Mortality trends and potential years of life lost due to ovarian cancer in Mexico, 2000-2014

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Abstract

Introduction: In Mexico, ovarian cancer accounting for 5.3% of cancer diagnoses in all age groups and 21% of gynecological cancers and it has had a steady increase in the last three decades. **Objective:** To determine mortality trends from ovarian cancer and potential years of life lost (PYLL) by state and socioeconomic region of Mexico between 2000 and 2014. **Method:** Records of ovarian cancer were obtained from the National Institute of Statistics and Geography. ICD-10 codes corresponding to ovarian cancer as the basic cause of death were identified. Mortality rates and YPLL rates were calculated by nationwide, states and socioeconomic region. **Results:** Between 2000 and 2014, age-adjusted rates per 100,000 women increased from 3.3 to 4.1. The highest mortality rates were identified in region 7, in Chihuahua, Baja California Sur, Colima, Quintana Roo, Zacatecas, Sonora, Coahuila, Aguascalientes and Queretaro. The highest rates of PYLL due to ovarian cancer were recorded in regions 7, 5 and 6, Nayarit, Baja California Sur, Zacatecas, Colima, Tlaxcala, Oaxaca, Quintana Roo, Coahuila, Aguascalientes and Queretaro. **Conclusions:** Mexico's socioeconomic region 7 had the highest rates of PYLL and mortality from ovarian cancer.

KEY WORDS: Ovarian cancer. Mortality. Potential years of life lost.

Introduction

Ovarian cancer (OC) is the seventh most common neoplasm in women and the eighteenth most frequent in the world. Approximately 239 000 cases were recorded in 2012, which accounted for almost 4 % of all new cancer cases of in women (2 % of total cases). OC incidence rates are higher in high-income countries than in those with medium and low income. In Central and Eastern Europe, in 2012, the age-standardized incidence rate was 11 per 100 000 women and in some parts of Africa it was less than 5. In the United Kingdom it was 11.7 and in the United States 8, in Brazil 5.2 and in China 4.1.¹

During the last two decades, OC mortality rates have shown a trend towards a balance or a decrease in several high-income European and North American countries, where they were high. The advance in OC diagnosis and treatment, as well as the use of oral contraceptives may have influenced, particularly in

high-income countries. There are persistent and substantial differences in OC patterns and trends in the world. In 2012, in the world, the country with the highest mortality was Lithuania, with a mortality rate of 7.1 per 100 000 women, adjusted for age with the world population; the country with the lowest mortality rate was the Republic of Korea with 2.2. That same year, in Europe, the countries with the highest OC mortality rates were Lithuania (7.1), Ireland (7.09) and Latvia (6.64), and the countries with the lowest mortality were Spain (3.69), Greece (3.5) and Portugal (3.03). In the region of Asia, Australia and Oceania, the countries with the highest mortality in 2011 were New Zealand (4.93) and Australia (4.27) and those that had the lowest mortality were Hong Kong (2.46) and the Republic of Korea (2.26). In the region of the Americas, the countries with the highest mortality in 2011 were Canada (4.95) and in 2012, the United States (4.85); those that had the lowest mortality in this continent in 2012 were Cuba (3.07) and Brazil (2.8).²

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In Mexico, OC accounts for 5.3 % of cancer diagnoses all age groups and 21 % of gynecological cancers. In 2004, there were 473 417 deaths recorded, out of which malignant tumors were the third cause of death with 31 443 deaths; 4.6 % of deaths in total female population were OC-related.³ A sustained annual increase of 1.4 % in OC mortality has been observed from 1980 to 2011. In comparison with Canada, the United States, Argentina and Uruguay, Mexico has an intermediate ovarian cancer mortality rate.⁴

The purposes of this study were to determine OC mortality trends and associated years of potential life lost (YPLL) per state and socioeconomic region of Mexico in the 2000-2014 period.

Methods

A mortality trends study design was used. OC-associated mortality records for the 2000-2014 period were obtained from the National Institute of Statistics and Geography (INEGI – *Instituto Nacional de Estadística y Geografía*).⁵ This information is collected from death certificates issued in the country.

All individual mortality records where the cause of death was OC were included. The codes of the International Classification of Diseases, 10th Edition, corresponding to OC as cause of death (C56) were identified.⁶

Nation-wide mortality rates were obtained, raw and age-adjusted, per 100 000 women, taking the world population as the standard.^{7,8} Age-adjusted mortality rates per 100 000 women of each state of residence and of each one of the 7 socio-economic regions established by INEGI were also obtained (Table 1).⁹ The population that was used for rate adjustments was the national population, estimated by the National Population Council for the years 2000- 2014.¹⁰

Mean annual change was calculated by means of simple linear regression analysis. This analysis was used to determine whether in the study period there was a decrease or increase in OC mortality rate, both in gross rates and in mortality rates adjusted by age with the world population per 100 000 women.¹¹

YPLL rates were also determined per 100 000 women adjusted for age according to the state of residence and socioeconomic region. Five-year age groups were used; the age limits that were used for calculation were the following: lower limit was 1 year and upper, 70 years for YPLL rates calculation, which were expressed per 100 000 women.^{12,13} YPLL age-adjusted rates were calculated separating the years lost in the respective age groups, based on individual age;

