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METHODOLOGY

Fundamental discrepancies in abortion estimates and abortion-related mortality: A reevaluation of recent studies in Mexico with special reference to the International Classification of Diseases

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Abstract: In countries where induced abortion is legally restricted, as in most of Latin America, evaluation of statistics related to induced abortions and abortion-related mortality is challenging. The present article reexamines recent reports estimating the number of induced abortions and abortion-related mortality in Mexico, with special reference to the International Classification of Diseases (ICD). We found significant overestimations of abortion figures in the Federal District of Mexico (up to 10-fold), where elective abortion has been legal since 2007. Significant overestimation of maternal and abortion-related mortality during the last 20 years in the entire Mexican country (up to 35%) was also found. Such overestimations are most likely due to the use of incomplete in-hospital records as well as subjective opinion surveys regarding induced abortion figures, and due to the consideration of causes of death that are unrelated to induced abortion, including flawed denominators of live births. Contrary to previous publications, we found important progress in maternal health, reflected by the decrease in overall maternal mortality (30.6%) from 1990 to 2010. The use of specific ICD codes revealed that the mortality ratio associated with induced abortion decreased 22.9% between 2002 and 2008 (from 1.48 to 1.14 deaths per 100,000 live births). Currently, approximately 98% of maternal deaths in Mexico are related to causes other than induced abortion, such as hemorrhage, hypertension and eclampsia, indirect causes, and other pathological conditions. Therefore, only marginal or null effects would be expected from changes in the legal status of abortion on overall maternal mortality rates. Rather, maternal health in Mexico would greatly benefit from increasing access to emergency and specialized obstetric care. Finally, more reliable methodologies to assess abortion-related deaths are clearly required.

Keywords: maternal health, maternal mortality, abortion, estimation methods, developing countries, International Classification of Diseases

Introduction

Improving maternal health is one of the eight Millennium Development Goals[1] stated by the United Nations (UN). Therefore, all UN member states have been implementing policies directed toward promoting health during pregnancy and the postnatal period. Although recent efforts have led to a decrease in maternal mortality by half during the last decade,[2] the UN indicates that more efforts are needed to achieve this Millennium Development Goal by 2015.[3] In this regard, improving maternal health and decreasing morbidity and mortality from induced abortions are key endeavors for all UN state members, especially for developing countries.[4] Clearly, accurate epidemiological

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information about maternal mortality is crucial before proposing evidence-based public health interventions or legal policies regarding women's health worldwide, as well as for accurately evaluating the effects of such interventions.

Study of actual statistics surrounding induced abortion is difficult in countries where it is restricted; therefore, researchers employ various epidemiologic methodologies to yield estimations around empirically plausible figures. Given their inherent estimative nature, constant challenge and adjustment of the methodologies are mandatory steps to ensure valid, accurate, and reliable abortion estimates. In addition, another important issue to adequately gauge the influence of abortion on maternal health is to consider the relative contribution of other causes of maternal morbidity and mortality. Thus, promoting the use of standardized methodologies along with an appropriate epidemiologic interpretation of the International Classification of Diseases (ICD) are two key endeavors that researchers should follow and policy makers should demand before intervening at a population level. This information becomes particularly important when resources are limited and adequate priorities must be defined to efficiently allocate such resources to improve maternal health, especially in low and middle income developing countries.

When attempting to evaluate how maternal health may be influenced by abortion at a population level, three major epidemiological indicators are frequently taken into account:

- Maternal mortality ratio (MMR): MMR is the acknowledged indicator for assessing maternal health worldwide.[5] It is obtained by dividing the number of maternal deaths (ie, female deaths during pregnancy, childbirth, and puerperium) by the number of live births in a given year. The reliability of this indicator will depend on the quality of the registry of vital statistics of each country, which has greatly improved during the last two decades for several Latin American countries.[4,6]
- Number of abortions: Many countries which have a liberal abortion law exhibit fairly accessible abortion statistics. However, most Latin American countries restrict induced abortion by law. Therefore, estimation methods are required to obtain approximate figures of induced abortion.
- Abortion mortality ratio or abortion-related mortality ratio (AMR): AMR is similar to MMR, and is calculated as the number of maternal deaths due to abortion divided by the number of live births in a given year. AMR is subject to some ambiguity, depending on what is included in the term "deaths due to abortion." This ambiguity becomes evident when some researchers include maternal deaths from spontaneous as well as induced abortions to calculate AMR. Thus this acronym may have different meanings depending on the study. Lack of a univocal definition of AMR complicates interpretation of this indicator, especially when assessing maternal mortality associated with induced abortion.

The present work aimed to reevaluate estimation methods employed to obtain abortion figures in countries exhibiting restrictive abortion laws and to re-analyze figures of maternal mortality and abortion mortality presented in recent studies conducted in Mexico as an illustrative case of major discrepancies regarding maternal health indicators in the context of Latin America.

