Is it worth weighting for? Health expectancies in Europe based on education-adjusted weights

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Abstract

This paper explores if health expectancies are affected by biases in the education structure of survey data. Health expectancies are widely used by scholars and policy makers to analyse how many years a person can expect to live in good health. For their calculation, life tables in combination with prevalence of good or bad health from survey data is needed. Yet survey data rarely resembles the education distribution in the general population, which is crucial given the strong positive correlation between educational attainment and good health. By generating education-adjusted post-stratification weights for 13 European countries, it is possible to analyse if and how this deviation affects health expectancy measures. The study utilises data provided by the Survey of Health, Ageing and Retirement in Europe (SHARE), as well as information from the 2011 census and population and mortality data from Eurostat. Results show that health expectancies are over-estimated for most countries analysed when the education distribution in the general population is ignored. In some countries, health expectancies are under-estimated without the education-adjusted weights. Yet none of the differences appear statistically significant.

1 Introduction

Life expectancy keeps increasing in Europe. We live longer, but do we live healthier? Answering this question is of utmost importance in the presence of demographic change. Public and private health care providers need this information to plan health coverage and care services. Furthermore, policy makers are interested in the employability of older generations when adapting pension systems, in particular, the retirement age. Whether we spend our additional life years in good or bad health is frequently analysed via health expectancies (HEX), an indicator that captures the number of years a person can expect to live in good health. The concept of HEX was developed half a century ago (Sanders 1964, Sullivan 1971) and has received increasing attention since then. For example, the European Commission stated their goal to add two years of healthy life for the average European by 2020 (European Commission 2011). Furthermore, many European governments use HEX to set health related targets and make policy changes based on the measure (Bogaert et al. 2018).

HEX usually combine information on mortality with prevalence rates of good or bad health from survey data. Therefore, they capture both the quantity and quality of additional life years. A key problem with this approach is that the education distribution of survey participants rarely resembles the distribution of the general population. A common deviation is that high-educated individuals are more likely to participate in surveys, leading to an over-representation of that group in the samples (Reinikainen et al. 2018, Demarest et al. 2013, Korkeila et al. 2001). This mismatch is crucial given the strong positive correlation between education and good health (Mirowsky 2003, Eide & Showalter 2011, Cutler & Lleras-Muney 2006, 2010). If the healthier, well-educated individuals are over-represented in surveys, countries appear healthier than they actually are.

We explore if and how HEX differ when the education structure in the general population is considered. For this purpose, post-stratification weights are computed, which adjust for the education-bias in survey response. We compare HEX with and without these education-adjusted weights to analyse if the deviation between surveys and the general population biases the outcomes. The analysis covers 13 European countries in 2011. Prevalence of bad health is taken from the Survey of Health, Ageing and Retirement in Europe (SHARE), one of the most commonly used sources for the computation of HEX in Europe. Auxiliary information on the education distribution in the general population is taken from Eurostat's Census database, which provides Population and Housing Censuses for most EU countries. Life tables are generated based on population and mortality data provided by Eurostat.

The remainder of this paper is structured as follows. In section 2, relevant literature is summarised. Following that, the methods and datasets are introduced in sections 3 and 4 respectively. Results are presented and discussed in sections 5. Section 6 concludes by summarising the study's findings.

2 Background

The positive correlation between education and good health is well established (Mirowsky 2003). Parts of the relationship can be explained with economic rationales, such as the positive links between education and income or correlations between education and occupational choice (Cutler & Lleras-Muney 2006). Additionally, differences in health behaviour are potential drivers of the education gradient in health. On the one hand, low-educated individuals are more likely to smoke, drink heavily, and be obese than high-educated individuals. On the other hand, they are less likely to use preventive care, drive safely, or live in safe houses (Cutler & Lleras-Muney 2010). Health behaviour of educational groups converges with age. Differences between high- and low-educated groups are largest at young age and start decreasing around age 50 (Cutler & Lleras-Muney 2006). While the positive correlation between education and health can be found all over Europe, its size varies by country. In Eastern European countries, Norway, and Germany, high-educated individuals are much healthier than low-educated individuals, whereas in Denmark, high-educated individuals are not that much different from low-educated individuals. Being less educated is particularly harmful for health in Czech Republic, Denmark, Belgium, Italy, and Hungary, but not so much in Sweden, Finland, Romania, Bulgaria, and Spain (Cambois et al. 2016).

In addition to health, education is associated with unit non-response in surveys, which is a major concern when calculating HEX. Participation in surveys is usually voluntary, which often leads to low response of certain socio-economic groups. If the socio-economic characteristics associated with the variable of interest are also associated with unit non-response, this can lead to a selection bias. Such associations are frequently shown in the case of education and health. Firstly, high-educated individuals are healthier than low-educated individuals, and secondly, high-educated individuals are more likely to participate in surveys. The under-representation of low-educated individuals appears in several national health surveys, for example in Belgium (Van Der Heyden et al. 2017, Demarest et al. 2013), Denmark (Ekholm et al. 2010), and Finland (Reinikainen et al. 2018). When inference about the health of the general population is made based on unweighted prevalence rates from these surveys, the general population appears healthier than they actually are. For example, Van Der Heyden et al. (2017) find that the prevalence of people with diabetes and asthma increases in Belgium once the actual education distribution in the general population is considered for via education-adjusted weights.

Prevalence rates of good or bad health are one of the main components needed when calculating HEX. Regardless of the evidence on biases in survey samples, prevalence rates for HEX are not usually calculated based on education-adjusted weights. One explanation for this disregard might be that auxiliary information on the actual education distribution in the general population is not readily available. Register data is only accessible for some European countries, and also censuses are conducted with long time intervals only. Still, evidence on HEX[1] is vast, but sometimes ambigiouse. Like life expectancy, HEX vary substantially between European countries and are particularly low in Eastern Europe (Jagger et al. 2011). Around 2010, HEX at birth are 70.1 for Swedish men, but only 52.6 for Slovakian men. For women, HEX at birth range from 71.5 years in Malta to 52.7 years in Slovakia (Jagger et al. 2013). Overall, women spend a larger proportion of their life disabled due to their longer survival (Pongiglione et al. 2015). While life expectancy clearly increased all over Europe, evidence on HEX is less conclusive. For example, Jagger et al. (2013) find little change between 2005 and 2009. On average over all countries, HEX slightly increased for men (+0.8 months), and decreased for women (-1.0 months). The lack of a clear time trend in HEX might partly be explained by the small sample sizes in surveys. Analysing prevalence by country, gender, and age requires sufficient numbers of observations in each country-gender-age cell. This is often not the case, especially, at older ages. Consequently, prevalence rates based on these small cells are often noisy and have huge confidence intervals - the small cell sizes make it difficult to separate the signal from the noise.

In the following sections, we analyse whether adjusting for the education distribution in the general population via post-stratification weights changes the prevalence of bad health and consquently HEX. Of course, unit non-response is not the only source of bias for survey estimates. Differences between survey data and the general population can also stem from measurement errors. For example, Bingley & Martinello (2014) find that a substantial proportion of Danish SHARE participants exaggerated their level of education, especially, when they were low-educated. Furthermore, education is not the only characteristic associated with non-response. Gender and age impact survey participation too, which is why these variables are also considered in our post-stratification weights. Furthermore, characteristics such as race (Shavers et al. 2002) or relationship status (Korkeila et al. 2001) are associated with non-response. Yet this study focuses on deviance in the education distribution only. Firstly, because the education gradient in response-behaviour is well established, and secondly, because auxiliary information on the education structure in the general population is more readily available than data on other socio-economic characteristics.

[1]Other commonly used terms for health expectancies are healthy life years, disability-free life expectancy, health-adjusted life expectancy, active life expectancy, or years of life without functional disabilities.

3 Data

The analysis relies on three different data sources. Computing HEX with Sullivan's method requires life tables along with prevalence of good or bad health (Sullivan 1971, Saito et al. 2014). Additionally, post-stratification weights rely on auxiliary data providing population totals of certain characteristics. We employ census data to obtain these totals. Since for most countries in our sample, census data is only available for 2011, our analysis focuses on that year. This section describes the three data sources utilised in more detail.

3.1 The Survey of Health, Ageing and Retirement in Europe (SHARE)

Prevalence rates of bad health are extracted from the fourth wave of SHARE, which was mainly conducted in 2011 (Börsch-Supan 2018, Börsch-Supan, Brandt, Litwin & Weber 2013, Malter & Börsch-Supan 2013). Some interviews took place in 2010 and 2012, yet 94 percent of all observations stem from 2011 interviews. In total, 16 European countries participated in the fourth wave. However, three of these countries do not provide reliable census data via Eurostat (see Section 3.2), which is why the remaining sample includes 13 countries only. These countries are Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Italy, Poland, Portugal, Slovenia, and Spain.

The target population of SHARE consist of all non-institutionalised individuals aged 50 and older, including their spouses, even if they are younger. Persons are not included in the target population if they are unable to speak the countries language(s). Citizenship or nationality are not criterions to be included in the target population, but regular residency in the respective country is (Börsch-Supan, Brandt, Hunkler, Kneip, Korbmacher, Malter, Schaan, Stuck & Zuber 2013, Lynn et al. 2013). The survey is based on probability samples with close to full population coverage for all countries, yet details regarding the sample design, in particular the sampling frame, vary by country, from simple random sampling to multi-stage designs (see Lynn et al. 2013, De Luca 2018, for an overview). The response outcome depends on how it is defined. When calculated strictly, it ranges from 33.1 percent in Czech Republic to 59.4 percent in Spain. When calculated less strictly, it ranges from 35.6 percent in the Netherlands to 89.4 percent in Austria (Bergmann et al. 2017). We dropped all observations that were younger than 50 years old, and observations that did not provide the main interview. The remaining country sample size lies between 1,615 observations in Germany and 6,754 observations in Estonia. Unfortunately, some of the countries have only small numbers of observations per gender-age-education cell, in particular, at higher ages. Details on the sample sizes and cell sizes for each country are summarised in Appendix A.2.

For the post-stratification weights, information on sample proportions by country, gender, age, and education is required. By construction, information on the country is non-missing for all observations. Also gender has no missing values. Information on age is available for all observations save six individuals in Czech Republic, which were dropped. The only variable of interest with missing information is education. Yet luckily, SHARE is a longitudinal dataset. By linking the fourth wave to the previous and subsequent waves, we are able to restore the education variable for almost all observations, only 1.7 percent remain with missing values. Education is split into three groups, in accordance with the International Standard Classification of Education (ISCED) (Eurostat 2018*b*). Firstly, the group "low-educated" includes individuals whos educational attainment is less than primary, primary, or lower secondary education. Secondly, the group "medium-educated" refers to individuals with upper secondary or post-secondary non-tertiary education. Finally, the group "high-educated" includes all individuals that have higher than post-secondary non-tertiary education. These education categories are directly comparable to the categories in the census data.