Table 1. Socioeconomic regions of Mexico

Socioeconomic regions	States
1	Chiapas, Guerrero, Oaxaca
2	Campeche, Hidalgo, Puebla, San Luis Potosí, Tabasco, Veracruz
3	Durango, Guanajuato, Michoacán, Tlaxcala, Zacatecas
4	Colima, Estado de México, Morelos, Nayarit, Querétaro, Quintana Roo, Sinaloa, Yucatán
5	Baja California, Baja California Sur, Chihuahua, Sonora, Tamaulipas
6	Aguascalientes, Coahuila, Jalisco, Nuevo León
7	Ciudad de México

Source: Instituto Nacional de Estadística y Geografía.

age-specific rates were calculated based on the population age group. These age-specific YPLL rates were weighted using the national population as the standard population and a single rate was calculated. The YPLL calculated rate was obtained with the following formula:¹³

Age – adjusted YPLL rates =

$$\sum_{i=1}^{69} ai \left(\frac{di}{pi} \right) \left(\frac{Pir}{Nr} \right) \times 100000$$

Where

pi = number of people of *i* age in current population.

Pir = number of people of *i* age in the reference population.

Nr = number of people between 1 and 70 years in the reference population.

di = number of deaths between ages *i* and *i* + 1.

ai = years of life remaining until age 70, when dying between ages *i* and *i* + 1 = 70- (*i* + 0.5).

The 7 socio-economic regions were defined by INEGI according to the 12th General Population and Housing Census, with the observed differences in social and economic conditions of the population in Mexico being presented. All 32 states are grouped in the 7 socio-economic regions according to the following indicators of well-being: education, occupation, health, housing and employment. States with similar characteristics were classified in the same region and each region is different from the other. According to the used indicators, socio-economic conditions had a rank in ascending order, from region 1, the least favorable, to region 7, the most favorable. The purpose of the methodology used for establishing the regions

Figure 1. Ovarian cancer mortality in Mexico, 2000-2014. Gross mortality rate per 100 000 women. Age-adjusted rate by direct method, standardized with world population per 100 000 women. Source: Analysis by the author of data obtained from the National Institute of Statistics and Geography and from the National Population Council: population estimates, 1990-2010 period and population projections for 2010-2030. *Mean annual change per 100,000 women/year and 95 % CI and p-value for crude mortality rates in the 2000-2014 period. **Mean annual change per 100,000 women/year and 95 % CI and p-value for standardized mortality rates in the 2000-2014 period.

was the creation of strata with minimal variation and, this way, by adhering to an established similarity criterion, group the elements of greater similarity, thus allowing the distinction between one region and another. The used techniques included Mahalanobis distances and a combination of factorial analysis and the K-means algorithm.⁹

The records were managed with the Access 2013 program. For the calculation of age-adjusted mortality rates and YPLL rates, the Epidat program, version 3.1, was used.¹⁴

Results

In Mexico, in the 2000-2014 period, 498 071 women died due to malignant neoplasms and, of these, 25 047 died from OC (5.02 % of total). In 2000, there were 1157 deaths, and in 2014, 2249 due to this neoplasm. In the study period, the mortality rate standardized by age with the world population per 100 000 women increased from 3.3 to 4.1, with a percentage change of 24.2 % and mean annual change of 0.043, 95 % CI = 0.032-0.055 (Fig. 1).

With increasing age, OC mortality did increase. Women aged between 55 and 59 years showed the highest mortality (3089 cases, 12.3 %) (Fig. 2). Age group-specific mortality trends did increase between 2000 and 2014, except in the < 30 years group. The group that showed the highest mortality increase was the 51 to 60 years group (data not shown).

In the period, 31 states had an increase in OC mortality trends; the only one that showed no changes was Nayarit. The states with the highest mortality rates were Chihuahua in the year 2000 (3.8, 95 % CI = 2.75-4.85), Baja California Sur in 2001, 2002, 2007 and 2009 (5.36, 95 % CI = 2.14-8.58; 4.27, 95 % CI = 1.3-7.25; 6.03, 95 % CI = 2.8-9.27; 4.44, 95 % CI = 1.76-7.11, respectively); Colima in 2003, 2005, 2011 and 2012 (4.75, 95 % CI = 2.25-7.24; 5.28, 95 % CI = 2.69-7.87; 4.46, 95 % CI = 2.26-6.72; 4.36, 95 % CI = 2.15-6.57, respectively); Quintana Roo in 2004 (4.26, 95 % CI = 1.63-6.89); Zacatecas in 2006 (4.39, 95 % CI = 2.85-5.9); Sonora in 2008 (3.98, 95 % CI = 2.88-5.07); Coahuila in 2010 (4.41, 95 % CI = 3.29-5.53); Aguascalientes in 2013 (4.6, 95 % CI = 2.86-6.34) and Querétaro in 2014 (5.2, 95 % CI = 3.72-6.68) (Table 2).

Figure 2. Ovarian cancer mortality by age-group, Mexico, 2000-2014. Analysis of the National Institute of Statistics and Geography database.

