The Education Composition's Effect on Life Expectancy

- Are females racing towards longer lives while males get left behind?

Mikkel Bruun-Jensen & Vladimir Canudas-Romo

Max-Planck Odense Center, University of Southern Denmark

Abstract

Purpose: This study aims to assess the impact that the changing education composition has on the life expectancy gap between the sexes from today until 2050 for Denmark.

Background: Individuals' education is a determinant factor for the observed life expectancy in a population. Life expectancy is normally calculated solely from the observed age-specific death rates. Today, the age groups with the greatest impact on the measure are the age-groups with the highest death rates - the older generation. However, the older generations have a completely different educational composition than the younger generations. Thus, we study the possible effects that the changing education composition will have in the future Danish life expectancy.

Methods: We propose the use of a weighed life expectancy, taking into account the changing education composition of a population. Using information of education and mortality from Danish registers, we construct scenarios of life expectancy up until 2050.

Preliminary results: A widening in the life expectancy gap between the sexes is observed; this is in contrast to projections by the UN, which predicts a reduction in the gap. These previous calculations are associated with a number of limitations, which will be addressed in this study.

Introduction

The cornerstone of health is the life expectancy measure. It is used as a parameter that measures a countries overall health. Governments use it as a criterion when assessing how the health sector is performing - Both over time, and compared to other nations (European Commission, 2009). Calculating life expectancy correctly thus makes up the foundation of correct health policies.

Females across the entire developed world have had higher life expectancy than males, with a median life expectancy of 76.52 years for females, and 70.86 for males in 2008 (Lalic & Ratery, 2011). In Denmark the difference in life expectancies between the sexes reached a peak in 1979 at 6 years. Since then it has decreased to around 4 years in 2014 (Danmarks Statistik, 2015a). This trend, along with the trend for 10 selected countries for comparison, can be seen on Figure 1 below:

Figure 1. Life expectancy gap (F-M) in selected countries
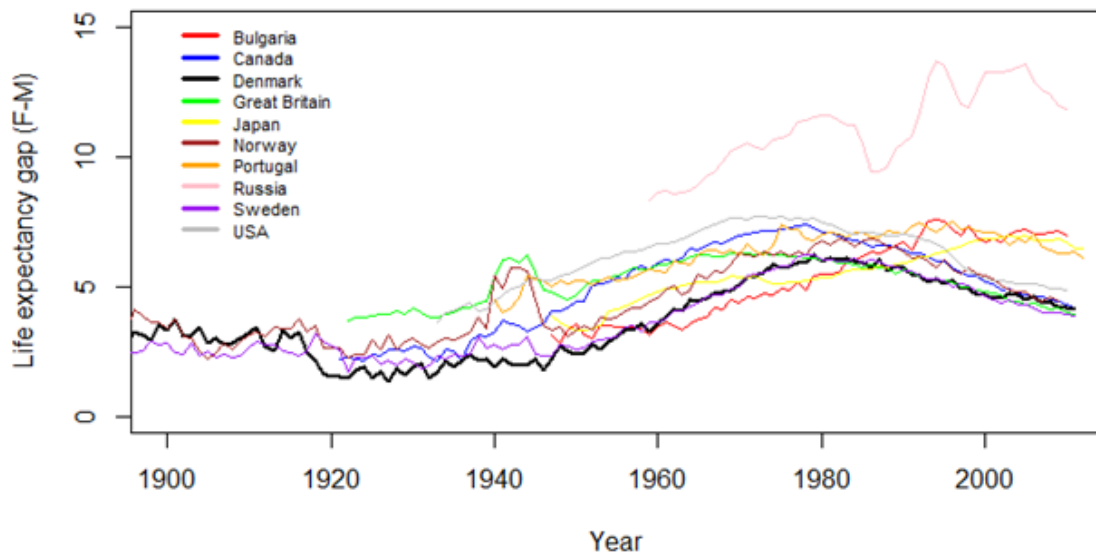
The United Nations (UN) projections for Denmark show a continuing decrease in the life expectancy sex-gap until it reaches a plateau at 3.4 years in 2050. (United Nations, 2013).

Females' remain ahead of males in terms of life expectancy; the difference can be attributed to sociological differences, but also to different biological characteristics, that are also found in many mammalian species (Vina et al., 2005). These biological differences, like the protective effects of oestrogen (Vina et al., 2005), and females' better immune system (Owens, 2002) assists in explaining the life expectancy gap between the sexes.

Other factors, than biological ones, contribute to the different levels of life expectancy found around the world. Smoking for example is considered one of the main factors contributing to the recent decrease in the life expectancy sex-gap (Juel & Christensen, 2007). Among the most important factors is also education, which is known to be highly correlated to longer life (Corsini, 2010).

