Mortality trends from hypertension in Mexico by socioeconomic region and state, 2000–2008

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ABSTRACT

Objective. *To determine mortality trends from hypertension in Mexico nationwide, by state, by socioeconomic region, and by sex and to establish an association between education, state of residence, and socioeconomic region with mortality from hypertension in 2000–2008.*

Methods. *Records of mortality associated with hypertension for 2000–2008 were obtained from the National Information System of the Secretariat of Health. This information is generated by the National Institute of Statistics, Geography and Informatics through death certificates issued throughout the country.* International Classification of Diseases, 10th Revision, *codes corresponding to the basic cause of death from hypertension were identified. Rates of mortality nationwide, by state, and by socioeconomic region were calculated. The strength of association (obtained by Poisson regression) between states where individuals resided, socioeconomic regions, and education with mortality from hypertension was determined. The seven socioeconomic regions were elaborated by the National Institute of Statistics, Geography and Informatics and include the 31 states and Mexico City according to indicators that are related to well-being such as education, occupation, health, housing, and employment.*

Results. *Individuals who did not complete elementary school had a higher risk of dying from hypertension than people with more or no education [relative risk (RR) 1.462, 95% confidence interval (CI) 1.442–1.482]. Mexico City, Oaxaca, and region 7 had the strongest association with dying from hypertension [Mexico City: RR 2.6, CI 2.1–3.2 (2000) and RR 2.5, CI 2.1–3.1 (2005); Oaxaca: RR 2.4, CI 2.0–3.0 (2006) and RR 2.7, CI 2.3–3.3 (2008); region 7: RR 1.58, CI 1.45–1.72 (2000) and RR 1.25, CI 1.17–1.34 (2008)].*

Conclusions. *Age-adjusted mortality rates per 100 000 inhabitants who died from hypertension increased from 15.7 to 18.5 between 2000 and 2008, taking the world population age distribution as standard. Mortality was higher in women than in men and in individuals who did not complete elementary school than in those with more or no education. The strongest associations were in Mexico City, Oaxaca, and region 7.*

Key words Hypertension; mortality; socioeconomic factors; Mexico.

Hypertension is a worldwide public health problem, with an estimated 972 million hypertensive people in 2000. Of this total, 333 million live in industrialized countries and 639 live in developing countries. In the same year, 26.4% of the adult population age 20 years or older in the world were identified with hypertension (1).

In the United States, at least 65 million hypertensive patients age 18 years or older were detected in 1999–2000. Of them, 35 million were women and 30 million were men. The total prevalence in those years was 31.3%. The total expenditure for hypertension in that period was $110 billion (2).

In Mexico, hypertension represents a public health problem; in 2000, the Na-

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tional Health Survey identified approximately 15 million hypertensive patients age 20 years or older (3), and the trend is increasing (4). Also, the survey showed that more than half of the population with hypertension were not aware of it. Of the patients who knew about their disease, fewer than half took medication, and the disease was controlled in only about 20% of them (3).

The increased morbidity from hypertension in Mexico could be related to the epidemiological transition that is taking place there, which is characterized by a gradual substitution of deaths due to transmissible causes with a pattern of a prevalence of chronic degenerative diseases like diabetes and cardiovascular disorders (5, 6).

The epidemiological transition has resulted in a longer life expectancy, which in turn results in greater economic development, better social organization, and industrialization (7).

At a given moment in the world, several countries, and even distinct regions in the same country, reveal different stages of epidemiological transition. This is also true for Mexico (7, 8).

The epidemiological transition has brought changes in the lifestyle of the population, which has contributed to an increase in some factors associated with hypertension, such as diabetes mellitus, smoking, hypercholesterolemia, obesity, and a sedentary lifestyle (6, 8–13).

Hypertension is defined as having a systolic blood pressure ≥ 140 mmHg and/or a diastolic blood pressure ≥90 mmHg on the first reading and confirmed by a second reading. Hypertension is a chronic degenerative disease that can produce complications such as cardiac failure, renal failure, blindness, and cerebral vascular disease among others (14, 15). Hypertension represents an important economic burden for health systems due to government expenditures in treating the disease as well as its complications (16).

The objectives of this study are to determine mortality rates nationwide, by state, by socioeconomic region, and by sex and to establish the strength of association between education, state of residence, and socioeconomic region with mortality from hypertension in 2000–2008.

MATERIALS AND METHODS

An ecological study design was used. Mortality records associated with hypertension for 2000–2008 were obtained from the National Information System of the Secretariat of Health of Mexico (17). This information is generated by the National Institute of Statistics, Geography and Informatics, and it is collected from death certificates issued nationwide. All individual records of mortality in which the basic cause of death was hypertension in the period 2000–2008 were included in the study. The codes of the *International Classification of Diseases, 10th Revision* (18), were identified. They corresponded to the basic cause of death from hypertension such as: I10 essential or primary hypertension, I11 hypertensive cardiac disease, I12 hypertensive renal disease, I13 hypertensive cardiorenal disease, and I15 secondary hypertension.

Raw and age-adjusted mortality rates nationwide per 100 000 inhabitants were obtained, taking the world population as the standard population (19, 20). Age-adjusted mortality rates per 100 000 inhabitants from each state and from each of the 7 socioeconomic regions (Table 1) established by the National Institute of Statistics, Geography and Informatics were also obtained (21). The national population, estimated by the National Population Council for 2000–2008 (22), was used for the rate adjustment. The relative risk (RR) and 95% confidence interval (CI) for mortality from hypertension for each of the seven socioeconomic regions and each state of residence were calculated by Poisson regression.

