not describe the methodology to develop a life table and apply to it health prevalence rates as it has been described in details elsewhere. Examples of such publications are “The life table and its applications” of Chiang (Chiang, 1984) and a number of reports and manuals developed in the context of the REVES program(Bossuyt & Van Oyen, 2000; Jagger et al., 2007). Based on these publications, the estimation of HLY was done by educational level using a program developed in the SAS software. In Appendix 2, you will find the SAS program used for the HLE estimation.

The prevalence of disability and of mortality show considerable fluctuation due to sampling variation and therefore HLY will be estimated with their standard errors. When mortality rates are extracted from the census then the variation resulting from the mortality rates is negligible and this part for the variance can be ignored. In our case, as mortality rates are estimated from a survey, we shall estimate the standard errors taking into account the variances of both mortality and morbidity rates.

To compare the results from the HIS and the SILC, we will compare mainly the educational gradient in both surveys. For this, we will estimate if the difference in the HLY of those in the lowest educational category and the HLY of those in the highest educational category is statistically significant. The test will be done by age group using the z-statistic. In Appendix 2, you will find the SAS program used for this test of difference.

4.2 Data

As mentioned in the previous section, we will use the HIS 2001 and SILC 2004 to estimate HLY by educational level. For a detailed description of these surveys, please refer to chapter 3.

The initial HIS survey has about 12 111 individuals, however after the linkage with the National Register, this number dropped to 10 093. The number of unlinked observation is quite high, but this is related to a problem in this specific linkage between HIS 2001 and the National Register. About 2018 people were not matched because there was a problem in their identification number. The problem of the mismatch was identified but due to the time constraint in this project, we were not able to another linkage. The initial sample of SILC survey is 10 146 individuals, and the linked dataset is 9 775 individuals. Only 371 individuals were not matched with the national register and therefore dropped from the dataset.

The ages of the subjects belonging to these two cohorts change during the follow up time, the longer the follow-up period is, the larger will be the difference between the ages of entry and those “acquired” during the follow up. To account for this, Lexis expansions of the original data is often used. For this, we divided the follow up period of each subject into 1-year age bands(Kirkwood & Sterne, 2003).

As mentioned in the previous section, both surveys include information on the Global Activity Limitation Indicator (GALI) that is the health outcome of interest in this report. As this question is based on the Minimum European Health Module, the questions are comparable in both surveys. For the HIS, the formulation in Fenchis: Etes-vous limité(e) depuis au moins 6 mois à cause d’un problème de santé, dans les activités que les gens font habituellement? Oui, sévèrement limité(e), Oui, limité(e), Non, pas du tout. For the SILC, itis : Durant les six derniers mois ou plus, un problème de santé vous a-t-il limité dans vos activités ? Oui, de façonimportante, Oui, un peu, Non.

As to educational level, its definition differs slightly by survey. In the HIS, the level of education is a household variable and not an individual variable. It reflects the highest educational level achieved within the household by the person of reference or his/her partner. In the SILC, the level of education is individual. Although these two educational indicators are slightly different, we opted to use the indicator developed and standardized by each survey team. For both surveys, the educational indicator was recoded as: primary educational level or less, lower secondary, higher secondary and higher education.

The health prevalence data are weighted to account for the study design of the specific survey.

4.3HLY by SES

This section presents the results of the estimation of HLY by educational level using the HIS survey and the SILC survey.

Table 4.1 shows the prevalence of disability by educational level using both surveys. This table shows higher prevalence of disability in the SILC compared to the HIS. For instance, 19% of the males in the HIS reported having limitations compared to 25% in the SILC. Similarly, among females 21% reported limitations in the HIS compared to 29% in the SILC. This pattern of higher disability in the SILC applies for all educational categories. Concerning the SES gradient, we find substantial inequalities in both surveys in the prevalence of disability between those having attained higher education and the other categories. For instance, among males in the HIS the difference in the prevalence between the highest and lowest educational categories is approximately 9%, and for the SILC it is about 22%. Among females, these figures are 15% for the HIS and 21% for the SILC.

Table 4.1: Crude (but weighted) and age adjusted prevalence of disability and their 95% confidence intervals by educational level and sex for the HIS 2001 and SILC 2004

		Males			**Females**		
HIS	**Education**	N	Crude %	Age adjusted % (95% CI)	N	Crude %	Age adjusted % (95% CI)
	Primaryeducation	656	35.52	23.54 (20.29-26.80)	768	42.84	31.48 (27.42-35.55)
	Lowersecondary	823	28.07	23.53 (20.83-26.23)	872	27.64	21.03 (18.53-23.54)
	Highersecondary	1319	18.57	18.38 (16.32-20.44)	1365	20.29	20.15 (18.08-22.22)
	Highereducation	1537	13.99	14.94 (13.21-16.68)	1580	14.11	16.20 (14.31-18.09)
	Total	4335	21.31	19.26 (18.18-20.35)	4585	23.34	20.58 (19.49-21.66)
		Males			**Females**		
SILC	**Education**	N	Crude %	Age adjusted % (95% CI)	N	Crude %	Age adjusted % (95% CI)
	Primaryeducation	895	42.46	38.71 (34.54-42.87)	1199	49.71	41.49 (37.70-45.27)
	Lowersecondary	841	27.47	29.70 (26.46-32.94)	849	34.75	33.33 (29.95-36.71)
	Highersecondary	1837	22.37	24.10 (22.13-26.08)	1656	24.88	26.88 (24.70-29.05)
	Highereducation	1296	17.05	16.93 (14.96-18.90)	1413	19.04	20.58 (18.37-22.78)
	Total	4869	25.53	24.99 (23.82-26.16)	5117	30.72	28.79 (27.60-29.98)

Table 4.2: Vital status by educational level and sex for the follow up of the HIS 2001 and SILC 2004

		Males				Females				Total			
HIS	Education	Death registration		No change in status		Death registration		No change in status		Death registration		No change in status	
		N	%	N	%	N	%	N	%	N	%	N	%
	Primaryeducation	111	18.20	498	81.80	91	17.67	592	82.33	202	17.91	1.090	82.09
	Lowersecondary	77	10.23	683	89.77	51	5.92	750	94.08	128	8.05	1.433	91.95
	Highersecondary	64	4.36	1.202	95.64	41	2.63	1.233	97.37	105	3.48	2.435	96.52
	Highereductation	53	2.69	1.394	97.31	24	1.81	1.441	98.19	77	2.26	2.835	97.74
	Total	305	6.64	3.777	93.36	207	5.27	4.016	94.73	512	5.95	7.793	94.05

		Males				Females				Total			
SILC	Education	Death registration		No change in status		Death registration		No change in status		Death registration		No change in status	
		N	%	N	%	N	%	N	%	N	%	N	%
	Primaryeducation	131	15.67	729	84.33	123	12.08	1.026	87.92	254	13.58	1.755	86.42
	Lowersecondary	49	6.27	755	93.73	30	4.00	792	96.00	79	5.12	1.547	94.88
	Highersecondary	74	4.45	1.705	95.55	39	2.59	1.562	97.41	113	3.57	3.267	96.43
	Highereductation	39	3.04	1.212	96.96	20	1.44	1339	98.56	59	2.21	2.551	97.79
	Total	293	6.46	4.401	93.54	212	4.81	4.719	95.19	505	5.61	9.120	94.39