Prevalence of bad health is calculated based on the Global Activity Limitation Indicator (GALI) by country, gender, and five-year age group. 85 years serves as an open-ended category. GALI is commonly used to calculate HEX in Europe (Bogaert et al. 2018, Robine 2003). Evaluations show that the indicator measures function and disability similarly across European countries (Jagger et al. 2010). In particular, GALI is based on the reply to the following survey question: "For the past six months at least, to what extent have you been limited because of a health problem in activities people usually do?" The question is answered by each survey participant based on three categories, (1) "severely limited", (2) "limited, but not severely", and (3) "not limited". For the purpose of this study, GALI is dichotomised into a binary variable with (1) "severely limited" and (0) "not severely limited".

3.2 Eurostat data for post-stratification weights and life tables

The calculation of post-stratification weights requires auxiliary information on the actual population structure. For this purpose, it is assumed that the auxiliary information captures the true structure in the population with respect to certain characteristics, in our case, age, gender, and education. Therefore, we rely on census data provided by Eurostat (Eurostat 2018*a*). Along with the National Statistical Institutes, Eurostat combined Population and Housing Censuses from 2011 for 32 European countries and structured them in a comparable manner. 16 of these countries overlap with the countries in SHARE. Since the Netherlands, Sweden, and Switzerland show some irregularities in the census data provided on Eurostat, these countries are not included in the analysis, leaving a sample of 13 countries.

Population totals by gender, age, and education for the population 50 plus are extracted for each of the countries. These totals are used as control totals when calculating post-stratification weights. No country has missing information on age and gender, but some countries have missing information on educational attainment. In particular, Belgium and Poland have small numbers categorised as "unknown education" in all age groups. In Denmark, Germany, Hungary, Portugal, and Slovenia information on education is missing at older ages. Consequently, four education categories were constructed. The education groups "low-educated", "medium-educated", and "high-educated" are based on the same criterion as applied for SHARE, which were described in Section 3.1. In addition, an education category "unknown education" was constructed. For details regarding the population proportions by country, gender, age, and education based on the censuses, consult Appendix A.2.

The final data source utilised is population and mortality data provided by Eurostat (Eurostat 2018*c*). The calculation of HEX with Sullivan's method requires life tables. We generate life tables for 2011 by country and gender based on the number of people living in each five-year age group (demo_pjan), and the number of people dying in each five-year age group (demo_magec).

4 Methods

To explore if deviations in the education distribution of survey data affect HEX, two sets of post-stratification weights are computed and compared, one of which is adjusted for education. These weights are calculated using iterative proportional fitting (IPF). Based on the two sets of weights, two sets of prevalence rates are calculated using the dichotomised GALI indicator from SHARE. Following that, these prevalence rates are used to measure and compare HEX, applying Sullivan's method. The methods employed are explained in more detail in the following paragraphs.

4.1 Generating post-stratification weights via iterative proportional fitting

Frequently, the proportions of certain characteristics in survey data deviates from the proportions of the same characteristics in the general population. Assuming that the distribution in the general population is known, weights can be generated to account for these discrepancies. We calculate such post-stratification weights for SHARE data applying IPF, a method also known as raking. For this purpose, marginal totals for each characteristic considered in the weights need to be provided by an auxiliary source that is assumed to capture the true distribution in the general population. In our case, these are country-specific population totals for age, gender, and education provided by census data. These totals are referred to as control totals and presented in Appendix A.2. In particular, design weights provided with the survey data are adjusted, so that the marginal totals of these adjusted weights are conform with the corresponding marginal totals from the general population (Battaglia et al. 2009).

SHARE comes with several sets of weights, two of which are relevant for this analysis. Firstly, the data set provides sampling design weights that compensate for unequal selection probabilities of sample units. They are defined as the inverse of the probability of being included in the sample. These design weights account for unequal selection of sample units, but not for unit non-response (Lynn et al. 2013). Consequently, SHARE provides a second set of weights to account for differences in response behaviour. These cross-sectional weights are based on the sampling design weights and consider deviances in the proportions of gender, age, and NUTS 1 regions (De Luca & Rossetti 2018). They are referred to as SHARE weights for the remainder of this paper. We extend these SHARE weights by further considering deviances in the education distribution.

The SHARE weights are generated based on a calibration approach by Deville & Särndal (1992), which is implemented using Stata's `sreweight` command by Pacifico (2014). Control totals for the SHARE weights stems from the Eurostat regional database. The weights are calculated separately for each country, considering NUTS 1 regions as well as eight gender-age groups, with cuts at 50-59 years, 60-69 years, 70-79 years, and an open-ended category 80+ years. In some countries, finer partitions are made below age 59. Each individual observation is assigned a weight depending on its sampling design weight as well as its age, gender, and the region it lives in (De Luca & Rossetti 2018, De Luca 2018).

In a first step, we replicate the SHARE weights. This second set of weights is referred to as replicated weights. Our aim is for the replicated weights to be as close as possible to the SHARE weights, yet some amendments are made so that later, education can be added as an additional control total. The generation of post-stratification weights gets less robust, the smaller the relevant cells are (Battaglia et al. 2009) and the more population totals are considered. Hence, the post-stratification method applied by SHARE is altered accordingly to fit the needs of our analysis. Firstly, control totals are used for each characteristic separately, instead of cross-tabulations. For example, instead of using age-gender totals, separate totals for age and gender are applied. Secondly, Stata's `survwgt rake` option is used to generate the replicate weights, since it appeared more robust than the `sreweight` command. Like for the SHARE weights, this method builds upon the original sampling design weights and adjusts them to the census population totals (Winter 2018). Thirdly, an additional age category 80 to 89 years is included, making 90+ the open-ended category. Fourthly, control totals for NUTS 1 regions are not considered in this study. They were implemented as a robustness test, but did not alter the results, which is why they are left out for the sake of less population totals. Finally, the Eurostat regional database does not provide information by education, which is why the 2011 census is used in this analysis instead. Although these changes were made, prevalence rates calculated based on the SHARE weights are almost identical to those calculated based on the replicated weights, which confirms the approach taken in this study.

As a second step, we calculate education-adjusted weights. They are identical to the replicated weights, except that an additional control total for education is considered when applying IPF via `survwgt rake`. Hence, education-adjusted weights vary for each individual observation, depending on that individual's sampling design weight, its gender, age, and educational attainment. Also the 1.7 percent of individuals with missing values for education receive a post-stratification weight, since the control totals include a category for "unknown education".

Finally, weighted prevalence rates of bad health are calculated based on all three sets of weights, the SHARE weights, the replicated weights, and the education-adjusted weights. In particular, the prevalence rates are based on the binary GALI measures. The means are calculated separately by country, gender, and five-year age group, as that is the most common way to calculate HEX in Europe. The statistical difference between the three sets of prevalence rates is assessed applying the Delta method (Oehlert 1992). The prevalence rates along with the confidence intervals are presented in Appendix A.3.

4.2 Calculating health expectancies with Sullivan's method

HEX are computed applying Sullivan's method, which requires life tables along with prevalence of good or bad health (Sullivan 1971, Saito et al. 2014). Two sets of prevalence rates are used to calculate two sets of HEX, namely prevalence rates based on the replicated weights, and prevalence rates based on the education-adjusted weights. The prevalence rates are used to divide the person years lived in the life table into healthy and unhealthy years. Following that, HEX can be calculated by dividing the number of individuals surviving to a certain age x by the total years lived healthily from age x onwards. Population and mortality data for the life tables are taken from Eurostat (Eurostat 2018*c*)). The life tables generated are standard abridged period life tables by country, gender, and five-year age group, with 85+ being the open ended category.

An alternative to calculating HEX via Sullivan's method is the multistate life table method, which is said to be more accurate (Rogers et al. 1990, 1989). Yet Mathers & Robine (1997) find that differences between the two methods are small. Furthermore, we want our work to be comparable with other European studies, most of which also apply Sullivan's method to calculate HEX.

5 Results

Based on comparing the the education distribution of participants in SHARE versus the education distribution in the censuses, three country groups can be differentiated: (i) country samples that fit the education distribution in the population, (ii) country samples in which high-educated individuals are over-represented and low-educated individuals are under-represented, and (iii) country samples in which it is the other way around. Graphs visualising the main results are provided for the three countries Italy, Austria, and Estonia, each exemplifying one of the three country groups (figures A.1 to A.4 in Appendix A.2). Tables describing the remaining countries can be found in Appendix A.2.

5.1 The education distribution in SHARE versus in the census

The only two country samples resembling the education distribution in the population are the samples for Italy and Spain. Population proportions by education based on SHARE as well as the census are plotted for Italy in figure A.1. Both lines are overlapping for most parts, indicating a good fit. Spain shows slight deviations in the younger age groups, but the overall fit is relatively good as well (table A.25). The two countries have little variation of education within age groups. For example, the vast majority of the population 70 plus is low-educated. This pattern might facilitate the good fit with respect to the education distribution. Yet Portugal has also little variation of education within age groups, still the education distribution in SHARE varies strongly from that in the census.

In most country samples provided by SHARE, high-educated individuals are over-represented and low-educated individuals are under-represented. This finding is in line with the literature discussed in section 2. The countries falling into that category are Austria, Belgium, Denmark, Germany, Hungary, Portugal, and to a lesser extend France and Slovenia. The deviation is particularly strong in Denmark, where the proportions in SHARE differ from the proportions in census on average by 51 percent for men and 52 percent for women in the age groups 50 to 89[2] (table A.7). As show in figure A.1, there are too many high-educated individuals in the SHARE sample, and too little low-educated individuals. The proportions for individuals with medium education fit relatively well, which is representative for most countries in this group.

Three of the countries analysed show the opposite pattern of that described above. In Czech Republic, Estonia, and Poland, low-educated individuals are over-represented. Deviations are minor for Estonia (figure A.1) and Poland (table A.19). Yet in Czech Republic, Share proportions deviate from the census by 95 percent for men and 38 percent for women on average (table A.5). Furthermore, high-educated individuals

[2]The age group 90+ is not considered in these calculations due to the high percentage of individuals in the Danish census with unknown education in this age group.

are under-represented in the Estonian and Polish sample, while in the Czech sample, medium-educated individuals are under-represented. Overall, the results presented in this subsection confirm the need for education-adjusted weights when making inference based on survey data.

5.2 Prevalence of bad health with and without education-adjusted weights

Weighted prevalence rates of bad health vary according to the deviation of the education structure in SHARE from that in the census. Figure A.2 visualises kernel densities of prevalence rates by weighting strategy for the three exemplary countries Italy, Austria, and Estonia. Results for all other countries can be found in Appendix A.3. Our replicated weights yield almost identical prevalence rates than those based on SHARE weights, indicated by the overlap of the dotted and dashed line in Figure A.2. This result confirms the IPF method applied.

