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Contribution of changes in demography and in the risk factors to the predicted pattern of cancer mortality among Spanish women by 2022

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ABSTRACT

Background: Changes in the burden of cancer mortality are expected to be observed among Spanish women. We predict those changes, in Spain, for breast cancer (BC), colorectal cancer (CRC), lung cancer (LC) and pancreatic cancer (PC) from 2013 to 2022.
Methods: Bayesian age–period–cohort modeling was used to perform projections of the cancer burden in 2013–2022, extrapolating the trend of cancer mortality data from 1998 to 2012. We assessed the time trends of the crude rates (CRs) during 1998–2012, and compared the number of cancer deaths between the periods 2008–2012 and 2018–2022 to assess the contribution of demographic changes and changes in the risk factors for cancer.
Results: During 1998–2012, CRs of cancer decreased for BC (0.3% per year) and increased for LC (4.7%), PC (2%) and CRC (0.7%). During 2013–2022, CRs might level off for CRC, whereas the time trends for the remaining cancers might continue at a similar pace. During 2018–2022, BC could be surpassed by CRC as the most frequent cause of cancer mortality among Spanish women, whereas LC could be the most common cause of cancer mortality among women aged 50–69 years (N/year = 1960 for BC versus N/year = 1981 for LC). Comparing 2018–2022 and 1998–2012, changes in the risk factors for cancer could contribute 37.93% and 18.36% to the burden of LC and PC, respectively, and demographic shifts – mainly due to ageing (19.27%) – will drive the burden of CRC.
Conclusions: During 2018–2022, demographic changes (ageing) and changes in risk factors could have a different impact on the lifetime risk of cancer among Spanish women.

1. Introduction

During 2012, breast cancer (BC), colorectal cancer (CRC), lung cancer (LC) and stomach cancer were the four most common cancer types amongst European women [1]. A similar pattern was observed for cancer mortality, although the fourth position of stomach cancer was surpassed by pancreatic cancer (PC) and other cancers depending on the country and the cancer incidence in that country [1,2]. However, changes in the burden of cancer mortality are expected to be observed across Europe within the next 10 years [3], due mainly to a decreasing trend of BC mortality [4]. In parallel, an increasing trend of LC was detected [1,3] suggesting that LC might surpass BC mortality in some age groups [3]. On the other hand, PC mortality has shown a striking rising trend of incidence and mortality since the beginning of 2000s [1,3]. Similar patterns were observed in certain regions of Spain until 2010, where these four cancers accounted for at least 47% of the total deaths from cancer [5–8].

To interpret changes in the trends of all these cancers, it is important to take into account changes in the risk of developing cancer in parallel with changes in demographic factors such as ageing of the population [9]. This last factor is related to a lifetime

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risk of developing cancer, which has been found to increase over time due to longer life expectancy [10]. Since Spain is predicted to be one of the world's oldest countries in 2050, with 40% of its population aged over 60 (Population Ageing and Development, 2009: www.unpopulation.org), the assessment of its cancer mortality burden and the effect of ageing is of crucial interest. The analysis of these four cancer sites provides a useful tool for planning cancer treatment and prevention programs, since mortality reduction is the main objective of the interventions based on screening and early treatment, and it is an indicator to assess the effectiveness of cancer control strategies.

We analyzed these remarkable changes of the top four cancer killers in Spain during 1998–2012 among women, and predicted their burden for 2018–2022, assessing how changes in the risk of death from cancer and changes in demographic factors may affect the number of cancer deaths in the future.

2. Materials and methods

2.1. Data

The National Institute of Statistics of the Spanish Government (INE, http://www.ine.es/) provided data on cancer mortality and age distribution of the female population for the period 1998–2012. Cancer mortality data for BC, CRC, LC and PC were arranged in three 5 year periods (1998–2002, 2003–2007, 2008–2012) and 18 5-year age groups (from 0 to 4 years to 85–89 years). Cancer codes were classified using International Classification of Diseases 10th revision, and these were C50 for BC, C33–C34 for LC, C18–C21 for CRC (colon, rectum and anus) and C25 for PC. Projections of future population counts and age distribution for the periods 2013–2017 and 2018–2022 were provided by the INE, which can project population data using rates of mortality, fertility and migration within a multiregional model [11].

2.2. Bayesian age–period–cohort modeling of the projections

We adapted the age–period–cohort modeling previously used for projecting breast cancer mortality in Spain up to 2020, considering temporal structures of model parameters [6]. For each cancer site, the annual percent change of the crude rates (CRs) during 1998–2012 and 2013–2020 was estimated through an age-drift model [6]. Details of the models used can be found in the Supplementary material (Section 1) at the end of this paper.