The states with the lowest mortality rates were Colima in 2000 and 2002 (1.01, 95 % CI = -0.14-2.16 and 1.34, 95 % CI = 0.02-2.67, respectively); Nayarit in 2001, 2007, 2009 and 2013 (1.14, 95 % CI = 0.22-2.05; 1.3, 95 % CI = 0.34-2.26; 1.79, 95 % CI = 0.68-2.91; 1.3, 95 % CI = 0.4-2.21, respectively), Yucatán 2003 (1.36, 95 % CI = 0.62-2.1; Guerrero in 2004 (1.03, 95 % CI = 0.54-1.52); Tabasco in 2005 and 2014 (1.44, 95 % CI = 0.65-2.23; 1.89, 95 % CI = 1.08-2.71, respectively); Quintana Roo in 2006 (0.72, 95 % CI = -0.14-1.58); Campeche in 2008 (1.28, 95 % CI = 0.15-2.4), Chiapas in 2010 (1.36, 95 % CI = 0.86-1.86); Baja California Sur in 2011 (1.68, 95 % CI = 0.2-3.15) and Zacatecas in 2012 (1.66, 95% CI = 0.79-2.54) (Table 2).

The socioeconomic region that showed the highest CO mortality rate in the 2000-2014 period was region 7, except in 2013, in which region 6 had the highest mortality. In 2000 and 2014, the mortality rates for region 7 were 3.35, 95% CI = 2.88-3.83 and 4.92, 95% CI = 4.36-5.49, respectively; for region 6, the mortality rate in 2013 was 4.28, 95% CI = 3.84-4.72 (Table 3).

Socioeconomic region 1 had the lowest OC mortality rate in the study period, except in 2001, in which region 2 showed the lowest mortality rate. Mortality rates for region 1 in 2000 and 2014 were 1.57, 95% CI = 1.24-1.91 and 2.65, 95% CI = 2.24-3.06,

respectively; for region 2, in 2001 it was 1.94, 95% CI = 1.67-2.21 (Table 3).

The states with the highest YPLL rate in the study period were Nayarit in year 2000 (41.6), Baja California Sur in 2001 and 2007 (86.2 and 71.2, respectively), Zacatecas in 2002 and 2006 (57.5 and 76.7, respectively), Colima in 2003, 2004 and 2010 (81.6, 74.1 and 70.4, respectively), Tlaxcala in 2005 (79.6), Oaxaca in 2008 (54.4), Quintana Roo in 2009 (54.5), Coahuila in 2011 and 2012 (64 and 63.8, respectively), Aguascalientes in 2013 (77.8) and Querétaro in 2014 (77.4) (data not shown).

The states with the lowest YPLL rate in the study period were Yucatan in 2000 and 2003 (19 and 15.9, respectively), Guerrero in 2001 and 2014 (15.1 and 26.3, respectively), Quintana Roo in 2002 and 2006 (11 and 11.2, respectively), Nayarit in 2004, 2009 and 2013 (7.2, 27 and 6.1, respectively), Tabasco in 2005 (16.9), Campeche in 2007 and 2010 (18.4 and 15, respectively), Chiapas in 2008 (20.7), Aguascalientes in 2011 (23.3) and Zacatecas in 2012 (13.8).

The regions with the highest YPLL rates in the study period were region 7 (in years 2000-2004, 2006-2012 and 2014, respectively) and regions 5 (2005) and 6 (2013). YPLLs for region 7 in 2000 and 2014 were 37.9 and 67.4, respectively; for region 5 it was 41.4 in 2005 and for region 6 it was 54.6 in 2013.

Table 2. Age-adjusted mortality rates and 95 % confidence intervals by state of residence of women who died from ovarian cancer, Mexico, 2000-2014

