The Life Expectancy of a Child Born in Ireland in the Twenty-First Century

S. Whelan, R. Naqvi

UCD School of Mathematics & Statistics, Belfield, Dublin 4.

Abstract

Period Life expectancies for the Irish population are projected and published by the Central Statistics Office (CSO) and the United Nations (UN). This article estimates cohort life expectancies at birth in Ireland over the remainder of the 21st century together with 80% and 95% prediction intervals consistent with these official estimates. We report that a female born in Ireland in calendar year 2020 can be expected to live to 92.6 years with a 95% prediction interval around this estimate of 86.8 years to 97.3 years. For males born in 2020, the central estimate is 90 years with 95% prediction interval of 83.9 years to 95.2 years. The probability that cohort life expectancies at birth will reach 100 years before the calendar year 2100 is less than 10% for females and less than 2.5% for males.

Introduction

Life expectancies in Ireland have shown a marked increase since statistics on births and deaths were systemically collected by the state after the Registration of Births and Deaths (Ireland) Act of 1863. Over the course of the twentieth century, period life expectancies for females increased by, on average, 0.3 years with the passage of each calendar year (0.25 for males)[1,2]. Mortality improvements were concentrated at the earlier ages in the first decades of the twentieth century but became more evident at later ages as the century progressed in a pattern sometimes referred to as "the aging of mortality improvements"[3,4,5].

Life expectancies in Ireland are forecast by the Central Statistics Office (CSO) as part of their population projections[6] and also by the United Nations (UN)[7]. However, both of these agencies forecast period life expectancies. A period life expectancy is estimated from mortality rates observed at each age over a particular period in the past (usually a calendar year or group of years). So the period life expectancy at birth according to the most recent Irish Life Tables published by the CSO relate to the mortality experience observed over the calendar years 2010 to 2012 and show period life expectancy at birth as 82.8 years for females and 78.4 years for males. However, period life expectancies do not give a measure of how long a person will live because, as the CSO makes clear: "Period expectation of life …is therefore not the number of years someone of that age could actually expect to live because death rates are likely to change in the future"**Error! Bookmark not defined.**.

The cohort life expectancy directly addresses the issue of how long a person can be expected to live as it estimates life expectancy not from historic mortality rates but from the (projected) mortality rates the person can be expected to experience as the individual ages. So, for example, a new-born in calendar year 2020 will be aged 50 years in calendar year 2070 so, in estimating the cohort life expectancy, the current mortality rate of a 50 year-old is adjusted to reflect how that mortality rate is expected to change over the next half-century. The resultant projected mortality rates (using this approach to project forward for each age and each future period) are used in the calculation of the cohort life expectancy.

There is generally a significant difference between the life expectancies calculated using the two different approaches, with the cohort life expectancy generally greater than the period life expectancy as mortality rates are expected to continue to decline in the future.

This article analyses the latest official mortality projections made by the CSO and the forecasts of life expectancies made by the UN for Ireland. Since 2014, the UN life expectancy forecasts are made using a stochastic approach, so not only are median future period life expectancies at birth reported but also the 80% and 95% prediction intervals. We derive projected mortality rates at each age and for each future calendar year consistent with the UN forecasted life expectancies and apply the resultant mortality rates to project cohort life expectancies together with 80% and 95% prediction bounds.

Methods

The CSO and the UN apply quite different approaches to project period life expectancies for Ireland. The CSO employ an expert panel to advise on short-term and long-term trends in mortality for males and females separately and then apply these trends to project mortality rates and thereby life expectancies. In the most recent projections published in 2018, the CSO[6] assumes that the short-term trend of mortality rates decline by 2.0% per annum for females (2.5% for males) and this will fall linearly to the assumed long term rate of decline of 1.5% per annum (both sexes) over a 25-year period and then remain declining at 1.5% per annum from then. This pattern of decline was applied to all ages up to age 90 years; from age 100 years no improvements in mortality rates were assumed; and for ages between 90 and 100, the rate of decline was solved by linear interpolation between the assumed rate at 90 years of age and the zero rate assumed at 100 years of age.