Education as a predictor

For Denmark, Statistics Denmark found that males with the highest level of education live 6.6 years longer, and females 5.1 years longer compared to those with only primary education (Danmarks Statistik, 2014). Furthermore the gap in life expectancy between education groups

appears to be widening (Olshansky, et al., 2012 ; Meara et al., 2008). Danish life expectancy for all

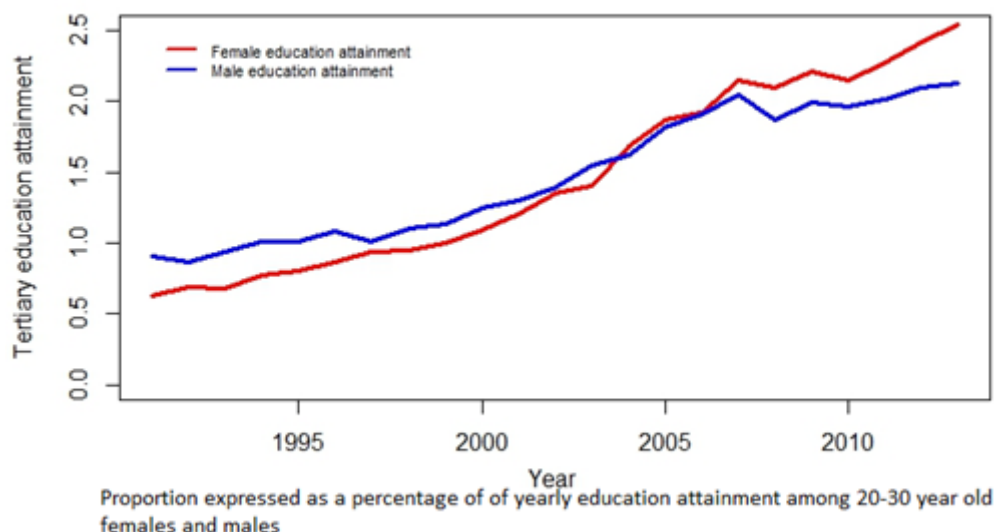levels of education and both sexes can be seen in Table 1 below:

Table 1. Life expectancy for 40 year-olds stratified for gender and highest level of education

Highest completed education	Females	Males	Gender difference
Primary school	80.4	76.1	4,3
General upper secondary education	83.4	78.7	4,7
Vocational upper secondary education	82.9	81	1,9
Vocational education	83.2	79	4.2
Short-cycle higher education	84.2	80.7	3.5
Medium-cycle higher education	84.8	81.6	3.2
Bachelor	85	81.2	3.9
Long-Cycle higher education	85.5	82.7	2.8

Source: Author's translation of Table from Højtuddannede lever længst, p. 1 by (Danmarks Statistik, 2014a)

Since 2004 more females than males attained the highest levels of education (Danmarks Statistik,

2015b). This increase is not due to a decline or stagnation amongst males, but a more rapid

increase in females' educational attainment (Danmarks Statistik, 2015b). The increase is depicted

in Figure 2 below:

Figure 2. Danish females and males, 1991-2013

Proportion expressed as a percentage of of yearly education attainment among 20-30 year old females and males

Why does this study argue that we should add education as a variable when discussing sex-

differentials in longevity? Normally life expectancy is calculated exclusively on the current

observed age specific death rates (Knudsen, 2012). Today, the age specific death rates that have the highest impact on measures of longevity are the old age-groups where most people die. In these older generations males are far ahead in educational levels compared to females. This distorts the calculations when we are also interested in the actual lifespan of currently living younger generations, with a very different educational composition than their older cohorts. The problem gets magnified since education *"is the single most important source of empirically observable population heterogeneity next to age and sex"* (Lutz et al., 2014, s.15).

Few studies forecast life expectancy for males and females, based on models that take educational levels into consideration. One study aggregated all educational groups from post-secondary courses up to the highest level of tertiary education levels under the category 'post-secondary' (Lutz et al., 2014). For countries with high educational levels, like Denmark, this aggregation is problematic since the life expectancy difference between the aggregated groups is years (Danmarks Statistik, 2014).

The purpose of this study is to assess the impact that the changing composition of education has on female and male life expectancy in Denmark from today until 2050.

Data

The data for this study comes from the Danish Centralized Civil Register maintained for research purposes by Statistics Denmark, which will carry out the record linkage and provide an anonymous version (Borchsenius L., 2005). The process and specific analysis plan adhere to security regulations established by Statistics Denmark, i.e. one is only allowed to take out results from analyses from which no individual can be identified. The study population consists of persons attaining 20 years of age or more between 1981 and 2013 in Denmark. Information on exact age and education level, as well as death information from the Registry of Causes of Death (Juel & Helweg-Larsen, 1999) for those that die in the period is known for every member of the population.

