Mortality trends and risk of dying from breast cancer in the 32 states and 7 socioeconomic regions of Mexico, 2002-2011

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ABSTRACT

BACKGROUND: To determine mortality trends from breast cancer in Mexico nationwide, by state, by socioeconomic region, and to establish an association between education, state of residence, and socioeconomic region with mortality from breast cancer in 2002–2011.

METHODS: Records of mortality associated with breast cancer were obtained. Rates of mortality nationwide, by state, and by socioeconomic region were calculated. The strength of association (obtained by Poisson regression) between states where women resided, socioeconomic regions, and education with mortality from breast cancer was determined.

RESULTS: Women who completed elementary school had a higher risk of dying from breast cancer than people with more education [relative risk (RR) 2.58, 95% confidence interval (CI) 2.49-2.67]. Mexico City had the strongest association with dying from breast cancer as state and as socioeconomic region 7 [Mexico City: RR 3.47, CI95% 2.7-4.46 (2002) and RR 3.33, CI95% 2.66-4.15 (2011) and region 7: RR 3.72, CI 95% 3.15-4.38 (2002) and RR 2.87, CI 95% 2.51-3.28 (2011)].

CONCLUSIONS: In Mexico, the raw mortality rates per 100,000 women who died from breast cancer increased. Mortality was higher in women who had elementary school than in those with more education. The strongest association was in Mexico City as state and as region 7.

Key words: breast cancer, mortality, socioeconomic factors, Mexico

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INTRODUCTION

Breast cancer (BC) is the most frequent diagnosed malignancy worldwide and is the main cause of death from cancer in women. In 2008, BC represented 23% (1.38 millions) of the total cases and 14% (458,400) of the deaths around the world. Developing countries

showed 691,300 cases of BC and 268,900 deaths from this disease, whereas developed countries had 692, 200 cases and 189,500 deaths.

In general, the incidence rates of BC in Western and Northern Europe, Australia, New Zealand and North America are high. Intermediate incidence rates are observed in South America, the Caribbean and Northern Africa, and low incidence rates are present in Asia and Sub-Saharan Africa. Factors that have contributed importantly to the international variation in the incidence rates of BC are reproductive and hormonal as well as the availability of early cancer detection [1]).

In Latin America, in general, the incidence and mortality from BC have remarkably increased due to aging of population, changes in reproductive patterns, higher exposure to risk factors and lack of a timely diagnosis and appropriate treatment [2]. It is estimated that each year 114,900 women are diagnosed with BC and 37,000 died from the disease. The variability of BC in Latin American countries is as important as it is between Latin America and other regions of the world. The highest incidence rates are observed in Uruguay, Argentina and Chile, with similar rates in Europe and The United States, The lowest incidence rates are observed in Mexico, Panama, Ecuador and Colombia with comparable rates in Asia and Africa. The highest mortality rates are observed in Argentina and Uruguay and for the rest of Latin American countries mortality rates are between 10 and 13.7 per 100,000 women. Countries with the lowest mortality rates are Ecuador and Colombia [3].

Breast cancer in Mexico is closely related to the demographic and epidemiologic transitions and represents a growing problem in public health. Mexico occupies number 101 in incidence and 135 in mortality among 172 countries [2]. BC in Mexico is the leading cause of death in women since 2006 and continues to increase. In the year 2011, there were 5,222 deaths from the disease; cervical cancer followed with 3,927 fatalities and cancer of the liver and intrahepatic bile ducts ranked third with 2,850 deaths [4].

Breast cancer represents a great burden of premature deaths in Mexico, since 60% of women who die are between 30 and 59 years of age. There is some evidence that the average age of onset of disease is lower in developing countries than in developed ones [5].

Breast cancer is the cause of an important economic burden for Mexico. The total cost of care of BC for the 16,346 patients who received care at the Mexican Social Security Institute (Instituto Mexicano del Seguro Social - IMSS) in 2002 (comprising both ambulatory and inpatient settings), which amounted to $MX1,806 million, or US$187 million; which is 1,7% of the IMSS budget. According to the National Committee for Health and Social Protection of the Secretary of Health (Comisión Nacional de Protección Social en Salud - Secretaría de Salud), by June 30 2010, the treatment of 11,468 BC cases for a total of MX$1,302 million had been authorized [3].

The objective of this study is to determine the trends of mortality rates nationwide, by state, by socioeconomic region, and to establish the relative risk (RR) between education level, state of residency and the socioeconomic region, with the mortality from BC in 2002-2011.

METHODS

An ecological study design was used. Mortality records associated with BC for 2002–2011 were obtained from the National Information System of the Secretariat of Health of Mexico [6]. This information is generated by the National Institute of Statistics and Geography and it is collected from death certificates issued nationwide. All individual records of mortality in which the basic cause of death was breast cancer in the period 2002-2011 were included in the study. The codes of the International Classification of Diseases, 10th Revision [7] were identified. They corresponded to the basic cause of death from BC (C50.0-C50.9).

Raw and age-adjusted mortality rates nationwide per 100,000 women were obtained, taking the world population as the standard population [8,9]. Age-adjusted mortality rates per 100,000 women from each state and from each of the 7 socioeconomic regions (Table 1) established by the National Institute of Statistics and Geography were also obtained [10]. The national population, estimated by the National Population Council for 2002–2011 [11], was used for the rate adjustment. The relative risk (RR) and 95% confidence interval (CI) for mortality from BC for each of the seven socioeconomic regions and each state of residence were calculated by

TABLE 1

SOCIOECONOMIC REGIONS OF MEXICO	
SOCIOECONOMIC REGIONS	STATES
1	Chiapas, Guerrero, Oaxaca
2	Campeche, Hidalgo, Puebla, San Luis Potosi, Tabasco, Veracruz
3	Durango, Guanajuato, Michoacan, Tlaxcala, Zacatecas
4	Colima, State of Mexico, Morelos, Nayarit, Queretaro, Quintana Roo, Sinaloa, Yucatan
5	Baja California, Baja California Sur, Chihuahua, Sonora, Tamaulipas
6	Aguascalientes, Coahuila, Jalisco, Nuevo Leon
7	Mexico City

Source: National Institute of Statistics and Geography of Mexico

Poisson regression.