Abortion estimates

A recent report published this year in *The Lancet*[7] presented global estimates of induced abortion for different regions, concluding that no progress was observed in Latin America over the last decade. Abortion estimations were based on a combination of in-hospital statistics and surveys of subjective opinion over a limited number of individuals and health institutions rather than on actual vital statistic data, eliciting largely overestimated figures.[7–15] The validity of this methodology is seriously questioned in a recent review.[16–19] The methodological approach first considers the estimation of the losses from spontaneous and induced abortions from the opinion of subjects who work in health institutions through a survey entitled Health Facilities Survey. Respondents are asked to remember the total number of women who received post-abortion care "in the average month and in the past month."[8] In a second step, another opinion survey entitled Health Professionals Survey, is applied to non-randomly selected individuals who are unrelated to the health facilities selected for the former survey. The Health Professionals Survey is used to estimate an expansive multiplier (x3, x4, x5, etc), which is then applied to the numbers obtained by the Health Facilities Survey.[7–15] In consequence, these estimation methods are subjective in nature and extremely subject to selection and recall bias, making them questionable instruments even when evaluating the general impression of abortion in a particular territory. In contrast, estimates using actual demographical data, fertility rates, observed live births, abortion mortality rates, and known abortion rates from standard populations, or complete abortion hospital discharges might be more accurate and objective than estimates based on opinion surveys. Moreover, significant overestimation of abortion figures[7–15] prompts unnecessary alarm in public opinion, especially when an allegation of

"no progress over time" is made, and when such an allegation disregards the actual progress on maternal health observed in most Latin American countries.[6,20]

Methodological problems can be illustrated when comparing indirect abortion estimates based on opinion surveys and actual abortion figures in the Federal District of Mexico (Mexico DF), the only Mexican state where elective abortion is legal (since April 24, 2007). For 2006, using a combination of in-hospital statistics and opinion surveys, Juarez et al[11] estimated between 725,070 and 1,024,424 induced abortions for the whole country of Mexico, and between 137,145 and 194,875 induced abortions for Mexico DF. Nevertheless, the total number of elective induced abortions registered the year after making abortion legal in this Mexican state was 10,137.[21] In fact, the figure of legally induced abortions carried out in the five cumulative years from April 2007 until April 2012 (ie, a period of time probably long enough to replace illegal abortion with legal procedures in Mexico DF) was 78,544; which is nearly 50% of the original estimate by the authors for only a single year.[23] During that period, induced abortions showed a clear upward trend year-by-year in Mexico DF, from 10,137 in 2008 to 14,390 in 2011 (Figure 1).[21] Moreover, Juarez et al have recently conducted another study[12] insisting on the use of the same methodology and showing figures of induced abortion overestimated by approximately 1000% for 2009 (ie, estimating 122,455 induced abortions instead of the actual figure of 12,221 for Mexico DF in 2009)[21] despite the existence of epidemiological surveillance on this matter by an independent non-governmental agency.[21] We acknowledge that underreporting of legal abortions may limit the reliability of estimations based on actual records in Mexico DF. Nevertheless, Mexican health authorities have been actively working towards decreasing the underreporting of maternal mortality statistics which, at least in terms of MMR, have decreased to a negligible percentage since 2003.[22,23] Even if such efforts have yet to be translated into a decrease in the potential underreporting of legal abortion records in Mexico DF, especially within the private sector, the figures proposed by Juarez et al[11,12] would still be overestimated. For instance, speculatively assuming an underreporting of 1- to 3-fold, the figure proposed by these authors[11,12] would be overestimated by 2.5 to 5 times.

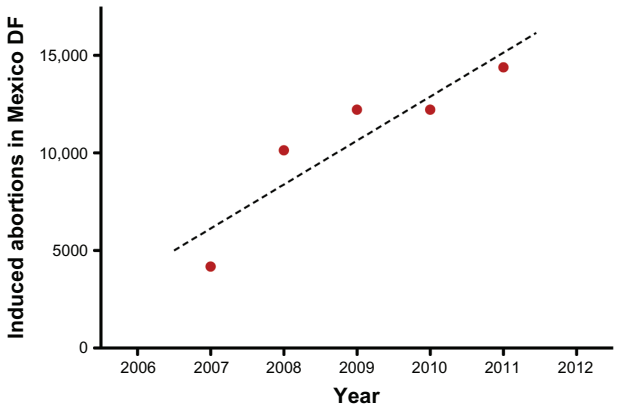

Figure 1 Trend of induced abortions in Mexico DF during 2008–2011.
Notes: Solid circles represent the number of induced abortions in women with residence in Mexico DF and the segmented line corresponds to a linear regression of the data ($r = 0.9483$, $P < 0.05$). Data were extracted from the database maintained by the GIRE.[21]
Abbreviation: GIRE, Grupo de Información en Reproducción Elegida.

In this scenario, conclusions about induced abortion rates drawn by studies based mainly on opinion surveys[7–15] appear to be inconsistent due to substantial overestimation in countries with restrictive abortion legislation.[16,19] In strict scientific rigor, they fail to reflect reality and therefore, an in-depth revision of the methodologies utilized by different authors[7–15] is warranted before drawing any definitive conclusion about actual abortion trends in Mexico and other Latin American countries where abortion is restricted by law.

Abortion-related mortality

A recent study by Schiavon et al[22] analyzed how maternal mortality and abortion-related deaths have evolved during the last two decades in Mexico (1990–2008). The authors concluded that Mexico has failed to show progress in abortion-related mortality during the last 20 years, particularly due to illegal abortions. This apparent lack of progress may be explained by two methodological discrepancies.

