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## International Journal of Gynecology and Obstetrics

journal homepage: www.elsevier.com/locate/ijgo



## CONSEQUENCES OF UNSAFE ABORTION ON MORBIDITY AND MORTALITY

## Analysis of maternal and abortion-related mortality in Mexico over the last two decades, 1990–2008

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## ARTICLE INFO

## Keywords:

Abortion  
International Classification of Diseases  
Maternal mortality  
Mexico  
Unsafe abortion

## ABSTRACT

To document the relative contribution of abortion-related deaths to overall maternal deaths in Mexico, official mortality data were analyzed according to International Classification of Diseases (ICD) codes. During 1990–2008, among 24 805 maternal deaths, 1786 (7.2%) were abortion related. Of these, 13.2% occurred in adolescents and 65% in uninsured women; 60% were probably associated with unsafely induced procedures. The study calculated the number of abortion-related deaths per 100 000 abortion-related hospitalizations, expressed as a modified abortion case-fatality rate. During 2000–2008, this rate was 48 at the national level, with wide variations among states: from 140 deaths in Guerrero to 8 in Baja California Sur per 100 000 abortion hospitalizations. Unsafe abortion continues to represent a significant proportion of all maternal deaths in Mexico.

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## 1. Introduction

Maternal mortality is a global burden and constitutes an unmet goal in reproductive health in most of the world and specifically in developing countries. Of the 358 000 maternal deaths estimated to have occurred worldwide in 2008, 99% took place in developing regions. The maternal mortality ratio (MMR), the best indicator for making comparisons among regions and over time, was estimated to be as high as 290 deaths per 100 000 live births in developing regions versus 14 in developed parts of the world. Latin America as a region stands with a mean MMR of 85, but with wide variations among and within countries [1].

Reliable measures of maternal deaths are essential to be able to define the dimension of the problem, track progress over time, and identify barriers, and for governments and health systems to make appropriate policy decisions. At the international and national level, accurate identification and timely recording of maternal deaths include all deaths “of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management” [2]. Classically, it does not include deaths during pregnancy, delivery, or the puerperium due to accidental causes, such as car accident in a pregnant woman, or incidental causes, such as fatal violence occurring in pregnancy [2].

Late maternal deaths may also be reported, and are often included in overall statistics. They comprise both direct and indirect

obstetric causes of death in women later than 42 days, but less than 1 year after termination of a pregnancy, as well as any sequelae, that is, deaths from any direct obstetric cause occurring 1 year or more after delivery. International recommendations, however, suggest exclusion of late deaths and sequelae from analysis and calculations of maternal mortality, and researchers should always specify whether they do otherwise, to allow for adequate comparisons between and among countries and over time [3,4].

The International Classification of Diseases (ICD) allows for the identification of specific causes of maternal deaths, usually grouped under main categories of principal diseases. The ICD coding system also separates direct obstetric (DO) causes – related to all kinds of complications, incorrect therapeutic interventions, or omissions in the course of gestation – from indirect obstetric (IO) causes – resulting from new or pre-existing diseases, not related to, but complicated or aggravated by, the pregnancy. Common examples of the latter are pre-existing diabetes and cardiac or autoimmune diseases.

Sources of information and methodologies used to estimate maternal deaths vary among countries. The most commonly used in developed countries is the vital registration data system; however, experts suggest complementing vital data with more in-depth methodologies, such as the Reproductive-Age Mortality Studies (RAMOS), to reach accurate estimates [5]. Where registration of births and deaths are not systematically and timely available, such as in most parts of the developing world, alternative methods are used to estimate and confirm maternal deaths, such as household death surveys (with universal or random samples), direct or indirect sisterhood methods, as well as verbal autopsy methodology and Confidential Enquires on Maternal Deaths (CEMD) [5–8]. Each of

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these methods has advantages and limitations, but it is highly probable that all of them underestimate the real number and ratio of this indicator [9].

Among all maternal deaths, abortion is an important and sensitive cause, and unsafe abortion, in particular, represents a public health problem. Its frequency is usually underregistered and can only be indirectly estimated, particularly in most developing countries with legally restricted settings. In these countries, safe and legal procedures are performed only rarely, under limited indications (rape, risk to the woman's life, or severe congenital malformations), and most induced abortions are performed in clandestine conditions and go unreported by women and health systems. Therefore, despite abortion being a universal phenomenon and a very common experience in women's lives all over the world, the proportion of maternal deaths officially attributable to abortion varies substantially among regions and countries, mainly because of legal conditions and access to services.

The most recent World Health Organization (WHO) report on mortality due to unsafe abortion estimates a total of 47 000 deaths due to this cause worldwide, or 13.1% of the 358 000 overall maternal deaths in 2008 – down from 69 000 abortion-related deaths, 12.6% of the total 546 000 maternal deaths in 1990. According to these recent figures, unsafe abortion accounts for 13% of all maternal deaths worldwide, 12% in the Latin American region, and 9% in Central America (including Mexico) [10,11].

In the Mexican public health sector, there has been a documented significant improvement over time in record keeping, sources, methodologies, and overall information systems to measure maternal mortality, as well as the related morbidity (hospitalizations due to specific maternal causes). Progress has been particularly noticeable in the last decade [12–14]. Mexico has thus been included among the A-class group of countries; this group accounts for 37% of all countries and only 15% of all births analyzed in the last WHO report on maternal mortality trends [5].

However, sound statistical information related to the incidence and prevalence of unsafely induced abortion, its complications, and especially its associated mortality is still limited in the country, and only a few analyses have been carried out, mainly using indirect methodologies and in small population samples [15–18]. A retrospective analysis was undertaken to generate evidence-based information on abortion as a cause of maternal death in Mexico. It is hoped that this information can guide legal and policy interventions able to prevent additional, unnecessary, and unjust deaths of women.

## 2. Materials and methods

### 2.1. Sources of data

The present study comprised a review of official mortality and morbidity data in Mexico related to maternal causes, specifically due to all abortive outcomes.