The seven socioeconomic regional categories for Mexico have been defined by the National Institute of Statistics, Geography and Informatics 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. Region 7 shows the states with the most favorable socioeconomic conditions according to the indicators used. Region 1 includes states with the least favorable socioeconomic conditions.

TABLE 1. Socioeconomic regions of Mexico

Region	Federative entities
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, Geography and Informatics of Mexico.

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 (21).

The Poisson regression model was chosen to determine the strength of association between states, socioeconomic regions of residence, and education with mortality from hypertension, because as a dependent variable, the number of deaths has a Poisson distribution that takes positive whole values. Poisson regression is equivalent to a logarithmic regression of mortality rates. The exponential coefficients allow for estimation of the RR of dying (23).

Registrations were handled by the Access 2003 program; all data were transferred to the Number Cruncher Statistical System program 2001 (24), with which the strength of association between each state and socioeconomic region of residence and mortality from hypertension was obtained by Poisson regression. The Epidat version 3.1 program was used to determine age-adjusted mortality rates by state and socioeconomic region.

TABLE 2. Mortality from hypertension by gender, Mexico, 2000–2008

Year of death	Number	Raw rate[a]	Standardized rate[b]	Men[b]	Women[b]
2000	9 754	9.7	15.7	13.7	21.3
2001	10 221	10.0	15.9	14.8	20.8
2002	10 668	10.4	16.0	14.8	20.9
2003	11 296	10.8	16.4	15.1	21.5
2004	12 191	11.6	17.1	16.1	22.1
2005	12 858	12.1	17.4	16.1	22.8
2006	12 892	12.0	16.7	16.1	21.4
2007	14 538	13.4	18.2	17.3	23.4
2008	15 389	14.0	18.5	17.9	23.6

[a] Raw rate of mortality per 100 000 inhabitants.
[b] Age-adjusted rate by direct method, standardized with world population per 100 000 inhabitants.

TABLE 3. Relative risk of dying from hypertension according to education level and 95% confidence interval according to Poisson regression, Mexico, 2000–2008

Education	Relative risk	95% confidence interval
No school	1.000	NA
Incomplete elementary school	1.462	1.442–1.482
Complete elementary school	0.251	0.245–0.257
High school or equivalent	0.171	0.167–0.176
Senior in high school or equivalent	0.098	0.095–0.102
College	0.121	0.117–0.125

Note: NA: not applicable.

RESULTS

From 2000 to 2008, 109 807 individuals died of hypertension in Mexico. During that time, the age-adjusted rate standardized per 100 000 inhabitants increased from 15.7 to 18.5; deaths in women predominated (Table 2).

The strength of association between education and death from hypertension was determined. Individuals who did not complete elementary school showed a higher risk of dying (RR 1.462, CI 1.442–1.482), while subjects with a higher education level had a lower risk of dying, as is the case for those with a college education (RR 0.121, CI 0.117–0.125) (Table 3).

Between 2000 and 2008, the trend of mortality rates was on the rise. In that period, the states with the highest mortality rates were Tabasco and Aguascalientes [Tabasco: mortality rate 12.1, CI 10.3–13.8 (2000) and mortality rate 18.1, CI 16.1–20.1 (2008); Aguascalientes: mortality rate 10.8, CI 8.7–13 (2000) and mortality rate 19, CI 16.3–21.8 (2008)] (Table 4).

Yucatan, Quintana Roo, and Campeche had the lowest mortality rates in 2000–2008 [Yucatan: mortality rate 4.6, CI 3.7–5.6 (2000) and mortality rate 7.4, CI 6.2–8.6 (2008); Quintana Roo: mortality rate 5.2, CI 3–7.4 (2000) and mortality rate 10.3, CI 7.6–13 (2008); and Campeche: mortality rate 5.4, CI 3.5–7.2 (2000) and mortality rate 11.9, CI 9.3–14.5 (2008)] (Table 4).

Socioeconomic region 7 had the highest mortality rate in the study period [mortality rate 10.4, CI 9.8–11 (2000) and mortality rate 13.4, CI 12.7–14.1 (2008)]. Socioeconomic region 1 had the lowest mortality rate in the period 2000–2006 [mortality rate 9.2, CI 8.6–9.8 (2000) and mortality rate 11.9, CI 11.2–12.5 (2006)]; in 2007 in 2008, region 4 presented the lowest rates [mortality rate 12.4, CI 12–12.9 (2007) and mortality rate 13.5, CI 13.0–14.0 (2008)] (Table 5).

The strength of association between each state of residence and death from hypertension in 2000–2008, was determined by Poisson regression, taking Yucatan, one of the three states with less mortality from hypertension in the study period, as a reference. The strongest associations were in Mexico City and Oaxaca [Mexico City: RR 2.6, CI 2.1–3.2 (2000) and RR 2.5, CI 2.1–3.1 (2005); Oaxaca: RR 2.4, CI 2.0–3.0 (2006) and RR 2.7, CI 2.3–3.3 (2008)] (Table 6).

In the study period, the state with the lowest strength of association with mortality from hypertension was Quintana Roo [RR 0.5, CI 0.3–0.8 (2000) and RR 0.7, CI 0.5–0.9 (2008)] (Table 6).

The strength of the association between each socioeconomic region of residence and death from hypertension was also determined by Poisson regression, taking as reference region 1; region 7 presented the strongest association with mortality from hypertension [RR 1.58, CI 1.45–1.72 (2000) and RR 1.25, CI 1.17–1.34 (2008)] (Table 7).