The first discrepancy occurs in calculating the numerator of AMR. Schiavon et al[22] use indicators that group maternal deaths by causes of diverse etiology – considering the numerator for AMR as deaths by "all pregnancies with abortive outcome" in the two more recent versions of the ICD (ICD-10 codes O00–O08 and ICD-9 codes 630–639).[22] This group includes causes of death ranging from abnormal products of conception to unspecified, and other abortions. Table 1 shows the most frequent clinical use of ICD codes for classifying deaths for pregnancies with an abortive outcome. In this regard, it is important to point out that ICD codes unrelated to induced abortion (such as hydatidiform mole or ectopic pregnancy) should not be included in the assessment of abortion mortality, particularly when the focus of the study is to address the influence of illegal abortion on maternal health. For example, if one wanted to measure the deleterious effects of alcoholism on the liver, one would want an indicator specific to alcoholism. If that indicator instead included liver damage caused by fulminant hepatitis, Wilson's disease, and drug-related liver damage, then the specific

Table 1 International Classification of Diseases (ICD) codes related to maternal mortality with abortive outcome and their clinical usage

ICD-10	Definition	Clinical usage	ICD-9*
O00	Ectopic pregnancy	Self-explanatory	633
O01	Hydatidiform mole	Self-explanatory	630
O02	Other abnormal products of conception	Self-explanatory	631, 632
O03	Spontaneous abortion	Complications after well-documented spontaneous miscarriages occurred during clinical pregnancies.	634
O04	Medical abortion	Complications related to medical procedures during or after a therapeutic or legal abortion.	635
O05	Other abortion	Complications of abortion due to accidental or intentional injury. Frequently used in post-abortion surgical interventions. May be used for complications due to suspected or undetermined illegal abortion.	–
O06	Unspecified abortion	Complications of abortion whose primary cause is unreported, unclear or poorly established. Frequently used in post-abortion surgical interventions. May be used to classify deaths due to suspected or undetermined illegal abortion.	637
O07	Failed attempted abortion	Self-explanatory. May be used to classify deaths due to suspected illegal abortion.	638
O08	Complications following abortion and ectopic and molar pregnancy	Self-explanatory	639

Notes: Clinical usage of each code is based on recommendations by the World Health Organization[24] and the most frequent uses in Chilean hospitals, emergency obstetric units, and maternal health facilities.[6,16,25] *ICD-10 and ICD-9 codes follow homologation described elsewhere.[6]

damage attributable to alcohol would be obscured. Similarly, if one wants to determine mortality from induced abortion, then deaths from other causes (such as hydatidiform mole or ectopic pregnancy) should be excluded.

The second major discrepancy is related to the calculation of the denominator. The authors use indirect estimations of live births instead of the readily available statistics of actual observed live births for the period of study. In addition, discrepancies in data found in the sources employed by the authors, most likely due to an honest mistake, led to an almost 35% overestimation of MMR and AMR for this country (Tables 2 and 3).

Not infrequently, it is thought that criminalization of abortion may lead to underreporting by misclassification of maternal deaths suspected to be the result of an illegally induced abortion.[26] As discussed elsewhere,[6] however, this is unlikely and becomes irrelevant when considering the existence of ICD-10 codes of death due to other abortion (O05), unspecified abortion (O06), and failed attempted abortion (O07), especially in countries with adequate civil registration of vital data and active epidemiological surveillance of maternal deaths. In fact, usage of these ICD codes allows safeguarding of both professional and patient confidentiality when physicians suspect an illegal abortion.[25] Moreover, nowadays in most countries, physicians are subject to legal sanctions if they are found guilty of distorting or misclassifying actual causes of death.[6] Thus, the reliability of mortality ratios associated with abortion is likely to depend on the registry quality of each territory studied. In this regard, it is important to note that civil registration in Mexico is characterized as virtually complete by the UN and the World Health Organization (WHO), with good attribution of causes of death. In fact, Mexico is classified in list A (complete vital statistic records) regarding the registry of maternal death causes, along with 64 other countries in the last report of global maternal mortality by WHO.[2]

Interestingly, Mexico exhibits a large historical registry of maternal mortality, similar to the case of Chile, the country with the lowest MMR in Latin America. A recent time series study between 1957 and 2009 conducted in Chile showed a reduction of MMR of 93.8%, from 270.7 to 16.9 maternal deaths per 100,000 live births.[6] The historical trend of MMR in Mexico, as reflected in the Mexican official records[27] of maternal deaths between 1957 and 2010, resembles the case of Chile (Figure 2). Between these years, overall MMR in Mexico decreased by 82.7% (from 216.6 to 37.5 deaths per 100,000 live births), with a specific decrease of 30.6% between 1990 and 2010 (from 54.0 to 37.5 deaths per 100,000 live births). With the exception of hemorrhage, the current profile of Mexican maternal mortality is similar to the case of Chile, dominated by gestational hypertension and eclampsia, and indirect causes of death, such as cardiovascular disease, diabetes, and other pre-existing chronic conditions (Figure 3). Of note, approximately

