



Original Research

Life expectancy and age–period–cohort effects: analysis and projections of mortality in Spain between 1977 and 2016

R. Cleries^{a,b,*}, J.M. Martínez^c, J. Valls^{a,d}, L. Pareja^a, L. Esteban^a, R. Gispert^e, V. Moreno^{b,f}, J. Ribes^a, J.M. Borràs^{a,b}

^a Catalan Cancer Registry, Generalitat de Catalunya/Catalan Institute of Oncology, IDIBELL, Hospitalet de Llobregat, Spain

^b Department of Clinical Sciences, Universitat de Barcelona, Barcelona, Spain

^c Unitat de Recerca en Salut Laboral, Universitat Pompeu Fabra, Barcelona, Spain

^d Departament de Matemàtiques, Universitat Autònoma de Barcelona, Spain

^e Registre de Mortalitat de Catalunya, Generalitat de Catalunya, Barcelona, Spain

^f Bioinformatics and Biostatistics Unit, Catalan Institute of Oncology, IDIBELL, Hospitalet de Llobregat, Spain

ARTICLE INFO

Article history:

Received 28 February 2008

Received in revised form

19 September 2008

Accepted 28 October 2008

Available online 20 January 2009

Keywords:

Mortality

Life expectancy

Age–period–cohort models

Projections

SUMMARY

Objectives: This study aimed to: (1) assess Spanish mortality trends between 1977 and 2001 and their impact on life expectancy; and (2) assess the differences in life expectancy between men and women for the period 2002–2016.

Study design: Time trends study using age–period–cohort (APC) analysis.

Methods: A Bayesian APC model was fitted to describe Spanish mortality rates for the period 1977–2001 and to project Spanish mortality rates for 2002–2016. Life expectancy was predicted through Chiang's method using projected mortality rates.

Results: There was a significant cohort effect for Spanish mortality, showing a slight increase in mortality among men aged 20–39 years between 1986 and 1997 (birth cohorts 1940–1970). Life expectancy is expected to increase by approximately 0.5% in men and women between 1977 and 2016 (1 year per 5-year period). Life expectancy for males born between 2012 and 2016 will be 77.15 years, compared with 84.95 years for females born during the same period.

Conclusions: The rising trend in mortality among the 1940–1970 cohorts may be due to the increased risk of avoidable causes of death related to acquired immunodeficiency syndrome, traffic accidents, and drug and alcohol abuse during the mid 1980s. The decline in mortality rates in recent years could lead to a mean increase in life expectancy of 1 year per 5-year period in both genders between 2002 and 2016. An increase in life expectancy for women and a levelling off for men is expected for age groups older than 79 years.

© 2008 The Royal Society for Public Health. Published by Elsevier Ltd. All rights reserved.

Introduction

Life expectancy (LE) trends over time provide major public health information that reflects social and political changes in populations. Different changes have been observed in European Union countries since the beginning of the 21st Century. Estimates of LE during recent decades showed that Sweden, Spain and France have the highest LE in Europe.¹ In particular, Spain compared favourably with other low-mortality countries between 1970 and 2000.² In 2004, LE at birth reached 83.8 years for Spanish women,

almost 7 years higher than that for Spanish men,¹ and close to that in Japan (85.5 years); the country which ranks the highest worldwide.³

In Spain, a previous study on the impact of avoidable causes of death, such as acquired immunodeficiency syndrome (AIDS), traffic accidents and alcohol and drug abuse, between 1987 and 2001 showed its effect on LE over the last two decades.⁴ Projections of future LE based on recent trends are relevant for major health policy decisions related to retirement funding and planning of health services.

This study aimed to: (1) assess recent Spanish mortality trends and LE by age group for each gender, and (2) project LE by gender taking into account the effects of age, period and birth cohort on the predicted mortality trends using a Bayesian approach, which allows the effect of the precision of a country's future population to be taken into account.⁵

* Corresponding author. Catalan Cancer Registry, Generalitat de Catalunya/Catalan Institute of Oncology, IDIBELL, Av Gran Via Km 2,7 Hospitalet de Llobregat 08907, Spain. Tel.: +34 932 607 812.