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Aguascalientes	2.14 (0.81-3.48)	3.05 (1.45-4.64)	2.06 (0.78-3.34)	2.13 (0.8-3.45)	3.7 (1.99-5.41)	3.35 (1.75-4.95)	3.89 (2.18-5.6)	3.16 (1.61-4.71)	3.44 (1.85-5.04)	3.86 (2.21-5.52)	3.69 (2.07-5.31)	2.54 (1.21-3.88)	3.36 (1.84-4.87)	4.6 (2.86-6.34)	4.19 (2.54-5.83)
Baja California	2.81 (1.8-3.83)	3.17 (2.09-4.25)	2.8 (1.8-3.8)	3.87 (2.71-5.04)	2.87 (1.88-3.87)	2.73 (1.81-3.65)	2.77 (1.85-3.7)	3.34 (2.33-4.36)	3.28 (2.31-4.24)	3.17 (2.2-4.14)	2.84 (1.96-3.72)	2.97 (2.08-3.85)	2.97 (2.1-3.83)	3.68 (2.7-4.66)	3.78 (2.8-4.76)
Baja California Sur	1.85 (-0.24-3.94)	5.36 (2.14-8.58)	4.27 (1.3-7.25)	4.01 (1.2-6.82)	2.1 (0.01-4.19)	3.11 (0.77-5.45)	1.72 (0.02-3.42)	6.03 (2.8-9.27)	2.99 (0.75-5.23)	4.44 (1.76-7.11)	3.68 (1.36-6)	1.68 (0.2-3.15)	4.02 (1.73-6.31)	2.15 (0.54-3.75)	2.74 (0.93-4.54)
Campeche	2.86 (0.99-4.73)	1.21 (0.02-2.41)	1.56 (0.19-2.94)	3 (1.13-4.86)	2.67 (0.92-4.41)	2.27 (0.69-3.84)	2.88 (1.09-4.67)	2.54 (0.88-4.21)	1.28 (0.15-2.4)	4.01 (1.98-6.05)	1.84 (0.47-3.2)	2.84 (1.16-4.52)	3.13 (1.36-4.91)	2.94 (1.27-4.61)	3.33 (1.58-5.08)
Chiapas	1.58 (0.98-2.19)	2.37 (1.63-3.1)	2.02 (1.35-2.69)	1.89 (1.24-2.54)	1.75 (1.14-2.36)	1.47 (0.91-2.03)	2 (1.36-2.64)	2.44 (1.73-3.15)	1.66 (1.07-2.25)	2.96 (2.19-3.73)	1.36 (0.86-1.86)	2.62 (1.92-3.32)	2.54 (1.85-3.24)	2.68 (1.98-3.38)	2.46 (1.79-3.13)
Chihuahua	3.8 (2.75-4.85)	2.86 (1.99-3.74)	2.6 (1.78-3.42)	3.84 (2.86-4.82)	2.94 (2.09-3.79)	3.05 (2.2-3.91)	3.16 (2.3-4.01)	3.65 (2.73-4.58)	3.31 (2.45-4.17)	2.2 (1.5-2.9)	2.79 (2-3.57)	3.25 (2.4-4.09)	3.61 (2.74-4.48)	3.91 (3-4.82)	4.16 (3.23-5.09)
Ciudad de México	3.35 (2.88-3.83)	3.49 (3-3.98)	3.37 (2.89-3.84)	3.38 (2.91-3.86)	3.58 (3.1-4.06)	3.38 (2.91-3.85)	4.21 (3.68-4.73)	3.62 (3.14-4.11)	3.77 (3.28-4.26)	3.78 (3.29-4.28)	3.9 (3.4-4.4)	4.1 (3.58-4.61)	4.1 (3.59-4.61)	4.1 (3.58-4.61)	4.92 (4.36-5.49)
Coahuila	2.69 (1.74-3.64)	2.65 (1.71-3.58)	3.1 (2.1-4.1)	2.85 (1.91-3.8)	3.07 (2.09-4.05)	2.59 (1.71-3.48)	3.4 (2.38-4.41)	4.16 (3.06-5.26)	3.02 (2.08-3.95)	3.21 (2.25-4.17)	4.41 (3.29-5.53)	3.75 (2.74-4.76)	4.13 (3.07-5.18)	4.07 (3.03-5.12)	4 (2.98-5.02)
Colima	1.01 (-0.14-2.16)	4.12 (1.78-6.46)	1.34 (0.02-2.67)	4.75 (2.25-7.24)	3.96 (1.72-6.21)	5.28 (2.69-7.87)	2.98 (1.03-4.93)	3.37 (1.37-5.37)	2.81 (0.97-4.65)	3.95 (1.8-6.1)	4.18 (1.99-6.36)	4.46 (2.2-6.72)	4.36 (2.15-6.57)	4.26 (2.1-6.42)	5.03 (2.71-7.36)
Durango	1.95 (0.83-2.98)	1.64 (0.71-2.58)	2.51 (1.38-3.64)	1.85 (0.88-2.82)	3.18 (1.9-4.45)	2.47 (1.36-3.59)	2.56 (1.44-3.69)	2.25 (1.21-3.29)	2.54 (1.43-3.66)	2.56 (1.47-3.66)	2.67 (1.55-3.79)	3.34 (2.1-4.58)	2.88 (1.73-4.03)	2.1 (1.13-3.07)	3 (1.85-4.16)
Guanajuato	2.05 (1.48-2.62)	1.7 (1.18-2.21)	2.04 (1.48-2.6)	2.07 (1.51-2.64)	2.58 (1.96-3.2)	2.74 (2.1-3.37)	2.67 (2.05-3.3)	2.76 (2.13-3.4)	3.61 (2.89-4.34)	2.87 (2.23-3.51)	3.03 (2.37-3.69)	3.08 (2.42-3.74)	3.76 (3.04-4.49)	3.62 (2.92-4.33)	4.06 (3.32-4.81)
Guerrero	1.51 (0.91-2.11)	1.47 (0.89-2.04)	1.53 (0.93-2.13)	1.74 (1.09-2.39)	1.03 (0.54-1.52)	1.67 (1.05-2.29)	1.77 (1.12-2.42)	1.56 (0.95-2.17)	1.79 (1.16-2.42)	2.08 (1.4-2.77)	2.04 (1.36-2.72)	1.78 (1.14-2.42)	2.29 (1.57-3.02)	2.44 (1.7-3.18)	2.21 (1.5-2.91)
Hidalgo	2.06 (1.26-2.85)	1.38 (0.72-2.03)	2.26 (1.45-3.07)	2.14 (1.34-2.93)	1.51 (0.84-2.17)	2.17 (1.38-2.96)	1.86 (1.13-2.59)	1.91 (1.18-2.65)	3.27 (2.32-4.23)	2.46 (1.63-3.28)	2.21 (1.43-2.99)	2.59 (1.76-3.43)	3.7 (2.7-4.69)	3.38 (2.43-4.33)	3.12 (2.22-4.02)
Jalisco	2.65 (2.1-3.2)	2.83 (2.26-3.39)	2.8 (2.24-3.35)	2.8 (2.25-3.35)	3.34 (2.74-3.94)	3.44 (2.83-4.04)	3.08 (2.51-3.65)	3.34 (2.75-3.94)	3.38 (2.79-3.97)	3.3 (2.72-3.88)	3.8 (3.18-4.42)	3.79 (3.17-4.4)	3.58 (2.98-4.17)	4.42 (3.76-5.08)	3.97 (3.35-4.59)
Estado de México	1.89 (1.54-2.25)	2.72 (2.3-3.14)	2.82 (2.4-3.24)	2.37 (1.98-2.75)	2.45 (2.07-2.84)	2.42 (2.04-2.8)	3.12 (2.7-3.54)	2.72 (2.33-3.11)	2.69 (2.31-3.07)	3.23 (2.82-3.65)	3.46 (3.04-3.88)	3.45 (3.03-3.86)	3.59 (3.17-4.02)	3.54 (3.12-3.96)	3.56 (3.15-3.97)
Michoacán	1.7 (1.16-2.23)	1.95 (1.36-2.53)	2.23 (1.62-2.85)	2.78 (2.09-3.48)	2.63 (1.97-3.3)	2.16 (1.55-2.77)	2.2 (1.59-2.82)	3.03 (2.31-3.74)	2.53 (1.88-3.18)	3.27 (2.53-4.01)	2.88 (2.19-3.57)	3.46 (2.7-4.22)	3.35 (2.61-4.09)	3.59 (2.82-4.36)	3.25 (2.53-3.98)