The seven socioeconomic regional categories for Mexico have been defined by the National Institute of Statistics and Geography in which differences observed in the social and economic conditions of the population throughout Mexico are presented according to the XII General Population and Housing Census. The seven socioeconomic regions comprise the 31 states and Mexico City according to indicators related to well-being such as education, occupation, health, housing, and employment. States classified in the same region have similar characteristics on average; that is, they are homogenous, while the regions differ from one another. According to the indicators used, the socioeconomic conditions increase from Region 1, least favorable, to region 7 most favorable.

The methodology used to establish the regions had the objective of forming strata with minimal variance in an effort to group the elements more alike or closer to each other following a criterion of established similarity, which allows for differentiating one region from another. Among the techniques used are Mahalonobis distances and a combination of factorial analysis and the algorithm of the K-means [10].

The Poisson regression model was chosen to determine the strength of association between states, socioeconomic regions of residence, and education with mortality from BC, because as a dependent variable, the number of deaths has a Poisson distribution that takes positive whole values. Poisson regression is equivalent to logarithmic regression of mortality rates. The exponential coefficients allow for estimation of the relative risk (RR) of dying [12].

Registrations were handled by the Access 2003 program. The strength of association between each state and socioeconomic region of residence and mortality from BC was obtained by Poisson regression through the Number Cruncher Statistical System program 2001 [13]. The Epidat version 3.1 program was used to determine age-adjusted mortality rates by state and socioeconomic region.

RESULTS

In the period of study 44,962 women died of BC in Mexico. In the year 2002, there were 3,824 deaths from the disease, and in the year 2011, there were 5,138 deaths. Raw mortality rate during the period of study, increased from 7.4 to 9.1 per 100,000 women (Figure 1).

Breast cancer increased notably with age. In the age group comprised between 25 and 29 years, 385 (0.86%) deaths were observed. In the group between 50-54 years there were 5,931 (13.1%) deaths, and from the age group of 55-59, mortality began to decrease with 5,685 (12.6%) deaths (Figure 2).

The strength of association between education and death from breast cancer was determined. Women who completed elementary school showed a higher risk of dying (RR 2.58, CI 2.49-2.67), while women with a higher education level had a lower risk of dying, as is the case for those with a college education (RR 1.28, CI 1.23-1.33) (Table 2).

The trend of mortality rates is going upward. There was no state with the highest mortality from BC in the period 2002-2011 (Figure 3). The states with the highest mortality

TABLE 2

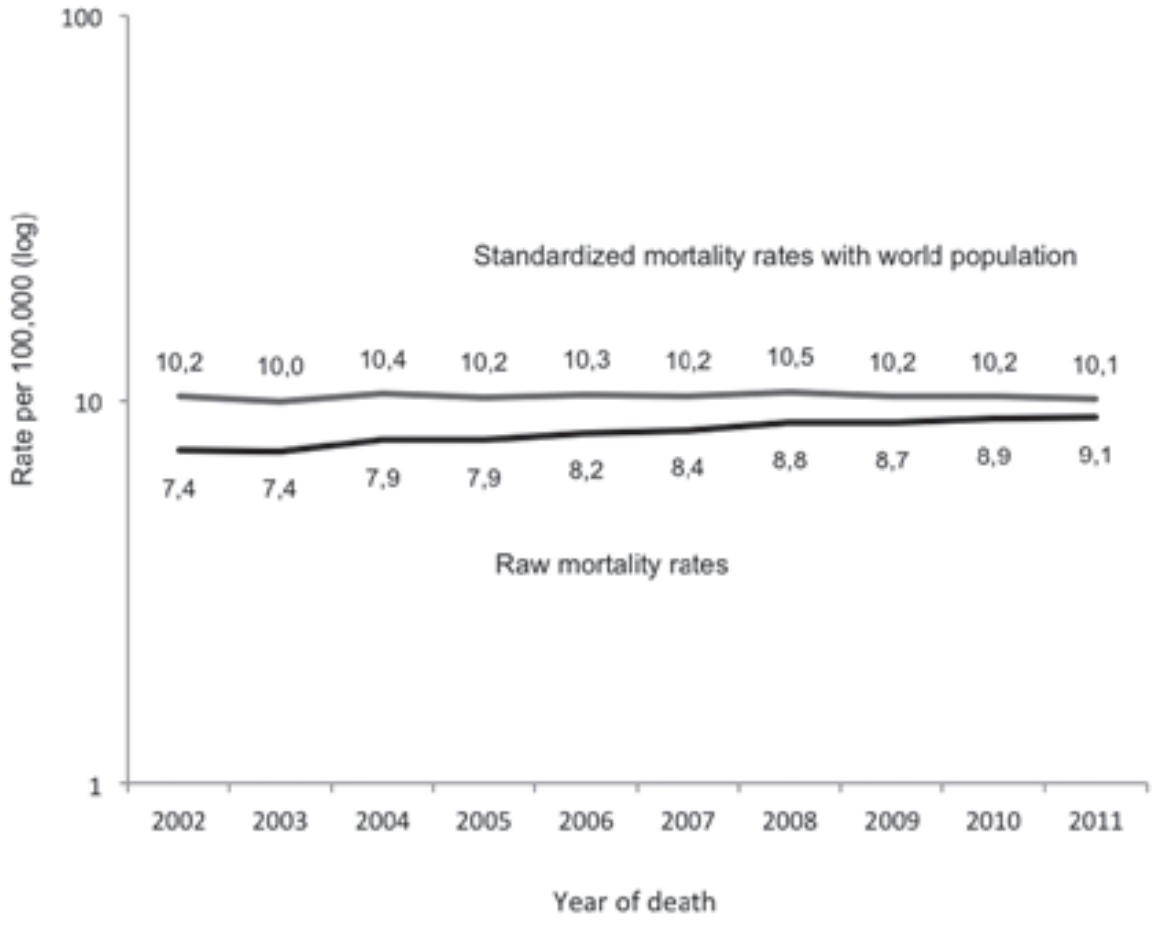
RELATIVE RISK (RR) OF DYING FROM BREAST CANCER ACCORDING TO EDUCATIONAL LEVEL, AND 95% CONFIDENCE INTERVAL (CI) ACCORDING TO POISSON REGRESSION. MEXICO, 2002-2011

