REVISTA ESPAÑOLA DE
ENFERMEDADES DIGESTIVAS
The Spanish Journal of Gastroenterology

Title:
Regional Differences in Colorectal Cancer Mortality Trends, Spain (1980-2018)

Authors:
Lucia Cayuela, Susana Rodriguez, Álvaro Giráldez Gallego, Aurelio Cayuela

DOI: 10.17235/reed.2020.7183/2020
Link: PubMed (Epub ahead of print)

Please cite this article as:
Cayuela Lucia, Rodriguez Susana, Giráldez Gallego Álvaro, Cayuela Aurelio. Regional Differences in Colorectal Cancer Mortality Trends, Spain (1980-2018). Rev Esp Enferm Dig 2020. doi: 10.17235/reed.2020.7183/2020.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Accepted Article

REVISTA ESPAÑOLA DE
ENFERMEDADES DIGESTIVAS
The Spanish Journal of Gastroenterology

OR 7183

Regional Differences in Colorectal Cancer Mortality Trends, Spain (1980-2018)

Lucía Cayuela[1], Susana Rodríguez-Domínguez[2], Álvaro Giráldez[3], Aurelio Cayuela[4].

1. Department of Internal Medicine. Hospital Severo Ochoa. Leganés. Spain.
2. Pino Montano A Health Centre. Seville. Spain.
3. Clinical Management Unit of Digestive Diseases. University Hospital Virgen del Rocio. Seville. Spain.
4. Unit of Public Health. Prevention and Health Promotion. South Seville Health Management Area. Seville. Spain.

Correspondence to: Susana Rodríguez-Domínguez. Centro de Salud Pino Montano A. Calle Forjadores, 1, 41015 Sevilla E-mail: susana.rodriguez.dominguez@gmail.com

ABSTRACT

Introduction

The aim of this study was to describe the trends of colorectal cancer (CRC) mortality by Autonomous Communities (ACs) and sex in Spain (1980-2018).

Methods

The age-standardized mortality rates (ASMRs) for CRC (per 100,000) were calculated by direct standardization, using the world standard population. Mortality trends were described by ACs using a joinpoint regression model in both sexes. The annual percent changes and average annual percentage of change was computed for trend using the joinpoint regression analysis.

Results

During the most recent 5-year period (2014-2018), rates decreased among both men and women, more pronounced in men (-2.3 %) than in women (-1.1 %) although with differences by ACs. ASMRs decrease in both sexes in the Basque Country, the Canary Islands, Catalonia, Castile & Leon, Andalusia, the Balearic Islands, Madrid, Murcia and

Accepted Article

Valencia, while in others ACs it only arise in men (Navarre, Castile-La Mancha, Extremadure and The Rioja) or in women(Aragon, Asturias and Galicia).

Conclusion

This updated analysis of temporal patterns of CRC mortality in Spain between 1980-2018, divided by ACs and sex shows gender differences in CRC mortality trends. D espite the favorable trends in both sexes, the sexual gap is widening.

Keywords

Joinpoint regression analysis, mortality, colorectal cancer, trend.

INTRODUCTION

Colorectal cancer (CRC) is an important public health issue. Globally (2018), CRC ranks as the third most diagnosed cancer and the fourth leading cause of cancer death, with nearly 1.8 million new cases and 881,000 deaths (1).

During the last decade of the 20th century, mortality from CRC decreased markedly in high-income countries of Western and Northern Europe (United Kingdom, France, and Sweden), North America (the United States and Canada), and Australia. At the beginning of the 21st century, Japan, Germany, and Italy also showed a downward trend (2). In contrast, most countries in Eastern Europe (such as Russia and Romania) and Southern Europe (such as Portugal and Spain) experienced a sharp increase in mortality from CRC; however, this was not the case in all countries (for example, the Czech Republic, Hungary and Slovakia) (3). On the other hand, less developed countries in Asia, Africa, and Latin America, where rates have been historically low, showed significant increases in CRC mortality rates (4).

In Spain, CRC mortality rates increased in both sexes during 1951-1995. Since then, rates have decreased in women and have remained stable in men until 2006 (5). In a previous report, we thoroughly analyzed CRC mortality trends in Andalusia (1980-2008) showing a more favorable CRC mortality trends for females (decreasing) than males (less rapidly rising) (6). Notwithstanding, there are no reports analyzing trends in CRC by sex and Autonomous Communities (ACs) in recent years.