The Kernel density of Italy does not change depending on what weights are applied. The distribution is the same for prevalence rates based on the original SHARE weights, the replicated SHARE weights, and the new weights considering education. The same holds for Spain. This result is in line with the finding that the SHARE sample from Italy and Spain fits education structure in the respective census.

For all country samples in which high-educated individuals are over-represented and low-educated individuals are under-represented, the kernel density of the prevalence rates is shifted to the right once education-adjusted weights are applied. This finding is in line with the evidence that education and good health are positively correlated. Once the over-representation of high-educated individuals is accounted for via weights, the average individual appears less healthy, shown by a shift of the distribution to the right. This pattern is exemplified with Austria in figure A.2. Depending on how strongly SHARE data varies from the census, the shift is minor for some countries such as France, and severe for other countries such as Denmark. Portugal is the only country, in which no clear shift is visible. Individuals in the Portuguese SHARE sample show now clear trend in prevalence over the life course. Furthermore, numbers of observations in some age-gender-education cells are small and confidence intervals are large, which makes it difficult to correctly interpret the results for Portugal.

The three countries in which low-educated individuals are over-represented experience a shift to the left in the kernel density of the prevalence of bad health once education-adjusted weights are applied. This indicates that the country is appears healthier, once the education structure in the general population is considered. The shift is least pronounced for Poland, which is in line with the finding that Poland's SHARE sample varied only slightly from the census in terms of the education distribution.

When plotted against age, the differences between prevalence rates according to the weighting strategy in place appear rather small (Figure A.3). The differences have the expected direction for most parts. For example, prevalence of bad health increases in most age groups in Austria, once education-adjusted weights are applied. By contrast, the prevalence rates decrease in Estonia once the education-adjusted weights are applied. Yet when considering the confidence intervals presented in appendix A.3, the differences appear to be non-significant. The large confidence intervals are likely due to the small numbers of observations in SHARE in some gender-age groups. For example, the male age group 90+ in Germany consists of 5 men only, in Slovenia it is 4 men only. In Austria, the male age group 90+ consists of 20 men, of which seven are low-educated, six are medium-educated, six are high-educated, and one has unknown education. When analysing the correlation between education and good health on the aggregated level, the positive link is obvious. Yet in these small gender-age, the correlation is sometimes turned around. For example, the seven low-educated men in the Austrian 90+ group reported on average better health than the six high-educated men. Due to that reversal, prevalence of bad health is slightly lower for that group, once education-adjusted weights are applied. Consequently, the dotted line in Figure A.3 for Austrian men older than 90 years is above the solid line. Given the small number of observations in certain country-age-gender-education cells and the subsequently large confidence intervals, HEX as well as differences in HEX have to be interpreted cautiously.

5.3 Health expectancies based on education-adjusted prevalence rates

The tables in appendix A.3 present two sets of HEX. The first set is calculated using prevalence rates of bad health based on the replicated weights, which do not consider the education distribution in the general population. The second set of HEX is calculated using education-adjusted prevalence rates. The tables as well as figure A.4 further present the differences in HEX depending on the weighting strategy, notated as Δ HEX. The difference is give in absolute years. Consequently, the difference between the two sets of HEX decreases with age, since life expectancy decreases with age.

For most parts, the differences in HEX exactly resemble the deviation between SHARE and the census and, accordingly, the deviation in prevalence rates by weighting strategy. In Italy and Spain, HEX do not depend on the weighting strategy. Deviations between the two sets of HEX are minor, reflecting the good fit of the Italian and Spanish SHARE sample. On the contrary, HEX is on average too high in all countries that have an over-educated country sample. Once the education distribution in the population is considered via education-adjusted weights, HEX decreases in these countries, making them appear less healthy. The opposite is true for countries in which low-educated individuals are over-represented. In Estonia, Czech Republic, and Poland, HEX are too low when calculated without education-adjusted prevalence rates. Once the education distribution in the general population is accounted for, these three countries appear healthier. Due to uncertainty in the data, some countries show the opposite sign than expected for Δ HEX. For example, this is the case in the male age group 90+ in Austria. Furthermore, results for Portugal have to be treated particularly careful given the random variation in prevalence rates in this country.

6 Conclusion

The education distribution of survey participants often deviates from the education distribution in the general population. This is also the case for most country samples provided by the Survey of Health, Ageing and Retirement in Europe (SHARE). This paper explored if biases in the education structure of SHARE affect measures of health expectancies (HEX) for 13 European countries in 2011. Knowing about the sensitivity of HEX measures is crucial given their immense scientific and political importance. Therefore, two sets of post-stratification weights were generated, one of which considers the education distribution in the general population taken from the 2011 censuses. These two sets of weights were then used to calculate two sets of prevalence rates of severe activity limitations based on the Global Activity Limitation Indicator (GALI), and subsequently, two sets of HEX applying Sullivan's method. We analysed if and how these HEX differentiated. The study was conducted separately for each country by gender and five-year age group.

The results show that 11 of the 13 SHARE samples analysed differed in their education distribution from that in the census. Once weights are applied to account for this deviation, prevalence rates and consequently HEX differ from calculations without education-adjusted weights. Yet these differences do not appear to be statistically significant in our framework. In most countries, high-educated individuals are over-represented and low-educated individuals are under-represented. Due to the positive correlation of good health and educational attainment, prevalence of bad health goes up in these countries once education-adjusted weights are applied. Subsequently, HEX are lower once the education structure in the general population is considered. By contrast, three countries analysed showed the opposite pattern. In Czech Republic, Estonia, and Poland, low-educated individuals were over-represented in the SHARE samples. Consequently, these countries' health was originally under-estimated and they appeared healthier once education-adjusted weights were applied. The only two countries in which the education structure in the survey and the census was aligned were Italy and Spain, probably, because their education distribution is rather uniform to begin with.

In summary, education-adjusted weights might not be necessary for the calculation of prevalence rates and HEX in countries, where the education gradient in health is not too pronounced. Yet uncertainty measures should be applied given the often noisy survey data and small observations counts in certain gender-age cells. Furthermore, the incorporation of educational differences in life expectancy is likely to affect HEX, yet data on education specific mortality is scarce, making such analysis difficult. Future studies could fruitfully explore if results vary when differences in health and life expectancy by education are more severe. The fact that European countries are rather homogeneous in that respect compared to other regions warrants future investigation.

A Appendix

A.1 Exemplary visualisation of the results for Italy, Austria, and Estonia

Figure A.1: Proportions of educational attainment by age and gender

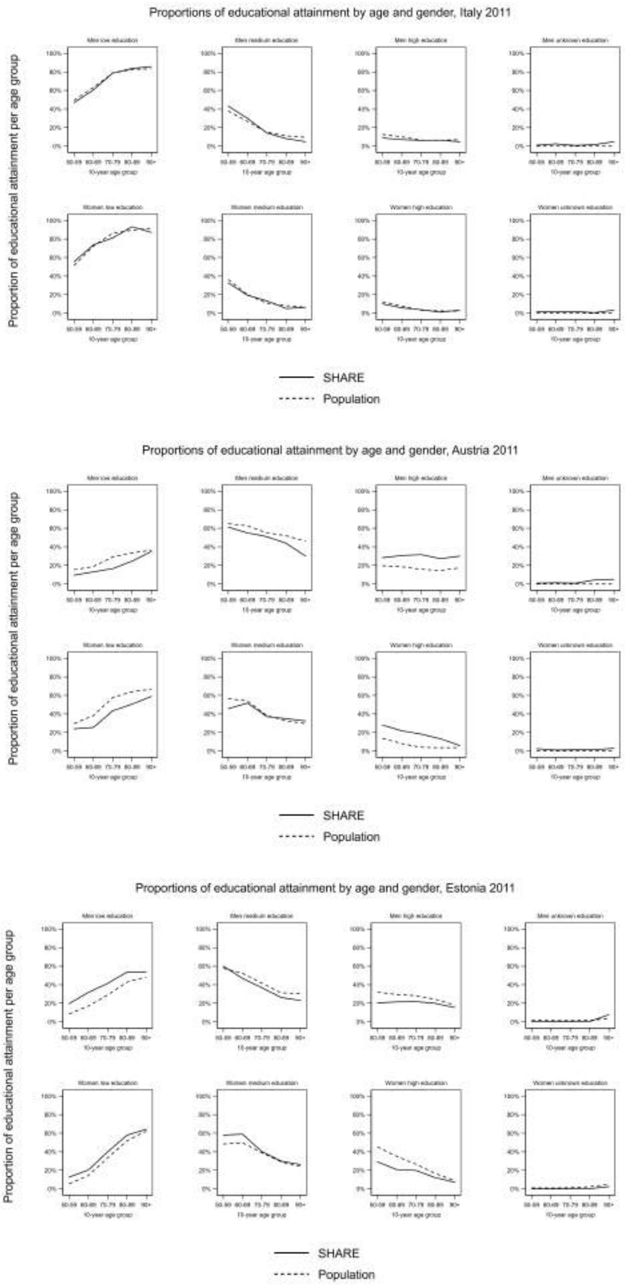


Figure A.2: Kernel density of prevalence rate of bad health by weighting strategy