EDUCATION	RELATIVE RISK	95% CONFIDENCE INTERVAL
No school	1	N/A
Incomplete elementary school	2.18	2.10-2.26
Complete elementary school	2.58	2.49-2.67
High School or Equivalent	1.41	1.36-1.47
Senior in High School or Equivalent	1.01	0.97-1.05
College	1.28	1.23-1.33

Note: N/A: Not applicable

FIGURE 1

MORTALITY FROM BREAST CANCER IN MEXICO. 2002-2011

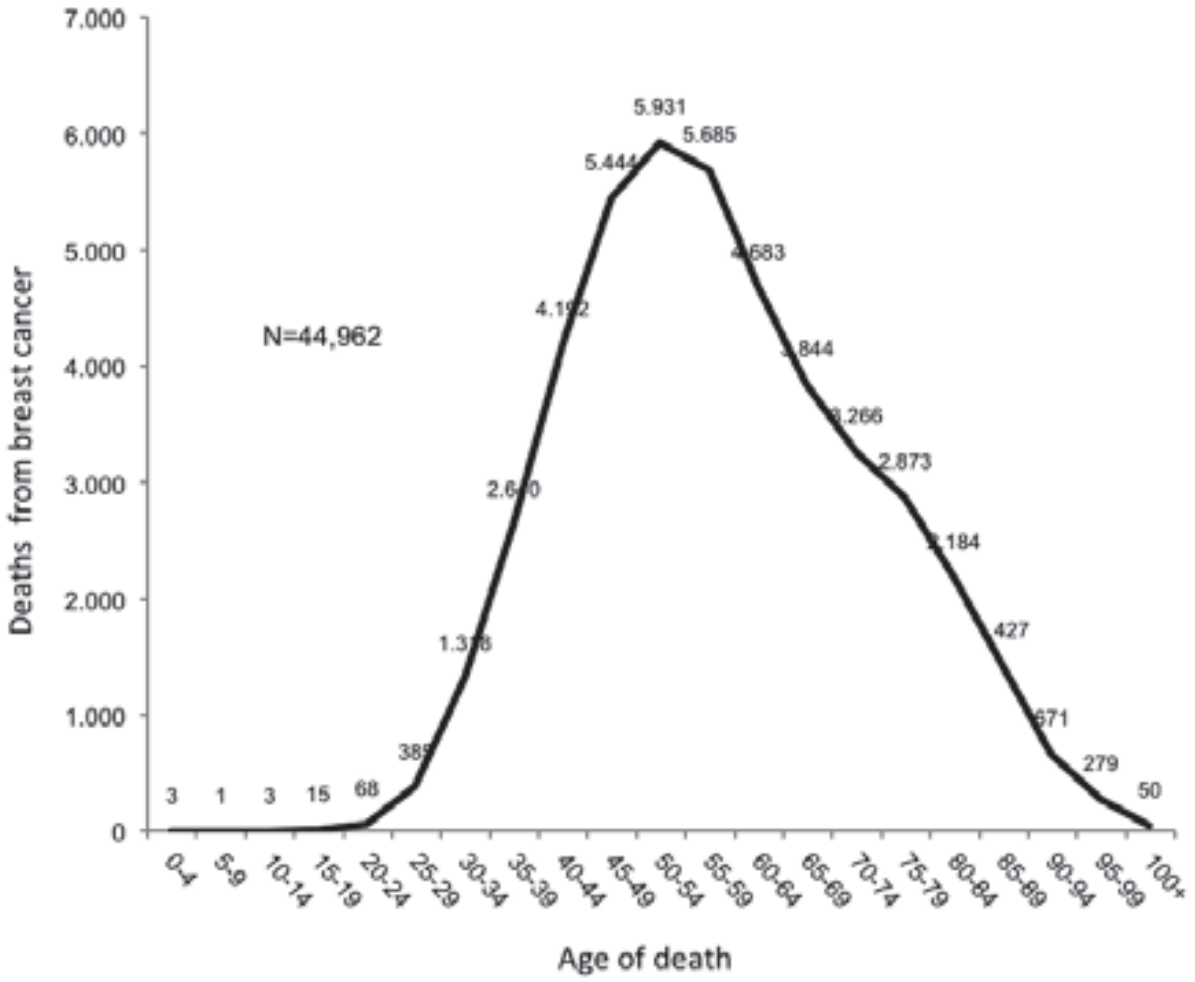


NOTE: Raw rate of mortality per 100,000 women.
Age-adjusted rate by direct method, standardized with world population per 100,000 women

in the period of study were Colima (2002), Baja California Sur (2003, 2006-2009, 2011) Sonora (2004), Jalisco (2005) and Nuevo Leon (2010). In the year 2002 Colima showed the highest mortality with a rate of 12.4. In the years 2003 and 2011, Baja California Sur had the highest

FIGURE 2

MORTALITY FROM BREAST CANCER BY AGE. MEXICO, 2002-2011



mortality with 13.6 and 15.2, respectively. In 2004 Sonora had the highest mortality with 11.1. In 2005 Jalisco showed the highest mortality with 11.2 and in 2010 Nuevo Leon was at the top with 13 (Figure 3).