Regions 4 and 5 presented the lowest strengths of association in the study period [region 4: RR 1.03, CI 0.96–1.12 (2000) and RR 0.87, CI 0.82–0.92 (2008); region 5, RR 1.12, CI 1.02–1.22 (2000) and RR 0.87, CI 0.81–0.93 (2008)] (Table 7). For region 4, the RR was not statically significant in 2000, 2004, and 2005; for region 5, the RR was not statistically significant in 2003–2005 (Table 7).

DISCUSSION

Hypertension has significantly increased in Mexico over the past 20 years (4). In 2000, the mortality rate per 100 000 inhabitants standardized with the distribution of the world population was 15.7 and increased to a rate of 18.5 in 2008 (Table 2). Mortality rates from hypertension will possibly continue to increase since, according to estimates by Kearney, the prevalence of hypertension will rise to 60% from 2000 to 2025 throughout the world, and it is predicted that it will amount to nearly 1 580 million hypertensive individuals. In comparison, in Latin America in 2000, 60 million men and 54.3 million women with hypertension were identified, and it is projected that by the year 2025, there will be 102.1 million men and 98.5 million women with hypertension (1).

In Mexico, in the period 2000–2008, 109 807 individuals died from hypertension. The mortality was higher in women than in men (Table 2). It has been observed that there are factors related to the development of hypertension in women, such as menopause, which produces increased sensitivity to salt. There is also evidence that oral contraceptives can enhance the risk of hypertension in women.

Advanced age could enhance mortality from hypertension in women compared with men. The prevalence and severity of hypertension increase markedly with advancing age in women, so that a higher percentage of women than men have high blood pressure after age 65 years. Furthermore, controlling

TABLE 4. Age-adjusted mortality rate[a] and 95% confidence interval by state of residence of individuals who died from hypertension, Mexico, 2000–2008

