Reclassifying causes of obstetric death in Mexico: a repeated cross-sectional study

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Objective To describe causes of maternal mortality in Mexico over eight years, with particular attention to indirect obstetric deaths and socioeconomic disparities.

Methods We conducted a repeated cross-sectional study using the 2006–2013 Búsqueda intencionada y reclasificación de muertes maternas (BIRMM) data set. We used frequencies to describe new cases, cause distributions and the reclassification of maternal mortality cases by the BIRMM process. We used statistical tests to analyse differences in sociodemographic characteristics between direct and indirect deaths.

Findings A total of 9043 maternal deaths were subjected to the review process. There was a 13% increase (from 7829 to 9043) in overall identified maternal deaths and a threefold increase in the proportion of maternal deaths classified as late maternal deaths (from 2.1% to 6.9%). Over the study period direct obstetric deaths declined, while there was no change in deaths from indirect obstetric causes. Direct deaths were concentrated in women who lived in the poorest municipalities. When compared to those dying of direct causes, women dying of indirect causes had fewer pregnancies and were slightly younger, better educated and more likely to live in wealthier municipalities.

Conclusion The BIRMM is one approach to correct maternal death statistics in settings with poor resources. The approach could help the health system to rethink its strategy to reduce maternal deaths from indirect obstetric causes, including prevention of unwanted pregnancies and improvement of antenatal and post-obstetric care.

Abstracts in العربية, 中文, Français, Русский and Español at the end of each article.

Introduction

Maternal mortality – defined as the death of a woman during pregnancy, childbirth or in the 42 days after delivery – is used as an outcome measure for any health system. The indicator of maternal mortality is the maternal mortality ratio (MMR), which is defined as the number of maternal deaths per 100 000 live births. MMR is a problematic indicator to measure, due to the relative few maternal deaths. It is even more challenging to measure cause-specific maternal mortality, since available methods have either low sensitivity or specificity. Therefore, accurate estimates of cause-specific maternal mortality are often not available in many countries.

The International statistical classification of diseases and related health problems, 10th revision (ICD-10) manual divides the causes of maternal mortality into three broad categories: direct obstetric deaths (resulting from obstetric complications of the pregnant state); indirect obstetric deaths (resulting from a disease, often pre-existing and aggravated by the physiologic effects of the pregnancy); and late maternal death (death between 42 days and one year post-obstetric event). Sequelae, which is maternal deaths that occur one year or more after delivery, is included in the late maternal death category. Indirect maternal deaths represent on average 20% of a country’s overall maternal mortality, but this proportion varies considerably across settings. Particularly indirect and late maternal causes are likely to be misclassified as non-maternal deaths. Even within countries with a very high quality vital registration system, there is a wide variation in the fraction of maternal deaths attributable to indirect causes; estimates range from zero to more than half of all reported maternal deaths.

In recent decades, Mexico has improved its measurement of maternal mortality, but problems of underreporting and misreporting in its vital statistics systems still exist. In response, a new strategy was undertaken by the government in 2002 that aimed to identify all maternal deaths in Mexico using an approach of intentional search, review and reclassification of maternal deaths. A new procedure, referred to as Búsqueda intencionada y reclasificación de muertes maternas (BIRMM) was put in place, which provides a mechanism for a comprehensive examination of maternal deaths in Mexico.

There has been a rapid increase in obesity, diabetes, hypertension, and hypercholesterolaemia in Mexico, which puts women of reproductive age at higher risk for pre-existing hypertensive disorders and diabetes mellitus. The epidemiologic transition from communicable to noncommunicable diseases has implications for maternal health.

The purpose of this study is to describe the reclassified and newly identified maternal deaths – especially indirect obstetric deaths – identified through the BIRMM process. We also compared sociodemographic characteristics at individual and municipality level of the women who died from direct and indirect causes.

Methods

We conducted a repeated cross-sectional study using the 2006–2013 BIRMM data set, which includes all deaths in women...
Table 1. ICD-10 codes for indirect causes of maternal deaths

| Category | Sub-category | Title |
|----------|--------------|-------|
| O10      | O10.0–O10.9  | Pre-existing hypertension complicating pregnancy, childbirth and the puerperium |
| O24      | O24.0–O24.9  | Diabetes mellitus during pregnancy |
| O98      | O98.0–O98.9  | Maternal infectious and parasitic diseases classifiable elsewhere but complicating pregnancy, childbirth and the puerperium |
| O99      | O99.0–O99.8  | Other maternal diseases classifiable elsewhere but complicating pregnancy, childbirth and the puerperium |

ICD: International classification of diseases and related health problems, 10th revision.

The total number of deaths in women of reproductive age during the study period obtained from the BIRMM was 357,446, of which 9043 deaths (2.5%) were subjected to the maternal death cause review and reclassification process.31

Table 2 summarizes the findings from the reclassification process. Before the review 7829 deaths were classified as maternal deaths. Of the deaths coded as non-maternal, we reclassified 1214 (13.4%) to maternal deaths. The number of late maternal deaths increased from 192 (2.1%) before the review to 628 (6.9%) after the review, representing over threefold increase in the proportion of late maternal deaths. There was a 6.8% (from 2099 to 2243 deaths) and 11.4% (from 5538 to 6172 deaths) increase in deaths categorized as indirect and direct, respectively. Deaths that were categorized the same before and after the review were, 85.5% (5281/6172) of direct, 68.8% (1544/2243) of indirect and 28.3 (178/628) of late maternal deaths.