All maternal and abortion-related mortality information was reviewed for the years 1990–2008 as reported by the National Institute of Statistics and Geography (Instituto Nacional de Estadística y Geografía: INEGI). It was accessed through the online data system known as Multi-Dimensional Online Analytical Processing (MOLAP) system, composed of official statistical digests, according to ICD codes, and updated yearly by institutions. MOLAP consists of aggregated patient data and not individual patient data. Analysis is therefore limited to the variables made available in the system, such as ICD diagnostic codes, health institution type, federal entity, patient age group, and site of fatality occurrence. Despite these limitations, MOLAP is an official, easy-to-use source of data that can be regularly accessed by researchers and decision makers [19]. Because the analyses used aggregated, deidentified official epidemi-

ologic and statistical data, institutional review board approval was not required.

### 2.2. Diagnostic codes and inclusion criteria

The study analyzed all diagnostic codes 630 to 676 according to the ICD Ninth Revision (ICD-9) classification for the years 1990 to 1997 and diagnostic codes O00–O95 and O98–O99 according to the ICD 10th Revision (ICD-10) classification for the years 1998 through 2008.

In ICD-10, all causes of death related to pregnancy, childbirth, and the puerperium are listed under Chapter XV (O00–O99) and split into 8 groups by cause: abortive outcomes (O00–O08); hypertensive disorders (O10–O16); other maternal disorders related to pregnancy (O20–O29); maternal care related to the fetus and amniotic cavity and delivery problems (O30–O48); complications of labor and delivery (O60–O75); delivery (O80–O84); complications of puerperium (O85–O92); and other obstetric conditions (O94–O99). Although ICD-9 does not separate early deaths (occurring at less than 42 days) from late deaths (occurring at more than 42 days to 1 year), nor identify sequelae, the most recent ICD-10 version does classify them under specific groups (O96 and O97, respectively).

The analysis also included specific diseases listed under different chapters but present during pregnancy, such as obstetrical tetanus (A34), HIV associated with pregnancy (B20–B24), and mental disorders associated with the puerperium (F53).

To allow for comparisons of these diagnostic categories over time, between health systems institutions and among states, they were clustered under 6 main groups of causes: maternal hemorrhage; hypertensive disorders of pregnancy; maternal sepsis and infections; abortion related; indirect obstetric causes; and all other maternal conditions (Table 1). This grouping is similar but not identical to that used to analyze the global burden of diseases [20,21], mainly because obstructed labor was included among the “other causes” and indirect obstetric causes were sorted out because of their increasing relevance at the national level.

According to international recommendations, accidental/incidental events, late deaths, and sequelae were excluded, as well as deaths that occurred in Mexico among women whose usual residence was outside of the country. Therefore, the final analysis included only early maternal events, either for direct or indirect causes.

It is essential to note that in this article, abortion is always referred to as “all pregnancies with abortive outcomes”, according to the ICD-10 O00–O08 block and the corresponding group of codes in ICD-9 classification (630–639) (Table 2). Illegally induced abortions were so coded only under the ICD-9 system, but disappeared as such under the most recent version. However, unsafe abortion mortality was intentionally looked for, using the subcategories within this block: ectopic pregnancy; trophoblastic disease; other abnormal product of conception (such as blighted ovum); spontaneous abortion, therapeutic abortion, and other/unspecified abortion. All these deaths were analyzed after clustering them under 4 main groups of causes, according to clearly pathological causes, spontaneous abortions, legally induced, and other/unspecified abortions (Table 2). It was assumed that most events clustered under this last group (other/unspecified abortion), could be related to induced procedures under unsafe conditions.

### 2.3. Descriptive analysis and set of indicators

Simple descriptive analyses were used for geographic distribution, age distribution, and site of occurrence of maternal and abortion-related deaths. The distribution of specific subcauses of abortion deaths was examined according to combined educational

**Table 1**  
Main groups of causes within maternal deaths categories and ICD-9 and ICD-10 classifications<sup>a</sup>

Main groups	Categories	ICD-9	ICD-10
All causes	–	630–676	O00–O99, A34, B20–B24, F53
Specific causes:			
Hemorrhagic	Obstetric hemorrhage	640, 641, 666	O20, O44–O46, O67, O72
Hypertensive	Edema, proteinuria, and hypertensive disorders	642, 646.1, 646.2	O10–O16
Infectious	Maternal and puerperal sepsis and infections/obstetric tetanus <sup>+</sup>	670, 672	O85–O86, A34 <sup>+</sup>
Abortion related	Pregnancy with abortive outcomes	630–639	O00–O08
Indirect causes	Infectious-parasitic and all other maternal diseases complicating pregnancy, childbirth and the puerperium	647–648	O98–O99
Other causes	All other causes, including obstructed labor <sup>*</sup> , other (noninfectious) complications of puerperium <sup>**</sup> , unspecified causes <sup>***</sup> , HIV with pregnancy <sup>§</sup> , mental disorders associated with the puerperium <sup>§§</sup> , late deaths <sup>#</sup> and deaths from sequelae <sup>##</sup>	643–646.0, 646.3–646.9, 649–659, 661–665, 667–669, 671, 673–676, 660 <sup>*</sup>	O21–O43, O47–O63, O64–O66 <sup>*</sup> , O68–O71, O73–O84, O87–O92 <sup>**</sup> , O95 <sup>***</sup> , B20–B24 <sup>§</sup> , F53 <sup>§§</sup> , O96 <sup>#</sup> , O97 <sup>##</sup>

Abbreviations: ICD-9, International Classification of Diseases, Ninth Revision; ICD-10, International Classification of Diseases, Tenth Revision.

<sup>a</sup> The symbols in the table correspond to the codes in the ICD-9 and ICD-10 categories columns.

Source: International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, 1992 [2].