In contrast, the UN Population Division employed a stochastic Bayesian hierarchical model to forecast life expectancies (i.e., not mortality rates) in a consistent manner for all 159 countries in the world with a population over 100,000 that are not experiencing an AIDS epidemic, with different parameters for each country drawn from a common world population[8,9]. This stochastic approach leads to many possible trajectories of life expectancies, which allows the estimation of prediction bounds alongside the median forecast. The UN publishes the median period life expectancy at birth for each calendar year 2020 to 2100, together with 80% and 95% prediction bounds[Error! Bookmark not defined.,10].

It proved possible to apply the CSO two-parameter model of future mortality rates to get a very close fit to the median and the different prediction bounds produced by the UN stochastic life expectancy model, by simply recalibrating the inputs for short-term and long-term trends[11]. Recalibrating the CSO model in this manner allows us to derive mortality rates at each age and at each future year consistent with the UN period life expectancies, and therefore gives us the building blocks to estimate future cohort life expectancies and their prediction bounds[11].

Results

Table 1 shows that a female born in Ireland in 2020 is projected to live, on average, 92.5 years according to the UN and 92.7 years according to the CSO. The 95% prediction bound around this estimate is 86.8 years to 97.3 years (roughly ±5 years). However, by the end of the 21st century, while it is expected that the average life expectancy for a female is 97.7 years according to the UN and 97.6 years according to the CSO model, there is a chance less than 10% that the average life expectancy at birth will be 100 years or over. Indeed, on the negative side, the table shows that there is a chance, somewhere between 2.5% and 10% that the average cohort life expectancy for a female by the end of this century could be lower than that expected in 2020.

Table 1: Male and female projected cohort life expectancies in Ireland for selected calendar years of birth, 2020-2100, with 50%, 80% and 95% prediction intervals consistent with UN 2019 forecasts (including CSO 2018 projection).

			Male			
Calendar Year of Birth	UN Lower 95%	UN Lower 80%	UN Median	CSO 2018 Projection	UN Upper 80%	UN Upper 95%
2020	83.88	85.96	89.71	90.38	93.41	95.21
2040	85.34	87.55	91.60	92.42	95.38	97.03
2060	86.74	89.02	93.18	94.08	96.82	98.25
2080	88.06	90.37	94.52	95.44	97.89	99.09
2100	89.29	91.58	95.64	96.54	98.69	99.68
			Female			
Calendar Year of Birth	Lower 95%	Lower 80%	Median	CSO 2018 Projection	Upper 80%	Upper 95%
2020	86.81	88.81	92.51	92.68	95.94	97.31
2040	87.99	90.25	94.22	94.32	97.55	98.73
2060	89.13	91.57	95.62	95.66	98.66	99.64
2080	90.20	92.76	96.75	96.74	99.44	100.22
2100	91.19	93.82	97.65	97.62	99.99	100.61

Discussion

The CSO and the UN models are consistent in projecting that period life expectancy at birth in Ireland will grow by 0.11 for females and 0.12 for males with the passage of each calendar year over the remainder of the 21st century. This is a considerable slowdown (roughly half) of the gains recorded over the previous century.

Part of the reason for this slowdown is that mortality rates are now so low at the younger ages that further percentage declines, even if at the same rate as in the past, will have less of an impact on extending life expectancies. Extension of life expectancies in the future largely depend on declines in mortality at advanced ages, especially at post retirement ages.

The extension of human lifetimes has been attributed to some mix of improvements in nutrition, in income and wealth, in behaviour, in education, in public health, and in medicine, with the mix depending on the country and the time[12]. The State, directly or indirectly, plays a key role in shaping many of these factors. Given the importance of reducing mortality rates at advanced ages to extend life expectancies further, the State and its policies on pensions and healthcare can be expected to have a key impact in the 21st century. Amongst other things, there must be increasing resources made available for the treatment of older patients with their associated clinical complexities[13].