Accepted Article

Monitoring CRC mortality trends by autonomous communities (ACs) can offer an interesting image from an epidemiological and public health perspective. Supporting the design and evaluation of public health interventions (for example should help us to evaluate the effectiveness of CRC screening programs), as well as for the evaluation of treatment effectiveness. Therefore, we propose to update CRC cancer mortality rates in Spain from 1980 to 2018 by sex and ACs.

METHODS

Data source

CRC death records were retrieved from the National Institute of Statistics for the study period (1980-2018). The codes used have been: 153-154 for the 9th edition, and codes C18-C21 for 10th edition of the International Classification of Diseases (ICD). Populations were estimated on 1 July of each year based on official census information.

Statistical analysis

Individual records broken down by sex, age and year of death were used to compute age-standardized mortality rates (ASMRs) per 100,000 person-years (using the world standard population by the direct method).

To estimate the changes in the temporal trend of the rates, we have used segmented Poisson regression models, also called “joinpoint regression analysis” (7). This helped to identify inflection points (so-called joinpoints) where a significant change in linear slope of the trend occurred and estimate the magnitude of the increase or decrease observed in each identified period. This method uses a statistical algorithm to define a best-fitting regression line through mortality data across time, determining how many, if any, joinpoints should be used to determine where significant changes take place. Tests of significance used a Monte Carlo permutation method with 4499 4,499 replicates. The models incorporate variation using the standard error of the rate; the annual percentage change (APC) for each segment is estimated by fitting a regression line to the natural logarithm of the rate, using calendar year as an independent variable. The analysis began with the minimum number of joinpoints (e.g. 0 joinpoint,

Accepted Article

representing a straight line) and tested whether one or more joinpoints were significant. To quantify the trend over the whole period, we computed the average annual percent change (AAPC) as a geometrically weighted average of the various APCs from the joinpoint regression analysis, with weights being equivalent to the length of each segment during the specified time interval. To determine the direction and magnitude of recent trends, AAPCs were also evaluated for the last available 5 years (2014-2018). Rates were considered to increase if the slope of the trends (APC or AAPC) was greater than zero ($p<0.05$)and to decrease if it was less than zero ($p<0.05$); otherwise, rates were considered stable.

All analyses were performed using the Joinpoint Regression Program (8). Default settings of the software were used to specify the modelling method, the criteria used to determine the locations of the joinpoints, autocorrelated errors options and the model selection method.

RESULTS

Mortality from CRC in Spain during the period studied has undergone a considerable increase in absolute numbers, rising from 2,256 deaths in 1980 to 9,222 in 2018 in men, and from 2,285 to 6,066 deaths in women.

ASMRs due to CRC in men and women (1980-2018) are illustrated in figure 1. Rates increased through the period both in men (from 9.6 to 15.8; AAPC: 1.3 %, $p<0.05$) and women (from 7.0 to 7.5; AAPC: 0.4 %, $p<0.05$). However, the joinpoint analysis identified three time periods in both sexes: an initial (1980-1995 in men and 1980-1988 in women) with a statistically significant increase (4.0 % in men and 3.9 % in women), followed by a period (1995-2012 in men and 1988-1997 in women) of a slowdown in the increase (0.4 % in men and 1.2 % in women) ending in a final period of decrease (2012-2018; -2.3 % in men and 1997-2018; -1.1 % in women).

Tables 1-2 shows ASMRs for the years 1980 and 2018, the AAPCs for the entire study period (1980-2018) and the last five years (2014-2018), and the results of the joinpoint regression analysis (i.e. the points in which rates changed significantly) and the APC for each trend by sex and AC.

Accepted Article

In men (Table 1), ASMRs exhibited upward trends during 1980-2018 in almost all the ACs (the Basque Country was the only region that remained stable), although some slope differences were detected. The sharpest increases were observed in Castile-La Mancha (2.4 %, p<0.05) and Extremadure (2.2 %, p<0.05). The most recent trends (2014-2018) show divergent trends between the different autonomous communities. While some show increases in rates (Castilla-La Mancha, Extremadure, Navarre, and The Rioja), others remain stable (Aragon, Asturias, Cantabria, and Galicia) or decrease (7 AC). Joinpoint regression analysis did not detect changes in Navarre and The Rioja where a significant upward trend was observed throughout the study period. The rest of ACS shows an initial period of increase in ASMR (which ranges between 2.8 % in the Basque Country and 5.7 % in Madrid), followed by a period in which ASMRS decreases its increase (5 AC), remain stable (6 AC) or decrease significantly (Baleares, Madrid and Murcia). Five ACs show a third period in which the rates decrease markedly (from -1.4 % in Andalusia to -5.1 % in the Basque Country).