**Table 2**  
Main groups of causes within “pregnancy with abortive outcome” categories and in the ICD-9 and ICD-10 classifications

Main groups	Categories	ICD-9	ICD-10
Pathological conditions	Ectopic pregnancy	633	O00
	Hydatidiform mole	630X	O01
Spontaneous abortion	Spontaneous abortion	634	O03
Legal/therapeutic abortion	Legally induced or medical abortion	635	O04
Unspecified/other abortions	Unspecified abortion	637	O06
	Other abnormal products of conception, incomplete or complete	631X	O02 <sup>b</sup>
		632X <sup>a</sup>	
	Illegally induced	636	–
	Other abortion	–	O05
Failed attempted abortion	638	O07	

Abbreviations: ICD-9, International Classification of Diseases, Ninth Revision; ICD-10, International Classification of Diseases, Tenth Revision.

<sup>a</sup> Retained products.

<sup>b</sup> Includes blighted ovum, missed abortion.

Source: International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, 1992 [2].

and socioeconomic categories using the National Population Council (Consejo Nacional de Población: CONAPO) Marginalization Index [22]. For this purpose, deaths in women living in more marginalized states (those with a “high” or “very high” index) were compared with less marginalized states (those with a “medium”, “low”, or “very low” index). The states classified as “more marginalized” include Guerrero, Chiapas, Oaxaca (very high marginalization index) plus Veracruz, Hidalgo, San Luis Potosí, Puebla, Campeche, Tabasco, Michoacán, and Yucatán (high). The states classified as “less marginalized” include Nayarit, Zacatecas, Guanajuato, Durango, Tlaxcala, Querétaro, Sinaloa (medium), Quintana Roo, Morelos, State of Mexico, Tamaulipas, Chihuahua, Baja California Sur, Colima, Sonora, Jalisco, Aguascalientes (low), Coahuila, Baja California, Nuevo León, and Federal District (very low marginalization index).

The study calculated a set of indicators, such as ratios (relative to live births) and rates (relative to women of reproductive age or number of estimated abortions), according to current definitions, to compare maternal and abortion mortality over time, among health institutions or across different states in the country [20,21].

The MMR expresses the number of maternal deaths per 100 000 estimated live births; the study used in the denominator the official

figures estimated by the CONAPO at the national or state level, for the corresponding period of time [23]. In 2002–2003, a systematic institutional effort was undertaken to adjust the national MMR, using a modified RAMOS methodology that was developed to correct for misclassification of maternal deaths, through intentional review of other causes of death in women of reproductive age [12–14]. Analysis of Demographic and Health Surveys (ENADID, for their initials in Spanish), also allowed identification of 20%–30% underreporting of maternal mortality during the previous decade. Thanks to these efforts, new estimates of maternal deaths were retrospectively calculated. Both uncorrected and adjusted maternal mortality ratios are presented in the following analysis.

Most of the indicators used to estimate the toll of unsafe abortion on women’s lives were adapted, for several reasons: (1) all diagnostic codes of abortions are referred to, not only unsafe abortions; (2) number of events (deaths and hospitalizations) occurring in women aged 10–54 years were routinely used; (3) the estimated population of women in the same age range was used as a denominator, in contrast to women in the standard range of 15–44 years. These methodological issues are important to take into account throughout the article.

The number of abortion deaths per 100 maternal deaths for all causes is expressed here as the percentage of maternal deaths due to all abortions. This measure describes the relative importance of unsafe abortion as a cause of maternal death.

The abortion mortality ratio for the study period is reported, calculated as the number of abortion deaths per 100 000 live births.

In addition, the abortion hospitalization rate is reported as the number of all abortion-related hospitalizations per 1000 women aged 10–54 years, using the official CONAPO population estimates for the period analyzed [23]. To do this, all abortion-related hospitalizations were included for the whole public health system, under the Ministry of Health (Secretaría de Salud: SSA), which assists poor persons with no health insurance; the Institute for Social Security of State Workers (ISSSTE), which covers state employees; the Mexican Institute of Social Security (IMSS), which gives health assistance to employees of private enterprises; and its rural component (IMSS-Oportunidades) as well as the Army medical institutions, and other minor public health systems. The methodology and inclusion criteria for the analysis of abortion morbidity are described in detail elsewhere [24].

The unsafe abortion case-fatality rate indicates the number of unsafe abortion deaths per 100 000 unsafe events, expressing the risk of death associated with this procedure [21]. According to the type of data accessed in this research, the study calculated the

number of all abortion-related deaths per 100 000 hospitalizations due to the same cause in women aged 10–54 years, what is defined here as a modified abortion-related case-fatality rate. Both the numerator and the denominator are based on official data sets, fairly reliable, and provided on a yearly base, by health institutions and at national and state levels. As reliable and consistent hospitalizations data for the whole public health system were available starting only in 2000, the analysis of these last two indicators was restricted to the period 2000–2008.

#### 2.4. Statistical analysis

Simple descriptive analyses were used for all variables mentioned above associated with abortion-related deaths. Correlations between the abortion hospitalization rate and the modified abortion-related case-fatality rate were explored using the Pearson correlation model, with statistical significance set at  $P < 0.05$ .

### 3. Results

#### 3.1. Maternal deaths and MMR

From 1990–2008, overall there were 25 150 officially registered maternal deaths; 24 827 deaths were counted, after eliminating late deaths, deaths due to malignant placental tumor, and deaths due to other events taking place after 42 days and before 1 year had elapsed from delivery. After additionally excluding deaths that occurred in Mexico among women usually residing abroad, the total number of maternal deaths was 24 805. This final number was used for all descriptive analyses.

The absolute annual number of maternal deaths was greater

**Table 3**  
Maternal and abortion related deaths, México 1990–2008

Year	All maternal deaths	MMR <sup>a</sup>	All abortion deaths	AMR <sup>b</sup>	% of maternal death
1990	1475	60.9	97	4.0	6.58
1991	1410	58.2	111	4.6	7.87
1992	1398	57.8	98	4.1	7.01
1993	1268	52.6	99	4.1	7.81
1994	1408	58.7	95	4.0	6.75
1995	1453	61.5	117	4.9	8.05
1996	1291	55.4	87	3.7	6.74
1997	1265	55.4	107	4.7	8.46
1998	1415	61.6	110	4.8	7.77
1999	1388	59.1	93	4.0	6.70
2000	1305	54.1	89	3.7	6.82
2001	1250	54.7	68	3.0	5.44
2002	1308	59.9	97	4.4	7.42
2003	1312	62.6	85	4.1	6.48
2004	1237	60.8	87	4.3	7.03
2005	1241	61.7	93	4.6	7.49
2006	1165	58.6	94	4.7	8.07
2007	1097	55.6	81	4.1	7.38
2008	1119	57.2	78	4.0	6.97
1990–2008	24 805	58.2	1786	4.2	7.20

<sup>a</sup> MMR, maternal mortality ratio: maternal deaths  $\times$  100 000 estimated live births.