Table 2 Maternal mortality ratio in Mexico, 1990–2010

Year	All maternal deaths[a]	Live births registered[b]	Live births estimated[c]	MMR directly calculated	MMR by Schiavon et al[24]	Overestimation (%)
1990	1,477[d]	2,735,312	2,422,242	54.0	60.9	12.8
1991	1,414[d]	2,756,447	2,423,293	51.3	58.2	13.5
1992	1,399[d]	2,797,397	2,419,406	50.0	57.8	15.6
1993	1,268	2,839,686	2,409,322	44.7	52.6	17.7
1994	1,409[d]	2,904,389	2,397,579	48.5	58.7	21.0
1995	1,454[d]	2,750,444	2,364,241	52.9	61.5	16.3
1996	1,291	2,707,718	2,330,478	47.7	55.4	16.1
1997	1,266[d]	2,698,425	2,285,050	46.9	55.4	18.1
1998	1,430[d]	2,668,428	2,296,222	53.6	61.6	14.9
1999	1,411[d]	2,769,089	2,350,401	51.0	59.1	15.9
2000	1,325[d]	2,798,339	2,411,271	47.3	54.1	14.4
2001	1,269	2,767,610	2,285,777	45.9	54.7	19.2
2002	1,309[d]	2,699,084	2,185,073	48.5	59.9	23.5
2003	1,313[d]	2,655,894	2,097,139	49.4	62.6	26.7
2004	1,239[d]	2,625,056	2,034,460	47.2	60.8	28.8
2005	1,242[d]	2,567,906	2,010,250	48.4	61.7	27.5
2006	1,166[d]	2,505,939	1,989,683	46.5	58.6	26.0
2007	1,097	2,655,083	1,971,734	41.3	55.6	34.6
2008	1,119	2,636,110	1,955,284	42.4	57.2	34.9
2009	1,207	2,577,214	1,940,107	46.8	–	–
2010	992	2,643,908	1,926,148	37.5	–	–
Total	27,097	56,759,478	46,505,160	47.7	58.2	22.0

Notes: MMR: maternal deaths per 100,000 live births. [a]SINAIS.[27] Data between 2002 and 2006 was also corroborated in Fernández et al.[28] [b]INEGI.[29] [c]CONAPO.[30] [d]data showing discrepancies with those reported in the study of Schiavon et al.[22]

Abbreviations: MMR, maternal mortality ratio; SINAIS, Ministerio de Salud, Sistema Nacional de Información en Salud; INEGI, Instituto Nacional de Estadística y Geografía; CONAPO, Consejo Nacional de Población.

Table 3 Abortion-related mortality in Mexico, 1990–2010

Year	Deaths with abortive outcome[a]	Live births registered[b]	Live births estimated[c]	AMR directly calculated	AMR by Schiavon et al[24]	Overestimation (%)
1990	98[d]	2,735,312	2,422,242	3.58	4.00	11.7
1991	112[d]	2,756,447	2,423,293	4.06	4.58	12.8
1992	98	2,797,397	2,419,406	3.50	4.05	15.7
1993	99	2,839,686	2,409,322	3.49	4.11	17.8
1994	95	2,904,389	2,397,579	3.27	3.96	21.1
1995	117	2,750,444	2,364,241	4.25	4.95	16.5
1996	87	2,707,718	2,330,478	3.21	3.73	16.2
1997	107	2,698,425	2,285,050	3.97	4.68	17.9
1998	110	2,668,428	2,296,222	4.12	4.79	16.3
1999	93	2,769,089	2,350,401	3.36	3.96	17.9
2000	89	2,798,339	2,411,271	3.18	3.69	16.0
2001	68	2,767,610	2,285,777	2.46	2.97	20.7
2002	97	2,699,084	2,185,073	3.59	4.44	23.7
2003	86[d]	2,655,894	2,097,139	3.24	4.05	25.0
2004	88[d]	2,625,056	2,034,460	3.35	4.28	27.8
2005	93	2,567,906	2,010,250	3.62	4.63	27.9
2006	94	2,505,939	1,989,683	3.75	4.72	25.9
2007	81	2,655,083	1,971,734	3.05	4.11	34.8
2008	78	2,636,110	1,955,284	2.96	3.99	34.8
2009	74	2,577,214	1,940,107	2.87	–	–
2010	94	2,643,908	1,926,148	3.56	–	–
Total	1958	56,759,478	46,505,160	3.45	4.19	21.4

Notes: AMR: deaths by ICD-10 codes O00–O08 and ICD-9 codes 630–639 per 100,000 live births as defined by Schiavon et al.[22] [a]SINAIS.[27] [b]INEGI.[29] [c]CONAPO.[30] [d]data showing discrepancies with those reported in the study of Schiavon et al.[22]

Abbreviations: AMR, abortion-related mortality ratio; ICD, International Classification of Diseases; SINAIS, Ministerio de Salud, Sistema Nacional de Información en Salud; INEGI, Instituto Nacional de Estadística y Geografía; CONAPO, Consejo Nacional de Población.