(Continúa)

Table 2. Age-adjusted mortality rates and 95 % confidence intervals by state of residence of women who died from ovarian cancer, Mexico, 2000-2014 (Continuación)

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Morelos	1.51 (0.69-2.33)	1.79 (0.91-2.67)	1.43 (0.65-2.21)	2.9 (1.8-3.99)	1.42 (0.65-2.2)	3.02 (1.9-4.14)	3.16 (2.03-4.29)	3.22 (2.08-4.35)	1.75 (0.92-2.59)	3.17 (2.07-4.28)	3.76 (2.56-4.96)	3.35 (2.22-4.47)	3.13 (2.04-4.22)	3.54 (2.4-4.68)	3.24 (2.15-4.33)
Nayarit	2.15 (0.87-3.42)	1.14 (0.22-2.05)	2.4 (1.04-3.77)	2.1 (0.86-3.34)	1.63 (0.56-2.69)	2.79 (1.38-4.21)	2.24 (0.97-3.52)	1.3 (0.34-2.26)	2.21 (0.96-3.46)	1.79 (0.68-2.91)	2.94 (1.54-4.34)	3.79 (2.21-5.38)	3.04 (1.64-4.45)	1.3 (0.4-2.21)	2.15 (0.98-3.32)
Nuevo Leon	2.91 (2.16-3.66)	2.66 (1.94-3.37)	3.24 (2.46-4.02)	2.6 (1.91-3.29)	3.21 (2.45-3.97)	3.51 (2.71-4.31)	4.3 (3.43-5.17)	2.96 (2.25-3.66)	2.91 (2.21-3.61)	3.34 (2.61-4.08)	3.42 (2.68-4.15)	3.87 (3.09-4.65)	3.49 (2.76-4.23)	4.09 (3.31-4.88)	3.66 (2.92-4.39)
Oaxaca	1.56 (1.02-2.09)	2.17 (1.52-2.81)	2.65 (1.94-3.37)	2.51 (1.81-3.21)	2.41 (1.74-3.08)	2.48 (1.8-3.15)	3.07 (2.3-3.83)	3.23 (2.45-4.01)	3.43 (2.63-4.24)	2.29 (1.63-2.95)	2.35 (1.69-3.01)	2.96 (2.21-3.7)	3.2 (2.44-3.96)	2.23 (1.59-2.87)	3.19 (2.42-3.96)
Puebla	1.71 (1.21-2.2)	1.73 (1.23-2.23)	2.04 (1.51-2.58)	2.22 (1.67-2.78)	2.32 (1.76-2.89)	2.16 (1.61-2.7)	2.67 (2.07-3.27)	2.71 (2.1-3.31)	3.02 (2.39-3.66)	2.07 (1.55-2.59)	2.87 (2.26-3.48)	3.06 (2.43-3.69)	3.33 (2.68-3.99)	3.01 (2.39-3.63)	3.24 (2.61-3.88)
Queretaro	2.65 (1.42-3.87)	3.04 (1.77-4.32)	1.79 (0.81-2.76)	2.97 (1.73-4.22)	3.7 (2.33-5.07)	2.72 (1.55-3.89)	3.1 (1.86-4.34)	3.42 (2.12-4.71)	3.39 (2.11-4.66)	2.93 (1.75-4.1)	4.3 (2.89-5.71)	3.66 (2.39-4.94)	3.09 (1.94-4.24)	4.31 (2.95-5.66)	5.2 (3.72-6.68)
Quintana Roo	1.38 (0.07-2.68)	2.11 (0.27-3.96)	1.5 (-0.05-3.05)	3.43 (1.21-5.65)	4.26 (1.63-6.89)	1.55 (0.23-2.87)	0.72 (-0.14-1.58)	2.85 (0.96-4.74)	2.31 (0.69-3.92)	3.12 (1.31-4.93)	2.09 (0.62-3.57)	3.47 (1.63-5.32)	3.29 (1.5-5.08)	2.27 (1.05-3.5)	4.19 (2.35-6.03)
San Luis Potosi	1.89 (1.13-2.65)	1.8 (1.06-2.53)	2.96 (2.02-3.91)	2.24 (1.41-3.07)	3.06 (2.09-4.02)	2.52 (1.65-3.38)	2.83 (1.91-3.74)	3.13 (2.19-4.07)	2.59 (1.72-3.47)	2.68 (1.81-3.55)	3.1 (2.16-4.04)	3.46 (2.48-4.44)	2.87 (1.98-3.76)	4.04 (2.98-5.1)	3.75 (2.74-4.76)