<sup>b</sup> AMR, abortion mortality ratio: abortion-related death  $\times$  100 000 live births.

Source: National Institute of Statistics and Geography (INEGI)/Ministry of Health, National System of Information in Health (SINAIS) [19]; CONAPO [23].

**Table 4**

Number of maternal and abortion-related deaths by age group, Mexico 1990–2008

Cause of death	Age group, y										Total
	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	Unspecified	
All maternal	139	3053	5141	5180	5081	4155	1728	216	46	66	24 805
Abortion-related	10	226	395	404	350	260	111	20	5	5	1786

Source: National Institute of Statistics and Geography (INEGI)/Ministry of Health, National System of Information in Health (SINAIS) [19].

than 1400 in 5 years of this period of nearly 2 decades: 1990, 1991, 1994, 1995, and 1998, with the lowest absolute number (1097) in 2007 (Table 3). Maternal deaths accounted for 3.6% of all fatalities among women of reproductive age during this period (maximum 4.4% in 1990, minimum 2.7% in 2007 and 2008) (data not shown).

The mean MMR was 58 registered deaths per 100 000 estimated live births during the whole period, with a maximum of 62.6 in 2003 and a minimum of 52.6 in 1993 (Table 3). However, after the 1990–2002 retrospective adjustment, the mean MMR reported for the whole period was 74, with a maximum of 89 in 1990 and a minimum of 55.6 in 2007 (Fig. 1).

According to the classification of main groups of causes (Table 1), hypertensive disorders were responsible for 7380 deaths (29.8%), “other causes” together accounted for 6864 deaths (27.7%), hemorrhage for 5585 deaths (22.5%), indirect obstetric causes for 2304 deaths (9.3%), abortion for 1786 (7.2%), and infections – mainly puerperal – for 886 (3.6%) deaths for the whole period analyzed. However, the relative distribution of these main groups of maternal causes changed significantly over time (Fig. 2). During these 2 decades, hemorrhage and hypertensive disorders clearly remained the two most prevalent single fatality causes, and, for most of the 1990s, “other maternal causes” accounted for more than 1 in 3 maternal deaths. However, indirect obstetric causes, which remained at single-digit percentage until 1997, started to increase steadily afterward, to become the third single cause of maternal deaths at the end of the period analyzed.

#### 3.2. Abortion-related deaths

Although the national MMR showed a slight but definite decline from 1990 to 2008, neither the absolute number of abortion-related deaths nor their relative contribution to maternal mortality demonstrated a downward tendency over these nearly 2 decades. All abortion-related causes were responsible for 1786 deaths, with a mean of 94 women dying every year (with a maximum of 117 in 1995 and a minimum of 68 in 2001). The percentage of maternal deaths due to all abortions averaged 7.2% during this period (maximum 8.5% in 1997 and minimum 5.4% in 2001) (Table 3).

In terms of geographic distribution, 60% of all deaths took place in 7 of the 32 states that comprise the Mexican Federation: State of Mexico, Federal District, Veracruz, Chiapas, Puebla, Guerrero, and Oaxaca – all of which are located in the central valley and in the southern part of the country. These states accounted for 45% of all women of reproductive age (10–54 years) and 44% of all live births in the same period (data not shown).

Death certificates showed that fully 76% of women with abortion-related deaths died in hospitals or health services – overwhelmingly public ones (68%). Another 16% of the women died at home, and only 0.33% in the street.

The age distribution of maternal and abortion-related deaths is shown in Table 4. The curve for abortion-related deaths is very similar to that for overall maternal deaths, just slightly “younger” (Fig. 3). Although 62.4% of all abortion-related fatalities occurred in women in their main reproductive years (20–34 years), it is important to mention the toll abortion took at the extremes of reproductive years. A total of 8% of deaths were in women aged 40 years or older. Among adolescents (10–19 years), 236 deaths

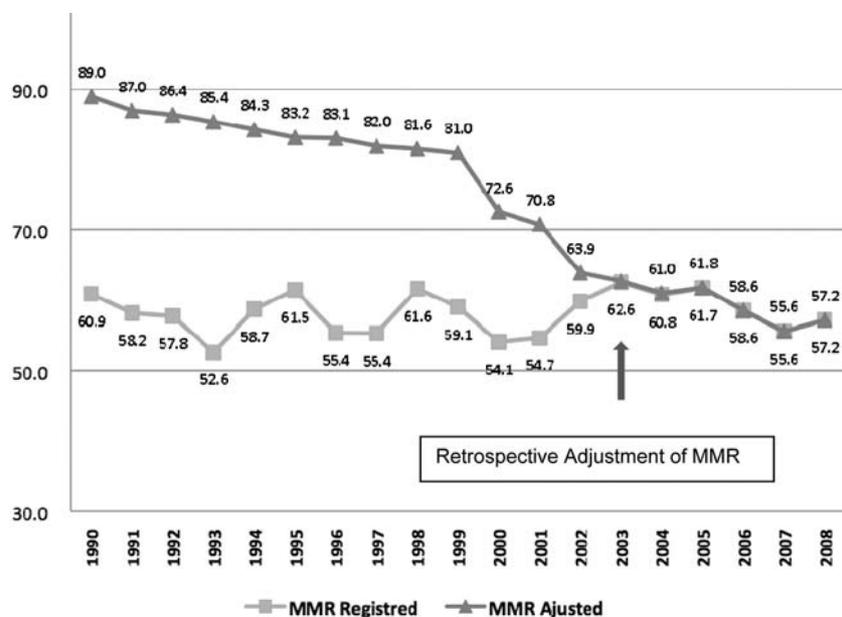


Fig. 1. Registered versus adjusted maternal mortality ratio, Mexico 1990–2008. Abbreviation: MMR, maternal mortality ratio. Note: Adjusted MMRs were adjusted using the RAMOS methodology for 2002–2008, and for 1991–2001 based on analysis of Demographic Surveys (ENADID) [12–14]. Source: National Institute of Statistics and Geography (INEGI)/Ministry of Health, National System of Information in Health (SINAIS) [19].