	Year of death																	
	2000		2001		2002		2003		2004		2005		2006		2007		2008	
State	MR	CI	MR	CI	MR	CI	MR	CI	MR	CI	MR	CI	MR	CI	MR	CI	MR	CI
Aguascalientes	10.8	8.7–13.0	11.7	9.4–13.9	15.8	13.2–18.4	15.8	13.2–18.4	15.6	13.0–18.1	14.4	11.9–16.8	14.6	12.2–17.1	18.5	15.7–21.2	19.0	16.3–21.8
Baja California	8.1	6.8–9.4	10.3	8.9–11.7	9.8	8.5–11.1	8.5	7.3–9.7	9.8	8.5–11.1	11.2	9.8–12.5	9.1	7.9–10.3	12.3	10.9–13.7	11.1	9.8–12.5
Baja California Sur	11.0	7.6–14.4	11.2	7.7–14.6	8.0	5.0–10.8	9.1	6.2–12.1	11.8	8.4–15.2	5.9	3.5–8.2	17.1	13.1–21.1	16.1	12.2–19.9	14.3	10.7–17.8
Campeche	5.4	3.5–7.2	5.5	3.7–7.4	7.0	4.9–9.1	5.6	3.8–7.4	7.1	5.0–9.2	8.7	6.5–11.0	8.2	6.0–10.4	10.6	8.1–13.1	11.9	9.3–14.5
Chiapas	7.9	6.8–8.9	7.6	6.6–8.6	6.9	6.0–7.9	7.4	6.5–8.4	8.2	7.2–9.2	10.0	8.9–11.1	10.3	9.2–11.4	11.9	10.7–13.1	12.7	11.5–13.9
Chihuahua	13.0	11.7–14.3	11.8	10.5–13.0	12.6	11.3–13.9	9.5	8.5–10.6	10.8	9.7–11.9	12.3	11.1–13.5	11.1	10.0–12.2	13.8	12.6–15.1	14.9	13.7–16.2
Coahuila	10.4	9.1–11.7	13.4	11.9–14.9	11.8	10.4–13.2	13.1	11.7–14.6	14.8	13.3–16.3	12.5	11.1–13.9	14.5	13.0–16.0	16.9	15.3–18.5	16.9	15.3–18.5
Colima	10.7	8.0–13.3	12.5	9.6–15.3	9.2	6.8–11.7	9.6	7.1–12.1	9.8	7.3–12.3	10.1	7.6–12.6	9.5	7.0–11.9	9.3	6.9–11.7	13.5	10.7–16.4
Durango	8.0	6.5–9.4	7.9	6.5–9.3	11.2	9.5–12.8	12.4	10.7–14.2	14.7	12.8–16.6	12.8	11.1–14.6	12.6	10.9–14.3	12.6	10.9–14.3	13.0	11.2–14.7
Guanajuato	10.4	9.5–11.4	11.5	10.6–12.5	11.0	10.1–12.0	11.7	10.7–12.7	12.9	11.9–13.9	13.4	12.4–14.4	13.0	12.0–14.0	15.1	14.1–16.2	15.4	14.3–16.5
Guerrero	7.6	6.6–8.5	7.8	6.8–8.8	7.9	6.9–8.9	8.4	7.4–9.4	8.4	7.4–9.4	8.7	7.7–9.7	10.0	8.9–11.1	11.7	10.5–12.9	11.5	10.4–12.7
Hidalgo	8.4	7.2–9.6	8.7	7.6–9.9	9.8	8.6–11.1	9.3	8.1–10.5	9.5	8.3–10.7	10.7	9.4–12.0	11.8	10.4–13.1	13.0	11.6–14.4	13.2	11.8–14.6
Jalisco	9.8	9.1–10.5	10.9	10.2–11.7	10.6	9.9–11.4	10.7	10–11.5	11.7	10.9–12.5	11.7	10.9–12.5	12.4	11.6–13.2	12.7	11.9–13.5	12.0	11.2–12.8
Mexico City	10.4	9.8–11.0	10.2	9.6–10.8	11.1	10.5–11.7	12.3	11.7–13.0	13.4	12.7–14.1	13.0	12.4–13.7	12.3	11.7–13.0	13.1	12.4–13.7	13.4	12.7–14.1
Michoacan	8.7	7.9–9.6	8.7	7.8–9.5	10.5	9.6–11.5	11.2	10.3–12.2	12.1	11.2–13.1	13.4	12.4–14.5	13.6	12.5–14.6	14.3	13.2–15.4	15.9	14.8–17.1
Morelos	7.7	6.4–9.0	10.0	8.5–11.5	9.0	7.6–10.4	9.6	8.2–11.0	9.2	7.8–10.6	12.2	10.6–13.8	13.3	11.7–15.0	13.3	11.6–14.9	12.9	11.3–14.6
Nayarit	10.9	9.0–12.9	11.2	9.2–13.2	12.0	10.0–14.1	10.9	9.0–12.8	12.3	10.3–14.4	12.1	10.1–14.1	9.5	7.7–11.2	13.3	11.2–15.4	13.5	11.4–15.6
Nuevo Leon	7.9	7.1–8.8	9.3	8.4–10.3	8.8	7.9–9.7	8.7	7.8–9.7	8.4	7.6–9.3	10.3	9.3–11.2	8.9	8.0–9.8	11.0	10.0–12.0	11.2	10.3–12.2
Oaxaca	11.4	10.3–12.5	10.8	9.8–11.9	11.9	10.8–13.0	11.6	10.5–12.6	13.7	12.6–14.9	15.0	13.8–16.1	14.3	13.2–15.5	16.8	15.5–18.0	18.6	17.4–19.9
Puebla	9.4	8.6–10.2	10.6	9.7–11.4	10.5	9.7–11.4	10.5	9.7–11.4	11.0	10.1–11.9	11.8	10.9–12.7	11.3	10.4–12.1	14.2	13.2–15.1	15.2	14.2–16.2
Queretaro	10.4	8.6–12.2	8.9	7.3–10.5	11.5	9.7–13.4	10.9	9.1–12.7	10.8	9.0–12.6	10.7	8.9–12.4	12.0	10.2–13.9	11.5	9.7–13.3	15.5	13.4–17.5
Quintana Roo	5.2	3.0–7.4	3.4	1.5–5.2	6.6	4.3–8.9	8.2	5.6–10.9	7.0	4.6–9.4	6.4	4.2–8.5	7.8	5.4–10.2	10.8	7.9–13.6	10.3	7.6–13.0
San Luis Potosi	10.5	9.3–11.8	9.6	8.4–10.8	9.4	8.2–10.6	10.7	9.4–11.9	10.0	8.7–11.2	11.6	10.3–12.9	12.8	11.4–14.2	13.4	12.0–14.8	14.1	12.7–15.5
Sinaloa	10.8	9.5–12.0	11.6	10.3–12.9	11.1	9.9–12.4	12.2	10.9–13.5	13.3	12.0–14.7	12.3	11.0–13.6	12.2	10.9–13.5	11.9	10.7–13.2	12.4	11.2–13.7
Sonora	10.9	9.6–12.3	11.4	10.0–12.8	11.6	10.2–13.0	12.0	10.6–13.5	13.3	11.8–14.8	13.8	12.4–15.3	12.1	10.8–13.5	14.2	12.7–15.7	14.9	13.4–16.4
State of Mexico	10.9	10.3–11.5	10.9	10.3–11.5	11.3	10.6–11.9	12.7	12.0–13.3	12.3	11.6–12.9	12.9	12.3–13.6	12.4	11.8–13.1	13.5	12.9–14.2	14.7	14.1–15.4
Tabasco	12.1	10.3–13.8	13.4	11.5–15.2	13.1	11.3–15.0	15.2	13.2–17.1	15.5	13.6–17.4	16.7	14.8–18.7	15.9	14.0–17.8	16.7	14.7–18.6	18.1	16.1–20.1
Tamaulipas	8.2	7.2–9.3	9.1	8.0–10.1	10.3	9.2–11.5	10.0	8.9–11.1	10.8	9.6–11.9	10.7	9.5–11.8	10.0	8.9–11.1	10.6	9.5–11.8	11.0	9.8–12.1
Tlaxcala	9.1	7.2–10.9	10.9	8.9–12.9	12.4	10.3–14.6	12.1	10.0–14.2	11.7	9.6–13.8	10.2	8.3–12.1	12.6	10.5–14.7	14.3	12.1–16.6	16.9	14.4–19.3
Veracruz	9.0	8.4–9.7	8.4	7.8–9.1	7.9	7.3–8.5	9.9	9.2–10.6	11.2	10.5–12.0	11.8	11.1–12.6	12.6	11.8–13.3	14.6	13.8–15.4	15.3	14.4–16.1
Yucatan	4.6	3.7–5.6	5.4	4.3–6.4	6.0	4.9–7.1	4.6	3.7–5.6	5.3	4.3–6.3	6.1	5.0–7.2	6.2	5.1–7.3	7.5	6.3–8.7	7.4	6.2–8.6
Zacatecas	10.3	8.7–11.8	9.4	7.9–10.9	11.4	9.7–13	9.3	7.8–10.8	10.8	9.2–12.4	12.6	10.9–14.4	11.3	9.7–12.9	13.6	11.8–15.3	13.9	12.1–15.7

Note: MR: mortality rate, CI: 95% confidence interval.
[a] Rate per 100 000 inhabitants adjusted by direct method using national population as standard population.