E-mail address: r.cleries@iconcologia.net (R. Cleries).

Methods

A time trend study was carried out using a Bayesian age–period–cohort (APC) analysis to estimate the effects of age, period of death and birth cohort on mortality.^{5–13} Age effects represent different risks associated with different age groups. Period effects reflect changes in treatment or exposure to a certain risk factor that would increase mortality in all age groups at the same time.^{12,13} Cohort effects are associated with long-term habits or long-term exposures, whereby different generations have been exposed to different risks. A change in exposure to risk factors or a change in population habits in time is detected through these effects when they show curvature (non-linear increase or decrease in mortality risk)^{7,12,13} at a certain point in time. As such, a key point in APC analysis is to detect these curvatures.^{7,10,12,13}

Population distribution

The National Institute of Statistics of the Spanish Government provided mortality data and population age distribution data for the period 1975–2004, as well as projected future population data for the period 2002–2016. The first 2 years (1975–1976) and the last 3 years (2002–2004) were used for internal validation of projections. Data were grouped into five 5-year periods (1977–1981, 1982–1986, 1987–1991, 1992–1996 and 1997–2001) and 18 5-year age groups (0–4 to 85–89 years, data for persons older than 89 years were excluded from the analysis due to non-precision of the population at risk estimates). Table 1 shows the population distribution used in this study and the percentage increase for each age group by consecutive 5-year periods. These age groups and calendar periods involved 22 overlapping 10-year cohorts due to the relationship cohort = period–age.^{6,7} The cohort groups were defined by their mid-years (starting with 1889 and finishing with 1999).

Statistical methods

A Bayesian APC analysis was undertaken to describe mortality time trends and projections. Although different methods have been proposed to obtain LE forecasts based on age-specific mortality rates, these do not take into account the birth cohort effect on mortality rates, when this exists. In this case, LE projections can be

improved by including the birth cohort effect. Under this scenario, the Bayesian framework is a flexible alternative to obtain LE forecasts including age, period and birth cohort.⁵

The analysis started by estimating recent mortality trends between 1977 and 2001 through modelling the ratio of number of deceased cases (numerator) and population at risk (denominator) using a Poisson distribution.^{12,13} Once the trends were estimated, predictions of mortality rates were obtained based on these trends and using the future population at risk^{12,13} between 2002 and 2016. Finally, future mortality rates by age group were used to predict LE based on Chiang's method.^{14,15}

Age, cohort and period effects were assessed using generalized linear models, assuming that the number of deaths follows a Poisson distribution.^{6,7} Under the Bayesian framework, trends corresponding to age, period and birth cohort were smoothed using second-degree autoregressive smoothing (non-parametric smoothing with autoregressive error component). This resulted in linear extrapolations for age, period and cohort.^{8–12} In APC analysis, the relationship cohort = period–age is associated with the problem of non-identifiability in the parameter estimates.^{6,7,13} Estimation of parameters extracted from the full APC model was undertaken assuming zero slopes for cohort effect, using 1977–1981 as the reference period and 1949 as the reference cohort. Graphical representation of the exponential of each of these parameters and their 95% credibility intervals (CRI, the Bayesian confidence intervals) has been reported. The number of predicted deaths for 2002–2016 was obtained using the APC model. Once the expected number of deaths was calculated, Chiang's method for constructing life tables was used to calculate LE in each projected 5-year period.^{14,15} Standard errors for predicted LE were obtained by means of the posterior distribution of the mortality projections obtained through the Bayesian APC model. Estimation of LE based on mortality predicted from an APC model requires the analyst to make strong parametric assumptions about the degree of data smoothing needed in order to obtain posterior standard errors of data functions such as LE. The Bayesian method extracts the necessary information from the data to describe the observed trend, projecting it into the future in the smoothest possible way,^{5,12} and achieving sensible predictions in situations when other methods would fail.^{12,13} This Bayesian APC model is particularly interesting because it allows the uncertainty associated with functions of the parameters to be readily explored.¹²