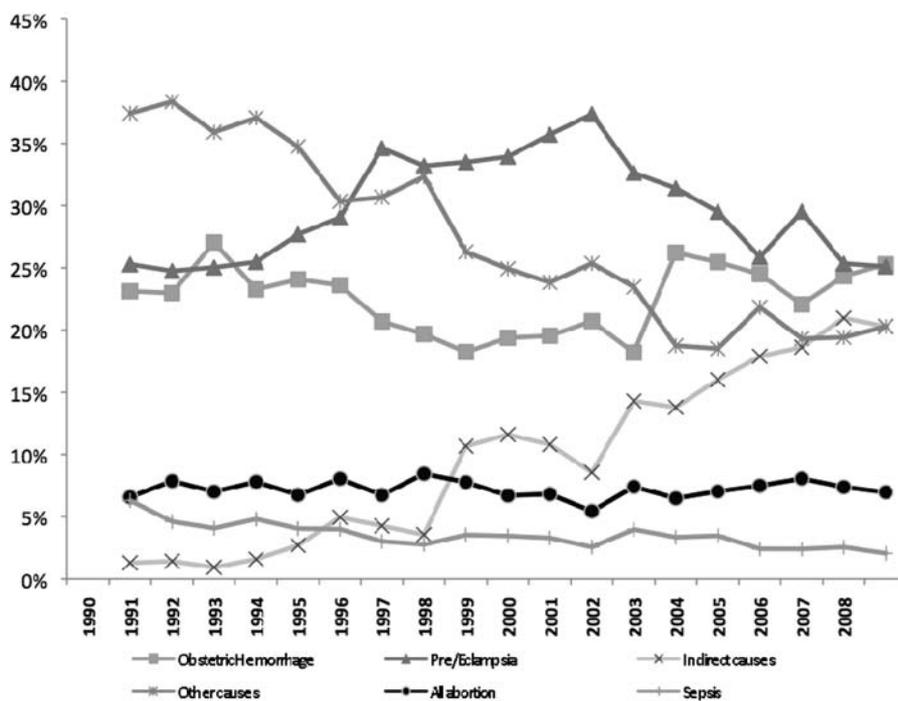


Fig. 2. Relative distribution of main causes of maternal death over time, Mexico 1990–2008. Source: National Institute of Statistics and Geography (INEGI)/Ministry of Health, National System of Information in Health (SINAIS) [19].

– including 10 deaths in 10–14-year-old girls – accounted for 13.2% of the total. Overall, there were 3192 maternal deaths among adolescents, including 139 in 10–14-year-old girls.

The study also analyzed whether women who died because of abortion had the right to care under any of the public health institutions that exist in Mexico (see Materials and Methods). Only 1 in 4 women who died from abortion belonged to the IMSS, ISSSTE, or other groups; fully 65% of the women dying had no public health insurance and were under the care of either Ministry of Health institutions (63%) or the new Universal Insurance (Seguro Popular: 2%). In 10% of the cases, no information was available.

As for the specific causes of abortion deaths, results showed that

only 10 deaths during the whole period were related to therapeutic abortions and legally induced procedures (1 during 1990–1997 and 9 during 1998–2008) (Fig. 4). Pathological conditions were responsible for 645 (36%) of all deaths; 73 (4%) were coded as deaths related to spontaneous abortion, while 1058 (59%) were registered as due to unspecified/other types of abortion. As mentioned in the Materials and Methods section, it is assumed that most fatalities clustered in this last subgroup of “unspecified/other” abortions may be attributable to unsafe abortions. Interestingly enough, the relative distribution of these diagnostic categories affected in a differential way women living in more marginalized versus less marginalized states: 65% of women in states with a

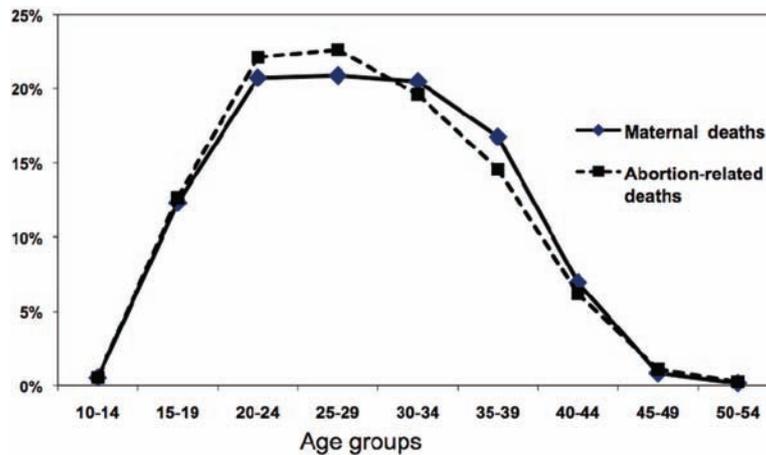


Fig. 3. Age distribution (%) of maternal and all abortion-related deaths, Mexico 1990–2008. Source: National Institute of Statistics and Geography (INEGI)/Ministry of Health, National System of Information in Health (SINAIS) [19].

