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Original Article

Mortality Trends and Risk of Dying From Pulmonary Tuberculosis in the 7 Socioeconomic Regions and the 32 States of Mexico, 2000–2009☆

Juan Jesús Sánchez-Barriga

Dirección de Investigación Operativa en Epidemiología, Dirección General de Epidemiología, Secretaría de Salud, Mexico City, Mexico

A B S T R A C T

Introduction: Tuberculosis (TB) is a world public health problem that still has a high morbidity and mortality rate mainly in countries with significant wealth gaps. Poverty, malnutrition, HIV infection, drug resistance, diabetes and addictions (mainly alcoholism) have been seen to contribute to the persistence of TB as an important health problem in Mexico.

Methods: Death certificates associated with pulmonary tuberculosis (PTB) for 2000–2009 were obtained from the National Information System of the Secretariat of Health. Rates of mortality nationwide, by state, and by socioeconomic region were calculated. The strength of association between states where individuals resided, socioeconomic regions, and education with mortality from PTB was determined.

Results: Age-adjusted mortality rates per 100 000 inhabitants who died from PTB decreased from 4.1 to 2 between 2000 and 2009. Men (67.7%) presented higher mortality than women (32.3%). Individuals failing to complete elementary education presented a higher risk of dying from PTB (RR 1.08 [95% CI: 1.05–1.12]). The socioeconomic region and the entities with the strongest association were regions 1, 5, Chiapas and Baja California. Region 1 in 2007 presented RR 7.34 (95% CI: 5.32–10.13), and region 5 in 2009 had RR 10.08 (95% CI: 6.83–14.88).

Conclusions: In Mexico, the annual mortality rate from PTB decreased. Men presented higher mortality than women. Individuals failing to complete elementary education showed a higher risk of dying from PTB. The states and regions of Mexico that presented a stronger association with mortality from PTB were Chiapas and Baja California, regions 1 and 5.

Tendencias de mortalidad y riesgo de muerte por tuberculosis pulmonar en las 7 regiones socioeconómicas y los 32 estados de México, 2000–2009

R E S U M E N

Introducción: La tuberculosis (TB) es un problema de salud pública mundial que continúa teniendo una morbimortalidad elevada, principalmente en los países con más desigualdades económicas. Se ha observado que la pobreza, la desnutrición, la infección por VIH, la resistencia a medicamentos, la diabetes y las adicciones, principalmente el alcoholismo, son factores que han contribuido a producir la persistencia de la TB como problema de salud pública importante en México.

Métodos: Se obtuvieron los registros de mortalidad asociada a la tuberculosis pulmonar (TBP) correspondientes al periodo 2000–2009 a partir del Sistema Nacional de Información de la Secretaría de Salud. Se calcularon las tasas de mortalidad nacionales, por estados y por regiones socioeconómicas. Se determinó la fuerza de asociación de los estados en los que residían los individuos, las regiones socioeconómicas y el nivel de estudios con la mortalidad por TBP.

Resultados: Las tasas de mortalidad debida a TBP por 100.000 habitantes ajustadas por edad disminuyeron de 4,1 a 2 entre 2000 y 2009. Los varones (67,7%) presentaron una mortalidad superior a la de las mujeres (32,3%). En los individuos que no habían completado los estudios primarios el riesgo de muerte por TBP

fue superior (RR 1,08 [IC 95%: 1,05–1,12]). Las regiones socioeconómicas y las entidades con mayor fuerza de asociación fueron la región 1, 5, Chiapas y Baja California. En 2007 la región 1 presentó un RR de 7,34 (IC 95%: 5,32–10,13), y en 2009 la región 5 presentó un RR de 10,08 (IC 95%: 6,83–14,88).

Conclusiones: En México hubo una disminución de la tasa de mortalidad anual por TBP. Los varones presentaron una mortalidad superior a la de las mujeres. Los individuos que no habían completado los estudios primarios presentaron un riesgo superior de muerte por TBP. Los estados y regiones de México que presentaron una mayor fuerza de asociación con la mortalidad por TBP fueron los de Chiapas y Baja California, regiones 1 y 5.