In women (Table 2), ASMRs exhibited stable trends during 1980-2018 in almost all the ACs (except in Andalusia, Asturias, Canary Islands, Castile-La Mancha, Galicia, and Madrid where ASMRs increased). The most recent trends (2014-2018) show decreasing trends in almost all the ACs (except in Cantabria, Castile-La Mancha, Extremadure, Navarre, and The Rioja where rates remained stable). Joinpoint regression analysis did not detect changes in Cantabria and Navarre where rates remained stable throughout the study period. The rest of ACS shows an initial period of increase in ASMR (which ranges between 1.6 % in the Basque Country and 9.3 % in The Rioja), followed by a period in which ASMRS decrease significantly (10 ACs) or remained stable (Castile and Leon, Castile-La Mancha, Extremadure, Madrid and The Rioja). Three ACs show a third period in which the rates decrease.

DISCUSSION

Our study reports on recent trends in mortality in Spain and confirms favorable trends in recent years in both men and women, but with some additional key findings.

Recently, a study (9) identifies three different patterns based on CRC incidence and mortality trends: (1) those with increasing or stable incidence and mortality

Accepted Article

(comprising several Eastern European countries, and also in populations in Latin America and Asia), (2) those with increasing incidence and decreasing mortality (Canada, the United Kingdom, Denmark, and Singapore), and (3) those with decreasing incidence and mortality (USA, Japan and France). In this study Spain is in group 1. But our results, with updated data, support that we are transitioning to groups 2-3.

The increasing number of colonoscopies since the end of the 20th century and the westernization process in some behavioral risk factors, such as diet and obesity, contributed likely to part of the incidence increasing trend (10). Decreasing or stabilizing incidence rates is mainly attributed to changes towards healthier lifestyle, along with introduction and implementation of population-based screening (progressively implemented since the beginning of the century (11) and reaching recently global coverage) (12).

Table 3 shows the main indicators of colorectal cancer screening programs in the different Autonomous Communities. These programs mostly use the Fecal Immunochemical Test. In 2017, participation rates varied among the regions, but the average was 46,86 %. More women than men participated (49.2 % vs 44.3 %). On average, 6.2 % of test results were positive, with a higher percentage found in men (7.7 %) than in women (4.9 %). The positive predictive value (PPV) for cancer was 4.8 %. The CRC detection rate was 2.6 per 1000 screenings (12).

Furthermore, our results show a decrease, in both sexes, in mortality rates. This reduction began earlier for women than for men (1997 and 2012 respectively). A similar pattern has also been observed in most European countries with CRC falling mortality rates since the early 1980s and 1990s for women and men, respectively (13.

During the most recent 5-year period, mortality rates decreased in Spain, more pronounced in men (-2.3 %) than in women (-1.1 %). These mortality trends are unevenly distributed among ACs, presenting considerable variability across sex. ASMRs decreased in both sexes in the Basque Country, the Canary Islands, Catalonia, Castile & Leon, Andalusia, the Balearic Islands, Madrid, Murcia, and Valencia. In others ACs it only occurs in men (Navarre, Castile-La Mancha, Extremadure, and The Rioja) or women (Aragon, Asturias, and Galicia). These declines are likely due to improvements in diagnosis and perioperative care, as well as chemotherapy and radiotherapy, with

Accepted Article

consequent longer disease survival (14). In Europe, mortality sex ratios (men/women) were around or slightly above unity in the 1950s, and systematically increased to approach 1.5 in the 1990s (15). In Spain, the sexual gap is widening figure 2

The observed differences by sex and by ACs in CRC mortality rates and their temporal trends could reflect factors that influence population incidence, survival and possibly other factors not yet identified (16). Men show low participation in screening programs, have less contact than women with the healthcare system, are less well informed about health issues, pay less attention to symptoms, and are less inclined to seek medical advice (17).

The results of this study are strengthened by including the latest available mortality data and using appropriate statistical methods for detecting changes in mortality trends over a long period (39 years). Joinpoint analysis help identify the time points at which trends changed in the several ACs, allowing to generate hypotheses about why these changes occurred at that particular point and help local health policymakers to identify local factors that may have influenced and accordingly act.