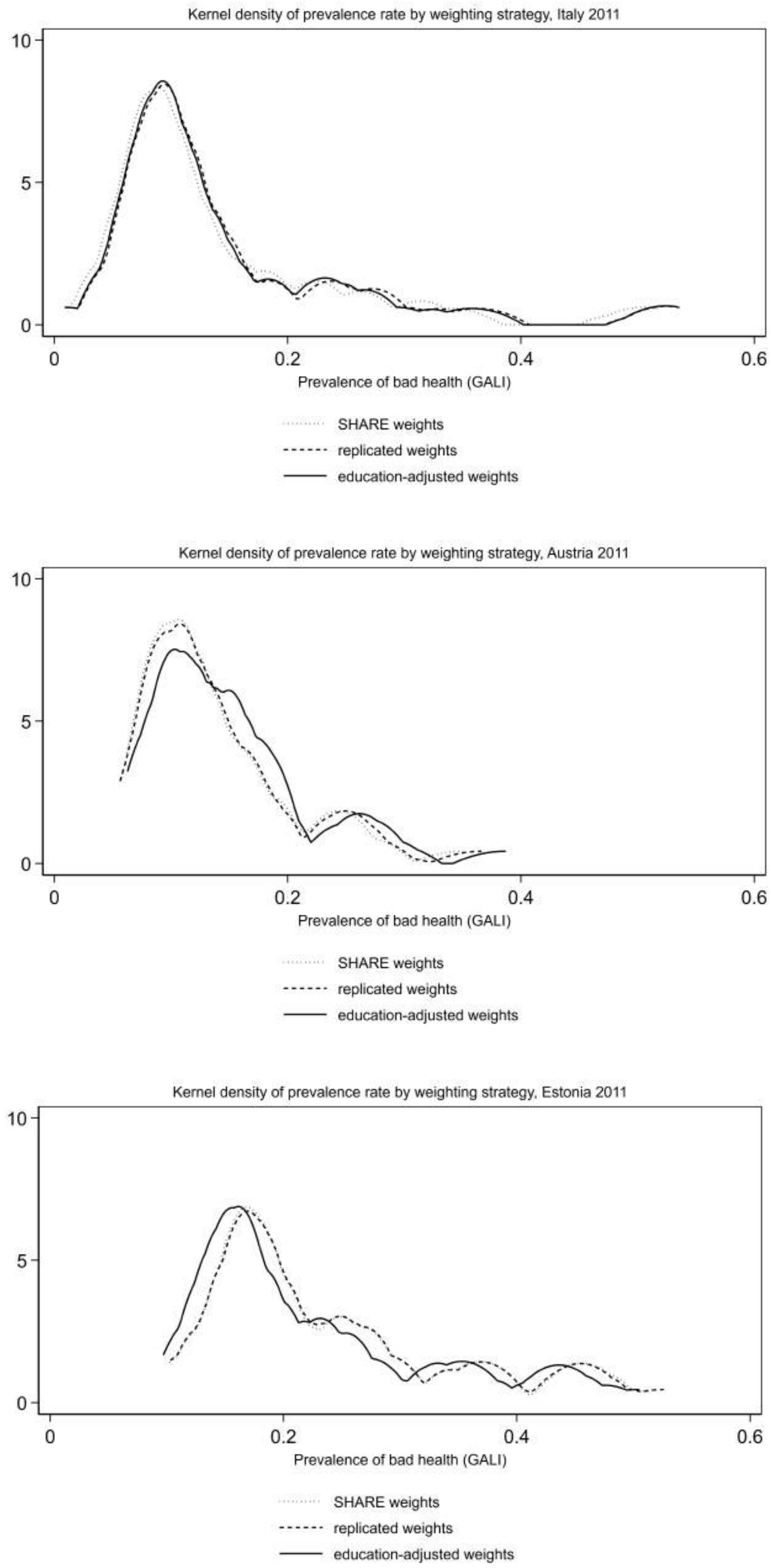


Figure A.3: Prevalence of bad health over the life course, by gender and weighting strategy

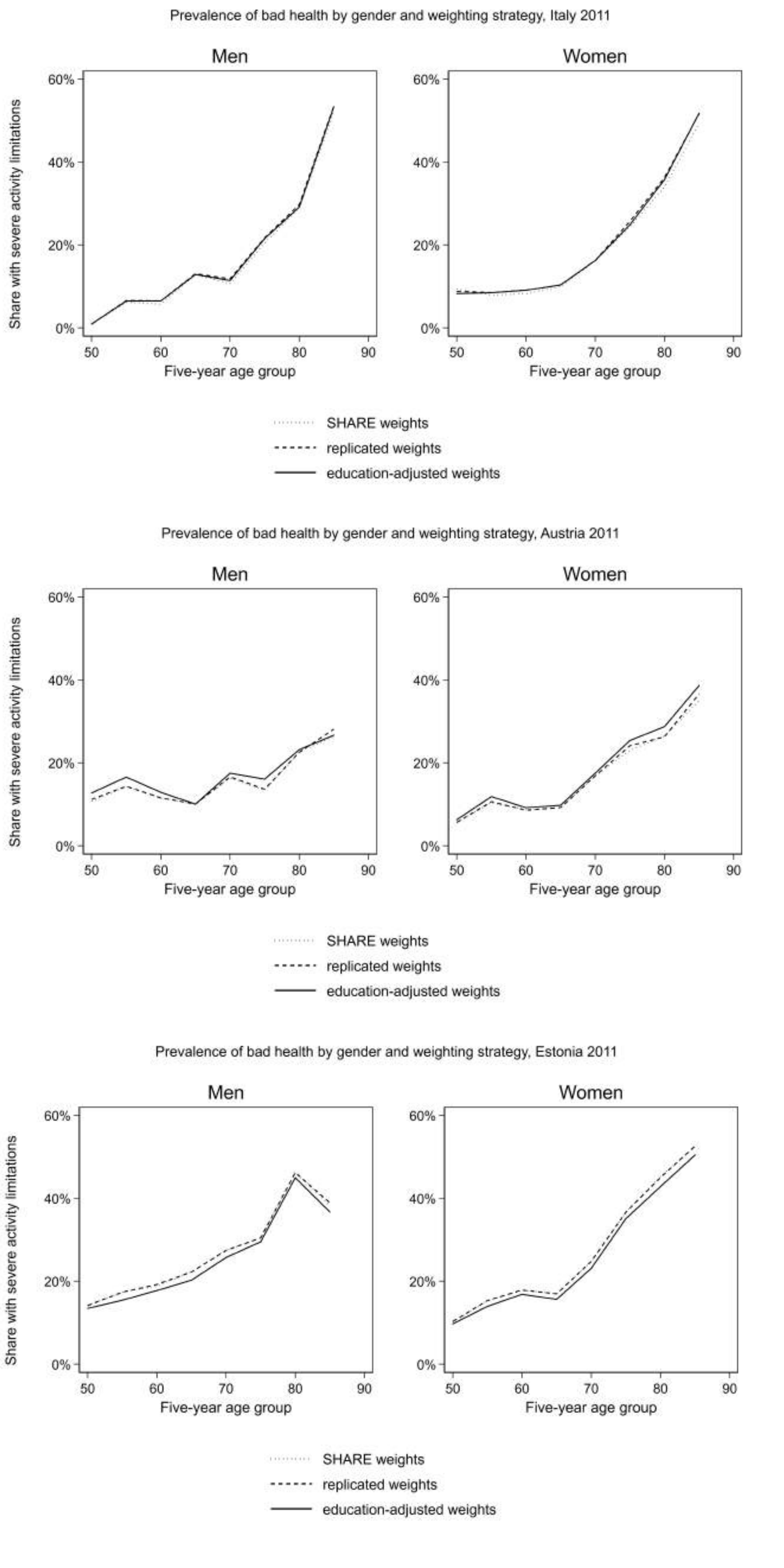
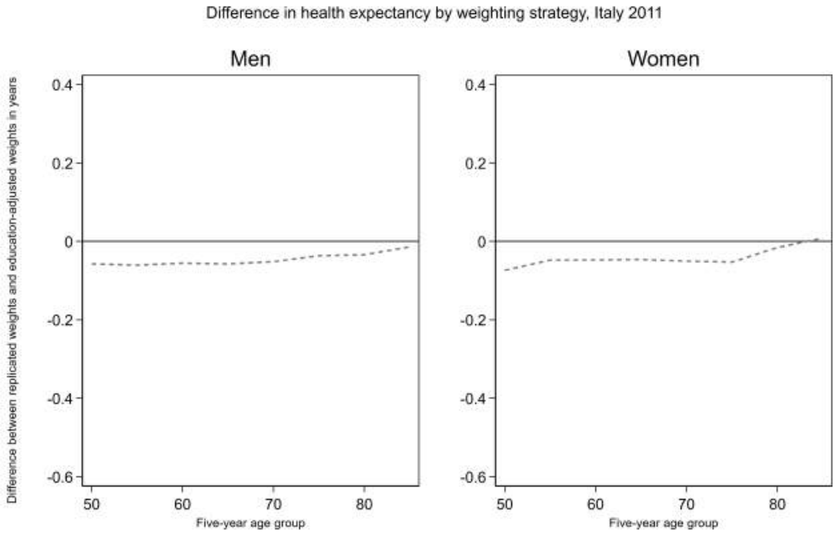
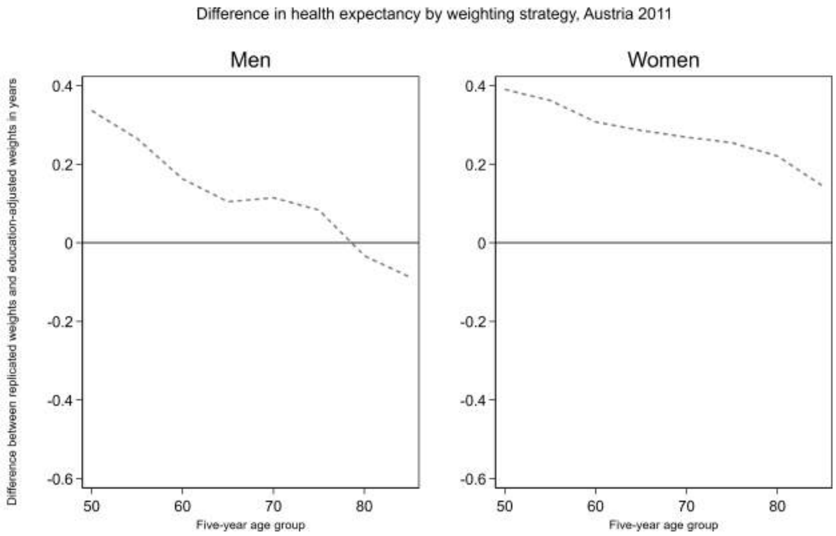
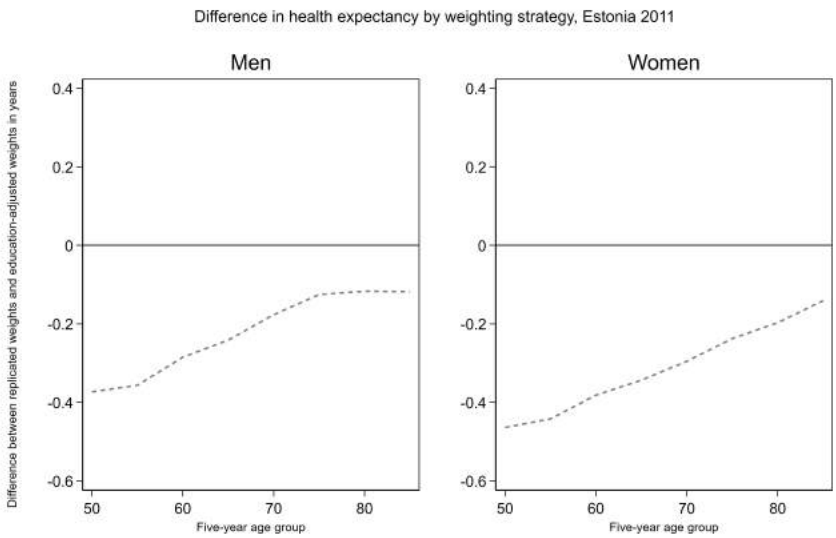