Methods

We suggest a new method to assess the impact that changing educational levels in the population will have on life expectancy, and the difference between the sexes. We plan to assess the current

situation of mortality differentials in Denmark by sex and the influence of education in mortality with multistate life tables (Preston et al., 2001) analysis which allows the transition of individuals to higher education levels, while studying the specific mortality at each education level. The database that allows us to study life expectancy and its association with education in Denmark is the population registers available at Statistics Denmark. The database will allow us to cross-reference individual level data on levels of education with data on mortality. With this information we plan to calculate mortality rates for each age, sex and educational group. Based on these mortality rates, life tables can be constructed for all levels of education in Denmark.

When you factor in the proportion of individuals at each level of education the data from all these life tables summed up equals a weighed life expectancy. If there are n education levels then life expectancy can be expressed as an average of life expectancies by education:

$$e_{a,s,t} = \sum_{e=1}^{n} e_{a,e,s,t} * P_{a,e,s,t}, \qquad (1)$$

where $P_{a,e,s,t}$ and $e_{a,e,s,t}$ are the proportion of individuals and life expectancy at each education level e, for each sex s, in each year t, and at each age a. Similarly $e_{a,s,t}$ is the resultant weighed life expectancy for each sex, at each age, and in each year. This formula is the cornerstone of the project, showing the weighting process of the education composition and its mortality in the building of overall life expectancy at each age.
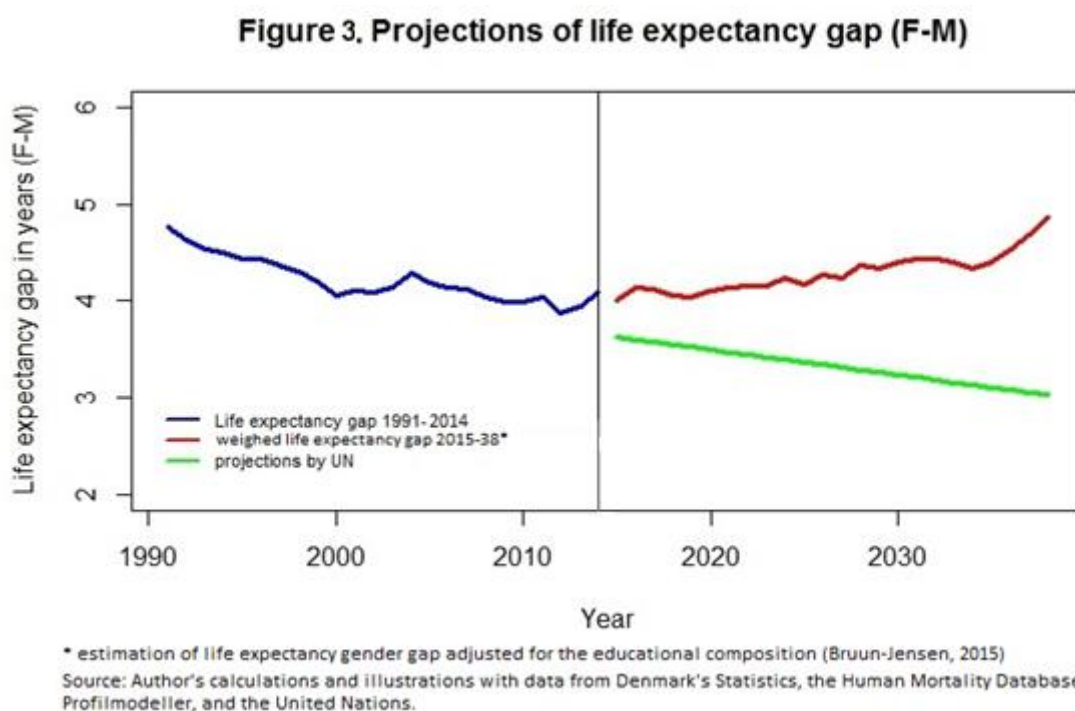
The usefulness of constructing it this way is that it allows us to vary the proportion of individuals at each education level, based on observed trends. A further advantage of this method is that the weighed life expectancy is a mathematic approximation of the usual life expectancy number. To show their similarity and the possibilities of learning the results of equation (1), both measures of life expectancy will be compared by trends over time and age.

This study will seek to create our own estimates of the future composition of educational levels based on analysis of data from Statistics Denmark. This estimate is highly sensitive to changes in the political prioritizations of education; such as the amount of money allocated to higher levels

education. In an attempt to take this into account, different scenarios of future trends in education will be created.