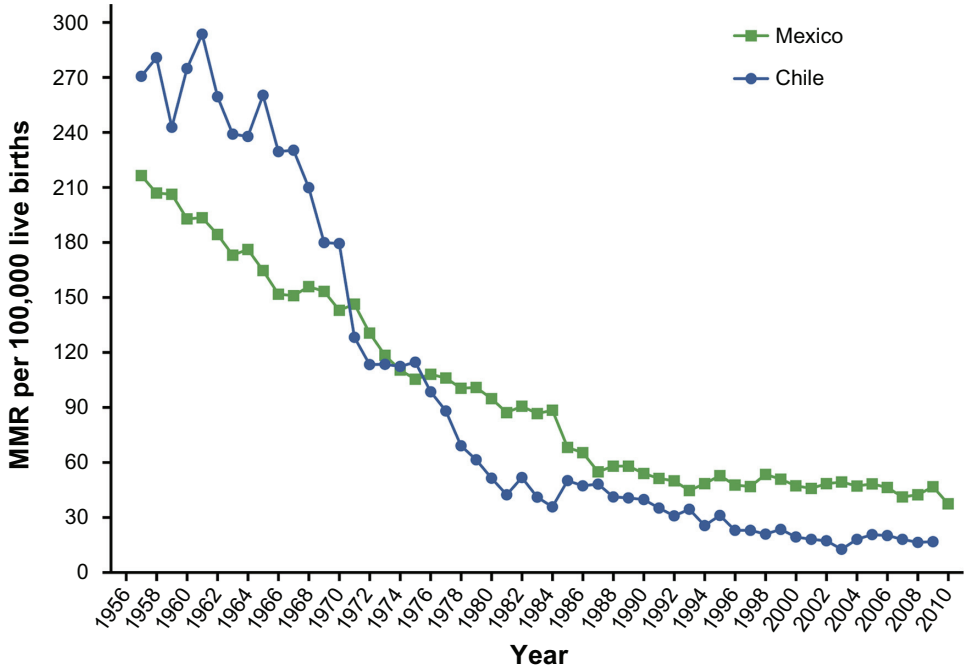

Figure 2 Historical trends of MMR in Mexico and Chile between 1957 and 2010.
Notes: Green squares and blue circles represent MMR data for Mexico and Chile, respectively. In Mexico, MMR decreased from 216.6 to 37.5 deaths per 100,000 live births, corresponding to 82.7% total reduction. In Chile, MMR decreased from 270.7 to 16.9 deaths per 100,000 live births, corresponding to 93.8% total reduction. Data were obtained from the Dirección General de Información en Salud (DGIS),[27] Instituto Nacional de Estadística y Geografía (INEGI),[29] and the Instituto Nacional de Estadísticas (INE) of Chile.[31]
Abbreviation: MMR, maternal mortality ratio.

98% of the current maternal deaths are related to causes other than induced abortion in both countries.

Re-classifying abortion-related deaths

As stated above, AMR as assessed by Schiavon et al[22] includes codes O00–O08 (or the corresponding ICD-9 codes 630–639). Nevertheless, selection of adequate ICD codes that illustrate maternal mortality related to abortion would require excluding those of ectopic pregnancy (O00 of ICD-10 or 633 of ICD-9), hydatidiform mole (O01 of ICD-10 or 630 of ICD-9), and other abnormal products of conception (O02 of ICD-10 or 631–632 of ICD-9). If the focus of a study is the impact of induced abortion on maternal health, then the

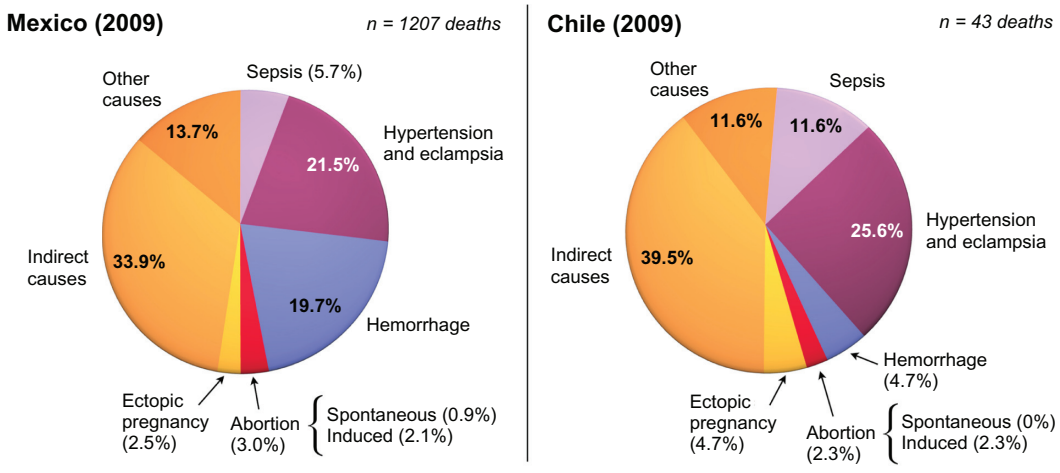

Figure 3 Relative contributions of different causes of maternal death in Mexico and Chile during 2009.
Notes: Causes of death were grouped as recently reported according to codes of the International Classification of Disease, 10th version:[6] Sepsis (O22, O23, O85–O88), Hypertension (O10–O16), Hemorrhage (O20, O43–O46, O67, O72, O73), Abortion (O03–O08), Ectopic Pregnancy (O00), Indirect Causes (O98–O99), and Other Causes (O01–O02, O21, O24–O26, O28–O36, O40–O42, O47–O48, O60–O66, O68–O71, O74–O75, O80). Data were obtained from the DGIS[27] and the Instituto Nacional de Estadísticas (INE) of Chile.[31]
Abbreviation: DGIS, Dirección General de Información en Salud.