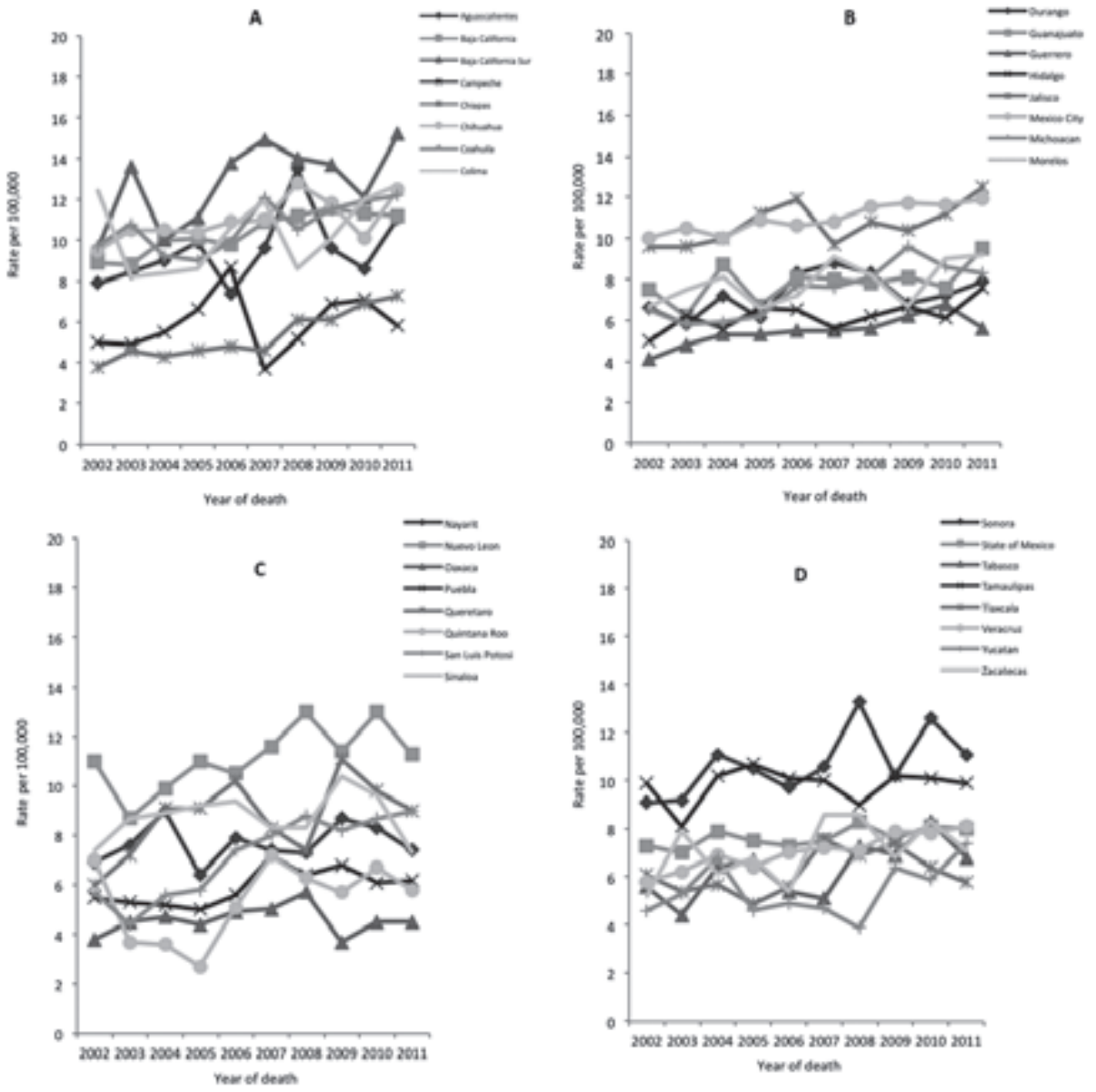
The states with the lowest mortality rates from BC in the period of study were Chiapas (2002, 2006), Quintana Roo (2003, 2004, 2005), Campeche (2007), Yucatan (2008) and Oaxaca (2009-2011) (Figure 3). In the years 2002 and 2006 the mortality rates in Chiapas was 3.8 and 4.8, respectively. In 2003 and 2005 in Quintana Roo was 3.7 and 2.7, respectively. In the year 2007 in Campeche was 3.7. In the year 2008 in Yucatan was 3.9, and in the years 2009 and 2011 the mortality rate in Oaxaca was 3.7 and 4.5 (Figure 3).

Regions 7 and 6 presented the highest mortality rates. In the years 2002-2005, 2007 and 2009, region 7 presented the highest mortality rates. In 2006 and 2008, it was region 6, and in 2010 and 2011, regions 7 and 6 were at the top. In the years 2002 and 2009, the mortality rates in region 7 were 10 and 11.7, respectively. In 2006 and 2008, the rates in region 6 were 10.8, and 11.6; and in 2010 and 2011 the mortality rates for regions 7 and 6 were 11.6 and 11.9 (Figure 4). The lowest mortality rates were in socioeconomic region 1. In the years 2002 and 2011the mortality rate for region 1 was 3.8 and 5.8, respectively (Figure 4).

The strength of association between each of the states of residence and death from BC in the period of study was determined by Poisson regression, taking as reference the state of Oaxaca since, it is one of the states that presented the lowest mortality in the