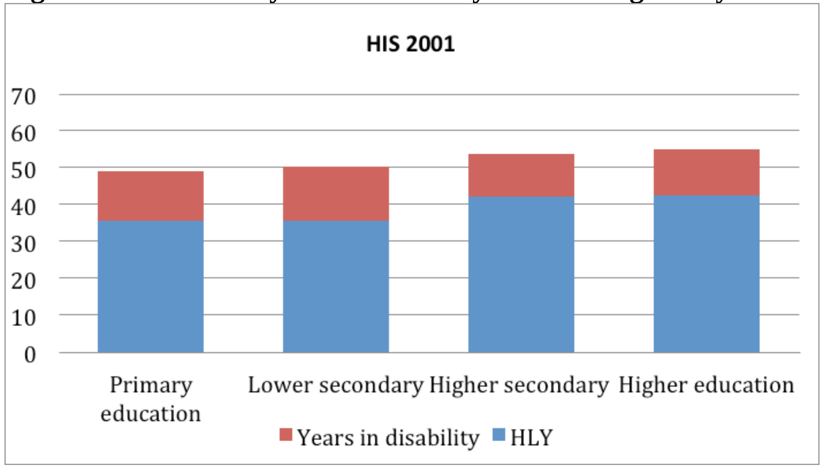
Table 4.2 presents the distribution of the survey participants by vital status and educational level for both surveys. We see that the prevalence of mortality is comparable in both surveys. In the HIS sample, 5.95% of the respondents died compared to 5.61% of the SILC sample. Concerning the SES gradient, we find significant inequalities in mortality by educational categories in both surveys. For instance, in the HIS almost 18% of the lowest SES category died compared to 2% in the highest category. In the SILC, these figures are respectively 14% and 2%.

In Appendix 3, you will find the tables showing HLY and their variances by educational level for all age groups. To highlight some results, the HLY by SES and gender at two selected ages (25 and 65 years) are presented in this section.

Figure 4.1 shows life expectancy broken down by HLY and years in disability for males aged 25 years in the HIS and the SILC. This figure shows very comparable LE in both surveys, but higher HLY in the HIS compared to the SILC. For instance, LE at 25 years for those with the lowest educational achievement is almost 50 years in the HIS and the SILC. Concerning HLY for the same group, it is 35 years in the HIS (28 % of LE spent in disability) compared to 28 years in the SILC (42% of LE spent in disability). Such higher figures for the years spent in disability in the SILC is expected as in table 1 the prevalence rates of disability are systematically higher in the SILC compared to the HIS. In both surveys important educational inequalities are observed in LE and in HLY. For instance, the difference in LE between the highest and lowest educational group is almost 6 years in the HIS and 9 years in the SILC. For HLY, these figures are respectively 7 years and 14 years.

Figure 4.2 shows life expectancy broken down by HLY and years in disability for females aged 25 years in the HIS and the SILC. As expected LE are higher for females compared to males, and years spent in disability are more important for females compared to males. Here also, we find more comparability between the SILC and the HIS in LE but not in HLY. Again, the SILC shows higher years in disability compared to the HIS. For instance, at 25 years women with the lowest educational achievement are expected to live 41% in disability according to the HIS, while this figure is 48% in the SILC. Important educational inequalities are detected in both surveys for LE and HLY.

Figure 4.1: HLY and years in disability for males aged 25 years



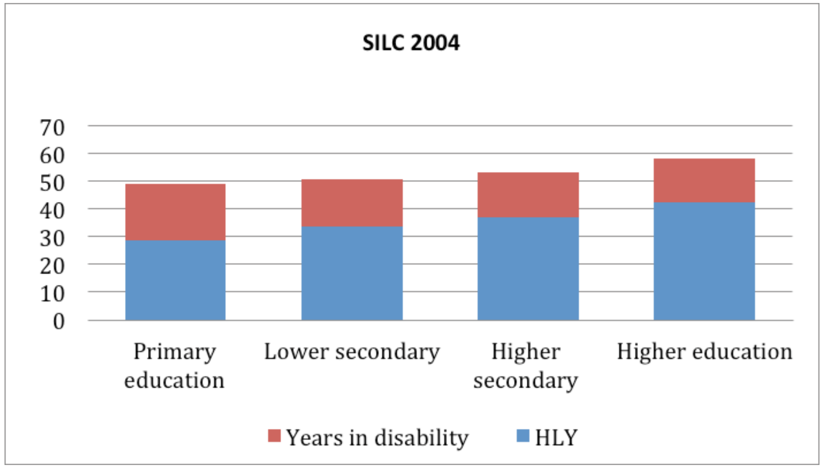
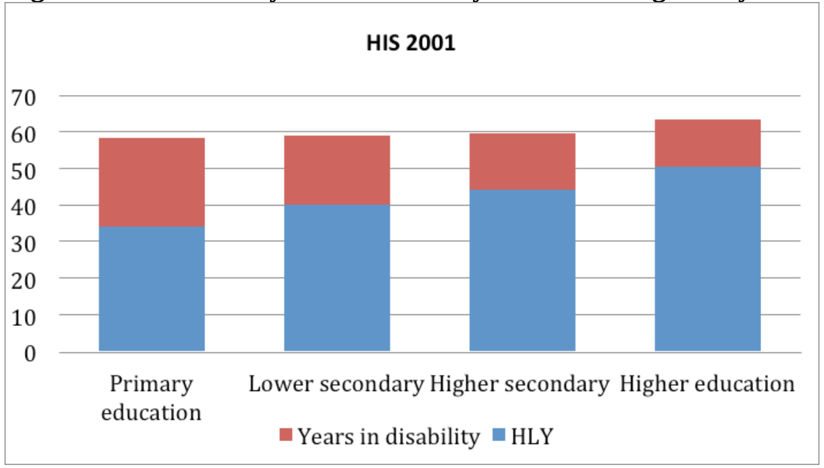