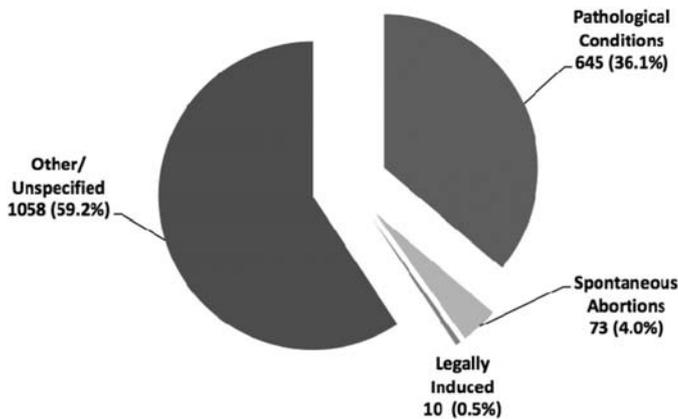


Fig. 4. Distribution (No. and %) of specific abortion deaths causes, Mexico 1990–2008. Source: National Institute of Statistics and Geography (INEGI)/Ministry of Health, National System of Information in Health (SINAIS) [19].

Table 5  
Main subgroups of causes of death within “pregnancy with abortive outcome” categories in women according to Marginalization Index, Mexico 1990–2008<sup>a</sup>

Subgroups of cause of death	No. (%)	
	High/very high	Medium/low/very low
Pathological (ectopic and molar pregnancy)	249 (30.5)	396 (40.9)
Spontaneous abortion	38 (4.6)	35 (3.6)
Other/unspecified abortions <sup>b</sup>	523 (64.0)	538 (55.2)
Total causes	817 (100)	969 (100)

<sup>a</sup> See text for classification of states by marginalization level.  
<sup>b</sup> Includes retained product, blighted ovum, missed abortion, etc. see Table 2.  
 Source: National Institute of Statistics and Geography (INEGI)/Ministry of Health, National System of Information in Health (SINAIS) [19]; CONAPO [22].

higher grade of marginalization died of unspecified/other types of abortion versus 55% in less marginalized states (Table 5). Ectopic and trophoblastic disease accounted for 30% in more marginalized versus 41% in less marginalized groups. Spontaneous abortion was fairly consistent across the 2 groups (5% and 4%, respectively).

Finally, based on these data, different indicators were built, as described in the Materials and Methods section. For the period 1990–2008, the abortion mortality ratio shows that overall, roughly 4 women died from abortion per 100 000 estimated live births, with slight variation in the years, with a maximum of 4.9 in 1995, and a minimum of 3.0 observed in 2001 (Table 3).

The abortion hospitalization rate shows clear evidence that access to abortion care varies greatly across the country, with a

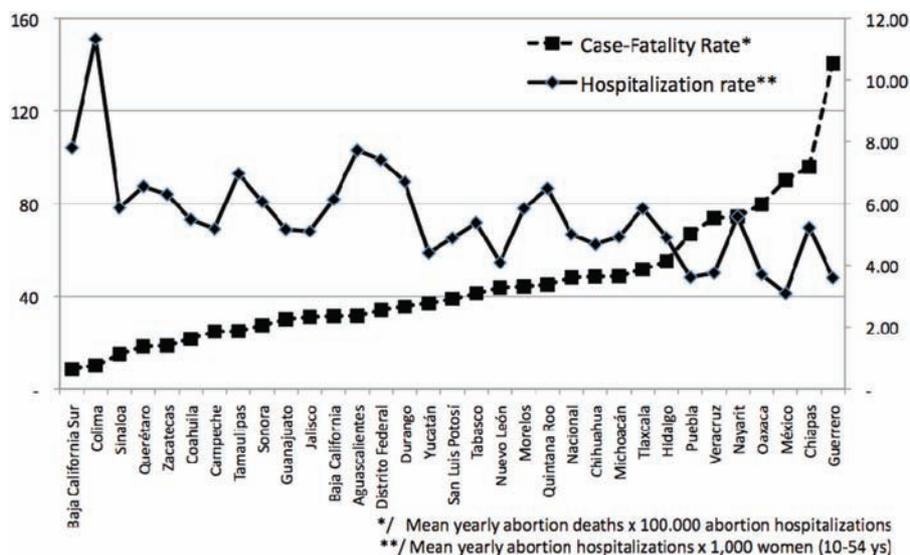
Table 6  
All-abortion hospitalization rates and abortion case-fatality rates by state, Mexico 2000–2008

States	All abortion hospitalizations		All abortion deaths	
	Total <sup>a</sup>	Rate <sup>b</sup>	Deaths <sup>a</sup>	Rate <sup>c</sup>
Aguascalientes	25 398	7.7	8	31.5
Baja California	50 965	6.1	16	31.4
Baja California Sur	11 748	7.8	1	8.5
Campeche	12 132	5.2	3	24.7
Coahuila	41 729	5.5	9	21.6
Colima	19 839	11.3	2	10.1
Chiapas	67 813	5.2	65	95.9
Chihuahua	45 417	4.7	22	48.4
Distrito Federal	211 984	7.4	72	34.0
Durango	30 950	6.7	11	35.5
Guanajuato	80 056	5.2	24	30.0
Guerrero	34 133	3.6	48	140.6
Hidalgo	36 300	4.9	20	55.1
Jalisco	106 382	5.1	33	31.0
México	135 476	3.1	122	90.1
Michoacán	61 754	4.9	30	48.6
Morelos	29 446	5.8	13	44.1
Nayarit	16 134	5.6	12	74.4
Nuevo León	52 627	4.1	23	43.7
Oaxaca	40 173	3.7	32	79.7
Puebla	59 841	3.6	40	66.8
Querétaro	32 779	6.6	6	18.3
Quintana Roo	22 242	6.5	10	45.0
San Luis Potosí	36 056	4.9	14	38.8
Sinaloa	46 789	5.9	7	15.0
Sonora	43 736	6.1	12	27.4
Tabasco	33 991	5.4	14	41.2
Tamaulipas	64 344	7.0	16	24.9
Tlaxcala	19 374	5.8	10	51.6
Veracruz	84 102	3.7	62	73.7
Yucatán	24 434	4.4	9	36.8
Zacatecas	26 832	6.3	5	18.6
National	1 604 976	5.0	771	48.0

<sup>a</sup> Includes all mortality or morbidity ICD-10 codes O00–O08.  
<sup>b</sup> All abortion-related hospitalizations × 1000 women aged 10–54 years.  
<sup>c</sup> Abortion case-fatality rate: all abortion deaths × 100 000 abortion hospitalizations in women aged 10–54 years.