TABLE 5. Age-adjusted mortality rate[a] and 95% confidence interval by socioeconomic region of individuals who died from hypertension, Mexico, 2000–2008

	Year of death																	
	2000		2001		2002		2003		2004		2005		2006		2007		2008	
Region	MR	CI	MR	CI	MR	CI	MR	CI	MR	CI	MR	CI	MR	CI	MR	CI	MR	CI
1	9.2	8.6–9.8	9.0	8.4–9.5	9.2	8.6–9.8	9.3	8.8–9.9	10.5	9.9–11.1	11.6	11.0–12.2	11.9	11.2–12.5	13.7	13.0–14.4	14.7	14.0–15.4
2	9.4	8.9–9.8	9.5	9.1–9.9	9.4	9.0–9.8	10.4	9.9–10.8	11.0	10.6–11.5	12.0	11.5–12.4	12.3	11.8–12.8	14.2	13.7–14.7	15.0	14.5–15.5
3	9.5	8.9–10.0	9.8	9.3–10.4	11.0	10.5–11.6	11.4	10.8–11.9	12.5	11.9–13.1	13.0	12.4–13.6	13.0	12.4–13.6	14.4	13.7–15.0	15.3	14.6–15.9
4	9.9	9.5–10.3	10.2	9.8–10.6	10.5	10.0–10.9	11.2	10.8–11.7	11.3	10.8–11.7	11.8	11.3–12.2	11.6	11.1–12.0	12.4	12.0–12.9	13.5	13.0–14.0
5	10.2	9.6–10.8	10.6	10.0–11.3	11.0	10.4–11.7	10.0	9.4–10.6	11.1	10.5–11.8	11.7	11.1–12.4	10.8	10.2–11.4	12.8	12.2–13.4	13.1	12.4–13.7
6	9.5	8.9–10.0	10.9	10.4–11.5	10.6	10.1–11.2	10.9	10.4–11.4	11.6	11.0–12.1	11.6	11.1–12.2	11.9	11.4–12.5	13.3	12.8–13.9	13.1	12.6–13.7
7	10.4	9.8–11.0	10.2	9.6–10.8	11.1	10.5–11.7	12.3	11.7–13.0	13.4	12.7–14.1	13.0	12.4–13.7	12.3	11.7–13.0	13.1	12.4–13.7	13.4	12.7–14.1

Note: MR: mortality rate, CI: 95% confidence interval.
[a] Rate per 100 000 inhabitants adjusted by direct method using national population as standard population.

TABLE 6. Relative risk of dying from hypertension by state of residence and 95% confidence interval, according to Poisson regression,[a] Mexico, 2000–2008