Figure A.4: Differences in health expectancy by weighting strategy







A.2 Proportions by education in SHARE versus in the censuses

Table A.1: Austria

Austria		Men				Women			
Age	Education	Share		Census		Share		Census	
		N	%	N	%	N	%	N	%
50-59	low	63	9.5	86887	15.4	206	23.9	170957	29.6
	medium	405	61.3	367802	65	393	45.6	326967	56.6
	high	187	28.3	111220	19.7	241	28	79609	13.8
	unknown	6	.9	0	0	21	2.4	0	0
	total	661	100	565909	100	861	100	577533	100
60-69	low	98	13	79259	18.8	255	25.4	176335	38.1
	medium	415	55	263463	62.6	518	51.6	249273	53.9
	high	231	30.6	78097	18.6	219	21.8	37067	8
	unknown	10	1.3	0	0	11	1.1	0	0
	total	754	100	420819	100	1003	100	462675	100
70-79	low	92	16.5	86735	29	316	43.3	215302	57.6
	medium	284	51	164705	55.1	271	37.1	143121	38.3
	high	176	31.6	47386	15.9	133	18.2	15268	4.1
	unknown	5	.9	0	0	10	1.4	0	0
	total	557	100	298826	100	730	100	373691	100
80-89	low	46	24.6	41385	33.6	152	50.5	151359	63.9
	medium	82	43.9	64003	51.9	105	34.9	77106	32.6
	high	51	27.3	17831	14.5	40	13.3	8221	3.5
	unknown	8	4.3	0	0	4	1.3	0	0
	total	187	100	123219	100	301	100	236686	100
90+	low	7	35	4742	36.4	20	58.8	29223	66.7
	medium	6	30	6016	46.2	11	32.4	12972	29.6
	high	6	30	2262	17.4	2	5.9	1647	3.8
	unknown	1	5	0	0	1	2.9	0	0
	total	20	100	13020	100	34	100	43842	100

Table A.3: Belgium

Belgium		Men				Women			
Age	Education	Share		Census		Share		Census	
		N	%	N	%	N	%	N	%
50-59	low	298	35.7	295514	39.9	329	31.1	296759	40
	medium	217	26	210435	28.4	339	32	213803	28.8
	high	297	35.6	180721	24.4	364	34.4	183135	24.7
	unknown	23	2.8	54628	7.4	26	2.5	48576	6.5
	total	835	100	741298	100	1058	100	742273	100
60-69	low	299	38.4	264576	48	331	40.4	315593	54.4
	medium	203	26.1	122045	22.2	240	29.3	117672	20.3
	high	265	34	121519	22.1	236	28.8	102593	17.7
	unknown	12	1.5	42791	7.8	13	1.6	44314	7.6
	total	779	100	550931	100	820	100	580172	100
70-79	low	213	46.1	223675	59.3	295	53.2	312619	66.1
	medium	103	22.3	58576	15.5	131	23.6	64268	13.6
	high	142	30.7	56867	15.1	122	22	44972	9.5
	unknown	4	.9	37802	10	7	1.3	51189	10.8
	total	462	100	376920	100	555	100	473048	100
80-89	low	140	56.5	106684	61.5	246	68.7	217454	69.8
	medium	50	20.2	25946	14.9	60	16.8	34466	11.1
	high	54	21.8	20467	11.8	50	14	18623	6
	unknown	4	1.6	20457	11.8	2	.6	41186	13.2
	total	248	100	173554	100	358	100	311729	100
90+	low	16	64	9905	61.3	42	73.7	35935	69.7
	medium	6	24	2155	13.3	6	10.5	4791	9.3
	high	2	8	2004	12.4	8	14	3018	5.9
	unknown	1	4	2087	12.9	1	1.8	7835	15.2
	total	25	100	16151	100	57	100	51579	100

Table A.5: Czech Republic

Czech Republic		Men				Women			
Age	Education	Share		Census		Share		Census	
		N	%	N	%	N	%	N	%
50-59	low	282	45	60953	8.8	372	42.3	143319	20
	medium	246	39.3	495476	71.2	398	45.2	468487	65.5
	high	93	14.9	108342	15.6	98	11.1	82322	11.5
	unknown	5	.8	31312	4.5	12	1.4	20992	2.9
	total	626	100	696083	100	880	100	715120	100
60-69	low	423	46	62905	10.4	544	43.7	180716	25.9
	medium	361	39.2	443380	73	559	44.9	441352	63.3
	high	117	12.7	84381	13.9	122	9.8	59052	8.5
	unknown	19	2.1	16975	2.8	20	1.6	16155	2.3
	total	920	100	607641	100	1245	100	697275	100
70-79	low	217	41.1	47015	16.4	370	53.3	173996	42.4
	medium	208	39.4	190935	66.6	252	36.3	202787	49.4
	high	94	17.8	41874	14.6	62	8.9	22715	5.5
	unknown	9	1.7	6933	2.4	10	1.4	11118	2.7
	total	528	100	286757	100	694	100	410616	100
80-89	low	75	38.9	23055	20	181	63.7	120760	50.6
	medium	70	36.3	69424	60.3	77	27.1	100546	42.1
	high	44	22.8	19280	16.7	19	6.7	8445	3.5
	unknown	4	2.1	3399	3	7	2.5	8933	3.7
	total	193	100	115158	100	284	100	238684	100
90+	low	3	25	1816	23	14	51.9	13684	54.6
	medium	4	33.3	4571	57.9	11	40.7	9393	37.5
	high	4	33.3	1158	14.7	1	3.7	736	2.9
	unknown	1	8.3	352	4.5	1	3.7	1242	5
	total	12	100	7897	100	27	100	25055	100

Table A.7: Denmark

Denmark		Men				Women			
Age	Education	Share		Census		Share		Census	
		N	%	N	%	N	%	N	%
50-59	low	40	10.5	86106	24	58	13.1	100625	28.2
	medium	177	46.3	172014	47.9	126	28.4	131424	36.8
	high	158	41.4	91671	25.5	255	57.6	117706	32.9
	unknown	7	1.8	9572	2.7	4	.9	7650	2.1
	total	382	100	359363	100	443	100	357405	100
60-69	low	33	9.6	92455	27.4	54	14.7	124807	36.1
	medium	168	48.8	155927	46.3	130	35.3	135091	39.1
	high	136	39.5	82314	24.4	179	48.6	80054	23.1
	unknown	7	2	6145	1.8	5	1.4	5932	1.7
	total	344	100	336841	100	368	100	345884	100
70-79	low	36	17.8	67694	37.9	77	35.3	112258	54
	medium	101	50	72763	40.8	77	35.3	60975	29.3
	high	64	31.7	33064	18.5	61	28	29855	14.3
	unknown	1	.5	4901	2.7	3	1.4	4969	2.4
	total	202	100	178422	100	218	100	208057	100
80-89	low	16	16.8	35204	48.7	74	50	78481	66.6
	medium	41	43.2	23873	33	48	32.4	25763	21.9
	high	33	34.7	11782	16.3	25	16.9	11554	9.8
	unknown	5	5.3	1437	2	1	.7	2045	1.7
	total	95	100	72296	100	148	100	117843	100
90+	low	4	30.8	335	3.5	15	60	1263	4.4
	medium	5	38.5	166	1.7	8	32	309	1.1
	high	3	23.1	278	2.9	1	4	190	.7
	unknown	1	7.7	8912	92	1	4	26913	93.9
	total	13	100	9691	100	25	100	28675	100

Table A.9: Estonia

Estonia		Men				Women			
Age	Education	Share		Census		Share		Census	
		N	%	N	%	N	%	N	%
50-59	low	160	19.5	6936	8.5	140	12.7	5282	5.5
	medium	492	60	47118	57.8	637	58	46585	48.3
	high	167	20.4	26085	32	321	29.2	43609	45.2
	unknown	1	.1	1425	1.7	1	.1	921	1
	total	820	100	81564	100	1099	100	96397	100
60-69	low	281	31.7	9704	17	238	20.3	11609	14.4
	medium	415	46.8	29786	52.3	692	58.9	40115	49.8
	high	190	21.4	16698	29.3	244	20.8	28206	35
	unknown	1	.1	779	1.4	1	.1	688	.9
	total	887	100	56967	100	1175	100	80618	100
70-79	low	314	41.4	11188	28.9	477	39.9	24889	33.4
	medium	278	36.7	16107	41.6	480	40.2	28996	38.9
	high	165	21.8	10877	28.1	237	19.8	19706	26.5
	unknown	1	.1	509	1.3	1	.1	882	1.2
	total	758	100	38681	100	1195	100	74473	100
80-89	low	143	53.6	5698	42.8	288	57.8	20559	51.9
	medium	70	26.2	4154	31.2	149	29.9	11561	29.2
	high	53	19.9	3230	24.3	60	12	6599	16.6
	unknown	1	.4	220	1.7	1	.2	916	2.3
	total	267	100	13302	100	498	100	39635	100
90+	low	7	53.8	441	48.3	27	64.3	2893	62.3
	medium	3	23.1	277	30.3	11	26.2	1114	24
	high	2	15.4	163	17.9	3	7.1	411	8.9
	unknown	1	7.7	32	3.5	1	2.4	222	4.8
	total	13	100	913	100	42	100	4640	100

Table A.11: France

France		Men				Women			
Age	Education	Share		Census		Share		Census	
		N	%	N	%	N	%	N	%
50-59	low	181	22.5	1303815	31.3	304	30.2	1703720	38.8
	medium	403	50	1959813	47.1	414	41.1	1716270	39.1
	high	203	25.2	895551	21.5	262	26	969392	22.1
	unknown	19	2.4	144	0	28	2.8	113	0
	total	806	100	4159323	100	1008	100	4389495	100
60-69	low	284	34.4	1264695	40	405	41.7	1748789	51.3
	medium	315	38.2	1277057	40.4	321	33	1106511	32.5
	high	201	24.4	617162	19.5	220	22.6	552731	16.2
	unknown	25	3	51	0	26	2.7	29	0
	total	825	100	3158965	100	972	100	3408060	100
70-79	low	271	50.6	1182924	57	461	67.7	1910878	70.9
	medium	166	31	645923	31.1	130	19.1	576136	21.4
	high	90	16.8	247312	11.9	70	10.3	207284	7.7
	unknown	9	1.7	0	0	20	2.9	0	0
	total	536	100	2076159	100	681	100	2694298	100
80-89	low	195	69.9	712663	68.2	368	79.7	1476693	78
	medium	52	18.6	220702	21.1	52	11.3	291174	15.4
	high	27	9.7	111301	10.7	30	6.5	125780	6.6
	unknown	5	1.8	0	0	12	2.6	0	0
	total	279	100	1044666	100	462	100	1893647	100
90+	low	15	53.6	80282	67.6	60	85.7	277819	74.4
	medium	7	25	23167	19.5	4	5.7	59599	16
	high	5	17.9	15255	12.9	5	7.1	35760	9.6
	unknown	1	3.6	0	0	1	1.4	0	0
	total	28	100	118704	100	70	100	373178	100