Source: National Institute of Statistics and Geography (INEGI)/Ministry of Health, National System of Information in Health (SINAIS) [19]; Hospitalizations: MOLAP and Ipas Mexico calculations, for main public health systems (IMSS Ordinario, IMSS Oportunidades, ISSSTE, SSa, PEMEX, SEDENA Y SEMAR); CONAPO [23].

3.5-fold difference across states (Table 6). Mexico State has the lowest rate, with 3.1 hospitalizations due to abortion per 1000 women aged 10–54 years, while the Federal District, surrounded by Mexico State in the same central valley, has more than double the rate, with a mean of 7.4 per 1000 women hospitalized per year during 2000–2008. Colima has the highest rate, with 11 per 1000



**Fig. 5.** Abortion case-fatality rate and abortion-related hospitalization rate by state, Mexico 2000–2008. Source: National Institute of Statistics and Geography (INEGI)/Ministry of Health, National System of Information in Health (SINAIS) [19]; Hospitalizations: MOLAP and Ipas Mexico calculations, for main public health systems (IMSS Ordinario, IMSS Oportunidades, ISSSTE, SSA, PEMEX, SEDENA Y SEMAR); CONAPO [23].

women (incidentally, it is worth mentioning that Colima has been for years the state with the lowest MMR in Mexico).

The calculations of the modified abortion case-fatality rate yielded a yearly mean of 48 abortion-related deaths per 100 000 hospitalizations due to abortions in women aged 10–54 years in the whole public health sector (Table 6). Over time, the ratio varied from 53.9 in 2000 to 40.5 in 2001, 56.9 in 2002, 50 in 2003, 49.9 in 2004, 51 in 2005, 51 in 2006, 42.5 in 2007, and 38.6 in 2008 for the public health systems altogether.

This indicator differed among the various health subsystems, with a rate in the Ministry of Health (60.4) nearly 3 times higher than that in IMSS (22.8), and a rate as high as 86.8 in the other subsystems grouped together. This probably reflects the different socioeconomic status of women attended by each of these subsystems as well as the diverse quality of care they received.

In terms of geographic variance, huge differentials were found, with the 3 most marginalized states – Guerrero, Chiapas, and Oaxaca – having the highest abortion case-fatality rates (140.6, 95.9, and 79.7 deaths per 100 000 hospitalizations, respectively) (Table 6). The State of Mexico, however, not a marginalized state by definition, placed third with an abortion case-fatality rate of 90.1; the states of Baja California Sur, Colima, and Sinaloa reported rates 10 times lower (8.5, 10.1, and 15, respectively).

Finally, the study analyzed whether the abortion hospitalization rate was correlated, state by state, with the modified abortion case-fatality rate in the reference period (2000–2008). A clear inverse correlation between the two indicators was found: the higher the hospitalization rate, the lower was the fatality rate (Fig. 5). Under the Pearson model, there was a significant negative coefficient ( $-0.632$ , with  $P < 0.01$ ).

These differences in hospitalization rates and case-fatality rates seem somewhat consistent with the diverse status of socioeconomic development in the states, and overall related to a north-to-south gradient in the country (Fig. 6).

#### 4. Discussion

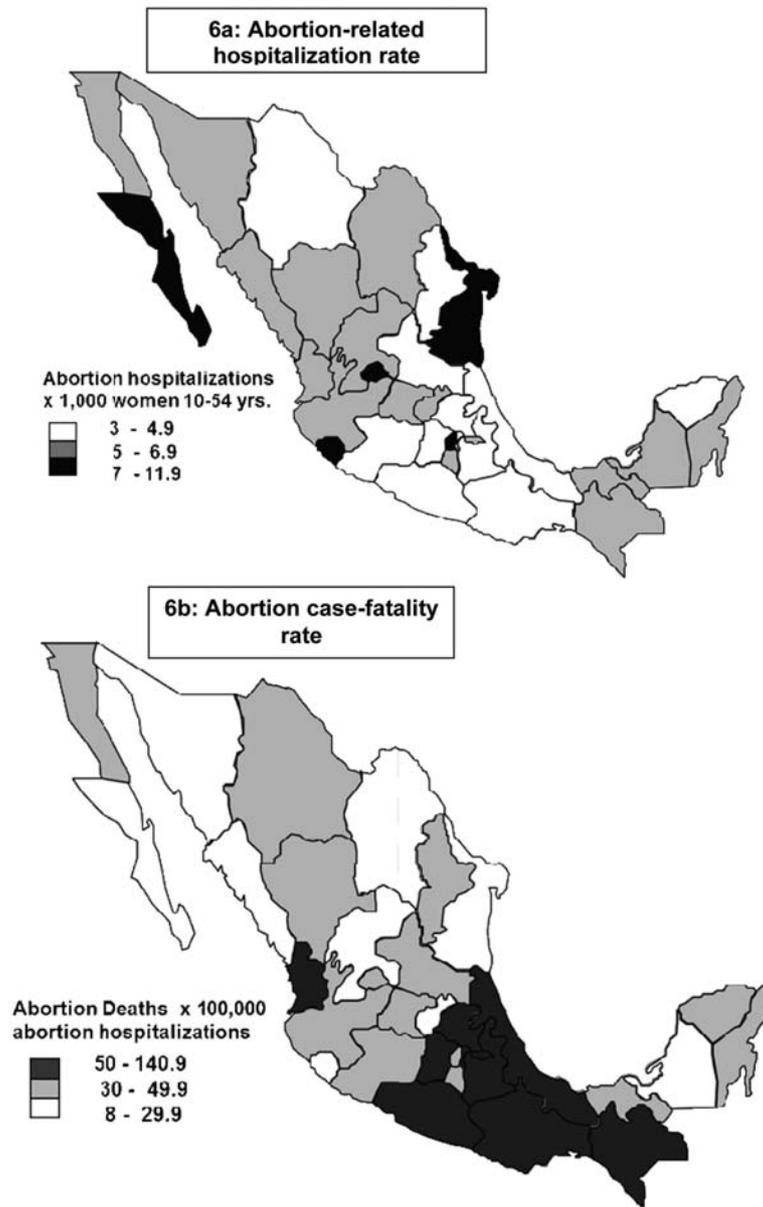
Maternal mortality overall still represents an unmet challenge for Mexico, as for the rest of the world [6]. Progress toward the reduction the country committed to according to Millennium Development Goal 5 (achieving an MMR of 22.3 by 2015) is slow, showing an erratic behavior and a stalling since the beginning of the