	Year of death																	
	2000		2001		2002		2003		2004		2005		2006		2007		2008	
State	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI
Aguascalientes	1.9	1.4–2.5	1.8	1.3–2.3	2.2	1.7–2.7	2.8	2.1–3.6	2.4	1.9–3.1	1.9	1.5–2.5	1.9	1.5–2.5	2.0	1.6–2.5	2.2	1.8–2.7
Baja California	1.2	0.9–1.6	1.4	1.1–1.7	1.2	0.9–1.5	1.3	1.0–1.7	1.3	1.0–1.7	1.3	1.0–1.6	1.1	0.9–1.3	1.2	1.0–1.5	1.1	0.9–1.4
Baja California Sur	1.8	1.2–2.6	1.5	1.0–2.1	1.0	0.7–1.5	1.5	1.0–2.2	1.6	1.2–2.3	0.7	0.5–1.1	2.1	1.5–2.7	1.6	1.2–2.1	1.5	1.1–2.0
Campeche	0.9	0.6–1.3	0.8	0.5–1.2	0.9	0.6–1.3	0.9	0.6–1.4	1.0	0.7–1.4	1.1	0.8–1.5	1.0	0.7–1.4	1.1	0.8–1.4	1.3	1.0–1.7
Chiapas	1.1	0.8–1.4	0.9	0.7–1.1	0.7	0.6–0.9	1.0	0.8–1.3	1.0	0.8–1.3	1.1	0.9–1.3	1.1	0.9–1.4	1.1	0.9–1.3	1.2	1.0–1.4
Chihuahua	2.3	1.8–2.9	1.8	1.5–2.3	1.8	1.4 –2.2	1.8	1.4–2.2	1.8	1.4–2.2	1.8	1.4–2.2	1.6	1.3–2.0	1.7	1.4–2.0	1.8	1.5–2.2
Coahuila	1.9	1.5–2.5	2.2	1.7–2.7	1.7	1.4–2.1	2.5	1.9–3.1	2.5	2.0–3.1	1.8	1.5–2.2	2.1	1.7–2.6	2.0	1.7–2.5	2.1	1.7–2.5
Colima	2.1	1.6–3.0	2.2	1.6–2.9	1.4	1.0–2.0	2.0	1.4–2.7	1.8	1.3–2.4	1.6	1.2–2.1	1.4	1.1–2.0	1.2	0.9–1.6	1.8	1.4–2.3
Durango	1.5	1.2–2.0	1.3	1.0–1.7	1.7	1.3–2.1	2.5	1.9–3.2	2.6	2.0–3.2	2.0	1.6–2.5	1.9	1.5–2.4	1.6	1.3–2.0	1.7	1.4–2.1
Guanajuato	2.0	1.6–2.5	1.9	1.5–2.3	1.6	1.3–2.0	2.2	1.8–2.8	2.1	1.7–2.6	1.9	1.6–2.4	1.9	1.6–2.3	1.8	1.5–2.2	1.9	1.6–2.3
Guerrero	1.4	1.1–1.8	1.3	1.0–1.6	1.2	0.9–1.5	1.7	1.3–2.1	1.5	1.2–1.8	1.3	1.1–1.6	1.5	1.2–1.9	1.5	1.2–1.8	1.5	1.2–1.8
Hidalgo	1.7	1.3–2.2	1.5	1.2–1.9	1.6	1.2–1.9	1.9	1.5–2.5	1.7	1.4–2.2	1.7	1.4–2.1	1.9	1.5–2.3	1.7	1.4–2.1	1.8	1.5–2.2
Jalisco	2.1	1.7–2.6	2.0	1.6–2.5	1.8	1.5–2.1	2.3	1.9–2.9	2.2	1.8–2.7	1.9	1.6–2.3	2.0	1.7–2.4	1.7	1.5–2.1	1.7	1.4–2.0
Mexico City	2.6	2.1–3.2	2.2	1.8–2.7	2.2	1.8–2.6	3.1	2.5–3.9	3.0	2.4–3.6	2.5	2.1–3.1	2.4	2.0–2.9	2.1	1.8–2.5	2.2	1.9–2.6
Michoacan	1.9	1.5–2.4	1.6	1.3–2.0	1.8	1.4–2.2	2.5	2–3.1	2.3	1.9–2.9	2.3	1.9–2.7	2.3	1.9–2.8	2.0	1.7–2.4	2.3	1.9–2.7
Morelos	1.6	1.2–2.1	1.8	1.4–2.3	1.5	1.1–1.8	2.0	1.6–2.6	1.7	1.3–2.2	2.0	1.6–2.5	2.1	1.7–2.7	1.8	1.5–2.2	1.8	1.5–2.2
Nayarit	2.4	1.9–3.2	2.1	1.7–2.8	2.1	1.6–2.7	2.5	1.9–3.3	2.4	1.9–3.1	2.1	1.6–2.7	1.6	1.2–2.1	1.9	1.5–2.4	2.0	1.6–2.5
Nuevo Leon	1.5	1.2–1.9	1.6	1.3–1.9	1.3	1.1–1.6	1.7	1.3–2.1	1.4	1.2–1.8	1.5	1.2–1.9	1.3	1.1–1.6	1.4	1.1–1.6	1.4	1.2–1.7
Oaxaca	2.4	1.9–3.1	2.0	1.6–2.5	2.0	1.6–2.4	2.5	2.0–3.2	2.7	2.2–3.3	2.5	2.1–3.1	2.4	2.0–3.0	2.4	2.0–2.8	2.7	2.3–3.3
Puebla	1.9	1.5–2.4	1.8	1.5–2.3	1.6	1.3–2.0	2.2	1.7–2.7	2.0	1.6–2.4	1.8	1.5–2.2	1.7	1.4–2.1	1.8	1.5–2.2	2.0	1.7–2.4
Queretaro	1.7	1.3–2.3	1.3	1.0–1.7	1.5	1.2–1.9	1.8	1.4–2.4	1.6	1.2–2.0	1.3	1.0–1.7	1.5	1.2–1.9	1.2	1.0–1.5	1.7	1.3–2.0
Quintana Roo	0.5	0.3–0.8	0.3	0.2–0.5	0.6	0.4–0.8	0.8	0.6–1.2	0.6	0.4–0.9	0.5	0.4–0.8	0.6	0.5–0.9	0.6	0.5–0.9	0.7	0.5–0.9
San Luis Potosi	2.2	1.7–2.8	1.7	1.4–2.2	1.5	1.2–1.9	2.3	1.8–2.9	1.8	1.5–2.3	1.9	1.5–2.3	2.1	1.7–2.6	1.8	1.5–2.2	2.0	1.6–2.4
Sinaloa	2.1	1.6–2.7	2.0	1.6–2.4	1.7	1.4–2.1	2.4	1.9–3.1	2.3	1.9–2.9	1.9	1.5–2.3	1.9	1.5–2.3	1.5	1.3–1.8	1.6	1.3–2.0
Sonora	2.0	1.6–2.6	1.8	1.5–2.3	1.7	1.4–2.1	2.3	1.8–2.9	2.2	1.8–2.8	2.0	1.6–2.5	1.8	1.4–2.2	1.7	1.4–2.1	1.9	1.5–2.3
State of Mexico	1.7	1.4–2.1	1.5	1.2–1.8	1.4	1.1–1.6	2.0	1.6–2.5	1.7	1.4–2.1	1.6	1.3–1.9	1.5	1.3–1.8	1.4	1.2–1.7	1.6	1.3–1.9
Tabasco	1.8	1.4–2.3	1.7	1.4–2.2	1.5	1.2–1.9	2.3	1.8–3.0	2.1	1.7–2.6	2.0	1.6–2.5	1.9	1.5–2.4	1.7	1.4–2.0	1.9	1.5–2.3
Tamaulipas	1.6	1.3–2.0	1.5	1.2–1.9	1.5	1.3–1.9	1.9	1.5–2.5	1.8	1.5–2.3	1.6	1.3–1.9	1.5	1.2–1.8	1.3	1.1–1.6	1.4	1.1–1.6
Tlaxcala	1.8	1.4–2.4	1.8	1.4–2.4	1.9	1.5–2.4	2.4	1.9–3.2	2.0	1.5–2.6	1.5	1.2–2.0	1.9	1.5–2.4	1.7	1.4–2.2	2.1	1.7–2.6
Veracruz	1.9	1.5–2.3	1.5	1.2–1.9	1.3	1.1–1.6	2.1	1.7–2.6	2.1	1.7–2.6	2.0	1.6–2.4	2.1	1.7–2.5	2.0	1.7–2.4	2.2	1.9–2.6
Zacatecas	2.3	1.8–3.0	1.8	1.4–2.4	2.0	1.6–2.5	2.1	1.6–2.7	2.2	1.7–2.8	2.2	1.7–2.7	2.0	1.6–2.5	2.0	1.6–2.4	2.1	1.7–2.6