Table A.13: Germany

Germany		Men				Women			
Age	**Education**	**Share**		**Census**		**Share**		**Census**	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
50-59	low	5	4.9	662600	11.6	22	11.8	1061130	18.2
	medium	51	50	3137380	54.7	101	54.3	3164500	54.4
	high	41	40.2	1936590	33.8	53	28.5	1590890	27.4
	unknown	5	4.9	0	0	10	5.4	0	0
	total	102	100	5736570	100	186	100	5816520	100
60-69	low	12	4.1	531050	12.4	41	12.7	1184640	26
	medium	162	55.1	2256210	52.8	175	54.3	2468540	54.1
	high	104	35.4	1486110	34.8	98	30.4	907790	19.9
	unknown	16	5.4	0	0	8	2.5	0	0
	total	294	100	4273370	100	322	100	4560970	100
70-79	low	10	3.6	609250	16.7	56	23.1	1936480	43.3
	medium	153	55.6	1983600	54.2	143	59.1	2023110	45.2
	high	102	37.1	1064890	29.1	39	16.1	513770	11.5
	unknown	10	3.6	0	0	4	1.7	0	0
	total	275	100	3657740	100	242	100	4473360	100
80-89	low	5	6	246230	20.1	39	41.5	1278640	54.4
	medium	47	56.6	656190	53.5	37	39.4	884140	37.6
	high	29	34.9	325090	26.5	15	16	189760	8.1
	unknown	2	2.4	0	0	3	3.2	0	0
	total	83	100	1227510	100	94	100	2352540	100
90+	low	1	20	21300	19.7	3	25	225740	55.8
	medium	2	40	56130	52	6	50	149430	37
	high	1	20	30450	28.2	2	16.7	29180	7.2
	unknown	1	20	0	0	1	8.3	0	0
	total	5	100	107880	100	12	100	404350	100

Table A.15: Hungary

Hungary		Men				Women			
Age	**Education**	**Share**		**Census**		**Share**		**Census**	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
50-59	low	52	12.3	120662	17.8	152	27.3	217215	28.6
	medium	309	72.9	453647	66.8	323	58.1	406335	53.5
	high	62	14.6	104882	15.4	80	14.4	135941	17.9
	unknown	1	.2	0	0	1	.2	0	0
	total	424	100	679191	100	556	100	759491	100
60-69	low	93	17.9	125036	24.3	200	33.3	271885	41.1
	medium	318	61.3	293669	57	296	49.3	297272	44.9
	high	107	20.6	96653	18.8	104	17.3	92447	14
	unknown	1	.2	0	0	1	.2	0	0
	total	519	100	515358	100	601	100	661604	100
70-79	low	79	29.5	177620	63.8	203	55.9	352237	73.9
	medium	133	49.6	52768	18.9	117	32.2	88451	18.6
	high	55	20.5	48165	17.3	42	11.6	35676	7.5
	unknown	1	.4	0	0	1	.3	0	0
	total	268	100	278553	100	363	100	476364	100
80-89	low	39	41.1	68943	64.7	118	77.1	212204	84.8
	medium	37	38.9	17325	16.3	25	16.3	25654	10.3
	high	18	18.9	20313	19.1	9	5.9	12365	4.9
	unknown	1	1.1	0	0	1	.7	0	0
	total	95	100	106581	100	153	100	250223	100
90+	low	4	44.4	7092	67.5	12	60	27893	87.4
	medium	2	22.2	1606	15.3	6	30	2657	8.3
	high	2	22.2	1806	17.2	1	5	1374	4.3
	unknown	1	11.1	0	0	1	5	0	0
	total	9	100	10504	100	20	100	31924	100

Table A.17: Italy

Italy		Men				Women			
Age	Education	Share		Census		Share		Census	
		N	%	N	%	N	%	N	%
50-59	low	169	46.8	1896312	49.5	281	55.4	2072038	51.3
	medium	156	43.2	1453862	37.9	166	32.7	1462737	36.2
	high	32	8.9	484544	12.6	51	10.1	502340	12.4
	unknown	4	1.1	0	0	9	1.8	0	0
	total	361	100	3834718	100	507	100	4037115	100
60-69	low	346	60.6	2079003	63.3	516	73.6	2586617	72.4
	medium	171	29.9	874563	26.6	135	19.3	711707	19.9
	high	40	7	333239	10.1	41	5.8	275036	7.7
	unknown	14	2.5	0	0	9	1.3	0	0
	total	571	100	3286805	100	701	100	3573360	100
70-79	low	384	78.9	1972475	78.6	413	81.1	2684196	86.1
	medium	69	14.2	374245	14.9	68	13.4	336083	10.8
	high	30	6.2	161577	6.4	19	3.7	95823	3.1
	unknown	4	.8	0	0	9	1.8	0	0
	total	487	100	2508297	100	509	100	3116102	100
80-89	low	144	83.7	936638	82.8	165	93.2	1778669	89.4
	medium	14	8.1	125891	11.1	9	5.1	161484	8.1
	high	11	6.4	68965	6.1	2	1.1	48485	2.4
	unknown	3	1.7	0	0	1	.6	0	0
	total	172	100	1131494	100	177	100	1988638	100
90+	low	18	85.7	110847	83.4	27	87.1	354613	91.5
	medium	1	4.8	12692	9.5	2	6.5	24650	6.4
	high	1	4.8	9432	7.1	1	3.2	8174	2.1
	unknown	1	4.8	0	0	1	3.2	0	0
	total	21	100	132971	100	31	100	387437	100

Table A.19: Poland

Poland		Men				Women			
Age	Education	Share		Census		Share		Census	
		N	%	N	%	N	%	N	%
50-59	low	22	17.1	421166	15	45	19.3	478116	16.1
	medium	90	69.8	1981997	70.8	136	58.4	2018930	67.8
	high	8	6.2	330327	11.8	17	7.3	423912	14.2
	unknown	9	7	67063	2.4	35	15	57925	1.9
	total	129	100	2800553	100	233	100	2978883	100
60-69	low	70	20.3	420733	24.7	142	36.4	672145	32.7
	medium	175	50.9	1019057	59.9	205	52.6	1116799	54.3
	high	41	11.9	230425	13.5	19	4.9	238273	11.6
	unknown	58	16.9	31166	1.8	24	6.2	29409	1.4
	total	344	100	1701381	100	390	100	2056626	100
70-79	low	84	45.4	395289	40.8	138	66	843444	55.3
	medium	64	34.6	432775	44.7	50	23.9	543307	35.6
	high	19	10.3	125120	12.9	8	3.8	113995	7.5
	unknown	18	9.7	14640	1.5	13	6.2	23721	1.6
	total	185	100	967824	100	209	100	1524467	100
80-89	low	52	57.8	199977	53.3	88	72.7	619859	73.2
	medium	25	27.8	120999	32.3	17	14	170244	20.1
	high	6	6.7	47888	12.8	2	1.7	32531	3.8
	unknown	7	7.8	6312	1.7	14	11.6	24220	2.9
	total	90	100	375176	100	121	100	846854	100
90+	low	4	57.1	17756	62.4	16	84.2	73860	77.2
	medium	1	14.3	7120	25	1	5.3	14091	14.7
	high	1	14.3	2691	9.5	1	5.3	2219	2.3
	unknown	1	14.3	891	3.1	1	5.3	5478	5.7
	total	7	100	28458	100	19	100	95648	100

Table A.21: Portugal

Portugal		Men				Women			
Age	Education	Share		Census		Share		Census	
		N	%	N	%	N	%	N	%
50-59	low	186	70.5	517091	77.4	286	74.7	558254	76.3
	medium	35	13.3	79694	11.9	46	12	79177	10.8
	high	40	15.2	71558	10.7	48	12.5	94237	12.9
	unknown	3	1.1	0	0	3	.8	0	0
	total	264	100	668343	100	383	100	731668	100
60-69	low	258	78.2	469350	85.1	299	77.5	556689	87.7
	medium	40	12.1	38466	7	33	8.5	29058	4.6
	high	30	9.1	43734	7.9	37	9.6	49145	7.7
	unknown	2	.6	0	0	17	4.4	0	0
	total	330	100	551550	100	386	100	634892	100
70-79	low	158	78.6	364241	90.9	181	86.2	493050	93.8
	medium	16	8	16569	4.1	6	2.9	12310	2.3
	high	23	11.4	19782	4.9	15	7.1	20192	3.8
	unknown	4	2	0	0	8	3.8	0	0
	total	201	100	400592	100	210	100	525552	100
80-89	low	50	79.4	155428	92	92	82.9	279326	95.2
	medium	4	6.3	6162	3.6	8	7.2	6897	2.4
	high	5	7.9	7370	4.4	7	6.3	7061	2.4
	unknown	4	6.3	0	0	4	3.6	0	0
	total	63	100	168960	100	111	100	293284	100
90+	low	4	57.1	18068	91.4	6	60	48108	95.8
	medium	1	14.3	748	3.8	1	10	1109	2.2
	high	1	14.3	952	4.8	1	10	990	2
	unknown	1	14.3	0	0	2	20	0	0
	total	7	100	19768	100	10	100	50207	100

Table A.23: Slovenia

Slovenia		Men				Women			
Age	Education	Share		Census		Share		Census	
		N	%	N	%	N	%	N	%
50-59	low	87	20.7	39279	25.3	152	29.1	51986	34.8
	medium	270	64.3	92682	59.7	263	50.4	71200	47.6
	high	62	14.8	23315	15	106	20.3	26313	17.6
	unknown	1	.2	0	0	1	.2	0	0
	total	420	100	155276	100	522	100	149499	100
60-69	low	61	16	26630	25.5	167	36.9	51794	45.9
	medium	240	63	60974	58.3	204	45	46809	41.5
	high	79	20.7	17011	16.3	81	17.9	14298	12.7
	unknown	1	.3	0	0	1	.2	0	0
	total	381	100	104615	100	453	100	112901	100
70-79	low	91	32.5	20867	31.6	206	59	59259	63.2
	medium	134	47.9	35849	54.3	108	30.9	28520	30.4
	high	52	18.6	9365	14.2	34	9.7	6036	6.4
	unknown	3	1.1	0	0	1	.3	0	0
	total	280	100	66081	100	349	100	93815	100
80-89	low	42	38.2	8192	36.2	114	63.7	36409	67.1
	medium	45	40.9	10734	47.4	55	30.7	15386	28.4
	high	22	20	3729	16.5	9	5	2434	4.5
	unknown	1	.9	0	0	1	.6	0	0
	total	110	100	22655	100	179	100	54229	100
90+	low	1	25	608	36.4	17	85	4361	67.1
	medium	1	25	751	45	1	5	1877	28.9
	high	1	25	310	18.6	1	5	266	4.1
	unknown	1	25	0	0	1	5	0	0
	total	4	100	1669	100	20	100	6504	100