FIGURE 3

AGE-ADJUSTED MORTALITY RATE TRENDS BY STATE OF RESIDENCE OF WOMEN WHO DIED FROM BREAST CANCER MÉXICO, 2002-2011



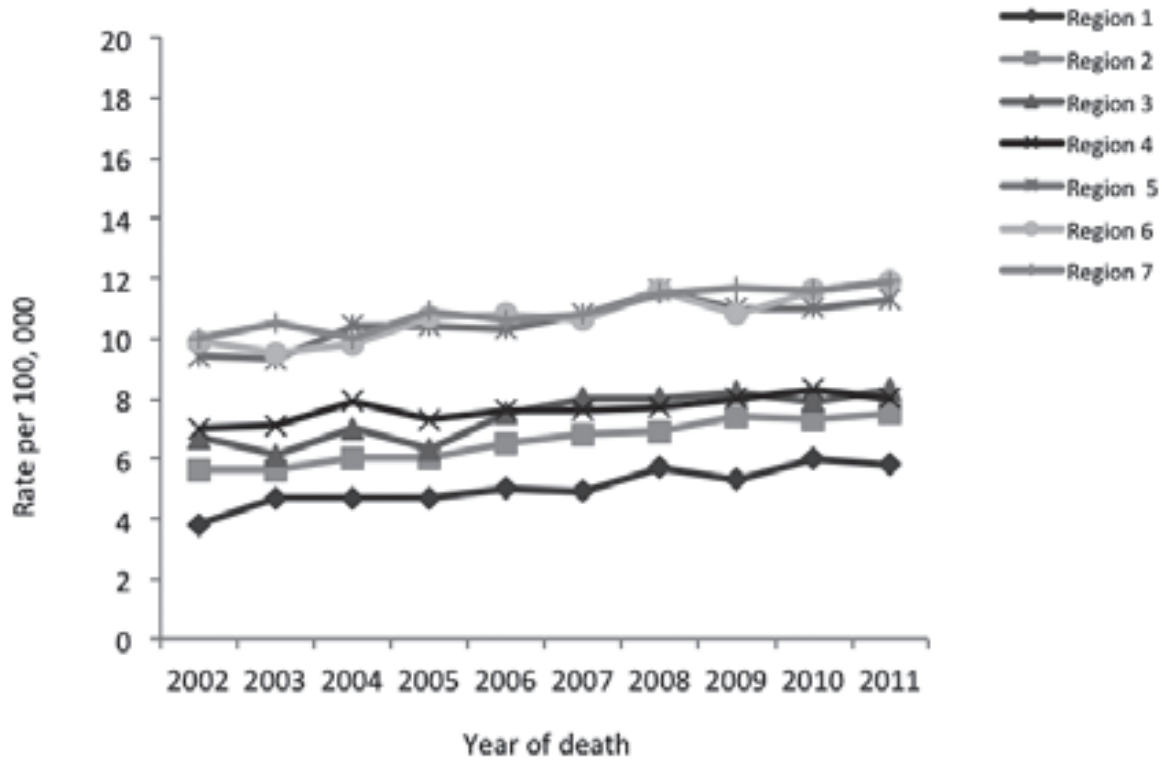
Rate per 100,000 women adjusted by the direct method using the national population as the standard population.

period of study (Figure 3 C) and is one of the 3 states with the lowest socioeconomic level in the country (Table 1). The state with the strongest association with death from BC in the years 2002-2011 was Mexico City. In the year 2002 and 2011 in Mexico City the RR was 3.47, CI95% 2.7-4.46 and 3.33, CI95% 2.66-4.15, respectively (Table 3).

In the period of study there was no particular state with the lowest strength of association with the mortality from BC. The states with the lowest strength of association with mortality from BC in the period of study were Chiapas (2002, 2006), Quintana Roo (2003-2005, 2009-2011), Campeche (2007) and Yucatan (2008) (Table 3). In the years 2002 and 2006 Chiapas presented a RR of 0.79, CI95% 0.56-1.12 and 0.77, CI95% 0.57-

FIGURE 4

AGE-ADJUSTED MORTALITY RATE TRENDS BY SOCIOECONOMIC REGION OF WOMEN WHO DIED FROM BREAST CANCER. MÉXICO, 2002-2011



Rate per 100,000 women adjusted by the direct method using the national population as the standard population

1.04, respectively. It should be noted that no RR in 2002-2011 in Chiapas was statistically significant. In the years 2004 and 2005 Quintana Roo showed a RR of 0.51, CI95% 0.28-0.94 and 0.44, CI95% 0.23-0.85, respectively. In the year 2007 Campeche showed a RR of 0.68, CI95% 0.38-1.2. In 2008 Yucatan showed a RR of 0.73, CI95% 0.51-1.06. The latter 2 RR´s were not statistically significant (Table 3).

Likewise, the strength of association between each socioeconomic region and death from BC was also determined by Poisson regression, taking as reference region 1; region 7 presented the strongest association with mortality from BC. In region 7 the RR in 2002 and 2011 was 3.72, CI 95% 3.15-4.38 and RR 2.87, CI 95% 2.51-3.28, respectively, (Table 4). Socioeconomic region 2 presented the lowest strength of association with mortality from BC in the period 2002-2011. In region 2 in 2002 and 2011 the RR was 1.64, CI 95% 1.4-1.94 and RR 1.45, CI 95% 1.27-1.65, respectively (Table 4).

DISCUSSION

Worldwide, BC is both the most common and the most deadly cancer in women [14]. This entity has incremented around the world from 1 to 3% in the last decades with a greater increase in developing countries where the risk of BC has been low in comparison with the developed ones [15]. In México, this disease has increased in the last 5 decades and possibly continue with an upward trend, since in the year 1990, 6000 new cases were reported and an increase close to 16,500 annual cases for 2020 has been estimated [5]. In the year 2002, the raw mortality rate per 100,000 women from BC in Mexico was 7.4 and increased in the following years to reach a rate of 9.1 in 2011 (Figure 1). The World Health Organization estimates that in the year 2015, Latin America will present 105,000 deaths from BC and in the year 2030 there will be 143,000 fatalities [16].

In Mexico, the mortality from BC has increased in the last decades. Similarly,

TABLE 3

RELATIVE RISK (RR) OF DYING FROM BREAST CANCER BY STATE OF RESIDENCE AND 95% CONFIDENCE INTERVAL (CI), ACCORDING TO POISSON REGRESSION, MEXICO, 2002-2011