ICD-10 code O03 (or the corresponding ICD-9 code 634) should also be excluded, as it refers to maternal deaths due to spontaneous abortion. ICD-10 code O04 (medical abortion) and ICD-9 code 635 (legal abortion) clearly refer to maternal deaths associated with medical/legally induced abortions. However, deaths classified as other abortion (O05 of ICD-10), unspecified abortion (O06 of ICD-10 and 637 of ICD-9), and failed attempted abortion (O07 of ICD-10 and 638 of ICD-9) are somewhat obscure and mixed in their interpretation and use (Table 1). Their ambiguity allows physicians to classify maternal deaths that do not fall in the previously described categories. Therefore, such codes may be employed in countries exhibiting restrictive abortion laws to classify maternal deaths suspected to be the result of complications arising from illegal abortion. In consequence, a more suitable indicator of maternal deaths related to induced abortions should include only the ICD-10 codes associated with medical abortion (O04), other abortion (O05), unspecified abortion (O06), and failed attempted abortion (O07), excluding all other causes of maternal death ending in abortion.

Interestingly, no maternal deaths have been registered in Mexico as caused by failed attempted abortion (O07) during the last decade (Table 4). In addition, registry of other specific causes with an abortive outcome, such as ectopic pregnancy, abnormal products of conception, and other well-defined pathological conditions, are virtually complete in this country. Therefore, deaths by unspecified abortion (O06), along with other abortion (O05), become the most likely indicators to approach complications due to illegal abortions for the particular case of Mexico. When taking this into consideration, even though the AMR shown by Schiavon et al[22] displays discrete changes between 1990 and 2008, unspecified abortion (O06) combined with other abortion (O05) between 2002 and 2008 shows a downward trend, with a 22.9% overall decrease from 1.44 to 1.10 deaths per 100,000 live births (Figure 4). This observation further supports the notion that the apparent lack of progress in abortion-related maternal mortality in Mexico is likely to be related to causes other than unspecified abortion (O06) and other abortion (O05), and therefore seems to be unrelated to illegal induced abortion.

Further analysis reveals interesting changes in the absolute number and relative contribution of some abortion-related causes of maternal deaths which occurred between 2002 and 2008 (Table 4 and Figure 5). First, increases in the relative contribution of spontaneous abortion (O03, from 1.0% to 10.3%) and other abortion (O05, from 3.1% to 7.7%) were observed; second, almost no changes were apparent in the relative contribution of medical abortion (O04, from 1.0% to 1.3%). Finally, decreases were observed in the relative contribution of pathological conditions (O00–O02, from 57.7% to 51.3%) and unspecified abortion (O06, from 37.1% to 29.5%) to abortion-related maternal deaths. If the assumptions made by Schiavon et al[22] were correct, then an increase in maternal deaths associated with codes O06 and O05 would be expected, since illegal induced abortion contributes partially to unspecified abortion (O06) and to other abortion (O05) deaths in Mexico. However, in contrast to the assumptions made by Schiavon et al,[22] the 22.9% decrease in mortality due to unspecified abortion (O06) combined with other abortion (O05) suggests that illegal abortions have decreased during the last decade in Mexico.

Table 4 Abortion-related deaths in Mexico observed in 2002 and 2008

Causes of death (ICD-10 code)	2002	2008
Pathological conditions (O00–O02)	56	40
Spontaneous abortion (O03)	1	8
Medical abortion (O04)	1	1
Other abortion (O05)	3	6
Unspecified abortion (O06)	36	23
Failed attempted abortion (O07)	0	0
Complications following abortion and ectopic and molar pregnancy (O08)	0	0
Total (O00–O08)	97	78

Note: Source: SINAIS.[27]
Abbreviations: ICD-10, International Classification of Diseases, Tenth Revision; SINAIS, Ministerio de Salud, Sistema Nacional de Información en Salud.

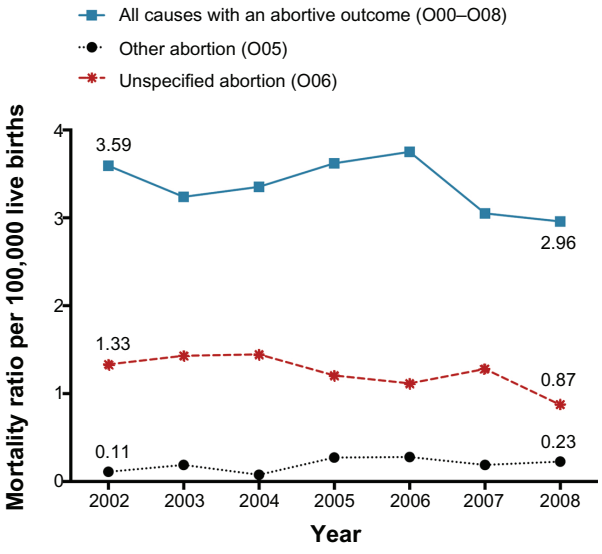

Figure 4 Trend of abortion-related maternal mortality in Mexico during 2002–2008.
Notes: Blue squares, red stars and black circles represent mortality ratio due to all abortion causes (O00–O08), mortality ratio due to unspecified abortion (O06), and mortality ratio due to other abortion (O05), respectively. Data were obtained from the DGIS[27] and Instituto Nacional de Estadística y Geografía (INEGI).[29]
Abbreviation: DGIS, Dirección General de Información en Salud.