Table A.25: Spain

Spain		Men				Women			
Age	**Education**	**Share**		**Census**		**Share**		**Census**	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
50-59	low	252	62.1	1644040	55.9	347	63.2	1807090	60.4
	medium	77	19	585055	19.9	105	19.1	555465	18.6
	high	63	15.5	711115	24.2	71	12.9	627870	21
	unknown	14	3.4	0	0	26	4.7	0	0
	total	406	100	2940210	100	549	100	2990425	100
60-69	low	370	72.5	1522130	68.2	467	82.8	1900160	78.8
	medium	52	10.2	279630	12.5	32	5.7	241585	10
	high	53	10.4	428610	19.2	38	6.7	268510	11.1
	unknown	35	6.9	0	0	27	4.8	0	0
	total	510	100	2230370	100	564	100	2410255	100
70-79	low	401	84.6	1253700	80.2	459	89	1763050	89.3
	medium	26	5.5	115365	7.4	19	3.7	105125	5.3
	high	28	5.9	193660	12.4	17	3.3	106470	5.4
	unknown	19	4	0	0	21	4.1	0	0
	total	474	100	1562725	100	516	100	1974645	100
80-89	low	209	87.1	663570	85.5	292	91	1185560	92.4
	medium	5	2.1	41485	5.3	3	.9	49605	3.9
	high	15	6.3	70815	9.1	11	3.4	48465	3.8
	unknown	11	4.6	0	0	15	4.7	0	0
	total	240	100	775870	100	321	100	1283630	100
90+	low	25	83.3	80655	84	54	94.7	226135	91.9
	medium	2	6.7	6185	6.4	1	1.8	9610	3.9
	high	1	3.3	9170	9.6	1	1.8	10450	4.2
	unknown	2	6.7	0	0	1	1.8	0	0
	total	30	100	96010	100	57	100	246195	100

A.3 Prevalence rates and health expectancies by weighting strategy

Table A.27: Austria

Austria		Weights without education				Weights with education				△ HEX
Gender	Age	Prev.	95% CI		HEX	Prev.	95% CI		HEX	
Men	50-54	.112	.071	.152	25.743	.127	.08	.174	25.407	.336
	55-59	.144	.099	.189	21.859	.166	.114	.218	21.594	.265
	60-64	.116	.084	.148	18.335	.129	.092	.166	18.172	.163
	65-69	.101	.068	.134	14.961	.101	.066	.135	14.857	.104
	70-74	.166	.127	.206	11.629	.175	.132	.218	11.514	.115
	75-79	.137	.085	.188	8.764	.161	.1	.222	8.681	.083
	80-84	.226	.151	.3	6.083	.232	.151	.313	6.116	-.033
	85+	.281	.176	.387	4.249	.267	.159	.375	4.336	-.087
Women	50-54	.056	.032	.08	29.246	.063	.034	.092	28.855	.39
	55-59	.106	.075	.138	24.856	.119	.081	.156	24.494	.362
	60-64	.086	.062	.11	20.832	.092	.065	.119	20.524	.308
	65-69	.092	.064	.12	16.825	.098	.068	.128	16.539	.286
	70-74	.169	.134	.204	12.945	.175	.137	.213	12.676	.269
	75-79	.241	.186	.296	9.552	.254	.195	.313	9.298	.255
	80-84	.263	.2	.325	6.764	.287	.219	.356	6.543	.221
	85+	.366	.279	.453	4.523	.386	.295	.478	4.378	.144

Belgium		Weights without education				Weights with education				△ HEX
Gender	Age	Prev.	95% CI		HEX	Prev.	95% CI		HEX	
Men	50-54	.083	.041	.126	24.698	.146	.039	.253	24.307	.39
	55-59	.158	.125	.192	20.652	.17	.127	.213	20.569	.083
	60-64	.155	.122	.189	17.191	.169	.125	.214	17.164	.027
	65-69	.137	.1	.175	13.898	.142	.102	.183	13.941	-.042
	70-74	.145	.101	.19	10.708	.136	.091	.18	10.78	-.072
	75-79	.246	.187	.304	7.667	.238	.178	.298	7.697	-.03
	80-84	.285	.214	.355	5.365	.284	.209	.359	5.36	.004
	85+	.392	.302	.482	3.601	.394	.289	.499	3.59	.011
Women	50-54	.188	.13	.247	25.451	.263	.161	.365	24.562	.889
	55-59	.204	.168	.239	21.734	.218	.17	.266	21.208	.526
	60-64	.193	.156	.229	18.223	.22	.172	.268	17.757	.466
	65-69	.227	.183	.271	14.726	.249	.194	.304	14.384	.342
	70-74	.262	.212	.313	11.49	.281	.223	.339	11.244	.246
	75-79	.319	.261	.377	8.532	.343	.274	.412	8.363	.168
	80-84	.348	.286	.411	6.07	.357	.29	.423	6.006	.063
	85+	.428	.357	.499	4.136	.433	.356	.51	4.101	.035

Czech Republic		Weights without education				Weights with education				△ HEX
Gender	Age	Prev.	95% CI		HEX	Prev.	95% CI		HEX	
Men	50-54	.125	.062	.188	21.923	.1	.037	.163	22.144	-.22
	55-59	.195	.148	.242	18.227	.198	.143	.252	18.327	-.1
	60-64	.15	.11	.19	15.133	.152	.106	.198	15.254	-.121
	65-69	.148	.108	.188	12.099	.132	.091	.172	12.241	-.142
	70-74	.151	.106	.197	9.313	.148	.098	.198	9.39	-.077
	75-79	.243	.181	.305	6.615	.238	.169	.308	6.691	-.075
	80-84	.342	.238	.447	4.519	.318	.201	.435	4.593	-.074
	85+	.366	.225	.508	3.196	.374	.2	.547	3.158	.037
Women	50-54	.121	.072	.17	25.8	.097	.046	.148	26.631	-.831
	55-59	.152	.113	.191	21.739	.136	.09	.182	22.46	-.721
	60-64	.11	.084	.136	17.975	.088	.064	.111	18.632	-.656
	65-69	.147	.113	.18	14.139	.133	.097	.168	14.705	-.566
	70-74	.196	.152	.241	10.673	.191	.14	.241	11.205	-.532
	75-79	.281	.219	.342	7.601	.241	.179	.302	8.16	-.559
	80-84	.323	.234	.412	5.175	.278	.184	.373	5.628	-.453
	85+	.442	.338	.546	3.356	.378	.266	.49	3.74	-.384

Denmark		Weights without education				Weights with education				Δ HEX
Gender	Age	Prev.	95% CI		HEX	Prev.	95% CI		HEX	
Men	50-54	.074	.035	.114	25.834	.107	.047	.168	25.306	.528
	55-59	.092	.047	.136	21.779	.134	.063	.205	21.405	.374
	60-64	.059	.021	.096	18.028	.077	.022	.132	17.853	.175
	65-69	.075	.035	.114	14.237	.106	.045	.167	14.147	.091
	70-74	.125	.063	.187	10.772	.123	.057	.188	10.838	-.066
	75-79	.215	.127	.303	7.749	.213	.115	.31	7.813	-.064
	80-84	.206	.101	.31	5.54	.164	.066	.262	5.611	-.07
	85+	.375	.24	.51	3.446	.404	.246	.561	3.288	.157
Women	50-54	.076	.039	.114	29.1	.11	.049	.172	28.79	.31
	55-59	.082	.044	.12	24.896	.095	.046	.145	24.753	.143
	60-64	.091	.05	.133	20.872	.108	.05	.166	20.792	.08
	65-69	.063	.027	.099	17.023	.069	.024	.113	17.026	-.003
	70-74	.115	.056	.175	13.204	.102	.046	.159	13.238	-.034
	75-79	.099	.04	.158	9.908	.098	.033	.163	9.877	.031
	80-84	.199	.117	.281	6.881	.215	.119	.311	6.837	.044
	85+	.323	.218	.428	4.595	.318	.208	.428	4.629	-.035

Estonia		Weights without education				Weights with education				Δ HEX
Gender	Age	Prev.	95% CI		HEX	Prev.	95% CI		HEX	
Men	50-54	.141	.102	.181	19.459	.135	.097	.173	19.832	-.373
	55-59	.173	.136	.211	16.024	.154	.119	.189	16.38	-.357
	60-64	.192	.156	.229	13.02	.178	.142	.213	13.305	-.285
	65-69	.222	.179	.265	10.311	.202	.16	.245	10.552	-.241
	70-74	.274	.23	.318	7.939	.257	.213	.301	8.116	-.177
	75-79	.305	.253	.357	5.856	.295	.242	.348	5.981	-.125
	80-84	.462	.39	.534	3.982	.45	.377	.523	4.099	-.117
	85+	.389	.271	.508	3.236	.367	.245	.489	3.354	-.118
Women	50-54	.103	.076	.13	24.726	.097	.07	.124	25.19	-.464
	55-59	.153	.123	.184	20.615	.139	.11	.168	21.058	-.442
	60-64	.179	.147	.21	16.821	.168	.137	.199	17.202	-.382
	65-69	.17	.136	.203	13.27	.156	.124	.189	13.613	-.344
	70-74	.248	.214	.282	9.775	.231	.197	.265	10.07	-.296
	75-79	.367	.323	.41	6.808	.351	.306	.395	7.046	-.238
	80-84	.45	.396	.504	4.621	.428	.373	.484	4.818	-.197
	85+	.526	.452	.6	3.085	.504	.427	.582	3.226	-.141

France		Weights without education				Weights with education				Δ HEX
Gender	Age	Prev.	95% CI		HEX	Prev.	95% CI		HEX	
Men	50-54	.095	.061	.13	25.585	.105	.066	.143	25.416	.169
	55-59	.102	.073	.13	21.732	.108	.077	.138	21.606	.126
	60-64	.111	.082	.141	18.088	.117	.086	.149	17.988	.1
	65-69	.115	.079	.151	14.577	.122	.083	.16	14.502	.074
	70-74	.179	.133	.226	11.211	.186	.136	.235	11.164	.047
	75-79	.194	.143	.244	8.221	.197	.146	.249	8.201	.02
	80-84	.356	.286	.427	5.486	.36	.288	.432	5.482	.004
	85+	.43	.334	.526	3.815	.428	.33	.525	3.83	-.016
Women	50-54	.097	.065	.129	30.078	.107	.071	.143	29.874	.204
	55-59	.103	.076	.131	25.934	.109	.08	.139	25.779	.155
	60-64	.079	.056	.102	21.894	.081	.057	.105	21.765	.129
	65-69	.109	.079	.139	17.79	.122	.088	.156	17.669	.121
	70-74	.152	.113	.191	13.92	.156	.115	.198	13.861	.058
	75-79	.201	.157	.245	10.331	.202	.157	.248	10.291	.04
	80-84	.271	.216	.325	7.183	.279	.223	.336	7.145	.038
	85+	.454	.389	.519	4.681	.454	.388	.519	4.681	.001