Figure 4.2: HLY and years in disability for females aged 25 years



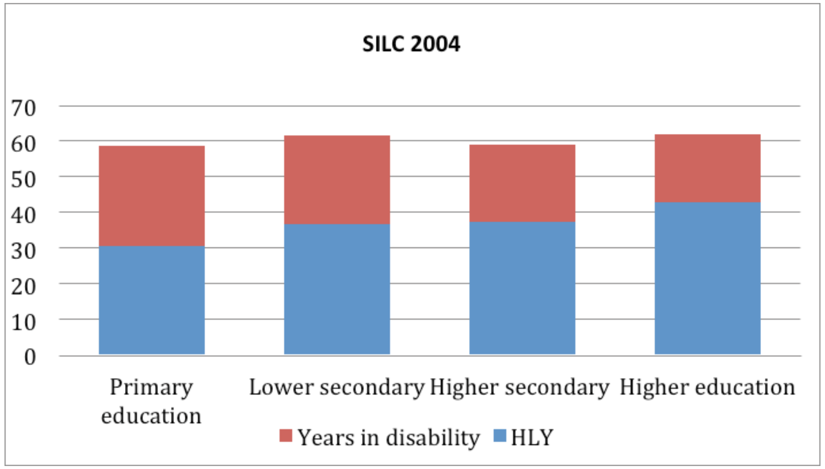


Figure 4.3: HLY and years in disability for males aged 65 years

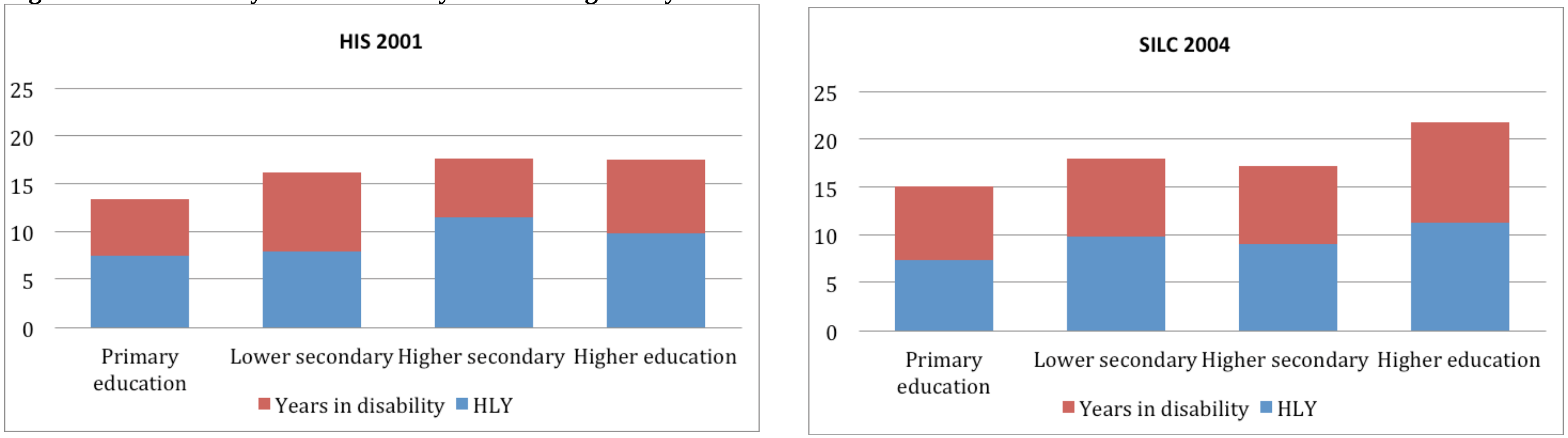
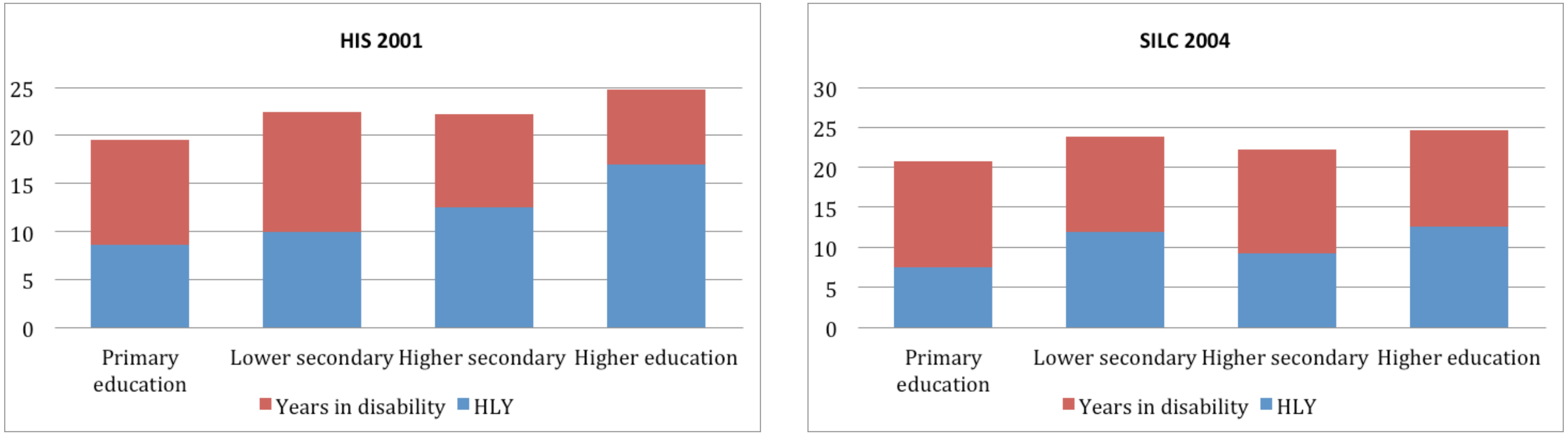


Figure 4.4: HLY and years in disability for males aged 65 years



Figures 4.3 and 4.4 show life expectancy broken down by HLY and years in disability for males and females aged 65 years in the HIS and the SILC. Among males aged 65 years old, we no longer see comparable LE between surveys; here differences are detected in both LE and HLY between the HIS and the SILC. Among females of 65 years old, we see similar pattern as in younger age concerning comparability between surveys in term of LE and HLY. For males and females, we see the same pattern as in the younger age group for higher years spent in disability in the SILC compared to the HIS. For instance, males with the lowest educational achievement in the HIS are expected to live 44% of their life with disability compared to 51% in the SILC. For females, these figures are 56% and 64%. As well, inequalities in LE and HLY are observed in these higher age groups.

Table 4.3 shows the result of the z-statistic for the difference between HLY in the lowest and highest educational categories. Statistically significant inequalities in HLY are detected in both surveys at in the 25 years old category. However, at 65 years old, significant inequalities are only found in the HIS but not in the SILC.

Table 4.3: Difference between HLY in the lowest and highest educational categories

Males

Survey	Age	HLY (variance)		Difference	z	p
		Primary education	Higher education	High-Low		
HIS	25	35,49 (2,03)	42,65 (1,02)	7,16 (3,05)	2,35	<0.02
	65	7,49 (0,27)	9,82 (0,77)	2,33 (1,04)	2,25	<0.05
SILC	25	28,44 (1,58)	42,28 (2,05)	13,84 (3,64)	3,80	<0.001
	65	7,38 (0,32)	11,28 (1,96)	3,89 (2,28)	1,71	<0.10

Females

Survey	Age	HLY (variance)		Difference	z	p
		Primary education	Higher education	High-Low		
HIS	25	34,25 (1,68)	50,48 (2,58)	16,24 (4,26)	3,81	<0.001
	65	8,62 (0,36)	16,95 (2,93)	8,33 (2,76)	3,02	<0.01
SILC	25	30,37 (1,16)	42,73 (3,07)	12,36 (4,23)	2,92	<0.01
	65	7,56 (0,23)	12,57 (3,05)	5,01 (3,28)	1,53	<0.20

5. Estimation of mortality by socioeconomic status in European countries

A growing number of European countries are involved in estimating healthy life expectancies by SES. Although the source for morbidity data is often from cross sectional surveys, the source of mortality data differs. This chapter describes the approaches used by a number of these countries to estimate mortality rates by socioeconomic status. See Table 5.1 for a summary.

Austria

Mortality rates by SES in Austria are generated through the linkage of individual records of the censuses 1981, 1991, and 2001 with death certificates in a 12-month follow-up period. No 'direct' matching through the national register number could be used. Instead, data was matched using primary matching variables: sex, date of birth, and last residential address of the deceased. The overall merging rate was about 90% for the 1981 and the 1991/92 death records, compared to almost 94% for the 2001/2002 death records. Using this dataset a study examined inequalities by educational level (Klotz & Doblhammer, 2008). In 2001/2002, life expectancy at age 35 for males was 40.1 years for the lowest educated group and 46.2 for the highest educated group. For women, these figures were 46.6 years and 49.4 years, respectively.