Preliminary results

Using forecasts on the education composition from the Danish Ministry of education, and data from Statistics Denmark on life expectancy at the age of 40 for both sexes, stratified for each ISCED education group from level 1 to 7, Bruun-Jensen (2015) calculated the life expectancy gap between the genders weighed by the educational composition. The results can be seen in Figure 3 below, together with a comparison to the UN projections:

Figure 3. Projections of life expectancy gap (F-M)

* estimation of life expectancy gender gap adjusted for the educational composition (Bruun-Jensen, 2015)
Source: Author's calculations and illustrations with data from Denmark's Statistics, the Human Mortality Database, Profilmodeller, and the United Nations.

While the study was limited by only having partial access to life expectancy data at each education level, making the results inconclusive, the large difference between the two different scenarios do call for future research. The study presented in this proposal solves these problems, by having direct access through collaborators in this study, to the "Danish Registers" that have the required information. With funding from either Novo Nordisk Foundation or the Danish Council for independent research, we will address these shortcomings prior to the EPC in September 2016.

References:

Borchsenius, L. (2005). New developments in the Danish system for access to micro data. Copenhagen, Denmark: Statistics Denmark.

Bruun-Jensen, M. (2015). The educational compositions effect on the life expectancy gender gap: Denmark 1991-2038. Odense, Denmark: SDU.

Corsini, V. (2010). Highly educated men and women likely to live longer. *Eurostat Statistics in focus*. Retrieved from http://ec.europa.eu/eurostat/en/web/products-statistics-in-focus/-/KS-SF-10-024

Danmarks Statistik. (2014). Nyt fra danmarks statistik, højtuddannede lever længst. Danmarks Statistik.

Danmarks Statistik. (18. September 2015a). Middellevetid. Retrived from http://www.statistikbanken.dk/statbank5a/selectvarval/saveselections.asp

Danmarks Statistik. (21 september 2015b). Lange videregående uddannelser. Retrieved from http://www.dst.dk/da/Statistik/emner/fuldtidsuddannelser/lange-videregaaende-uddannelser

European Commission. (2009). Solidary in health:Reducing health inequalities in the EU. Brussels: COMMISSION OF THE EUROPEAN COMMUNITIES.

Juel, K., & Christensen, K. (2007). Kønsforskelle i dødelighed i Danmark 1840-2005. Ugeskrift for læger 169/26. pp. 2398-2403.

Juel, K., & Helweg-Larsen, K. (1999). The Danish registers of causes of death. Dan Med Bull:, 46, 354-357.

Knudsen, L. B. (2012). Introduktion til demografisk metode. Odense: Syddansk Universitetsforlag.

Lalic, N., & Ratery, A. E. (2011). Joint probabilistic Projection of Female and Male life expectancy. Washington: University of Washington, Center for Statistics and the Social Sciences.

Lutz, W., Butz, W. P., & KC, s. (2014). World population and human capital in the twenty-first century. Oxford: Oxford university pres.

Meara, E. R., Richards, S., & Cutler, D. M. (2008). The Gap Gets Bigger: Changes In Mortality And Life Expectancy, By Education, 1981-2000. *Health Affairs*, pp. 350-360.

Olshansky, J. S., Antonucci, T., Berkman, L., Binstock, R. H., Boersch-Supan, A., Cacioppo, J. T., . . . Rowe, J. (2012). Differences In Life Expectancy Due To Race And Educational Differences Are Widening, And Many May Not Catch Up. *Health Affairs*, s. 1803-1813.

Owens, I. P. (2002). Sex Differences in Mortality Rate. Science, pp. 2008-2009.

Preston, S. H., Heuveline, P., & Guillot, M. (2001). Demography - Measuring and Modeling Population Processes. Oxford: Blackwell Publishing.

The Human Mortality Database. (21. May 2015). Denmark. Retrieved from http://www.mortality.org/cgi-bin/hmd/country.php?cntr=DNK&level=1

Undervisningsministeriet. (22. September 2015). Rapporter. Retrived from http://statweb.uni-c.dk/databanken/uvmDataWeb/ReportsForCategory.aspx?category=PRO

United Nations, population division. (2013). World population prospects The 2012 revision. New York: United Nations, Department of Economic and Social Affairs, Population.

United Nations. (22. September 2015). Excel tables - Mortality Data. Retrieved from http://esa.un.org/unpd/wpp/Excel-Data/mortality.htm

Vina, J., Borras, C., Gambini, J., Sastre, J., & Pallardo, F. V. (2005). Why females live longer than males? Importance of the upregulation. FEBS Letters, pp. 2541-2545.