The present study has some methodological considerations. In Spain, the available data on the incidence of CRC is limited, which limited our ability to explain mortality trends. Mortality data is the only source of data available which satisfies the criteria of continuity and globality (18). A limitation of studies based on death certificates is that they may be influenced by the quality of the death records, including problems of data validity and reliability. Nevertheless, in Spain, although certification can be improved, death certificates have been considered accurate to estimate the burden of cancer (19) and the quality of our mortality statistics has improved over the years (20). Another problem related to death certificates is that during the study period, two different classification systems were used, ICD-9 and ICD-10, but there were no relevant changes in the definition of CRC (21) and the trend of the main causes of mortality was not greatly affected by revisions in the ICD-10 (22). Despite their different aetiologies, colon and rectum cancers were combined to avoid possible misclassification of tumors diagnosed at the rectosigmoid junction (23). Finally, the ecological design of our study only allows us to suggest hypotheses about the possible causes of the observed trends.

Accepted Article

CONCLUSIONS

This updated analysis of temporal patterns of CRC mortality in Spain between 1980-2018, divided by ACs and sex shows gender differences in CRC mortality trends. Despite the favorable trends in both sexes, the sexual gap is widening. Knowing the causes of the observed trends is essential to plan efficient intervention strategies and, therefore, more studies are needed.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CONFLICT OF INTEREST

All authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception and design of the work; the acquisition, analysis, and interpretation of data; drafting the work and revising it critically for important intellectual content; approved the version to be published; and are responsible for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are properly investigated and resolved.

REFERENCES

1. Bray F, Ferlay J, Soerjomataram I, et al. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2018;68(6):394–424.
2. Siegel RL, Miller KD, Fedewa SA, et al. Colorectal cancer statistics, 2017. CA Cancer J Clin. 2017;67(3):177-193.
3. Matsuda T, Zhang M. Comparison of time trends in colorectal cancer mortality (1990–2006) in the world, from the WHO mortality database. Jpn J Clin Oncol. 2009;39(11):777–8.

Accepted Article

4. Arnold M, Sierra MS, Laversanne M, et al. Global patterns and trends in colorectal cancer incidence and mortality. Gut. 2017;66(4):683–691.
5. Béjar L, Gili M, Díaz V, et al. Incidence and mortality by colorectal cancer in Spain during 1951-2006 and its relationship with behavioural factors. Eur J Cancer Prev. 2009;18(6):436-44.
6. Cayuela A, Rodríguez-Domínguez S, Garzón-Benavides M, et al. Study of colorectal mortality in the Andalusian population. Rev Esp Enferm Dig. 2011;103(6):289–293.
7. Kim HJ, Fay MP, Feuer EJ, et al. Permutation tests for joinpoint regression with applications to cancer rates. Statistics in Medicine 2000;19:335–351.
8. Joinpoint Regression Program, Version 4.7.0.0. National Cancer Institute. Bethesda, EE.UU. disponible en: https://surveillance.cancer.gov/joinpoint/download último acceso 13/04/2020.
9. Arnold M, Sierra MS, Laversanne M, et al. Global patterns and trends in colorectal cancer incidence and mortality. Gut. 2017;66(4):683–691.
10. Marcos Prieto HM, Velasco-Guardado A, Álvarez Delgado A, et al Increasing incidence of colorectal cancer in the province of Salamanca. Comparison of two periods: 2004-2006 and 2010-2012. Rev Esp Enferm Dig. 2016;108(7):417-20.
11. Arnold M, Abnet CC, Neale RE, et al. Global Burden of 5 Major Types Of Gastrointestinal Cancer. Gastroenterology. 2020:S0016-5085(20)30452-2.
12. Red de programas de Cribado de Cáncer. Programas de Cribado de Cáncer Colorrectal. Informe de evaluación 2017 (Datos: julio 2019). www.cribadocancer.es last accessed 20/04/2020.
13. Ait Ouakrim D, Pizot C, Boniol M, et al. Trends in colorectal cancer mortality in Europe: retrospective analysis of the WHO mortality database. Version 2. BMJ. 2015;351:h4970.
14. Cubiella J, Marzo-Castillejo M, Mascort-Roca JJ, et al. Clinical practice guideline. Diagnosis and prevention of colorectal cancer. 2018 Update. Guía de práctica clínica. Diagnóstico y prevención del cáncer colorrectal. Actualización 2018. Gastroenterol Hepatol. 2018;41(9):585–596.
15. Fernandez E, Bosetti C, La Vecchia C, et al. Sex differences in colorectal cancer mortality in Europe, 1955-1996. Eur J Cancer Prev. 2000;9(2):99–104.