	YEAR OF DEATH									
STATES	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGUASCALIENTES	1.98 (1.32–2.95)	1.69 (1.16–2.46)	1.82 (1.27–2.62)	2.14 (1.5–3.05)	1.39 (0.95–2.04)	1.79 (1.27–2.54)	2.28 (1.68–3.08)	2.41 (1.68–3.46)	1.76 (1.23–2.52)	2.26 (1.62–3.14)
BAJA CALIFORNIA	2.17 (1.6–2.94)	1.68 (1.26–2.24)	1.86 (1.41–2.45)	2.06 (1.56–2.72)	1.77 (1.36–2.32)	1.97 (1.52–2.55)	1.79 (1.39–2.29)	2.72 (2.06–3.59)	2.22 (1.71–2.88)	2.18 (1.68–2.82)
BAJA CALIFORNIA SUR	2.41 (1.46–3.96)	2.55 (1.65–3.93)	2.02 (1.26–3.22)	2.39 (1.52–3.74)	2.61 (1.75–3.91)	2.81 (1.9–4.14)	2.28 (1.54–3.37)	3.35 (2.22–5.06)	2.52 (1.67–3.8)	3.09 (2.12–4.5)
CAMPECHE	1.2 (0.7–2.07)	0.95 (0.56–1.62)	1.1 (0.67–1.81)	1.34 (0.84–2.15)	1.63 (1.09–2.45)	0.68 (0.38–1.21)	0.86 (0.53–1.4)	1.67 (1.06–2.64)	1.41 (0.91–2.18)	1.16 (0.73–1.86)
CHIAPAS	0.79 (0.56–1.12)	0.8 (0.59–1.09)	0.74 (0.54–1.01)	0.85 (0.62–1.16)	0.77 (0.57–1.04)	0.75 (0.56–1.01)	0.87 (0.66–1.13)	1.33 (0.99–1.79)	1.22 (0.93–1.6)	1.29 (0.99–1.69)
CHIHUAHUA	2.59 (1.95–3.45)	2.26 (1.74–2.94)	2.29 (1.77–2.97)	2.4 (1.84–3.12)	2.21 (1.72–2.83)	2.27 (1.77–2.9)	2.31 (1.83–2.9)	3.2 (2.44–4.18)	2.23 (1.73–2.88)	2.75 (2.15–3.51)
COAHUILA	2.65 (1.96–3.57)	2.37 (1.81–3.11)	2.01 (1.52–2.66)	2.11 (1.59–2.8)	2.03 (1.56–2.66)	2.5 (1.93–3.23)	1.92 (1.49–2.47)	3.13 (2.36–4.15)	2.66 (2.05–3.45)	2.71 (2.09–3.51)
COLIMA	3.45 (2.3–5.17)	1.83 (1.16–2.88)	1.87 (1.2–2.92)	2.05 (1.32–3.19)	2.19 (1.46–3.27)	2.51 (1.72–3.68)	1.6 (1.05–2.44)	2.81 (1.85–4.27)	2.71 (1.85–3.96)	2.87 (1.98–4.16)
DURANGO	1.77 (1.23–2.54)	1.27 (0.89–1.83)	1.54 (1.1–2.16)	1.4 (0.98–2.01)	1.67 (1.21–2.29)	1.78 (1.3–2.43)	1.49 (1.1–2.03)	1.82 (1.28–2.6)	1.6 (1.15–2.24)	1.73 (1.25–2.39)
GUANAJUATO	1.88 (1.42–2.49)	1.26 (0.97–1.65)	1.76 (1.37–2.26)	1.45 (1.11–1.89)	1.53 (1.2–1.96)	1.54 (1.2–1.97)	1.32 (1.04–1.67)	2.05 (1.56–2.69)	1.58 (1.23–2.03)	1.98 (1.55–2.52)
GUERRERO	1.04 (0.74–1.47)	0.98 (0.72–1.35)	1.08 (0.8–1.46)	1.15 (0.85–1.57)	1.03 (0.77–1.38)	1.03 (0.77–1.39)	0.94 (0.71–1.25)	1.59 (1.17–2.16)	1.44 (1.08–1.91)	1.16 (0.86–1.56)
HIDALGO	1.38 (0.97–1.95)	1.38 (1.01–1.88)	1.25 (0.91–1.72)	1.58 (1.16–2.14)	1.35 (1–1.82)	1.18 (0.87–1.61)	1.14 (0.85–1.53)	1.89 (1.38–2.59)	1.4 (1.03–1.9)	1.71 (1.29–2.29)
JALISCO	2.69 (2.07–3.49)	2.19 (1.72–2.77)	2.25 (1.78–2.85)	2.69 (2.12–3.42)	2.5 (1.99–3.12)	2.04 (1.62–2.56)	2 (1.62–2.48)	2.9 (2.25–3.74)	2.56 (2.03–3.23)	2.81 (2.24–3.54)
MEXICO CITY	3.47 (2.7–4.46)	2.93 (2.34–3.68)	2.78 (2.22–3.49)	3.23 (2.56–4.07)	2.77 (2.23–3.45)	2.81 (2.26–3.5)	2.65 (2.16–3.26)	3.99 (3.13–5.1)	3.27 (2.61–4.09)	3.33 (2.66–4.15)
MICHOACAN	1.77 (1.33–2.37)	1.28 (0.97–1.68)	1.28 (0.97–1.68)	1.43 (1.08–1.88)	1.57 (1.22–2.02)	1.54 (1.2–1.99)	1.44 (1.13–1.83)	2.59 (1.98–3.39)	1.92 (1.49–2.47)	1.81 (1.4–2.34)
MORELOS	1.89 (1.33–2.69)	1.71 (1.24–2.37)	1.84 (1.34–2.51)	1.62 (1.16–2.26)	1.54 (1.12–2.11)	1.95 (1.45–2.62)	1.56 (1.16–2.09)	1.9 (1.35–2.66)	2.13 (1.58–2.86)	2.14 (1.59–2.87)
NAYARIT	1.91 (1.27–2.89)	1.71 (1.17–2.51)	2.05 (1.43–2.93)	1.61 (1.08–2.4)	1.65 (1.14–2.38)	1.56 (1.07–2.28)	1.37 (0.95–1.99)	2.48 (1.71–3.59)	1.98 (1.38–2.83)	1.69 (1.16–2.47)
NUEVO LEON	3.14 (2.4–4.12)	2 (1.55–2.58)	2.26 (1.76–2.91)	2.67 (2.08–3.43)	2.25 (1.77–2.86)	2.49 (1.97–3.16)	2.47 (1.98–3.08)	3.23 (2.49–4.2)	3 (2.37–3.81)	2.6 (2.04–3.3)
PUEBLA	1.48 (1.11–1.98)	1.15 (0.88–1.5)	1.1 (0.84–1.44)	1.14 (0.87–1.5)	1.13 (0.88–1.46)	1.46 (1.14–1.87)	1.14 (0.89–1.45)	1.8 (1.37–2.37)	1.33 (1.03–1.72)	1.35 (1.05–1.75)
QUERETARO	1.43 (0.97–2.11)	1.41 (1–2)	1.74 (1.26–2.4)	1.85 (1.33–2.57)	1.84 (1.36–2.5)	1.48 (1.07–2.05)	1.2 (0.87–1.66)	2.65 (1.93–3.64)	1.99 (1.46–2.7)	1.79 (1.31–2.45)
QUINTANA ROO	1.27 (0.78–2.05)	0.63 (0.36–1.1)	0.51 (0.28–0.94)	0.44 (0.23–0.85)	0.82 (0.52–1.31)	1.02 (0.67–1.56)	0.75 (0.48–1.16)	1 (0.62–1.61)	0.9 (0.58–1.41)	0.83 (0.53–1.31)
SAN LUIS POTOSI	1.56 (1.12–2.18)	0.96 (0.68–1.36)	1.22 (0.89–1.68)	1.38 (1–1.89)	1.55 (1.16–2.07)	1.67 (1.26–2.22)	1.62 (1.24–2.11)	2.26 (1.67–3.06)	1.97 (1.49–2.62)	2.03 (1.53–2.68)
SINALOA	2.01 (1.47–2.73)	1.9 (1.43–2.51)	1.93 (1.47–2.55)	2.13 (1.61–2.82)	1.91 (1.47–2.5)	1.7 (1.29–2.24)	1.51 (1.16–1.97)	2.83 (2.14–3.76)	2.13 (1.63–2.79)	1.63 (1.22–2.16)
SONORA	2.45 (1.81–3.32)	2.03 (1.53–2.7)	2.43 (1.85–3.18)	2.48 (1.88–3.27)	1.97 (1.51–2.59)	2.17 (1.66–2.83)	2.41 (1.89–3.07)	2.77 (2.08–3.7)	2.8 (2.16–3.63)	2.45 (1.88–3.19)
STATE OF MEXICO	1.85 (1.43–2.38)	1.43 (1.13–1.8)	1.61 (1.28–2.02)	1.64 (1.3–2.08)	1.43 (1.15–1.78)	1.48 (1.18–1.84)	1.42 (1.16–1.75)	1.98 (1.55–2.54)	1.74 (1.39–2.18)	1.72 (1.37–2.15)
TABASCO	1.32 (0.91–1.91)	0.85 (0.58–1.24)	1.2 (0.86–1.68)	1.36 (0.97–1.9)	0.94 (0.66–1.33)	0.94 (0.66–1.33)	1.16 (0.85–1.57)	1.64 (1.17–2.3)	1.68 (1.24–2.27)	1.37 (1–1.88)
TAMAULIPAS	2.75 (2.06–3.66)	1.81 (1.37–2.38)	2.28 (1.75–2.96)	2.51 (1.92–3.27)	2.07 (1.6–2.67)	2.06 (1.6–2.66)	1.64 (1.28–2.11)	2.78 (2.11–3.67)	2.26 (1.75–2.92)	2.17 (1.68–2.81)
TLAXCALA	1.59 (1.03–2.44)	1.13 (0.73–1.75)	1.19 (0.78–1.81)	1.08 (0.69–1.69)	1.08 (0.71–1.64)	1.48 (1.02–2.14)	1.19 (0.82–1.73)	1.9 (1.29–2.8)	1.35 (0.91–1.99)	1.21 (0.81–1.81)
VERACRUZ	1.7 (1.3–2.23)	1.47 (1.15–1.88)	1.6 (1.25–2.04)	1.63 (1.27–2.1)	1.55 (1.22–1.96)	1.61 (1.28–2.04)	1.38 (1.11–1.73)	2.34 (1.81–3.03)	1.91 (1.51–2.42)	1.96 (1.55–2.48)
YUCATAN	1.35 (0.92–1.97)	1.27 (0.9–1.8)	1.59 (1.15–2.19)	1.16 (0.81–1.67)	1.07 (0.76–1.52)	1.02 (0.72–1.45)	0.73 (0.51–1.06)	1.8 (1.28–2.53)	1.37 (0.98–1.9)	1.68 (1.24–2.29)
ZACATECAS	1.47 (0.99–2.18)	1.73 (1.24–2.42)	1.33 (0.92–1.91)	1.61 (1.13–2.29)	1.1 (0.76–1.6)	1.73 (1.25–2.38)	1.57 (1.15–2.15)	1.87 (1.3–2.69)	1.9 (1.37–2.64)	1.62 (1.15–2.27)