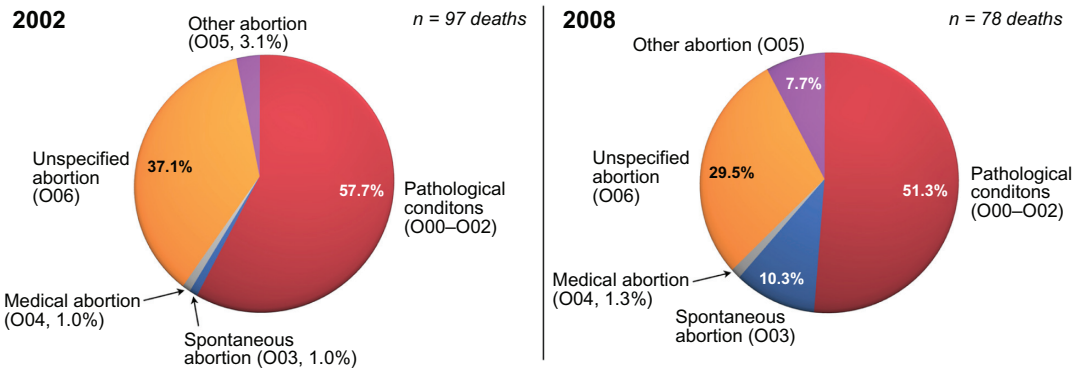

Figure 5 Relative contribution of abortion-related causes of death to maternal mortality in Mexico during 2002 and 2008.
Note: Data were obtained from the DGIS.[27]
Abbreviation: DGIS, Dirección General de Información en Salud.

It is important to note that code O05 is frequently used to classify maternal deaths due to complications of abortions caused by accidental injuries or violence-related trauma. Interestingly, most Mexican states (30 out of 32 federal counties) exhibit a specific non-punishable law for women in cases of an abortion provoked by unintentional injury, or intentional harm with the participation of a third part.[32] National surveys on violence against women conducted in Mexico in 2003 and 2006 show increases in the prevalence of violent relationships (from 25.8% to 33.3%), physical violence from the current intimate partner (from 9.8% to 33.3%), and physical violence during pregnancy (from 5.3% to 9.4%).[33,34] Thus, the observed 3.1% to 7.7% increase in the relative contribution of maternal deaths due to other abortion (O05) between 2002 and 2008 might be partially explained by an increase in violence towards women rather than an increase in illegal abortion. Although a more in-depth analysis is required to evaluate this postulate, if correct, mortality by illegal abortion would be even lower than current figures. Consequently, the apparent lack of progress in terms of maternal mortality due to abortion is not likely to be a reflection of an increase on complications from illegal abortions but rather explained by the emergence of a residual pattern of abortion-related deaths due to spontaneous abortions and other abortions. This conjecture is strongly supported by the increase in the absolute number and relative importance of these causes over total abortion deaths (Table 4 and Figure 5, respectively), independently of the downward trend in overall MMR observed in Mexico.

Re-evaluating maternal health indicators

It seems that a common irregularity in specialized reports of maternal health is the lack of consensus when constructing or utilizing an indicator of study. In a previous study, homologation of ICD codes related to deaths during pregnancy, childbirth, and puerperium has been proposed for 7th through 10th versions.[6] Access to uniformity in ICD codes of maternal death enables the scientific community to analyze and present results that are comparable among different regions. In the present study, we propose a re-definition of some indicators regarding maternal health in Table 5, indicating differences when compared to MMR. These are MMR with Abortive Outcome (MMR_{AO}), AMR, and Induced AMR (iAMR). We

Table 5 Proposed re-definition of maternal health indicators related to abortion

	Main purpose	Measures	Required codes (ICD-10)*
MMR	To track maternal health improvements	General maternal mortality over live births	O00–O99
MMR_{AO}	To track the impact of all deaths with an abortive outcome on maternal health	Specific mortality with abortive outcome over live births	O00–O08
AMR	To track the impact of mortality by all types of abortion on maternal health, excluding specific well-defined pathological conditions as primary causes	Specific mortality by all types of abortion, excluding specific well-defined pathological conditions, over live births	O03–O07
iAMR	To track the impact of mortality by induced abortion on maternal health	Specific mortality by induced abortion over live births	O04–O07

Note: *Codes of causes of deaths correspond to ICD-10, but homologation of different versions of previous ICD can also be considered, as has been reported elsewhere.[6]
Abbreviations: ICD-10, International Classification of Diseases, Tenth Revision; MMR, maternal mortality ratio; AMR, abortion-related mortality ratio; MMRAO, maternal mortality ratio with abortive outcome.

propose these definitions to allow accurate and unequivocal use of these indicators when assessing advances in maternal health on both general and specific grounds, depending on the subject and territory in discussion. Since they are based on existing vital statistics, reliability will be directly proportional to that of the national mortality registry of the country evaluated. Remarkably, these simple indicators are based on readily available figures of deaths by specific causes and registry of live births, allowing assessment of the progress of maternal health independently of the legal status of abortion of the territory under study. The indicators proposed in Table 5 may allow better interpretation of previously published reports, as well as orientation on forthcoming ones. However, it is necessary to remark that these indicators do not resolve per se the problem of ambiguity and mixed interpretation of codes O05 and O06 of the current version of the ICD. Clearly, a more precise definition of these codes is warranted.