Table 1

Population distribution in Spain by gender and for age groups 0–89 years during 1997–2016, and comparison of evolution (%) between consecutive 5-year periods from 1997–2001 to 2012–16

Age group (years)	Men						Women					
	Period 1997–2001	Period 2002–2006	Period 2007–2011	Period 2012–2016	Evolution (%) 2002–2006 vs 1997–2001	Evolution (%) 2012–2016 vs 2007–2011	Period 1997–2001	Period 2002–2006	Period 2007–2011	Period 2012–2016	Evolution (%) 2002–2006 vs 1997–2001	Evolution (%) 2012–2016 vs 2007–2011
0–4	943,345	1,098,496	1,162,856	1,231,607	16.45	5.91	890,346	1,037,432	1,096,540	1,162,294	16.52	6.00
5–9	1,011,847	1,007,487	1,057,678	1,135,608	–0.43	7.37	956,029	956,164	1,002,720	1,074,511	0.01	7.16
10–14	1,127,778	1,076,978	1,065,078	1,073,696	–4.50	0.81	1,069,422	1,019,189	1,008,574	1,017,947	–4.70	0.93
15–19	1,397,046	1,202,193	1,176,093	1,172,201	–13.95	–0.33	1,329,175	1,140,663	1,112,894	1,107,878	–14.18	–0.45
20–24	1,669,800	1,532,922	1,459,361	1,409,414	–8.20	–3.42	1,598,718	1,465,320	1,391,446	1,348,488	–8.34	–3.09
25–29	1,685,106	1,883,533	1,899,661	1,857,511	11.78	–2.22	1,627,137	1,781,430	1,782,697	1,749,795	9.48	–1.85
30–34	1,643,018	1,874,666	2,004,187	2,109,119	14.10	5.24	1,611,053	1,777,266	1,870,654	1,955,786	10.32	4.55
35–39	1,548,887	1,782,869	1,881,315	1,995,145	15.11	6.05	1,542,538	1,729,348	1,792,785	1,875,043	12.11	4.59
40–44	1,387,934	1,645,601	1,750,917	1,850,575	18.56	5.69	1,395,217	1,632,005	1,717,860	1,796,407	16.97	4.57
45–49	1,237,487	1,446,421	1,558,405	1,664,731	16.88	6.82	1,247,161	1,457,066	1,562,805	1,661,313	16.83	6.30
50–54	1,169,236	1,260,594	1,325,153	1,423,174	7.81	7.40	1,198,366	1,287,278	1,353,579	1,453,825	7.42	7.41
55–59	990,073	1,168,186	1,210,072	1,243,241	17.99	2.74	1,033,626	1,223,472	1,266,519	1,299,750	18.37	2.62
60–64	947,031	973,073	1,061,310	1,130,025	2.75	6.47	1,038,836	1,045,832	1,140,710	1,217,992	0.67	6.77
65–69	963,090	900,825	869,044	906,512	–6.47	4.31	1,103,561	1,029,260	983,803	1,014,867	–6.73	3.16
70–74	783,301	864,556	869,815	839,435	10.37	–3.49	977,083	1,058,215	1,059,927	1,020,231	8.30	–3.75
75–79	544,481	642,452	680,368	713,216	17.99	4.83	779,257	887,246	927,438	960,726	13.86	3.59
80–84	293,007	389,419	428,671	457,679	32.90	6.77	521,452	635,903	684,621	723,695	21.95	5.71
85–89	204,926	237,399	265,248	299,465	15.85	12.90	460,854	540,992	587,440	640,483	17.39	9.03

Population for 2007–2016 is based on projection method (see Spanish National Institute of Statistics⁴⁰).

Download English Version:

<https://daneshyari.com/en/article/1088955>

Download Persian Version:

<https://daneshyari.com/article/1088955>

[Daneshyari.com](https://daneshyari.com)