Note: RR: relative risk, CI: 95% confidence interval.
[a] The state of Yucatan was taken as a reference value for analysis of Poisson regression.

TABLE 7. Relative risk of dying from hypertension by socioeconomic region and 95% confidence interval according to Poisson regression,[a] Mexico, 2000–2008

	Year of death																	
	2000		2001		2002		2003		2004		2005		2006		2007		2008	
Region	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI
2	1.14	1.05–1.23	1.18	1.09–1.28	1.14	1.05–1.23	1.23	1.14–1.33	1.17	1.08–1.25	1.14	1.07–1.23	1.15	1.08–1.23	1.15	1.08–1.22	1.13	1.06–1.20
3	1.19	1.09–1.29	1.25	1.15–1.36	1.36	1.26–1.48	1.38	1.27–1.49	1.34	1.24–1.44	1.25	1.17–1.35	1.22	1.14–1.31	1.16	1.09–1.24	1.15	1.07–1.22
4	1.03	0.96–1.12	1.09	1.01–1.18	1.09	1.01–1.17	1.14	1.06–1.23	1.02	0.95–1.10	0.96	0.9–1.03	0.93	0.87–0.99	0.86	0.81–0.91	0.87	0.82–0.92
5	1.12	1.02–1.22	1.18	1.08–1.29	1.20	1.10–1.30	1.06	0.97–1.15	1.05	0.97–1.14	1.00	0.92–1.07	0.90	0.83–0.97	0.91	0.85–0.98	0.87	0.81–0.93
6	1.16	1.07–1.26	1.37	1.27–1.49	1.29	1.19–1.40	1.30	1.20–1.41	1.22	1.13–1.32	1.11	1.03–1.19	1.10	1.02–1.18	1.06	0.99–1.13	0.97	0.91–1.03
7	1.58	1.45–1.72	1.59	1.46–1.73	1.69	1.55–1.84	1.85	1.70–2.00	1.77	1.64–1.92	1.50	1.46–1.69	1.44	1.34–1.56	1.32	1.23–1.41	1.25	1.17–1.34

Note: RR: relative risk, CI: 95% confidence interval.
[a] Region 1 was taken as a reference value for analysis of Poisson regression.

hypertension is more difficult to achieve in older women. Data from the Framingham Heart Study showed gender differences in blood pressure control rates and in the pattern of antihypertensive medications prescribed. An age-related decrease in blood pressure control rates was more pronounced in women than in men. Among the oldest participants with hypertension, only 23% of women (vs. 38% of men) were controlled to a blood pressure of 140/90 mmHg. It is unknown whether the age-related decline in blood pressure control among women is related to true treatment resistance because of biological factors or to inappropriate drug choices in the clinical setting (25, 26).

Mortality from hypertension was higher in individuals with a low education level (Table 3). Education level is a socioeconomic indicator of health, for it has been observed that persons with more education have more possibilities of being employed and therefore of having better incomes and consequently greater well-being, which directly affects their health. In addition, persons with a higher education level (4 more years of schooling) are less likely to smoke (11 percentage points relative to a mean of 23%), to drink a lot (7 fewer days of 5 or more drinks in a year, among those who drink, of a base of 11 days), and to be overweight or obese (5 percentage point lower obesity, compared with an average of 23%). Among individuals with chronic conditions, such as diabetes and hypertension, the more educated are more likely to have their condition under control. Evidence suggests that a higher education level is associated with a lower risk of having hypertension (27–30).

The states that presented the strongest association with mortality from hypertension were Mexico City (2000–2005) and Oaxaca (2006–2008) (Table 6). On the other hand, Mexico City as region 7 presented the strongest association with mortality from hypertension in the period of study (Table 7). Factors such as obesity, sedentary lifestyle, and stress could be associated with a higher risk of dying from hypertension in this region.

Mexico City has a very low degree of marginality, which implies a better economic situation (Table 1). The latter is a result of changes and technological innovations. Some of these changes reduce physical activity of individuals and produce modifications in their eating habits (30–32), which could favor obesity and thereby increased morbidity and mortality from hypertension (33, 34).

The results of the National Health and Nutrition Survey showed that the urban population has a higher prevalence of obesity than the rural population. Mexico City presented the highest prevalence of obesity in the adult population together with the northern states of the country (35). In Mexico City, a prevalence of obesity (body mass index $\geq$30 kg/m^2) of 41% in women and 27% in men has been found (36). Obesity is associated with hypertension, and it represents a strong predictor of cardiovascular-related mortality (37, 38).

Sedentary lifestyle is another factor associated with hypertension, as it is linked to obesity (39). It has been identified with higher frequency in urban areas than in rural ones, and it could be contributing to morbidity and mortality from hypertension in region 7 (40–42). In this region, sedentary lifestyle has a very high prevalence in the population: 71% of men and 82% of women (36). Regular physical activity is inversely associated with development of hypertension. Regular physical activity avoids insulin resistance and keeps individuals at a normal weight. These benefits could be contributing to prevent hypertension (43).