Bulgaria

In Bulgaria, data for estimating mortality by SES come from a linkage between the 1992 population census and death certificates. The follow-up period stopped in 1998.The link between census and mortality data was performed on the basis of a personal identification number that is uniquely assigned to each Bulgarian citizen and is included on death and census records. Approximately 93 % of all death certificates for the study period were linked to the 1992 census records.

Using such data, a study obtained age and sex specific death rates from a parametric specification of the mortality hazard based on a Gompertz model(Kohler et al., 2008). Life expectancy lost and probability of dying between age 40 and 70 are calculated. It is estimated that men with high education can expect to live 2.56 years longer than men with low education between ages 40 and 70. For women, the difference in life expectancy lost between low and high education is 0.64 years.

Denmark

In Denmark, data regarding education and occupation is collected in national registers from the 1970 census. Since 1980, education data have been reported and updated annually. To calculate mortality rate by social status, SES data from the registers is linked to mortality records for all inhabitants. A study examined the inequalities for the 30 to 74 year olds in the period 1996-2005. In this age group and period about 2.3% of the mortality data failed to be linked (due to unclassified or missing data on education). The authors calculated age-standardized death rates for every calendar year by education and sex. For the period 1996-2005, the analysis reveals an increase in social inequality in life expectancy: for the lower educational level the increase in life expectancy at 30 years was 0.73 years for men and 0.42 years for women whereas for the higher educational level the increase was 1.06 years and 0.75 years, respectively (Bronnum-Hansen & Baadsgaard, 2007). Using the same source of mortality data, another study examined health expectancy by occupational status(Bronnum-Hansen, 2005). The authors found that among 30-year-old men, high-level salaried employees had the longest expected lifetime in perceived good health, 41 years, which amounts to 89% of life expectancy, compared to 34 years (73%) forfarmers, 32 years (73%) for unskilled workers, and 19 years (56%) for economically inactive men. Expected lifetime inperceived good health for high-level salaried female employees from age 30 was 46 years (91% of life expectancy). The lowestwas found for assisting spouses, 36 years (71%) and economically inactive women, 25 years (56%). Large differences werealso found when data on long-standing illness were used.

Finland

A study analyzed Finish data together with Bulgarian data in a comparative fashion(Kohler et al., 2008). The approach for calculating mortality by socioeconomic status was thus fundamentally the same. Like for Bulgarian data, census and mortality data were linked using a unique personal identification code. Non-linkage of death records to census records is less than 0.5%. The difference with Bulgarian method is that an 11% random sample of longitudinal census data file was studied in the case of Finland. Analysis reveals that health inequality by education is less pronounced than in Bulgaria, at least for males: men with high education can expect to live 1.79 years longer than men with low education between ages 40 and 70. For women, the difference in life expectancy lost between low and high education is 0.62 years.

France

The data used in France comes from a permanent demographic sample currently including about one million people (approximately 1% of the population), randomly selected. Socio-demographic data is updated at each census and information regarding mortality is permanently updated by the means of vital status forms. In other words, a follow-up of the representative sample is constantly ensured.

Using these data, a study used Cox models to estimate relative risks with age as the time variable, occupational group or educational level being treated as quantitative variables(Saurel-Cubizolles et al., 2009). Relative index of inequality (RII) were also estimated to obtain a global measure of the magnitude of inequalities in mortality. Using data from the period 1990-1999 of 30 to 64 years old the analysis reveals wider social inequalities among men than among women. Based on education, RII is estimated to vary between 2.72 and 3.23 for men and between 2.29 and 2.99 for women. From an occupational perspective, the difference between men and women is more evident: RII is estimated to vary between 5.54 and 6.68 for men and between 2.96 and 3.96 for women.

Lithuania

Recently, linkage procedures have been usedin Lithuania(Shkolnikov et al., 2007). Linkage between the 2001 census, death and migration records was accomplished using personal identification numbers as unique identifiers for the same individuals. The follow-up ended in 2004. The method allowed matching about 95% of the death records to the corresponding census records. A special redistribution procedure was applied to the remaining census-unlinked deaths.

Education level served as a proxy for socio-economic position. Data regarding education were available both from the census and the death records. Although the two sources of information did not use the same categories to describe education levels, it was possible to classify individuals in one of the 3 following broad categories of educations: *higher education* (at least 14 years of schooling), *secondary education* (10-13 years of schooling), *lower than secondary* *or unknown education* (up to 9 years of schooling). Specific research was undertaken to determine whether the use of one source of information rather that another would matter (differences might arise from actual changes during the interval between the census and registration, from the attitude of declarants or to the definition of the categories and the formulation of the questions used for collecting information). Analysis revealed significant disagreement between the two sources of information (death and population records), but no systematic overstatement in the census records. It was decided to use census data to measure education level.

Researchers used this data to estimate life expectancies at age 30(Shkolnikov et al., 2007). Standard errors were calculated using the Chiang method. Poisson regressions were also used to compute mortality rate ratios by education (controlling for other factors). The analysis shows that life expectancy at age 30 differs by 11.3 years between men with the highest and those with the lowest educational levels. For women, the difference was estimated to equal 6.9 years.

Netherlands

Socio-demographic data were collected within the framework of the prospective GLOBE study (Gezondheid en LevensOmstandighedenBevolking Eindhoven en omstreken). In 1991 a random sample of 27 070 non-institutionalised Dutch persons (aged 15-74 years) drawn from municipal population registers from Eindhoven and its surrounding was sent a postal questionnaire. The response rate was 70.1%. Two sub-samples of the respondents were approached for a structured interview[1].

In the study a total 4087 respondents were eligible for the analyses(van Oort et al., 2005). Education is chosen as a proxy for socio-economic position. The follow-up of all subjected that started in 1991 ended in 1998. Information about mortality (and changes of address) was collected annually via municipal population registers and could therefore be easily linked to socio-demographic data. No information is provided regarding the data that failed to be linked.

[1] One sub-sample overrepresented people with chronic lung disease, severe heart disease, diabetes, and persistent back trouble (response 72.3%), n = 2865). The other sub-sample was a random sample of respondents to the postal questionnaire (response 79.4%, n = 2802).

All analyses were weighted to make the sample representative for the original GLOBE respondents. Hazard ratios for levels of education adjusted for age, gender and other covariates (were calculated material factors, behavioural factors, and for psychosociological factors). It was shown that hazardsare between 1.43 and 4.46 times higher for the lowest educated level than for the highest educated group.

Spain

Mortality rates by SES were estimated in the two major cities of the country: Madrid and Barcelona. The population at risk comes from the 1991 Municipal Censuses. The censuses information is revised every 5 years through the active collection of data by the statistical office of each municipality. Between these major revisions, the information is continually updated to incorporate data on births and deaths. Death register and municipal censuses are thus linked. Using 1993 and 1994 mortality data, linkage problems (due to problems of record linkage or missing data) appeared in 1.5% of deaths in Madrid and 9% in Barcelona.
Education levels served as an indicator of socio-economic position. Three levels of education were distinguished: *no education* (0-4 years of schooling), *primary education* (5-11 years) and *secondary or higher education* (more than 11 years).

This data has been used to estimate age- and sex-specific mortality rates and life expectancy at 25 years for each educational level using the life-table method(Borrell et al., 1999). Rate ratios were also calculated. Results showed that the mortality risk for the 25 to 34 year old males in Madrid is between 6.08 and 8.27 times higher for low educated than for higher educated. For females in Madrid, the same risk is estimated to vary between 4.91 and 8.17. The analyses show that the differences in mortality by education are more important for the younger population than for the middle-aged and the elderly population.