Oaxaca was taken as reference value for the analysis of Poisson regression

the incidence and mortality rates from this disease among women have been increasing rapidly in many Eastern European, Asian, Latin American, and African countries [14]. Factors that contribute to these increasing trends are not fully understood, but thought

TABLE 4

RELATIVE RISK (RR) OF DYING FROM BREAST CANCER BY SOCIOECONOMIC REGION AND 95% CONFIDENCE INTERVAL (CI), ACCORDING TO POISSON REGRESSION, MEXICO, 2002-2011

	YEAR OF DEATH									
REGION	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2	1.64 (1.4–1.94)	1.34 (1.15–1.56)	1.43 (1.23–1.66)	1.44 (1.25–1.68)	1.47 (1.28–1.7)	1.56 (1.36–1.8)	1.37 (1.19–1.56)	1.57 (1.37–1.8)	1.37 (1.2–1.56)	1.45 (1.27–1.65)
3	1.89 (1.6–2.24)	1.42 (1.21–1.67)	1.62 (1.38–1.89)	1.44 (1.23–1.69)	1.6 (1.38–1.86)	1.73 (1.49–2.01)	1.5 (1.3–1.72)	1.67 (1.45–1.93)	1.41 (1.23–1.62)	1.55 (1.35–1.78)
4	1.95 (1.67–2.29)	1.6 (1.39–1.85)	1.78 (1.55–2.05)	1.65 (1.44–1.91)	1.62 (1.41–1.86)	1.65 (1.44–1.9)	1.45 (1.27–1.65)	1.61 (1.41–1.84)	1.48 (1.31–1.68)	1.49 (1.31–1.69)
5	2.68 (2.27–3.16)	2.15 (1.85–2.51)	2.39 (2.06–2.77)	2.4 (2.07–2.78)	2.22 (1.92–2.56)	2.35 (2.04–2.72)	2.18 (1.91–2.5)	2.24 (1.95–2.57)	1.95 (1.71–2.22)	2.09 (1.83–2.38)
6	2.96 (2.52–3.47)	2.31 (2–2.68)	2.37 (2.05–2.74)	2.58 (2.24–2.98)	2.46 (2.14–2.83)	2.45 (2.13–2.81)	2.3 (2.02–2.62)	2.32 (2.03–2.65)	2.19 (1.93–2.49)	2.32 (2.04–2.64)
7	3.72 (3.15–4.38)	3.19 (2.74–3.7)	3.01 (2.59–3.5)	3.28 (2.83–3.8)	3.01 (2.61–3.48)	3.09 (2.67–3.57)	2.85 (2.49–3.26)	3.08 (2.68–3.55)	2.7 (2.37–3.09)	2.87 (2.51–3.28)