Concluding remarks

When evaluating maternal health in Latin American countries, epidemiological trends in maternal mortality observed in most of them show significant progress over the last three decades.[2,3,6,20] Clearly, decreasing abortion-related mortality is always a relevant factor that positively influences maternal health in a country. Nevertheless, it is also critically relevant to carefully analyze methodologies employed to estimate abortion figures and abortion-related mortality in countries where abortion is restricted or banned, as in most Latin American countries, in order to provide reliable data for evidence-based public health interventions.

The reevaluation of methodologies used recently to estimate abortion figures and abortion-related mortality in Mexico allows us to make the following important observations:

- Considering the time elapsed since abortion legalization in Mexico DF (ie, 5 years), it is expected that most of the previous illegally induced abortions have been replaced by legal procedures in this state. Even though some degree of underreporting in the number of elective abortions may occur in Mexico DF at the present, particularly in the private sector, the methodology used to estimate induced abortion figures[11,12] has resulted in a significant overestimation (at least 10-fold) of induced abortion in this state.
- The abortion registry in Mexico DF suggests that abortion legalization is associated with an increase in the number of legally induced abortions. This is not surprising and has been well documented in developed countries.[19,35] For example, induced abortion figures in Spain have steadily increased between 1987 (2 years after its legalization) and 2008, from 16,728 to 115,812.[16,36,37]
- Reliable estimation of abortion-related mortality requires consideration of deaths by other abortion (O05), unspecified abortion (O06), and failed attempted abortion (O07) as the most likely indicators of deaths suspected to be related to complications of illegal abortion in Latin American developing countries. Clearly, it is misleading to include other well-defined causes with an abortive outcome (eg, ectopic pregnancy, spontaneous abortion, and other specific pathological conditions) in this context because these outcomes are not related to induced abortion.
- Since the Mexican mortality ratio by other abortion (O05) and unspecified abortion (O06) has decreased by 22.9% between 2002 and 2008 (1.44 to 1.10 deaths per 100,000 live births), along with a more discrete reduction of the relative contribution of these categories to all causes of death with an abortive outcome (from 40% to 37%) during the same period, it is possible to suggest that illegal abortion and/or complications related to illegal abortions have decreased in Mexico.
- Overall, all deaths with an abortive outcome (O00–O08) in Mexico represent 6.5% of global maternal causes of death. The MMR_{AO} has decreased from 3.59 to 2.96 deaths per 100,000 live births. Interestingly, specific pathological conditions (O00–O02) and spontaneous abortions (O03) appear to be the major components of maternal mortality due to abortion in Mexico, with a relative contribution of over 60% to global abortion-related mortality during 2008.
- If the number of illegal induced abortions for Mexico is between 725,070 and 1,024,424,[11] then a high morbidity and mortality by other abortion (O05), unspecified abortion (O06), and failed attempted abortion (O07) would be expected. However, the contribution of these categories to overall maternal mortality in Mexico is barely 2% to 4% of the total causes of maternal death. For instance, according to official figures for the whole country in 2009, the iAMR was 0.97 per 100,000 live births. Indeed, other abortion (O05) and unspecified abortion (O06) represented barely 2.07% of the total causes of maternal death (25 cases out of 1207 total maternal deaths).
- The increase in the absolute number and relative importance of other abortion (O05) between 2002 and 2008 might be partially explained by an increase in violence towards women or unintentional injuries rather

than an increase in illegal abortion. Additional research is required to clarify this issue.

- Re-defining indicators of abortion mortality (see Table 5) becomes useful when assessing whether each indicator reflects complications of general abortive outcome, and if they are the result of spontaneous or induced procedures. This may prove crucial when assessing the influence of induced or illegal abortion on maternal health in Latin America.

Taken together, these observations indicate that the maternal health of Mexico may be slightly improved by policies directed to addressing abortion-related complications, increasing coverage in obstetric emergency facilities, and specialized obstetric care.[6] More importantly, this approach will additionally have a positive impact by decreasing overall maternal causes of death. It is necessary to emphasize that approximately 98% of maternal deaths are related to causes other than illegal induced abortion in Mexico. Therefore, only marginal or practically null effects would be expected from abortion legalization or abortion prohibition on overall maternal mortality rates in this Latin American country, as recently shown in a natural experiment conducted in Chile.[6] Finally, considering the current profile of Mexican maternal mortality, it can be hypothesized that maternal health in this country would greatly benefit from public health policies directed to provide adequate medical treatment of conditions such as hemorrhage, gestational hypertension, eclampsia, and indirect causes of maternal death, mainly characterized by pre-existing chronic diseases.

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Disclosure

EK, PA, SG, and MB are co-authors of the research articles quoted in references.[6,16,19] AH and BC declare that no competing interests exist.

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