Switzerland

In Switzerland, recent mortality studies by SES are based on the Swiss National Cohort, a national longitudinal research platform. Initial data comes from the 1990 census. Although no unique personal identifier is available in Switzerland, the exact data of birth was included in that census for the first time, making it possible to link census data and mortality data from that period of time onwards. Accordingly, the 1990 census was linked with the 2000 census, mortality and emigration records using both deterministic and probabilistic methods of matching. In the first step, pairs of records that were matched on sex, date of birth, martial status, nationality, religion and place of residence were identified. In subsequent steps, probabilistic record linkage was used, which estimates the probability that a pair of records from different datasets relates to the same person. Additional variables, in particular information on the spouse and family structure were used in the process. Based on probability weights, possible matches were accepted or rejected. Linkage was automated using the Generalized Record Linkage System (GRLS) packaged developed by Statistics Canada. Of all individuals registered in the 1990 census, 81.9% could be linked to a 2000 census record, and during the period 1990-2000, 2.6% to an emigration record and 8.6% to a mortality record. For the remaining individuals with a 1990 census record (6.9%) no satisfactory link could be found. Note also that of all the death recorded from 1990 to the end of 2000, 95.3% could be linked successfully to a census record.

This dataset was used to analyse inequalities for those aged between 40 and 79(Faeh & Bopp, 2010). Socio-economic position was assessed by the education level as measured in the 1990 census. Two approaches were used. For regression analysis (i.e. the calculation of relative change of hazard ratios by the means of Cox model), the estimated years of education was used. For descriptive mortality and prevalence rates (calculated using lexis expansion for 5-year age classes), the denotations used in the censuses were reclassified into 3 categories of education. The study shows mortality per additional year of education decrease in the youngest age group by about 7 % (in French Switzerland) and 9% (in German Switzerland) in men an by about 6% (in French Switzerland) and 4% (in German Switzerland) in women.

The United Kingdom

In the UK, mortality rates by socio-economic position are preferably estimated by combining death records (numerator) with mid-year population estimates (denominator) obtained at every census (i.e. every 10 years). The method involves the correction for biases resulting from the use of unlinked data. In order to contribute to the monitoring of health inequalities over time, the Office for National Statistics investigated the feasibility of using survey data – namely, the Labour Force Survey (LFS) – to provide population denominators for the estimation of mortality rates by socio-economic status. The LFS collects detailed data on occupation for a sample of approximately 60,000 households in the UK quarterly and annually (annual dataset being boosted). The survey measures socio-economic position by the means of the National Statistics Socio-economic Classification (NS-SEC), which is derived from an individual's occupation and employment status and the size of their organization. Since size of organisation is not collected on the death register, a version of NS-SEC is used which is derived from occupation and employment status alone. This is known as 'reduced NS-SEC'. A specific methodology was developed for estimating mi-year populations by age (5-years classes) and NS-SEC using the LFS. LFS data were standardized by age to ONS mi-year population estimates, and adjusted for potential health selecting using the same proportional adjustments as were used for a previous census-based denominator study. The age-specific rates for each NS-SEC class were then standardised to the European standard population to produce age-standardised mortality rates for each class.

The study using the described methodology focused on men aged 25-64. For instance, for the higher managerial class age-standardised mortality rate was estimated between 162 and 175 (per 100,000). For the Routine class it is estimated between 525 and 543. (Johnson & Langford, 2010)Also, in the UK inequality in mortality has been examined by geographical area (Wells & Gordon, 2008).

EUROSTAT recommendations

Eurostat has been requested to develop comparable information on mortality by socio-economic status on a regular basis for all EU Member States. In fact, the data described above are the results mainly of ad hoc studies. Given the heterogeneity of the possible methods to estimate such indicators, Eurostat is currently working on guidelines regarding the preferable methodologies for the estimation of mortality by SES. This is a work in progress, but some recommendations are already available:

1. It is suggested to use educational attainment as proxy for socio-economic position: provided a standard classification is used (i.e. ISCED), education level can determined for all individuals, it is more stable and it is in line with countries' practices.
2. The preferable measure of mortality is life expectancy. Life expectancy has a ready interpretation and it is comparable across populations with different age structure.
3. Regarding the source of information used to calculate mortality rates, it is recommended to link death certificates with census information from the censuses broken down by educational attainment, using a personal identity number. Indeed, the procedure avoids inconsistencies between the numerator and the denominator. Nevertheless, a bias is to be expected because the SES is measured at the time of the

census and not at the time of death (but it should be limited if the follow-up period is short). If no unique personal number is available, deterministic methods or probabilistic methods should be used.

In parallel, Eurostat is encouraging the National Statistical Institutes of Member States to carry out the "census recordslinkage" and follow-up on the occasion of the 2011 census round. Therefore, a list of guidelines andof related methodological issues is being developed on order to help the NISs interested in doingthis exercise. These guidelines refer to: linkage procedure and software;handling of non-matched deaths;calculation of deaths rates;follow-up period; follow up of migration and emigration and possible sources of bias.

Table 5.1: Estimation of mortality by SES in a number of European countries

Country	SES indicator	Period	Source of data	Linkage approach
Austria REF	Education	1981-1982 1991-1992 2001-2002	Mortality follow up of the national census	Individual linkage , no unique personal identifier
Bulgaria REF	Education	1992-1998	Mortality follow up of national census	Individual linkage, unique identifier
Denmark	Education Occupation	1996-2005 1986-1990	Mortality follow up of the national census	Individual linkage, unique identifier
Finland	Education	1994-1998	Mortality follow up mortality of a sample of the national census	Individual linkage, unique identifier
France	Education Occupation	1990-1999	Mortality follow up of the permanent demographic sample	Individual linkage, unique identifier
Lithuania	Education	2001-2004	Mortality follow up of the national census	Individual linkage, unique identifier
Netherlands (Eindhoven)	Education	1991-1998	Mortality follow up of the GLOBE longitudinal survey	Individual linkage, unique identifier
Spain (Madrid, Barcelona)	Education	1993-1994	Mortality follow up of the municipal census	Individual linkage, unique identifier
Switzerland	Education	1990-2000	Mortality follow up of the Swiss National Cohort longitudinal study No unique personal identifier	Individual linkage , no unique personal identifier
United Kingdom	Reduced NS-SEC	2001-2007	Mortality follow up of the national Labor Force Survey	Unlinked approach

6. Evaluation of the alternatives and recommendations

The aim of this project is to propose an approach to estimate HE by SES using databases other than the national census. Using the census and its mortality follow up is the golden standard for such estimations but this approach is not feasible anymore in Belgium as the 2001 census was the last ‘classical’ census. We examined two alternative approaches: an unlinked approach using two different databases and a linked approach using the follow up mortality of survey data.

The comparison of the linked and unlinked approaches to estimate mortality rates undertaken in chapter 2 illustrates that the use of non-linked data results in a considerable bias, mortality rates being significantly underestimated both among men and women and for quasi all educational levels. The bias results from the quality of the educational information in the death certificates, with a very high percentage of missing information. More than 70% of the deaths in the certificates have a missing value for education. This group clearly has a much higher mortality rate in the non-linked data. Social inequalities in mortality between the educational groups generally seem overestimated when using non-linked data.