Accepted Article

16. Wang L, Lo CH, He X, et al. Risk Factor Profiles Differ for Cancers of Different Regions of the Colorectum. Gastroenterology. 2020:S0016-5085(20)30408-X.
17. Salas Trejo D, Portillo Villares I, Espinàs Piñol JA, et al; Spanish Cancer Screening Network. Implementation of colorectal cancer screening in Spain: main results 2006-2011. Eur J Cancer Prev. 2017;26(1):17-26.
18. Glasser JH. Editorials: The quality and utility of death certificate date . Am J Public Health 1981; 71:231-233.
19. Pérez-Gómez B, Aragonés N, Pollán M, et al. Accuracy of cancer death certificates in Spain: a summary of available information. Gac Sanit. 2006;20 Suppl 3:42-51.
20. Cirera L, Salmerón D, Martínez C, et al. More than a decade improving medical and judicial certification in mortality statistics of death causes. Rev Esp Salud Publica. 2018;92:e201806031.
21. Ruiz M, Cirera Suárez L, Pérez G, et al; Grupo CAMPARA. Comparability between the ninth and tenth revisions of the International Classification of Diseases applied to coding causes of death in Spain. Gac Sanit. 2002;16(6):526-32.
22. Salmerón D, Cirera L, Saez M, et al. Influence of the introduction of the ICD-10 on tendencies of mortality by causes (1980-2004). Gac Sanit. 2009;23(2):144–146.
23. Rawla P, Sunkara T, Barsouk A. Epidemiology of colorectal cancer: incidence, mortality, survival, and risk factors. Prz Gastroenterol. 2019;14(2):89–103.

Accepted Article

Table 1: Age-standardized per 100,000 mortality rates and joinpoint results. Men, Spain 1980-2018.

	ASMRs		AAPCs		Trend 1		Trend 2		Trend 3	
Autonomous Community	1980	2018	1980-2018	2014-2018	Period	APC	Period	APC	Period	APC
Andalusia	7.81	17.37	1.8*	-1.4*	1980-1997	3.7*	1997-2012	1.0*	2012-2018	-1.4*
Aragon	11.58	17.47	1.5*	0.3	1980-1997	3.0*	1997-2018	0.3		
Asturias	11.5	19.85	1.7*	0.1	1980-1998	3.5*	1998-2018	0.1		
Balearic Islands	10.63	14.19	0.8*	-1.1*	1980-1992	5.3*	1992-2018	-1.1*		
Canary Islands	6.7	13.35	1.5*	-3.8*	1980-1993	4.8*	1993-2012	1.0*	2012-2018	-3.8*
Cantabria	10.34	17.65	2.0*	0.4	1980-1995	4.4*	1995-2018	0.4		
Castile & Leon	10.4	16.87	1.4*	-2.5*	1980-1994	4.1*	1994-2010	1.2*	2010-2018	-2.5*
Castile-La Mancha	5.93	15.18	2.4*	0.9*	1980-1995	4.7*	1995-2018	0.9*		
Catalonia	12.23	15.38	0.8*	-2.9*	1980-1993	3.5*	1993-2012	0.1	2012-2018	-2.9*
Valencia	9.82	15.8	1.3*	-0.5*	1980-1998	3.4*	1998-2018	-0.5*		
Extremadure	7.09	19.1	2.2*	1.3*	1980-2001	3.0*	2001-2018	1.3*		
Galicia	9.53	17.23	1.9*	-0.4	1980-2000	3.9*	2000-2018	-0.4		
Madrid	8.31	12.8	1.5*	-1.1*	1980-1995	5.7*	1995-2018	-1.1*		
Murcia	7.94	15.14	1.3*	-0.8*	1980-1999	3.5*	1999-2018	-0.8*		
Navarre	15.11	12.57	0.5*	0.5*	1980-2018	0.5*				
Basque Country	10.82	14.09	0.4	-5.1*	1980-1999	2.8*	1999-2012	-0.3	2012-2018	-5.1*
The Rioja	9.91	17.34	1.3*	1.3*	1980-2018	1.3*				
Spain	9.61	15.8	1.3*	-2.3*	1980-1995	4.0*	1995-2012	0.4*	2012-2018	-2.3*

ASMRs: age-standardized mortality rates using the world standard population.