2.3. Separating the contribution of the changes in demography and changes in the risk of death from cancer

Differences in the numbers of BC, CRC, LC and PC deaths across the 10-year period 2008–2012 and 2018–2022 were evaluated, separating changes due to demography and risk factors for cancer according to the method of Bashir and Estève [12] and adapting these to the Bayesian framework. For each age group, the number of deaths in 2018–2022 was broken down into those due to changes in demography (size and age distribution) and those due to changes in the risk of death from cancer using the reference period 2008–2012. We calculated the absolute net percentage of change between these two time periods as $Net(\%) = Demography(\%) + Risk(\%)$ (See Section 1 of the Supplementary material for mathematical details), and, making use of the predictive distribution of the number of deaths during 2018–2022, we presented the 95% prediction intervals (PIs) of those percentage changes. The inclusion of the 0 value within the PI of the percentage change due to any of the two additive percentages shows that the corresponding percentage might not be influencing the absolute percentage net change between periods.

3. Results

3.1. Time trends during 1998–2012

Table 1 shows the CRs and annual average of the number of deaths for the periods 1998–2002, 2003–2007 and 2008–2012, as well as their annual percentage change by age groups. The number of deaths increased for all cancers and in all age groups with the exception of BC among women aged 50–69. For this cancer, we detected a 0.7% decrease in the number of deaths and a levelling off of the CRs among women aged 69 and older. In this age group, CRC was still the cancer with the largest number of deaths, showing a rise of 0.3% of the CRs during 1998–2012. On the other hand, among women younger than 69 years, CRs of BC and CRC decreased substantially. Finally, the CRs of LC rose in all age groups, whereas for PC they rose among women older than 50 years.

Table 1
Time trends of the burden of breast, colorectal, lung and pancreatic cancer among Spanish women during the period 1998–2012 by age groups, and their corresponding median and 95% credible interval of the annual percentage change.

Age group	Period 1998–2002			Period 2003–2007			Period 2008–2012			Annual percentage change 1998–2012								
	<50	50–69	>69	<50	50–69	>69	<50	50–69	>69	<50			50–69			>69		
		(*N*)			(*N*)			(*N*)		Me	LL	UL	Me	LL	UL	Me	LL	UL
Breast	770	2111	2754	789	1957	3086	822	1970	3427	0.6%	0.2%	1.1%	−0.7%	−1.0%	−0.4%[a]	2.2%	1.9%	2.4%
Colorectal	216	1211	3563	209	1156	4084	219	1321	4532	0.1%	−0.8%	0.7%	0.9%	0.5%	1.2%	2.4%	2.2%	2.6%
Lung	236	620	1011	348	877	1281	358	1442	1610	3.8%	3.1%	4.5%	9.1%	8.6%	9.4%	4.7%	4.3%	5.1%
Pancreas	61	489	1310	82	541	1563	93	673	1901	5.2%	1.6%	7.9%	3.7%	2.9%	4.5%	4.5%	3.5%	5.7%

Age group	Period 1998–2002			Period 2003–2007			Period 2008–2012			Annual percentage change 1998–2012								
	<50	50–69	>69	<50	50–69	>69	<50	50–69	>69	<50			50–69			>69		
		(CR)			(CR)			(CR)		Me	LL	UL	Me	LL	UL	Me	LL	UL
Breast	5.9	48.5	99.2	5.6	42.2	97.1	5.5	37.7	99.6	−0.7%	−1.1%	−0.3%[a]	−2.5%	−3.0%	−2.2%[a]	0.1%	−0.4%	0.3%
Colorectal	1.7	27.8	128.3	1.5	24.9	129.1	1.5	25.3	132.1	−1.2%	−2.0%	−0.4%[a]	−1.1%	−1.5%	−0.6%[a]	0.3%	0.1%	0.5%
Lung	1.8	14.2	36.4	2.5	18.9	40.3	2.4	27.6	46.8	2.5%	1.9%	3.2%	6.9%	6.5%	7.3%	2.5%	2.2%	2.9%
Pancreas	0.7	11.1	46.1	0.8	11.5	48.9	0.8	12.1	55.3	0.1%	−0.5%	0.4%	0.1%	−0.4%	0.3%	3.8%	2.2%	4.2%

N: number of deaths (annual average); CR: crude rate per 100,000 women-years; Me: median of the estimated annual percentage change; LL: lower limit of the 95% credible interval; UL: upper limit of the 95% credible interval.
[a] Decreasing annual percentage changes.