These conclusions have important implications. If mortality and social inequalities in mortality need to be investigated through non-linked data, educational level should be registered correctly and exhaustively in the certificates. Mortality and inequalities cannot be investigated correctly when information on educational level is missing for more than three quarters of the population. Respondents for whom educational data are missing could eventually be distributed in such a way that the educational distribution of the total population in the census 2001 is respected. Or educational information could be derived from other socioeconomic characteristics, such as professional class.

However, even if educational level is registered correctly in the certificates, errors can occur when using non-linked datasets to compute mortality rates by educational level (differing registration of education in both data sets, technical problems, registration errors in mortality). The best option is that data can be linked. The availability of a unique identification number allows for a relatively correct linkage of data, ensuring that the linked information applies to the one and same person. This is the best approach to calculate mortality rates by educational level. The 2001 census was the last ‘classical’ census in Belgium. It will be replaced by an administrative census. In this administrative census the registration of education is not ensured for the total population in Belgium. This definitely has repercussions for the follow-up of social inequalities in mortality.

As an alternative, using the follow up mortality of surveys is an interesting approach. In this approach, we do not have the problem of numerator denominator bias, but other issues have to be considered. The main issue is the selection bias generated due to the difference between the census and the survey. The surveys are based on a sample while the census aims at enumerating the whole population. Also the surveys are not compulsory and so respondents may chose not to participate. This implies that a bias will be generated due to the selection of survey participants. In fact, a study has shown that people in lower SES categories were less likely to participate in a survey when they had a poor health status compared to people in higher educational categories(Lorant et al., 2007). In this case, health inequalities may be underestimated. Although in both the HIS and the SILCan effort is deployed to increase the response rate and to account for participation rate, still selection bias may be an important issue using this approach. Further the size of the survey may be too small and surveys may not cover all age groups or may be not designed to representative at levels other than the national level.

Based on this, we issue a number of recommendations to monitor HE by SES in Belgium:

1-The golden standard for estimating the mortality part of the HE is to use a unique identifier to link the census with the National Register. In the absence of such source of data other approaches will be used.

2-If an unlinked approach is to be used, it is important to highlight that there is a significant nominator denominator bias that has to be acknowledged.

3-If survey follow up is to be used, a choice has to be made on the survey. The surveys that were evaluated (HIS and SILC) provide estimation of HE with comparable variances. This is because the sample size is comparable in both surveys. Therefore, the decision of using one survey over the other to monitor HE by SES should not be based on the statistical stability of the estimation but rather on other criteria.

If one is interested in monitoring HE by SES by region then the HIS is a better choice. In fact, the SILC data is representative at the national level, but there is no additional effort to generate estimate that are accurate at the regional level. Still, estimations for the Walloon and the Flemish regions may be accurate, but it is not the case for Brussels. The HIS, however, is designed to be representative of the three regions and therefore theoretically to derive acute estimators. In the present report, no estimations have been undertaken at the regional level, but we expect that the estimation is feasible even if the sample size is smaller (3500 in Flanders, 3500 in Wallonia, and 3000 in Brussels) and therefore the statistical precision would be lower. Methods can be used to overcome this limitation, such as using the bootstrap method to estimate the variance of HE.

As seen in Chapter 4 and Appendix 3 the difference in SES is significant for younger ages in both surveys, however, for older ages, the gradient exists only in the HIS. This may be another advantage of the HIS where there is an oversampling of elderly people. Therefore, if the aim of the monitoring is to estimate inequalities at older ages, then the HIS may be a better option. This is especially true that a number of studies have found significant social inequalities in HLYat older ages (add ref).

The main advantage of the SILC is its annual periodicity. The data of the SILC are issued yearly, however the HIS is collected every 4 to 5 years. Therefore, if the aim is to monitor HLY by SES frequently, then the SILC may be the best alternative.

4-It is important to highlight that the HIS and the SILC can both be used to estimate inequalities in HLY in Belgium but the results are not interchangeable. In other words, it is possible to compare HLY estimates within surveys but not between surveys. Therefore, a decision has to be made on the survey to be used at this point and the future estimations must also be based on the same survey. Otherwise, comparison would be meaningless.

3-Concerning the SES stratification, we used in this report educational level. As seen in the chapter reviewing the situation in a number of European countries and the Eurosat recommendations, education is the variable of choice. Therefore, we recommend its use for the monitoring system.

4-Concering the health outcome to be used, we propose the use the indicator we used in this report that is the Global Activity Limitation Indicator (GALI). As mentioned previously in this report, the GALI allows the estimation of disability free life expectancy that is a structural indicator of the EU. This indicator is based on the Minimum European Health Module (MEHM) that is included in the SILC since 2004 and in the HIS since 2001. It is also interesting for potential European comparison as the MEHM has been implemented in several European countries and European surveys.

5-Concerning the methods for estimating health expectancies, we recommend the use of the Sullivan method. This is the method that is predominately used in the literature. This method has a number of drawbacks mainly that it is based on current morbidity prevalence rates, and not current incidence rates. Also, it assumes the current mortality rates will prevail in future cohorts as they reach the same age. Still, this method is viewed as the method of choice to estimation HE due to its simplicity, relative accuracy and ease of interpretation. Also, we recommend calculating the variances with the HE. This will allow a better understanding of the stability of the estimates.

We also recommend to account for the fact that the ages of the subjects in the surveys change during the follow up time, the longer the follow-up period is, the larger will be the difference between the ages of entry and those "acquired" during the follow up. To account for this, Lexis expansions of the original data is often used. For this, we divided the follow up period of each subject into 1-year age bands(Kirkwood & Sterne, 2003).The steps and programs used to estimate HE are found in Appendix 2.

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Appendix 1: Final tables

Tables of life expectancy and healthy life years by age groups, sex and education using the HIS and the SILC

			HIS			SILC		
Age groups	Sex	Education	Life Expectancy	HLY	Variance of HLY	Life Expectancy	HLY	Variance of HLY
15	Male	Primary	59,12	44,55	2,1	57,62	35,14	2,28
20	Male	Primary	54,12	40	2,07	52,62	30,74	2,25
25	Male	Primary	49,12	35,49	2,03	48,69	28,44	1,58
30	Male	Primary	45,6	32,4	0,9	43,69	25,11	1,29
35	Male	Primary	40,6	28,23	0,83	38,69	21,41	1,11
40	Male	Primary	35,6	23,82	0,78	33,69	18,46	0,98
45	Male	Primary	30,6	19,95	0,72	29,33	15,7	0,81
50	Male	Primary	25,6	16,06	0,66	24,73	13,33	0,68
55	Male	Primary	21,08	13,03	0,52	21,18	11,07	0,53
60	Male	Primary	17,15	10,51	0,37	17,8	8,9	0,41
65	Male	Primary	13,38	7,49	0,27	15,03	7,38	0,32
70	Male	Primary	10,98	5,81	0,17	12,32	5,57	0,28
75	Male	Primary	8,13	3,75	0,13	10,11	4,05	0,31
80	Male	Primary	6,43	2,47	0,12	6,86	2,53	0,32
85	Male	Primary	4,7	2,27	0,07	5,25	1,42	0,68