AAPC: average annual percent change

APC: annual percentage change

* $p<0.05$

Table 2: Age-standardized per 100,000 mortality rates and joinpoint results. Women, Spain 1980-2018.

	ASMRs		AAPCs		Trend 1		Trend 2		Trend 3	
Autonomous Community	1980	2018	1980-2018	2014-2018	Period	APC	Period	APC	Period	APC
Andalusia	6.68	8.41	0.7*	-0.8*	1980-1995	3.0*	1995-2018	-0.8*		
Aragon	6.41	7.73	0.2	-1.0*	1980-1994	2.2*	1994-2018	-1.0*		
Asturias	6.79	7.7	0.6*	-0.7*	1980-1993	3.1*	1993-2018	-0.7*		
Balearic Islands	8.08	8.06	0.1	-1.6*	1980-1994	3.1*	1994-2018	-1.6*		
Canary Islands	5.98	7.45	0.6*	-1.5*	1980-2001	2.4*	2001-2018	-1.5*		
Cantabria	6.08	8.68	0.2	0.2	1980-2018	0.2				
Castile & Leon	7.09	6.94	0.1	-4.6*	1980-1996	1.7*	1996-2013	-0.5	2013-2018	-4.6*
Castile-La Mancha	5.96	7.23	1.0*	-0.3	1980-1987	6.9*	1987-2018	-0.3		
Catalonia	8.49	7.35	-0.2	-3.6*	1980-1988	4.3*	1988-2013	-1.0*	2013-2018	-3.6*
Valencia	8.28	7.69	0.1	-1.3*	1980-1994	2.5*	1994-2018	-1.3*		
Extremadure	6.03	8.32	0.8	-0.5	1980-1988	5.8*	1988-2018	-0.5		
Galicia	6.75	8.24	0.8*	-0.9*	1980-1996	3.2*	1996-2018	-0.9*		
Madrid	6.38	6.11	0.6*	-2.2*	1980-1991	5.4*	1991-2004	-0.4	2004-2018	-2.2*
Murcia	7.18	6.72	0.1	-1.8*	1980-1999	2.0*	1999-2018	-1.8*		
Navarre	6.26	6.82	0	0	1980-2018	0				
Basque Country	6.25	6.73	0.2	-0.9*	1980-1997	1.6*	1997-2018	-0.9*		
The Rioja	5.65	9.36	1.3	-0.8	1980-1988	9.3*	1988-2018	-0.8		
Spain	7.03	7.52	0.4*	-1.1*	1980-1988	3.9*	1988-1997	1.2*	1997-2018	-1.1*

ASMRs: age-standardized mortality rates using the world standard population.

AAPC: average annual percent change

APC: annual percentage change

* $p<0.05$

Table 3: Colorectal cancer screening programs, main indicators by Autonomous Community in 2017 (last year available) and the year detected by the joinpoint analysis in which the rates start to fall.

	Colorectal cancer screening program (CRC)					Year mortality began to decline	
Autonomous Community	**Start year**	**Participation rates**	**Positive rates**	**CRC detection rate**	**Positive Predictive Value**	**Men**	**Women**
Andalusia	2014	19.7	10.8	0.0	0.0	2012	1995
Aragon	2014	54.2	13.7	5.6	4.7		1994
Asturias	2015	43.0	7.3	5.5	8.5		1993
Balearic Islands	2015	unavailable	unavailable	unavailable	unavailable	1992	1994
Canary Islands	2009	32.8	5.1	1.8	4.4	2012	2001
Cantabria	2008	45.9	5.7	3.0	6.0		
Castile & León	2010	41.4	6.1	1.9	3.7	2010	2013
Castile-La Mancha	2015	33.3	8.0	4.4	6.1		
Catalonia	2000	44.0	6.1	2.7	4.8	2012	2013
Valencia	2005	48.7	5.2	2.2	4.9	1998	1994
Extremadure	2016	41.1	9.5	4.2	4.8		
Galicia	2013	44.4	6.7	3.7	5.8		1996
Madrid	2017	45.4	8.4	4.2	6.9	1995	2004
Murcia	2006	49.1	8.4	2.3	3.0	1999	1999
Navarre	2014	73.6	6.3	3.0	5.1		
Basque Country	2009	72.3	4.9	1.6	3.5	2012	1997
The Rioja	2010	52.6	5.6	2.7	5.3		