Sinaloa	2.14 (1.34-2.95)	2.33 (1.49-3.16)	1.76 (1.04-2.48)	2.41 (1.57-3.24)	2.24 (1.44-3.04)	3.3 (2.33-4.26)	2.53 (1.69-3.37)	2.5 (1.67-3.33)	2.66 (1.81-3.5)	2.9 (2.02-3.78)	2.86 (2-3.73)	2.76 (1.91-3.6)	2.2 (1.45-2.95)	2.82 (1.98-3.67)	4.08 (3.07-5.09)
Sonora	3.32 (2.23-4.42)	3.47 (2.36-4.58)	3.12 (2.1-4.14)	2.89 (1.92-3.86)	3.14 (2.14-4.14)	3.59 (2.53-4.66)	2.94 (1.97-3.9)	3.06 (2.1-4.02)	3.98 (2.88-5.07)	2.66 (1.77-3.54)	3.65 (2.62-4.69)	3.22 (2.27-4.18)	3.88 (2.84-4.91)	3.73 (2.72-4.73)	4.3 (3.23-5.37)
Tabasco	1.68 (0.8-2.57)	2.13 (1.14-3.12)	1.95 (1.01-2.89)	1.85 (0.94-2.77)	1.97 (1.06-2.89)	1.44 (0.65-2.23)	1.62 (0.8-2.45)	2.25 (1.29-3.22)	2.3 (1.36-3.25)	3.03 (1.94-4.12)	2.46 (1.47-3.45)	4.18 (2.92-5.44)	2.36 (1.41-3.31)	3.22 (2.13-4.3)	1.89 (1.08-2.71)
Tamaulipas	2.03 (1.29-2.77)	2.18 (1.41-2.95)	2.45 (1.65-3.25)	2.33 (1.55-3.1)	2.82 (1.96-3.67)	2.79 (1.97-3.62)	2.5 (1.73-3.28)	3.06 (2.2-3.92)	3.34 (2.45-4.22)	3.8 (2.87-4.73)	4.27 (3.29-5.25)	3.47 (2.59-4.34)	3.87 (2.95-4.79)	3.8 (2.89-4.7)	3.85 (2.95-4.75)
Tlaxcala	1.44 (0.37-2.51)	2.92 (1.44-4.41)	2.34 (1.01-3.67)	2.89 (1.42-4.36)	1.73 (0.6-2.86)	3.76 (2.11-5.41)	2.63 (1.25-4.01)	3.64 (2.04-5.23)	2.71 (1.33-4.08)	2.91 (1.48-4.34)	2.56 (1.26-3.86)	2.78 (1.42-4.15)	3.33 (1.86-4.79)	3.13 (1.72-4.54)	3.94 (2.36-5.52)
Veracruz	2.08 (1.64-2.53)	2.35 (1.88-2.83)	2.25 (1.79-2.71)	3.16 (2.61-3.7)	2.82 (2.3-3.33)	2.96 (2.44-3.49)	2.81 (2.3-3.32)	2.55 (2.07-3.03)	3.1 (2.58-3.63)	3.12 (2.59-3.64)	2.98 (2.47-3.5)	3.75 (3.17-4.32)	2.96 (2.45-3.47)	3.44 (2.9-3.99)	3.27 (2.74-3.8)
Yucatan	1.69 (0.86-2.53)	1.91 (1.03-2.79)	1.97 (1.08-2.85)	1.36 (0.62-2.1)	1.15 (0.47-1.84)	1.63 (0.83-2.44)	2.28 (1.35-3.22)	3.02 (1.96-4.09)	2.04 (1.17-2.92)	2.42 (1.47-3.37)	1.43 (0.7-2.15)	2.84 (1.82-3.85)	2.51 (1.56-3.46)	2.48 (1.54-3.42)	3.28 (2.21-4.35)
Zacatecas	2.93 (1.7-4.17)	2.93 (1.67-4.19)	3.35 (2.03-4.68)	2.33 (1.22-3.44)	3.74 (2.35-5.13)	3.31 (2-4.61)	4.39 (2.88-5.9)	3.45 (2.12-4.79)	2.27 (1.19-3.35)	3.54 (2.22-4.87)	2.79 (1.59-3.98)	4.26 (2.82-5.7)	1.66 (0.79-2.54)	3.1 (1.88-4.33)	4.54 (3.03-6.05)

(Continúa)

Table 2. Age-adjusted mortality rates and 95 % confidence intervals by state of residence of women who died from ovarian cancer, Mexico, 2000-2014 (Continuación)