			HIS			SILC	
Age groups	Sex	Education	Life Expectancy	HLY	Variance of HLY	Life Expectancy	HLY
15	Male	Lowersecondary	58,35	43,88	2,30	60,69	41,78
20	Male	Lowersecondary	54,29	39,89	1,86	55,69	37,17
25	Male	Lowersecondary	50,20	35,72	1,47	50,69	33,42
30	Male	Lowersecondary	45,20	30,96	1,44	45,69	29,82
35	Male	Lowersecondary	40,20	26,69	1,37	41,78	26,89
40	Male	Lowersecondary	35,93	23,33	1,13	37,50	23,74
45	Male	Lowersecondary	31,51	19,81	0,97	32,89	19,97
50	Male	Lowersecondary	27,35	16,67	0,82	27,89	15,91
55	Male	Lowersecondary	23,49	13,44	0,68	23,98	13,23
60	Male	Lowersecondary	20,00	11,13	0,53	20,73	11,26
65	Male	Lowersecondary	16,22	7,85	0,43	17,93	9,80
70	Male	Lowersecondary	12,66	4,99	0,38	13,69	6,79
75	Male	Lowersecondary	9,60	3,69	0,33	9,63	4,55
80	Male	Lowersecondary	6,54	2,57	0,30	6,22	3,34
85	Male	Lowersecondary	3,53	0,41	0,11	5,52	2,29

Age groups	Sex	Education	HIS Life Expectancy	HLY	Variance of HLY	SILC Life Expectancy	HLY	Var of
15	Male	Highersecondary	62,56	50,87	1,76	63,03	46,21	0
20	Male	Highersecondary	58,15	46,59	1,55	58,03	41,62	0
25	Male	Highersecondary	53,67	42,24	1,40	53,03	37,04	0
30	Male	Highersecondary	48,67	37,69	1,39	48,30	32,97	0
35	Male	Highersecondary	43,67	33,34	1,36	43,83	29,14	0
40	Male	Highersecondary	38,67	28,92	1,35	39,03	25,18	0
45	Male	Highersecondary	33,91	25,00	1,31	34,21	21,28	0
50	Male	Highersecondary	29,60	21,07	1,26	29,89	18,22	0
55	Male	Highersecondary	25,64	17,93	1,17	25,37	15,11	0
60	Male	Highersecondary	21,48	14,97	1,08	20,92	11,74	0
65	Male	Highersecondary	17,57	11,51	1,02	17,13	9,06	0
70	Male	Highersecondary	13,95	9,08	0,97	13,55	6,73	0
75	Male	Highersecondary	11,10	6,96	1,02	9,76	4,06	0
80	Male	Highersecondary	7,94	5,13	1,15	7,37	3,16	0
85	Male	Highersecondary	8,55	6,73	2,04	5,88	2,61	1

			HIS			SILC		
Age groups	Sex	Education	Life Expectancy	HLY	Variance of HLY	Life Expectancy	HLY	Vari of
15	Male	Highereducation	64,42	51,79	1,27	68,09	51,87	2
20	Male	Highereducation	59,42	47,02	1,26	63,09	46,87	2
25	Male	Highereducation	55,06	42,65	1,02	58,09	42,28	2
30	Male	Highereducation	50,06	37,96	1,01	53,09	38,00	2
35	Male	Highereducation	45,35	33,80	0,96	48,40	33,84	1
40	Male	Highereducation	40,35	29,33	0,95	43,40	29,35	1
45	Male	Highereducation	35,57	25,06	0,92	38,40	25,12	1
50	Male	Highereducation	30,57	20,82	0,90	34,21	21,63	1
55	Male	Highereducation	26,01	16,62	0,87	29,72	17,85	1
60	Male	Highereducation	21,60	13,19	0,82	25,79	14,69	1
65	Male	Highereducation	17,52	9,82	0,77	21,78	11,28	1
70	Male	Highereducation	13,29	6,48	0,70	17,69	8,20	1
75	Male	Highereducation	11,11	5,46	0,66	15,07	6,29	2
80	Male	Highereducation	7,90	4,04	0,59	11,24	4,37	2
85	Male	Highereducation	4,46	2,79	0,47	6,68	1,86	2

			HIS			SILC		
Age groups	Sex	Education	Life Expectancy	HLY	Variance of HLY	Life Expectancy	HLY	Vari of
15	Female	Primary	65,54	41,72	1,64	66,98	36,47	2
20	Female	Primary	63,50	38,67	1,77	63,56	33,11	1
25	Female	Primary	58,50	34,25	1,68	58,56	30,37	1
30	Female	Primary	53,50	30,56	1,40	53,56	27,68	0
35	Female	Primary	48,50	27,68	1,13	48,56	23,84	0
40	Female	Primary	43,50	23,61	1,03	43,56	20,61	0
45	Female	Primary	38,50	20,50	0,86	38,56	18,03	0
50	Female	Primary	33,50	17,42	0,70	33,56	14,50	0
55	Female	Primary	28,50	14,83	0,58	29,76	12,37	0
60	Female	Primary	23,50	11,70	0,47	24,76	9,70	0
65	Female	Primary	19,54	8,62	0,36	20,80	7,56	0
70	Female	Primary	16,13	6,39	0,29	16,42	5,39	0
75	Female	Primary	13,15	4,48	0,26	13,33	4,00	0
80	Female	Primary	9,71	3,38	0,26	9,78	2,09	0
85	Female	Primary	6,85	1,54	0,19	7,77	1,40	0

			HIS			SILC		
Age groups	Sex	Education	Life Expectancy	HLY	Variance of HLY	Life Expectancy	HLY	[illegible]
15	Female	Lowersecondary	68,84	49,68	1,45	69,58	43,78	
20	Female	Lowersecondary	63,84	45,04	1,41	64,58	39,59	
25	Female	Lowersecondary	58,84	40,14	1,40	61,47	36,75	
30	Female	Lowersecondary	53,84	35,46	1,36	56,47	33,58	
35	Female	Lowersecondary	48,84	30,72	1,33	51,47	30,12	
40	Female	Lowersecondary	43,84	26,69	1,27	46,47	26,94	
45	Female	Lowersecondary	38,84	22,61	1,22	41,47	23,66	
50	Female	Lowersecondary	34,35	18,58	1,13	36,47	20,40	
55	Female	Lowersecondary	31,72	16,29	0,90	31,92	17,87	
60	Female	Lowersecondary	26,72	12,79	0,84	28,14	14,98	
65	Female	Lowersecondary	22,41	9,91	0,75	23,84	11,90	
70	Female	Lowersecondary	18,41	6,66	0,73	19,22	9,01	
75	Female	Lowersecondary	15,08	4,85	0,74	15,29	6,65	
80	Female	Lowersecondary	11,59	3,28	0,70	11,18	4,67	
85	Female	Lowersecondary	7,83	2,02	0,69	8,67	5,38	

			HIS			SILC		
Age groups	Sex	Education	Life Expectancy	HLY	Variance of HLY	Life Expectancy	HLY	V
15	Female	Highersecondary	69,67	53,17	1,64	69,10	46,16	
20	Female	Highersecondary	64,67	48,86	1,61	64,10	41,68	
25	Female	Highersecondary	59,67	44,06	1,60	59,10	37,33	
30	Female	Highersecondary	54,67	39,39	1,59	54,10	33,44	
35	Female	Highersecondary	50,08	35,06	1,52	49,10	29,71	
40	Female	Highersecondary	45,08	30,79	1,50	44,10	25,83	
45	Female	Highersecondary	40,08	26,56	1,47	39,34	22,05	
50	Female	Highersecondary	35,36	22,93	1,43	34,77	18,55	
55	Female	Highersecondary	30,36	19,41	1,38	30,40	15,20	
60	Female	Highersecondary	26,56	16,01	1,31	26,31	12,27	
65	Female	Highersecondary	22,18	12,53	1,25	22,24	9,26	
70	Female	Highersecondary	18,07	10,19	1,19	18,74	6,64	
75	Female	Highersecondary	13,60	7,18	1,12	15,12	4,77	
80	Female	Highersecondary	10,14	5,39	1,22	11,21	2,85	
85	Female	Highersecondary	7,20	3,94	1,29	8,03	1,18	