Frequently, it has been observed that individuals from urban areas have more stress than those from rural areas (44), and there is evidence that stress is associated with the development of hypertension. The mechanisms by which stress could cause hypertension are an increase in vascular reactivity and slow poststress recovery (45).

States with a greater well-being, according to the classification by socioeconomic regions of the National Institute of Statistics, Geography and Informatics (Table 1), comprise those that constitute region 7. This region presented one of the highest mortality rates as well as the strongest association with mortality from hypertension, whereas the states that form regions 2–6 presented a similar strength of association with mortality from hypertension but lower than that of region 7 (Table 7).

Mexico is in distinct stages of the epidemiological transition process; at the same time, it has great disparities in health services, education, employment, and personal incomes. These factors could affect mortality from hypertension (29, 30, 46).

This study observed that mortality from hypertension is high, with an increasing trend. Mexico City as a state and as region 7 presented one of the highest mortality rates and the highest risk of dying from this disease in the period of study. Therefore, it is important to emphasize preventive measures such as healthy nutrition and physical activity. It is also necessary to improve medical attention in order to detect hypertension promptly and to treat complications in an efficient way, thereby improving the quality of life and decreasing mortality in these individuals. The preceding could be accomplished by applying multisectoral programs in which health and education institutions promote healthy nutrition and appropriate physical activity and discourage obesity.

Applying government policies aimed at regulating the media in referring to unhealthy food and promoting physical activity, preventing development of the disease in groups at risk, and improving blood pressure monitoring in individuals already ill is strongly indicated.

The limitations of this paper lie in the fact that hypertension is a risk factor for cardiovascular disease in general and not only for cardiac, renal, and cardiorenal diseases. It is also associated with cerebral hemorrhage, myocardial infarction, and arrhythmias, although these entities were not evaluated because there are no codes in the *International Classification of Diseases, 10th Revision*, with a specific category for hypertension and the three diseases. In addition, in Mexico in the period 1999–2001, an underregistration of deaths of 13.7% was identified (47); therefore, the mortality and the strength of association in some states and socioeconomic regions could be higher.

CONCLUSIONS

In Mexico, from 2000 to 2008, the mortality rate from hypertension increased from 15.7 to 18.5 per 100 000 inhabitants. Women exhibited higher mortality than men. Individuals who did not complete elementary school presented a higher risk of dying from hypertension (RR 1.462, CI 1.442–1.482) than those who had no school. The states with the strongest association with mortality from hypertension were Mexico City from 2000 to 2005 and Oaxaca from 2006 to 2008. The socioeconomic region with the strongest association with mortality from hypertension was region 7.

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RESUMEN

Tendencias de mortalidad por hipertensión arterial por región socioeconómica y estado en México, 2000–2008

Objetivo. Determinar las tendencias de mortalidad por hipertensión arterial en México a nivel nacional, por estado, por región socioeconómica y por sexo, así como establecer una asociación entre la educación, el estado de residencia y la región socioeconómica y la mortalidad por hipertensión arterial entre los años 2000 y 2008.

Métodos. Los datos de mortalidad asociada a la hipertensión arterial correspondientes a los años 2000–2008 se obtuvieron del Sistema Nacional de Información de la Secretaría de Salud. Esta información es generada por el Instituto Nacional de Estadística, Geografía e Informática a través de los certificados de defunción expedidos en todo el país. Se determinaron los códigos de la *Clasificación Internacional de Enfermedades, 10.ª Revisión*, que corresponden a la hipertensión arterial como principal causa de muerte. Se calcularon las tasas de mortalidad en toda la nación, por estado y por región socioeconómica. Se determinó la potencia de la asociación (mediante la regresión de Poisson) entre el estado de residencia, la región socioeconómica y el nivel de educación y la mortalidad por hipertensión arterial. El Instituto Nacional de Estadística, Geografía e Informática agrupa los 31 estados y la Ciudad de México en siete regiones socioeconómicas según los indicadores relativos al bienestar, tales como la educación, la ocupación, la salud, la vivienda y el empleo.

Resultados. Las personas que no finalizaron la escuela primaria tenían un riesgo mayor de morir por hipertensión arterial que las personas con un mayor nivel educativo o sin ninguna formación (riesgo relativo [RR]: 1 462; intervalo de confianza de 95% (IC): 1 4421 482). La Ciudad de México, Oaxaca y la región 7 tenían la asociación más potente con la muerte por hipertensión arterial [Ciudad de México: RR: 2,6; IC: 2,13,2 (2000) y RR: 2,5; IC: 2,13,1 (2005); Oaxaca: RR: 2,4; IC: 2,03,0 (2006) y RR: 2,7; IC: 2,33,3 (2008); región 7: RR: 1,58; IC: 1,451,72 (2000) y RR: 1,25; IC: 1,171,34 (2008)].

Conclusiones. Las tasas de mortalidad por hipertensión arterial ajustadas por edad aumentaron de 15,7 a 18,5 por 100 000 habitantes entre los años 2000 y 2008, tomando como estándar la distribución de edades en la población mundial. La mortalidad fue mayor en las mujeres que en los hombres y en las personas que no finalizaron la escuela primaria que las personas con un mayor nivel educativo o sin ninguna formación. Las asociaciones más potentes se observaron en la Ciudad de México, Oaxaca y la región 7.

Palabras clave Hipertensión; mortalidad; factores socioeconómicos; México.