The above mortality projections are, arguably, the best that can be done, but that does not make them reliable. The UN will revise their projections in a year or two and the CSO will do the same following the next census (due in 2021). In the past, projections of life expectancies by official agencies or academics have been poor, generally underestimating increases[14].

So life expectancies are projected to continue to increase throughout the twenty-first century, albeit at about half the pace of the 20th century. A key question is what proportion of the additional years will be in good heath – "Dorian Gray" years - and what proportion maybe less desirable "Struldbrugg" years. Early evidence is that there is little change in the proportion of "Dorian Gray" years to "Struldbrugg" years over time. A recent study[15] shows that there has almost been no change between ratio of healthy life expectancies to total life expectancies between 1990 and 2017 in Ireland as well as other countries with high incomes and high educational attainment (the ratio being about 86% at birth and 75% at age 65).

Declaration of Conflicts of Interest:
The authors confirm that they have no conflict of interest to declare in relation to this work.

Corresponding Author:
Dr Shane Whelan,
Actuary & Associate Professor,
UCD School of Mathematics & Statistics,
Belfield,
Dublin 4.
E-mail: Shane.Whelan@ucd.ie

References:
1. Naqvi R, Whelan S. Future Life Expectancies in Ireland. Journal of the Statistical & Social Inquiry Society of Ireland. Read to the Society on 14th November 2019 and available from http://ssisi.ie/meeting.php
2. Central Statistics Office, Ireland. Irish life tables no. 16, 2010-2012. Available from https://pdf.cso.ie/www/pdf/-20171121010152_Irish_Life_Tables_No_16_20102012_full.pdf [Accessed 08 August 2019].
3. Whelan S. Projecting Population Mortality for Ireland. Journal of the Statistical & Social Inquiry Society of Ireland. Journal of the Statistical and Social Inquiry Society of Ireland, Vol. XXXVII, *(2007/2008),* 135-163. Available from www.ssisi.ie.
4. Hall M. Mortality in Ireland 1901 to 2006. British Actuarial Journal. 2013;18(2):436-51.
5. Whelan S. Mortality in Ireland at advanced ages, 1950-2006: Part 1: crude rates. Annals of Actuarial Science. 2009;4(1):33-66.
6. Central Statistics Office, Ireland. Population and labour force projections 2017-2051.Available from https://www.cso.ie/en/releasesandpublications/ep/p-plfp/populationandlabourforceprojections2017-2051/populationprojectionsresults/ [Accessed 08 August 2019].
7. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects 2019. Available from https://population.un.org/wpp/ [Accessed 28 July 2019].
8. Raftery AE, Alkema L, Gerland P. Bayesian population projections for the United Nations. Statistical science: a review journal of the Institute of Mathematical Statistics. 2014 Feb;29(1):58.
9. Raftery A, Chunn J, Gerland P, Ševčíková H. Bayesian Probabilistic Projections of Life Expectancy for All Countries. Demography. 2013;50(3):777-801.
10. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects 2019: Data Booklet (ST/ESA/SER.A/424). 2019.
11. Naqvi R. Modelling the Pattern of Mortality Decline in Ireland and the United Kingdom. PhD Thesis, UCD School of Mathematics and Statistics; Submitted December 2019.
12. Riley JC. Rising life expectancy: a global history. Cambridge University Press; 2001.
13. Johnson H, O'Farrell A, McKeown D, Sayers G, Hayes C, Beaton D. Is Increasing Life Expectancy Leading to More Complexity? Irish medical journal. 2018 Jan;111(1):672-.
14. Oeppen J, Vaupel JW. Broken limits to life expectancy. Science. 2002 May 10;296(5570):1029-31.
15. GBD 2017 DALYs and HALE Collaborators. Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet. 2018 Nov 10;392(10159):1859-922.