			HIS			SILC	
Age groups	Sex	Education	Life Expectancy	HLY	Variance of HLY	Life Expectancy	HLY
15	Female	Highereducation	73,37	60,07	2,60	-	-
20	Female	Highereducation	68,37	55,32	2,59	66,85	47,42
25	Female	Highereducation	63,37	50,48	2,58	61,85	42,73
30	Female	Highereducation	58,37	45,75	2,58	56,85	38,29
35	Female	Highereducation	53,37	41,07	2,57	51,85	34,04
40	Female	Highereducation	48,37	36,41	2,56	47,09	29,97
45	Female	Highereducation	43,37	31,79	2,55	42,09	25,83
50	Female	Highereducation	38,64	28,03	2,52	37,57	22,18
55	Female	Highereducation	34,17	24,35	2,49	32,57	18,75
60	Female	Highereducation	29,46	20,67	2,45	28,43	15,37
65	Female	Highereducation	24,81	16,95	2,39	24,62	12,57
70	Female	Highereducation	21,00	14,90	2,30	19,62	9,63
75	Female	Highereducation	16,47	11,77	2,13	16,29	8,15
80	Female	Highereducation	13,55	9,61	2,00	12,59	5,75
85	Female	Highereducation	10,59	8,25	1,75	8,25	3,19

Difference between HLY in the lowest and highest educational categories among men in the HIS

Age groups	HLY Low	Variance HLYlow	HLY high	Variance HLYhigh	Difference HLY	Difference variance	z	pva
15	44,55	2,10	51,79	1,27	7,23	3,37	2,15	0,0
20	40,00	2,07	47,02	1,26	7,02	3,32	2,11	0,0
25	35,49	2,03	42,65	1,02	7,16	3,05	2,35	0,0
30	32,40	0,90	37,96	1,01	5,56	1,91	2,91	0,0
35	28,23	0,83	33,80	0,96	5,57	1,79	3,11	0,0
40	23,82	0,78	29,33	0,95	5,51	1,73	3,19	0,0
45	19,95	0,72	25,06	0,92	5,11	1,64	3,12	0,0
50	16,06	0,66	20,82	0,90	4,75	1,56	3,05	0,0
55	13,03	0,52	16,62	0,87	3,60	1,39	2,59	0,0
60	10,51	0,37	13,19	0,82	2,68	1,19	2,25	0,0
65	7,49	0,27	9,82	0,77	2,33	1,04	2,25	0,0
70	5,81	0,17	6,48	0,70	0,67	0,87	0,77	0,4
75	3,75	0,13	5,46	0,66	1,71	0,79	2,17	0,0
80	2,47	0,12	4,04	0,59	1,56	0,71	2,20	0,0
85	2,27	0,07	2,79	0,47	0,52	0,53	0,98	0,3

Difference between HLY in the lowest and highest educational categories among women in the HIS

Age groups	HLY Low	Variance HLYlow	HLY high	Variance HLYhigh	Difference HLY	Difference variance	z
15	41,72	1,64	60,07	2,60	18,36	4,24	4,33
20	38,67	1,77	55,32	2,59	16,65	4,37	3,81
25	34,25	1,68	50,48	2,58	16,24	4,26	3,81
30	30,56	1,40	45,75	2,58	15,20	3,97	3,82
35	27,68	1,13	41,07	2,57	13,38	3,70	3,62
40	23,61	1,03	36,41	2,56	12,80	3,60	3,56
45	20,50	0,86	31,79	2,55	11,28	3,41	3,31
50	17,42	0,70	28,03	2,52	10,61	3,22	3,30
55	14,83	0,58	24,35	2,49	9,52	3,08	3,09
60	11,70	0,47	20,67	2,45	8,97	2,92	3,08
65	8,62	0,36	16,95	2,39	8,33	2,76	3,02
70	6,39	0,29	14,90	2,30	8,52	2,59	3,29
75	4,48	0,26	11,77	2,13	7,29	2,39	3,04
80	3,38	0,26	9,61	2,00	6,24	2,26	2,76
85	1,54	0,19	8,25	1,75	6,71	1,94	3,46

Difference between HLY in the lowest and highest educational categories among men in the SILC

Age groups	HLY Low	Variance HLYlow	HLY high	Variance HLYhigh	Difference HLY	Difference variance	z	pva
15	35,14	2,28	51,87	2,08	16,72	4,35	3,84	0,0
20	30,74	2,25	46,87	2,08	16,12	4,32	3,73	0,0
25	28,44	1,58	42,28	2,06	13,84	3,64	3,80	0,0
30	25,11	1,29	38,00	2,03	12,88	3,32	3,88	0,0
35	21,41	1,11	33,84	1,99	12,43	3,11	4,00	0,0
40	18,46	0,98	29,35	1,98	10,88	2,96	3,68	0,0
45	15,70	0,81	25,12	1,96	9,42	2,77	3,40	0,0
50	13,33	0,68	21,63	1,92	8,30	2,60	3,19	0,0
55	11,07	0,53	17,85	1,90	6,78	2,43	2,79	0,0
60	8,90	0,41	14,69	1,93	5,79	2,34	2,47	0,0
65	7,38	0,32	11,28	1,96	3,89	2,28	1,71	0,0
70	5,57	0,28	8,20	1,98	2,63	2,26	1,17	0,2
75	4,05	0,31	6,29	2,30	2,24	2,61	0,86	0,3
80	2,53	0,32	4,37	2,31	1,84	2,63	0,70	0,4
85	1,42	0,68	1,86	2,24	0,44	2,92	0,15	0,8

Difference between HLY in the lowest and highest educational categories among women in the SILC

Age groups	HLY Low	Variance HLYlow	HLY high	Variance HLYhigh	Difference HLY	Difference variance	z
15	36,47	2,09	-	-	-	-	-
20	33,11	1,43	47,42	3,08	14,31	4,51	3,18
25	30,37	1,16	42,73	3,07	12,36	4,23	2,92
30	27,68	0,86	38,29	3,06	10,60	3,92	2,71
35	23,84	0,74	34,04	3,04	10,19	3,79	2,69
40	20,61	0,63	29,97	3,03	9,36	3,66	2,56
45	18,03	0,54	25,83	3,01	7,80	3,55	2,20
50	14,50	0,47	22,18	3,01	7,67	3,49	2,20
55	12,37	0,35	18,75	2,97	6,38	3,32	1,92
60	9,70	0,30	15,37	3,00	5,67	3,30	1,72
65	7,56	0,23	12,57	3,05	5,01	3,28	1,53
70	5,39	0,19	9,63	2,90	4,25	3,09	1,37
75	4,00	0,17	8,15	2,92	4,14	3,09	1,34
80	2,09	0,13	5,75	2,97	3,66	3,10	1,18
85	1,40	0,18	3,19	2,69	1,79	2,87	0,62