Introduction

Tuberculosis has been a global public health problem since it was first identified, and continues to be a significant problem, primarily in developing countries, despite advances in diagnosis, prevention and treatment. TB is the 10th highest cause of death worldwide[1] and is the 2nd cause of death from infection after human immunodeficiency virus (HIV). All countries are affected by this disease, but Africa and Asia account for 85% of the cases (30% and 55%, respectively), while 35% of the TB cases occur in the Asian subcontinent, in India and China.[2]

In 2010, the number of cases of TB worldwide was estimated at between 8.5 million and 9.2 million, with between 1.2 million and 1.5 million deaths, including those due to TB in HIV-positive patients.[3] However, mortality from this disease has fallen by more than one-third since 1990.[4]

The economic burden of TB can be devastating, particularly for the poor. Direct and indirect costs of TB and its social consequences are catastrophic for patients, families and the community.[5] The cost-per-patient has been estimated at 20% and 40% of a family's annual income, and up to 70% of the annual per capita income. Studies conducted in Myanmar, Bangalore and India have shown that the mean cost of care expressed as a proportion of annual income was much greater in patients with a lower socioeconomic level than those with greater means (68% vs 32% of per capita income in Myanmar).[6]

In Mexico, around 15 000 new cases of pulmonary tuberculosis (PTB) are reported every year and almost 2000 deaths are attributed to this cause, representing a significant loss of potential years of healthy life, since the mean age at death from this disease is 54 years.[7] However, mortality has fallen substantially in recent years: the mortality rate per 100 000 inhabitants in 1990 was 61, while in 2009 and 2010 it was lower than 2.[3] Poverty,[8] malnutrition, HIV infection,[9] drug resistance,[10] diabetes,[11,12] and addictions, primarily alcoholism,[13] are factors that contribute to the persistence of TB as a significant health problem in Mexico.

No studies investigating mortality trends in PTB by state and by socioeconomic region have hitherto been conducted in Mexico, nor have any data been published on the strength of association between educational level, state of residence, socioeconomic region and mortality from PTB.

The aim of this study was to determine trends in nationwide mortality rates by state and by socioeconomic region, and to determine the relative risk (RR) of educational level, state of residence and socioeconomic region with PTB mortality from 2000 to 2009.

Methods

An ecological study design was used. Records of PTB deaths between 2000 and 2009 were obtained from the Health Information National System of the Mexican Secretariat of Health.[14] This information, based on death certificates issued throughout the country, is generated by the National Institute of Statistics and Geography. All individual death certificates in which the underlying cause of

Table 1
Socioeconomic Regions of Mexico.

Socioeconomic regions	Federal 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	Mexico City

Source: National Institute of Statistics and Geography.

death was recorded as PTB between 2000 and 2009 were included. International Classification of Disease codes (10th edition)[15] corresponding to underlying cause of death TBP (A15-A15.9, A16-A16.9) were identified.

Gross and age-adjusted mortality rates per 100 000 inhabitants in Mexico, standardized to the world population, were obtained.[16,17] Age-adjusted mortality rates per 100 000 inhabitants were also obtained for each state and each of the 7 socioeconomic regions (Table 1) defined by the National Institute of Statistics and Geography.[18] The national population of Mexico, estimated by the National Population Board for the period 2000–2009,[19] was used for rate adjustment. Poisson regression was used to calculate the RR and 95% confidence interval (CI) for PTB mortality for each of the 7 socioeconomic regions and for each state of residence.

The 7 categories of socioeconomic regions in Mexico were defined by the National Institute of Statistics and Geography on the basis of differences in social and economic conditions of the population of Mexico as a whole, and presented as part of the XII Census of Population and Housing. The 7 socioeconomic regions include the 31 Mexican states and Mexico City, and are determined according to indicators of wellbeing, such as educational level, occupation, health, housing and employment. The states classified under a single socioeconomic region generally have similar characteristics, i.e., they are homogeneous, while the regions differ. According to the indicators used, socioeconomic conditions range from region 1, the worst, to region 7, the best.

The methodology used for establishing the regions aimed to create strata with minimal variance. The objective was to pool the most similar or closely connected elements following established similarity criteria for differentiating one region from another. Techniques employed included Mahalonobis distances and a combination of factorial analysis and *k*-means clustering.[18]

The Poisson regression model was used to determine the strength of association between states, socioeconomic regions of residence and level of studies, and PTB mortality, because the number of deaths, as a dependent variable, has a Poisson distribution of whole positive numbers. The Poisson regression is equivalent to a logarithmic regression of mortality rates. Exponentiated coefficients allow the RR of death to be estimated.[20]