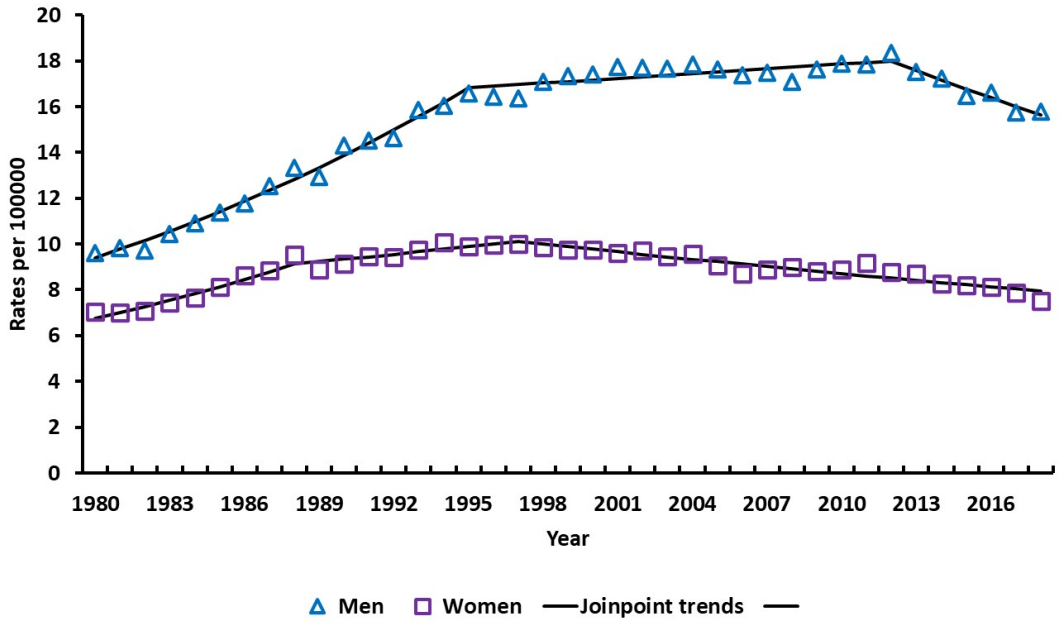

Figure 1: Age-standardized mortality rates due to colorectal cancer by sex (Spain 1980-2018)

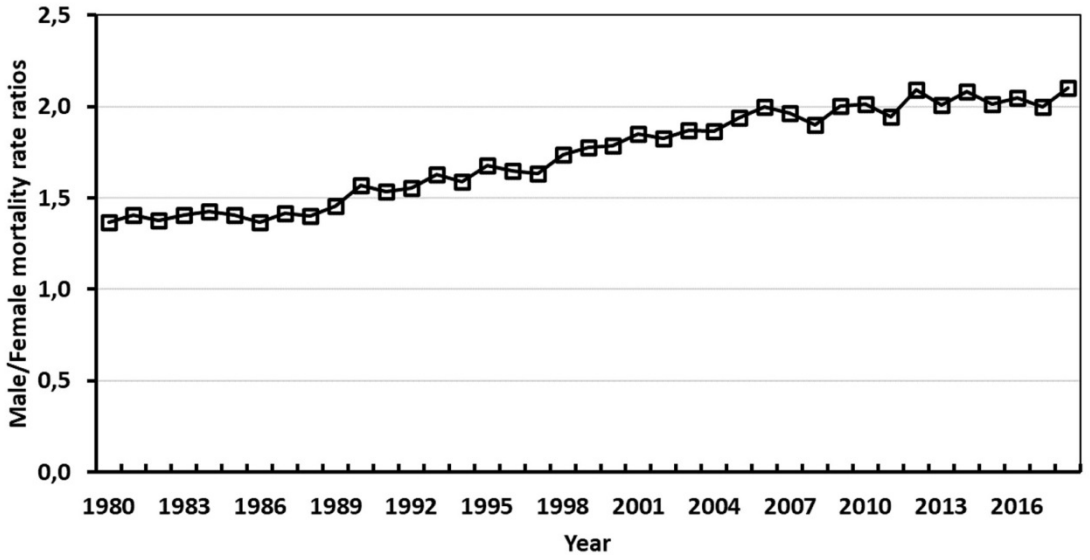

Figure 2. Mortality and incidence sex ratios (male/female). Spain 1980-2012/2018