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	1.57 (1.24-1.91)	2 (1.63-2.38)	2.09 (1.7-2.47)	2.03 (1.65-2.41)	1.79 (1.44-2.14)	1.91 (1.55-2.28)	2.32 (1.92-2.72)	2.46 (2.05-2.87)	2.33 (1.93-2.72)	2.45 (2.04-2.85)	1.94 (1.58-2.3)	2.51 (2.1-2.92)	2.71 (2.29-3.13)	2.46 (2.06-2.87)	2.65 (2.24-3.06)
2	1.94 (1.67-2.21)	1.94 (1.67-2.21)	2.23 (1.94-2.51)	2.56 (2.25-2.86)	2.48 (2.18-2.77)	2.45 (2.15-2.74)	2.55 (2.25-2.85)	2.55 (2.25-2.85)	2.92 (2.6-3.23)	2.73 (2.43-3.04)	2.77 (2.47-3.08)	3.4 (3.06-3.73)	3.07 (2.75-3.39)	3.36 (3.02-3.69)	3.18 (2.86-3.5)
3	1.98 (1.64-2.32)	1.99 (1.65-2.33)	2.33 (1.97-2.69)	2.36 (2-2.73)	2.73 (2.34-3.13)	2.65 (2.27-3.04)	2.67 (2.29-3.05)	2.93 (2.53-3.33)	2.92 (2.52-3.31)	3.04 (2.64-3.44)	2.89 (2.49-3.28)	3.34 (2.92-3.76)	3.29 (2.87-3.7)	3.34 (2.92-3.75)	3.72 (3.28-4.16)
4	1.92 (1.65-2.18)	2.51 (2.21-2.81)	2.35 (2.06-2.63)	2.46 (2.17-2.74)	2.36 (2.08-2.64)	2.58 (2.29-2.87)	2.88 (2.58-3.18)	2.76 (2.47-3.05)	2.57 (2.29-2.85)	3.06 (2.76-3.36)	3.27 (2.96-3.58)	3.37 (3.06-3.68)	3.27 (2.97-3.57)	3.33 (3.03-3.63)	3.67 (3.36-3.99)
5	2.92 (2.45-3.4)	2.96 (2.5-3.43)	2.78 (2.33-3.22)	3.23 (2.76-3.7)	2.88 (2.44-3.32)	3.04 (2.59-3.49)	2.82 (2.39-3.25)	3.41 (2.94-3.88)	3.45 (2.99-3.91)	3 (2.57-3.43)	3.42 (2.97-3.87)	3.16 (2.73-3.59)	3.63 (3.18-4.09)	3.73 (3.27-4.19)	3.97 (3.5-4.43)
6	2.71 (2.32-3.1)	2.73 (2.35-3.12)	2.91 (2.52-3.3)	2.72 (2.34-3.09)	3.28 (2.87-3.69)	3.3 (2.89-3.71)	3.53 (3.11-3.95)	3.35 (2.95-3.76)	3.18 (2.79-3.58)	3.33 (2.93-3.73)	3.78 (3.35-4.2)	3.72 (3.31-4.14)	3.63 (3.22-4.04)	4.28 (3.84-4.72)	3.9 (3.48-4.31)
7	3.35 (2.88-3.83)	3.49 (3-3.98)	3.37 (2.89-3.84)	3.38 (2.91-3.86)	3.58 (3.1-4.06)	3.38 (2.91-3.85)	4.21 (3.68-4.73)	3.62 (3.14-4.11)	3.77 (3.28-4.26)	3.78 (3.29-4.28)	3.9 (3.4-4.4)	4.1 (3.58-4.61)	4.1 (3.59-4.61)	4.1 (3.58-4.61)	4.92 (4.36-5.49)

Mortality rate per 100 000 women adjusted by the direct method using the national population as standard population. Source: Analysis by the author of data obtained from the National Institute of Statistics and Geography and from the National Population Council: population estimates, 1990-2010 period and population projections for 2010-2030.

The regions with the lowest YPLL rate in the study period were regions 1 (in 2000, 2001, 2004, 2005, 2008 and 2010-2014, respectively), region 5 (in 2002, 2006, 2007 and 2009, respectively) and region 4 (2003). YPLLs for region 1 were in 22.4 and 37.5 in 2000 and 2014, respectively; for region 5, they were 30 and 35.5, respectively in 2002 and 2009; and for region 4, 32.3.

Discussion

In the studied period, OC mortality rate standardized by age with the world population per 100 000 women increased from 3.3 to 4.1, with a percentage change of 24.2 % and a mean annual change of 0.043, 95 % CI = 0.32-0.55 (Fig. 1). In the world, in the last two decades, the rates of OC-related mortality have stabilized or decreased. However, there are persistent and substantial differences in OC patterns and trends.² In Mexico and in other countries, the sustained increase in mortality rates of this cancer might be due to late diagnosis, the absence of highly curative chemotherapy and ovarian tumors high degree of molecular heterogeneity, a finding that is a consequence of typical high tumor burden in patients at this cancer's presentation.¹⁵

In high-income countries of North America and Europe, one of the factors that has been observed to have contributed to OC decrease is the widespread use of oral contraceptives.² The use of oral contraceptives by women is associated with a 40 to 50 % reduction in OC risk.¹⁶ In Mexico, there is no information regarding the use of oral contraceptives and their impact on OC.