new millennium. Although obstetric hemorrhage and hypertensive disorders represent the main causes of maternal deaths during the whole period analyzed, in the most recent years, indirect obstetric causes have been steadily increasing and presently represent the third single major cause of maternal death. This trend, while surely reflecting more accurate classifications, suggests a true changing pattern as well, due to the emerging epidemiologic transition and an increasing prevalence of chronic illnesses in women of reproductive age [25].

In Mexico, all abortion-related fatalities account for 1 in 13 maternal deaths – significantly less than the proportion estimated worldwide, but only 2% below the proportion recently estimated for the region [10,11]. A number of reasons may explain this relatively reduced contribution of abortion to overall maternal fatalities in the country. One is the increased uptake of contraceptive methods to prevent unwanted pregnancies, but another major factor has been increased access to safer abortion providers, safer services, and safer methods (especially medications such as misoprostol) [11]. It is difficult, however, to explain the steadiness of abortion contribution to overall maternal mortality in the last nearly 2 decades, and more in-depth, qualitative methodology must be used to test diverse hypotheses.

As mentioned previously, all abortion-related deaths registered in the official sources used were analyzed, as the identification of unsafe abortions within these fatalities cannot be proved with certainty. The main limitation of the study is its reliance on the quality of the national recording system, and especially on the accuracy of recording at the local and regional levels. This is additionally problematic in stigmatized and legally restricted contexts.

Ascertaining the reliability of the ICD-9 and ICD-10 classifications for identifying unsafe abortion was not a purpose of this study. However, the clustering in the 4 groups proposed in this analysis seems to suggest that a major proportion of deaths registered as other/unspecified abortions are related to unsafe procedures. Accordingly, the differences in the relative distribution of specific causes between women living in more and less marginalized localities may support the plausibility of such a clustering. Again, qualitative methodologies and careful review of clinical records, applied to specific samples of hospitals, settings, and health providers, would be required to validate the assumptions and propose a wider application of this methodology in countries with similar quality of data.



**Fig. 6.** Abortion-related hospitalization rate and abortion case-fatality rate by state, Mexico 2000–2008. Source: National Institute of Statistics and Geography (INEGI)/Ministry of Health, National System of Information in Health (SINAIS) [19]; Hospitalizations: MOLAP and Ipas Mexico calculations, for main public health systems (IMSS Ordinario, IMSS Oportunidades, ISSSTE, SSa, PEMEX, SEDENA Y SEMAR); CONAPO [23].

As they are internationally recognized, ratios and rates are needed to allow for comparison over time and among different populations of women and diverse regions [21]. Suggested standard indicators, such as the unsafe abortion mortality rate, may be difficult to analyze in most of the developing world because of the stigma and legal restrictions that surround the topic [26,27]. Measures of the event depend on precise recording or else on reasonable estimates [28]. In Mexico, although the vital statistics and the number of deaths may have acceptable accuracy [12, 13], the number of induced abortions is not known and can be estimated only through indirect methodologies and complex surveys at specific points in time [15,28].

This paper investigated official health system data sets for all “pregnancies with abortive outcomes”, according to ICD codes, and assessed the feasibility of certain indicators (such as the abortion hospitalization rate and the modified abortion case-fatality rate) for use as tools to study the severity of unsafe abortion in Mexico. Abortion measures in the whole range of reproductive ages (among women aged 10–54 years) were also evaluated. These two

methodological issues must be taken into account when comparing these data with other sets of data at the international or national level [10,11,15,24,28].

The abortion hospitalization rate seems to be a sensitive indicator to analyze access to care in the diverse states and regions of the country, as mentioned in the Results section. It was not within the scope and the ability of this study to determine whether the 3-fold difference in the indicator reflects also a different need for abortion or diverse severity of complications that require hospitalizations.

The modified abortion case-fatality rate also seems to be a simple and promising tool to apply in epidemiologic research on abortion, especially in countries where health service institutions maintain record systems that have some degree of accuracy and legitimacy. Although there are weaknesses and possible biases related to this indicator, such as incorrect diagnosis of death and underreporting of hospitalizations due to abortion, the authors believe that it may be used as a simple and sensitive enough indicator to analyze differences and inequalities as well as changes and trends related to abortion mortality.

Detecting the differences among health institutions and federal entities, the modified abortion case-fatality rate seems able to identify regions and populations of particularly vulnerable women, those not belonging to the best public health insurance systems, and those living in more deprived and less developed states, with higher fertility, and lower access to safe health services, or where legal restrictions, medical discrimination, and social stigma are prevalent. Overall, the results are in line with old and new research that has found a higher prevalence of unsafe abortions, and related maternal mortality, associated with poverty, low education, indigenous ethnicity, and residence in poorest states in Mexico [29,30].

The inverse association found between a lower hospitalization rate and a higher abortion case-fatality rate is particularly interesting. It strongly suggests that where women have wider access to services, they have a higher probability of surviving an unsafe procedure and/or have greater access to safer methods overall. These two indicators, taken together, may represent an interesting approximation to express the conditions women face in inducing their abortions, the different access to health services they have, and finally, the quality of care they receive within the services.

Applying this simple methodology in the future in regions and states where changes have occurred in laws and norms may further demonstrate its usefulness and sensitivity for measuring potential impact in access to safe and legal abortion services.

#### Acknowledgments

This paper was supported by an anonymous donor.

#### Conflict of interest

The authors declare that they have no conflicts of interest.

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