Germany		Weights without education				Weights with education				Δ HEX
Gender	**Age**	**Prev.**	**95% CI**		**HEX**	**Prev.**	**95% CI**		**HEX**	
Men	50-54	.554	-.131	1.24	21.37	.519	-.173	1.212	21.367	.003
	55-59	.176	.093	.258	19.664	.17	.087	.253	19.482	.182
	60-64	.174	.109	.239	16.278	.185	.109	.261	16.061	.217
	65-69	.143	.086	.2	13.056	.153	.082	.223	12.882	.174
	70-74	.179	.121	.237	9.772	.166	.107	.226	9.63	.142
	75-79	.222	.142	.303	6.799	.22	.137	.304	6.567	.232
	80-84	.415	.281	.548	4.233	.451	.311	.592	3.927	.307
	85+	.517	.318	.716	2.748	.558	.354	.762	2.514	.234
Women	50-54	.139	-.008	.286	25.926	.189	-.011	.39	25.433	.494
	55-59	.2	.129	.272	21.95	.215	.133	.297	21.701	.249
	60-64	.142	.089	.195	18.374	.161	.094	.228	18.194	.18
	65-69	.223	.148	.298	14.626	.224	.146	.303	14.536	.09
	70-74	.209	.14	.278	11.326	.227	.148	.306	11.239	.087
	75-79	.265	.167	.362	8.078	.275	.162	.388	8.075	.002
	80-84	.356	.213	.499	5.339	.366	.204	.527	5.393	-.055
	85+	.509	.368	.651	3.302	.49	.341	.639	3.431	-.129

Hungary		Weights without education				Weights with education				Δ HEX
Gender	**Age**	**Prev.**	**95% CI**		**HEX**	**Prev.**	**95% CI**		**HEX**	
Men	50-54	.135	.051	.218	18.3	.145	.048	.242	18.208	.092
	55-59	.252	.138	.366	15.019	.255	.141	.369	14.975	.043
	60-64	.199	.122	.275	12.623	.206	.131	.281	12.591	.032
	65-69	.216	.112	.32	10.165	.214	.119	.308	10.167	-.002
	70-74	.18	.096	.265	7.803	.187	.103	.271	7.796	.008
	75-79	.372	.185	.56	5.349	.358	.18	.536	5.381	-.031
	80-84	.584	.368	.801	3.911	.593	.359	.828	3.871	.039
	85+	.288	.09	.485	4.007	.289	.089	.489	4	.007
Women	50-54	.145	.045	.245	23.579	.176	.054	.298	23.297	.281
	55-59	.159	.077	.241	19.86	.16	.087	.234	19.73	.131
	60-64	.143	.054	.233	16.354	.162	.056	.269	16.224	.13
	65-69	.186	.06	.311	12.895	.186	.079	.293	12.855	.04
	70-74	.245	.164	.325	9.708	.237	.159	.316	9.666	.041
	75-79	.258	.16	.356	6.981	.27	.165	.375	6.896	.085
	80-84	.481	.343	.619	4.527	.481	.356	.607	4.488	.039
	85+	.42	.25	.591	3.531	.43	.26	.6	3.473	.058

Italy		Weights without education				Weights with education				Δ HEX
Gender	**Age**	**Prev.**	**95% CI**		**HEX**	**Prev.**	**95% CI**		**HEX**	
Men	50-54	.009	-.006	.024	26.765	.009	-.006	.025	26.823	-.058
	55-59	.066	.03	.102	22.229	.065	.029	.1	22.29	-.061
	60-64	.065	.035	.095	18.122	.065	.035	.095	18.177	-.056
	65-69	.131	.088	.173	14.169	.129	.087	.171	14.227	-.058
	70-74	.118	.078	.159	10.759	.114	.074	.154	10.811	-.052
	75-79	.217	.158	.277	7.413	.215	.156	.275	7.45	-.037
	80-84	.297	.211	.384	4.77	.291	.205	.378	4.805	-.034
	85+	.536	.399	.673	2.701	.533	.397	.67	2.715	-.014
Women	50-54	.088	.029	.147	28.667	.083	.025	.14	28.741	-.074
	55-59	.085	.049	.121	24.376	.085	.049	.121	24.424	-.048
	60-64	.091	.061	.121	20.147	.091	.06	.121	20.194	-.047
	65-69	.103	.069	.138	16.024	.104	.069	.138	16.07	-.046
	70-74	.163	.118	.207	12.071	.162	.118	.207	12.122	-.051
	75-79	.257	.192	.322	8.518	.248	.184	.313	8.571	-.053
	80-84	.362	.271	.454	5.63	.357	.266	.449	5.646	-.016
	85+	.517	.4	.634	3.531	.518	.4	.635	3.523	.008

Poland		Weights without education				Weights with education				Δ HEX
Gender	Age	Prev.	95% CI		HEX	Prev.	95% CI		HEX	
Men	50-54	0	.	.	21.151	0	.	.	21.371	-.22
	55-59	.158	.088	.228	17.073	.154	.082	.226	17.304	-.231
	60-64	.194	.136	.251	14.006	.177	.117	.237	14.232	-.225
	65-69	.193	.128	.258	11.327	.186	.116	.256	11.492	-.164
	70-74	.179	.101	.257	8.849	.172	.094	.25	9.002	-.154
	75-79	.335	.232	.437	6.324	.34	.223	.456	6.472	-.148
	80-84	.361	.226	.497	4.732	.335	.196	.475	4.965	-.233
	85+	.346	.197	.494	3.613	.307	.164	.45	3.827	-.214
Women	50-54	.031	-.029	.092	24.458	.048	-.044	.14	24.421	.037
	55-59	.112	.068	.156	20.02	.113	.067	.159	20.067	-.048
	60-64	.107	.065	.15	16.093	.1	.059	.142	16.146	-.053
	65-69	.186	.12	.252	12.255	.186	.119	.253	12.274	-.019
	70-74	.334	.245	.422	8.875	.333	.242	.424	8.897	-.023
	75-79	.439	.326	.552	6.281	.448	.331	.564	6.303	-.023
	80-84	.5	.392	.608	4.396	.474	.362	.587	4.468	-.072
	85+	.528	.381	.674	3.134	.536	.386	.686	3.081	.053

Portugal		Weights without education				Weights with education				Δ HEX
Gender	Age	Prev.	95% CI		HEX	Prev.	95% CI		HEX	
Men	50-54	.05	-.003	.102	25.805	.047	.001	.092	25.813	-.008
	55-59	.182	.032	.332	21.802	.185	.019	.351	21.796	.006
	60-64	.039	.007	.071	18.552	.045	.008	.081	18.56	-.008
	65-69	.215	.067	.364	14.716	.229	.072	.385	14.753	-.037
	70-74	.09	.026	.153	11.951	.079	.02	.139	12.062	-.11
	75-79	.225	.101	.349	8.798	.216	.09	.342	8.87	-.072
	80-84	.244	.046	.443	6.714	.225	.017	.433	6.755	-.04
	85+	.035	-.02	.09	5.523	.045	-.024	.115	5.462	.061
Women	50-54	.206	.068	.344	26.071	.212	.067	.358	27.008	-.936
	55-59	.088	.034	.141	22.388	.087	.031	.143	23.368	-.979
	60-64	.158	.054	.262	18.175	.104	.043	.165	19.166	-.991
	65-69	.1	.047	.153	14.366	.1	.044	.157	15.107	-.741
	70-74	.27	.098	.442	10.334	.197	.077	.317	11.106	-.772
	75-79	.211	.084	.337	7.289	.189	.071	.307	7.735	-.446
	80-84	.409	.228	.59	4.102	.378	.192	.565	4.495	-.393
	85+	.717	.499	.935	1.97	.668	.379	.958	2.312	-.341

Slovenia		Weights without education				Weights with education				Δ HEX
Gender	Age	Prev.	95% CI		HEX	Prev.	95% CI		HEX	
Men	50-54	.068	.029	.107	25.847	.072	.03	.113	25.749	.098
	55-59	.055	.027	.082	21.814	.056	.027	.084	21.731	.082
	60-64	.086	.04	.133	18.03	.087	.042	.133	17.947	.082
	65-69	.084	.043	.124	14.576	.087	.045	.128	14.494	.082
	70-74	.174	.108	.241	11.314	.18	.111	.249	11.237	.077
	75-79	.198	.122	.275	8.793	.203	.126	.28	8.734	.059
	80-84	.136	.057	.215	6.884	.148	.062	.234	6.834	.05
	85+	.041	-.007	.089	5.354	.041	-.007	.09	5.353	.001
Women	50-54	.117	.072	.161	28.919	.129	.08	.179	28.665	.254
	55-59	.132	.034	.231	24.862	.147	.034	.261	24.668	.194
	60-64	.103	.045	.161	20.978	.11	.045	.176	20.855	.123
	65-69	.163	.074	.252	17.073	.171	.078	.265	16.985	.088
	70-74	.173	.072	.275	13.624	.182	.073	.292	13.572	.052
	75-79	.215	.113	.317	10.329	.215	.112	.318	10.321	.008
	80-84	.165	.096	.235	7.73	.167	.095	.238	7.717	.012
	85+	.208	.098	.317	5.382	.209	.099	.319	5.373	.009

Spain		**Weights without education**				**Weights with education**				**∆ HEX**
Gender	**Age**	**Prev.**	**95% CI**		**HEX**	**Prev.**	**95% CI**		**HEX**	
Men	50-54	.03	.001	.058	28.899	.026	0	.052	28.94	-.041
	55-59	.048	.015	.08	24.649	.043	.013	.073	24.674	-.025
	60-64	.053	.025	.08	20.675	.048	.022	.074	20.679	-.004
	65-69	.042	.013	.071	16.908	.044	.014	.075	16.887	.021
	70-74	.037	.014	.059	13.284	.033	.012	.055	13.274	.01
	75-79	.099	.063	.136	9.869	.105	.066	.144	9.839	.03
	80-84	.158	.097	.219	7.095	.159	.096	.222	7.089	.006
	85+	.185	.11	.261	5.129	.186	.11	.261	5.129	.001
Women	50-54	.012	.001	.022	33.853	.013	0	.026	33.851	.002
	55-59	.013	0	.027	29.242	.013	0	.026	29.247	-.005
	60-64	.009	-.001	.019	24.708	.009	-.001	.018	24.709	-.001
	65-69	.042	.019	.065	20.206	.041	.017	.065	20.205	.001
	70-74	.05	.021	.08	15.978	.052	.021	.082	15.971	.007
	75-79	.088	.055	.121	11.966	.09	.055	.125	11.964	.002
	80-84	.138	.086	.19	8.494	.14	.087	.193	8.503	-.009
	85+	.253	.187	.318	5.772	.25	.184	.316	5.795	-.023

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