In this study, the highest OC mortality was identified to occur in the 55 to 59 years' group (Fig. 2). The risk for suffering from OC has been observed to increase with age.¹ Factors that could be related to the presentation of OC as age increases are incessant ovulation, stimulation by gonadotropins and mutations. The ovaries of older women have been observed to show more morphological changes than those of younger women. Ovarian aging is characterized by ovarian morphological changes such as papillomatosis, invaginations of the ovarian superficial epithelium, inclusion cysts and epithelial stratification, with these alterations, which might be pre-neoplastic lesions, being found more often in postmenopausal and perimenopausal women. During ovulation, ovarian damage can occur, and in post-ovulation there is cell proliferation, which is produced to repair the ovarian surface epithelium, and these mechanisms can generate mutations that accumulate in epithelial cells and, finally, participate in the formation of tumors. The gonadotropin stimulation

theory posits that gonadotropins initiate each ovulation and persist at high levels for many years even after menopause. Gonadotropins stimulate ovarian surface epithelial cells and induce cell transformation.¹⁷

Another factor related to OC increase by age increase are mutations. Genomic studies indicate that approximately 10 to 12 % of ovarian carcinomas are characterized by mutations in the *BRCA1* and *BRCA2* genes;¹⁵ these mutations occur at an advanced age, reaching their highest frequency in the 50 to 59 years' group.¹⁸

Socioeconomic region 7, which corresponds to Mexico City, showed the highest OC-related mortality rate in the 2000-2014 period. Family history of ovarian cancer, early menarche, late menopause, nulliparity, infertility, polycystic ovarian syndrome, hormone replacement therapy in postmenopausal women, exposure to asbestos, talcum powder, endometriosis, pelvic inflammatory disease, obesity, high consumption of saturated fats, sedentary lifestyle and smoking (it increases the possibilities of mucinous OC by 50 %) have been reported to be risk factors for suffering from OC.¹⁹ Some risk factors that might be associated with ovarian cancer mortality in Mexico City are obesity, high consumption of saturated fats, sedentary lifestyle and smoking. In the National Health and Nutrition Survey, Mexico City was observed to have one of the highest prevalences of overweight and obesity in the country;²⁰ women had a higher prevalence of overweight (BMI ≥ 25 kg/m²) than men (BMI 29.5 kg/m² versus 27.9 kg/m², respectively). The prevalence of obesity (BMI ≥ 30 kg/m²) was also higher in women than in men (41 % versus 27 %, respectively, $p < 0.00001$).²¹ In Mexico City, a higher prevalence of physical inactivity than in the rest of the country is also observed (41.4 %).²⁰ Physical inactivity in Mexico City has been reported at 82 % in women and 71 % in men.²¹ Mexico City has one of the highest prevalences of smoking in the country. The Smoking in Young People in Mexico Survey²² reported that Mexico City had the highest prevalence of young smokers (27.8 %); 58.3 % of women had the smoking habit.

Region 7 is the region with the best socio-economic conditions of the country; in the study period, it showed the highest YPLL (Fig. 3) and OC-related mortality rates (Table 3).

YPLLs are one of the measures of the relative impact of several diseases and health conditions in society, which illustrate the losses suffered by society as a consequence of young people's death or premature deaths. Death is considered to be premature when it occurs before a certain predetermined age,

Figure 3. Rate of years of potential life lost due to ovarian cancer by socioeconomic region. Mexico, 2000-2014. YPLL rate per 100,000 women adjusted for age using the national population as standard reference population.

which corresponds, for example, to life expectancy at birth in the studied population. Considering the age at which people die and not just the event of death itself, allows assigning a different weight to deaths that occur at different moments of life. The assumption on which YPLLs are based is that the more "premature" death is, the greater life loss is, some of which are sensitive to health and social measures.¹²

The American Society of Gynecologic Oncology recommends the following strategies for OC prevention:¹⁶

- Use of oral contraceptives.
- Tubal occlusion.
- Risk reduction by means of salpingo-oophorectomy in women with high hereditary breast and ovarian cancer risk,
- Genetic counseling and genetic testing for women with high family OC risk.
- Salpingectomy once parity is satisfied.

Conclusions

In the study period, 25 047 women died of OC, the mortality rate, standardized by age with the world population per 100 000 women, increased from 3.3 to 4.1, with a percentage change of 24.2 % and an average annual change of 0.043, 95 % CI = 0.32-0.55. In the study period, the states and the socioeconomic region

that had the highest mortality rates were Chihuahua (2000), Baja California Sur (2001, 2002, 2007 and 2009), Colima (2003, 2005, 2011, 2012), Quintana Roo (2004), Zacatecas (2006), Sonora (2008), Coahuila (2010), Aguascalientes (2013), Querétaro (2014) and region 7. The states and regions that showed the highest YPLL rate in the study period were Nayarit (2000), Baja California Sur (2001 and 2007), Zacatecas (2002), Colima (2003, 2004 and 2010), Tlaxcala (2005), Zacatecas (2006), Oaxaca (2008), Quintana Roo (2009), Coahuila (2011-2012), Querétaro (2014) and regions 7 (2000-2004, 2006-2012, 2014), 5 (2005) and 6 (2013).

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