Region 1 was taken as reference value of Poisson regression.

to reflect lifestyle changes associated with westernization, including late child bearing, having fewer children, and consumption of calorie-dense food, physical inactivity, and obesity. The unfavorable mortality trend in several of these countries may have been exacerbated by poor survival because of lack of or limited access to early detection services and treatment [17].

In this study it was observed that the mortality from BC increased greatly with age attaining the highest mortality in the group from 50-54 years with 5,931 deaths and from the group of age of 55-59 years, mortality began to decrease with 5,685 deaths (Figure 2), possibly due to the diminution in circulating levels of estrogens [18]. Age is a risk factor for BC. It has been observed that women under 25 years of age present 10 cases of BC per 100, 000 women, whereas in women 45 years of age, the probability of presenting BC increases up to 100 times. This behavior suggests that female hormones participate in the etiology of BC [19].

Long time exposure to estrogens is associated with an increase in the risk for BC (relative risk 2.00-2.58) [20]. The most widely accepted theory holds that estradiol, acting through estrogen receptor alpha, stimulates cell proliferation and initiates mutations arising from replicative errors occurring during premitotic DNA synthesis. The promotional effects of estradiol then support the growth of cells harboring mutations. Over a period of time, sufficient numbers of mutations accumulate to induce neoplastic transformation [21].

The mortality from BC was high in women with a low level of education (Table 2). Educational level is an indicator of health, since it has been observed that persons with higher education have better possibilities to be employed and to have higher incomes, therefore to be prosperous, which directly affects their health [22]. In Mexico, the lack of education has contributed to the prevalence of social inequality and poverty [23]. A high level of education is related to the low mortality and a better health of the population [24]. In Mexico, It has been observed that persons without education or with a low level of it, are usually found in socially, geographically and economically marginal populations. Women in these populations have a higher possibility of dying from preventable cancers like BC, which can be attributed to the fact that they do not receive an opportune diagnosis and treatment, therefore, they present a lower survival and a higher mortality [25]. In the year 2010, over 50% of the confirmed cases of BC were in advanced stages, (III and IV) [26].

Breast cancer is associated with the socioeconomical level both individually and at population level. The risk of having BC is higher in women who live in cities or who have a high socioeconomic level [27]. Mexico City as

state and as socioeconomic region 7, presented the strongest association with the mortality from breast cancer in the period 2002-2011 (Table 3 and 4).

Other studies performed in Mexico have observed that the RR of dying from breast cancer in Mexico City was the highest in the country. Palacio-Mejia observed a RR of dying from BC in Mexico City in the years 2000 and 2006, of 1.44, CI 95% 1.07-1.95 and 1.44, CI95% 1.32-1.56, respectively [25]. Another study performed in The Unites States also observed that women living in cities have a higher risk of having BC that the ones living in rural communities (odds ratio 1.17, CI95% 1.06-1.28) [27].

Some factors associated with BC like low physical activity and obesity are more common in cities. This could be due to the westernization of life styles [28,29]. Obesity could be related to BC due to a steady increment in the estrogens levels in obese women [21].

Mexico City is one of the entities with higher prevalence of obesity in the country [30], 41% in women and 29% in men, between the ages of 35-54 years. In Mexico City, it has also been observed that a high percentage of the population is sedentary, 82% are women and 71% are men [31].

In Mexico, BC began to be considered a priority health problem toward the end of the 1990 decade, for which The Mexican Official Norm for the Prevention, Treatment and Control of Cancer of Uterine Cervix and Breast was established in 1994. In the year 2001 a Program of Action for BC was elaborated for the first time and, in September 2003, the Mexican Official Norm for the Prevention, Treatment, Control and Epidemiological Surveillance of BC was published [2]. In Mexico there have been advances in early detection, prompt treatment and development of integrated programs for breast health; however, in spite of these advances, mortality trends from this disease continue to increase, since this increment in morbidity and mortality has not been accompanied by a concomitant increase in its detection and treatment. In addition, there are not sufficient services available for early detection, neither are there the necessary human resources and equipment and clinical supplies to effectively deal with the problem. Consequently, the cases are detected in advanced stages, when the probability of survival at 5 years with treatment is less than 30%, the costs for women and their families and for the health system are the highest and treatments are more difficult, more invasive and less effective.

In Mexico, it is necessary to strengthen and extend the public politics for the detection of BC, possibly through a new program or to widen the scope of the current programs. Among other measures, it is necessary to sensitize the population on the growing importance of this disease, to recognize that early detection is the key to the control of it and to struggle against cultural barriers, which prevent its rational approach [32].

This study has some limitations. One of them is that it is an ecological study and thus individual-level associations cannot be inferred from the results. Another limitation is that mortality and the strength of association among some federative entities and socioeconomic regions in Mexico reported in this paper could be even higher since in Mexico there is an under-registration of mortality. In the period 2001-2003 this was 9.7%. However, Mexico is considered by the Pan-American Health Organization a country where the under-registration of mortality is low [33].

CONCLUSIONS

In the period 2002-2011, raw mortality rates per 100,000 women increased from 7.4 to 9.1. The mortality was higher in women with a low educational level (complete elementary school 2.58, CI 95% 2.49-2.67). Mexico City as state and as socioeconomic region 7 presented the strongest association with mortality from breast cancer.

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