In the poorest municipalities, 14.7% (694) of maternal deaths were recoded from non-maternal to maternal, while in the wealthiest municipalities this figure was 8.1% (108). An additional 14.8% (30) of all direct deaths in the wealthiest quintile were reclassified to indirect deaths (Table 2).

Table 3 (available at: http://www.who.int/bulletin/volumes/94/5/1633560) shows the original codes of the deaths recoded to indirect maternal deaths. Many indirect maternal deaths were originally misclassified as infectious and parasitic diseases (96), diseases of the circulatory system (94), diseases of the respiratory system (70) and neoplasms (56). In addition, there was miscoding within the maternal chapter of the ICD. For instance, 40 deaths were originally assigned to O10–O16 (oedema, proteinuria and hypertensive disorders in pregnancy, childbirth and the puerperium); 46 deaths were assigned to O21, O23–O31, O34 (other complications of pregnancy) and 46 more maternal deaths were assigned with the codes O89–O92 (other complications during the puerperium). Two hundred and twenty indirect maternal deaths were coded as direct obstetric causes before the correction.
Table 2. Summary of the intentional search and review outcomes of maternal deaths, by municipality-level development index quintiles, Mexico, 2006–2013

| Cause of death | After review | Cause of death, no. (%) | Total, no. (%) |
|----------------|--------------|-------------------------|----------------|
|                | Indirect<sup>a</sup> | Direct<sup>b</sup> | Late maternal<sup>c</sup> | Indirect<sup>a</sup> | Direct<sup>b</sup> | Late maternal<sup>c</sup> |
| All quintiles  | Before review | 479 (21.3) | 365 (5.9) | 370 (58.9) | 1214 (13.4) |
|                | Indirect<sup>a</sup> | 1544 (68.8)<sup>e</sup> | 514 (8.3) | 41 (6.5) | 2099 (23.2) |
|                | Direct<sup>b</sup> | 218 (9.7) | 5281 (85.5)<sup>e</sup> | 39 (6.2) | 5538 (61.2) |
|                | Late maternal<sup>c</sup> | 2 (0.1) | 12 (0.2) | 178 (28.3)<sup>e</sup> | 192 (2.1) |
|                | Total | 2243 (100.0) | 6172 (100.0) | 628 (100.0) | 9043 (100.0) |
| Quintile 1 (poorest) | Before review | 280 (21.1) | 193 (6.4) | 221 (57.7) | 694 (14.7) |
|                | Indirect<sup>a</sup> | 921 (69.4)<sup>e</sup> | 303 (10.1) | 22 (5.7) | 1246 (26.4) |
|                | Direct<sup>b</sup> | 124 (9.3) | 2507 (83.3)<sup>e</sup> | 23 (6.0) | 2654 (56.2) |
|                | Late maternal<sup>c</sup> | 2 (0.2) | 5 (0.2) | 117 (30.5)<sup>e</sup> | 124 (2.6) |
|                | Total | 1327 (100.0) | 3008 (100.0) | 382 (100.0) | 4718 (100.0) |
| Quintile 5 (wealthiest) | Before review | 38 (18.8) | 36 (3.3) | 34 (64.1) | 108 (8.1) |
|                | Indirect<sup>a</sup> | 134 (66.3)<sup>e</sup> | 48 (4.4) | 5 (9.4) | 187(13.9) |
|                | Direct<sup>b</sup> | 30 (14.8) | 1008 (92.1)<sup>e</sup> | 1 (1.9) | 1039 (77.0) |
|                | Late maternal<sup>c</sup> | 0 (0.0) | 2 (0.2) | 13 (24.5)<sup>e</sup> | 15 (1.1) |
|                | Total | 202 (100.0) | 1094 (100.0) | 53 (100.0) | 1350 (100.0) |

<sup>a</sup> Indirect is defined as maternal deaths resulting from a disease, often pre-existing and aggravated by the physiologic effects of the pregnancy.

<sup>b</sup> Direct is defined as maternal deaths resulting from obstetric complications during pregnancy.

<sup>c</sup> Late maternal is defined as death between 42 days and one year post-obstetric event.

<sup>e</sup> All other maternal deaths not coded to direct, indirect or later maternal.

<sup>g</sup> Concordant pair before and after review.

For maternal deaths categorized as direct, there was a declining trend in MMR between 2006 and 2013, from 46.4 to 32.1 deaths per 100 000 live births. There was no change for indirect maternal deaths. MMR for indirect deaths was 12.2 deaths per 100 000 live births in 2006 and 13.3 deaths per 100 000 live births in 2013. There was a peak in 2009, mainly due to the Influenza A (H1N1) epidemic, which is known to increase the risk of hospitalization, severe illness and death in pregnant women.14,15 The trends for both direct and indirect causes were similar before and after re-classifying the causes of deaths (Fig. 1).

Comparison of sociodemographic characteristics and health system use showed that women who died of indirect maternal causes had fewer pregnancies, were slightly younger and were better educated than women dying of direct causes. The deceased women were also more likely to have delivered, received care for their first complication and died in Instituto Mexicano del Seguro Social facilities, which are employment-based insurance-affiliated facilities. Skilled birth attendants were more likely to have been present for the mothers who died of direct causes, but this could be due to the fact that women who died of indirect causes died before delivery (Table 4; available at: http://www.who.int/bulletin/volumes/94/5/15-163560).

For direct causes, poorer municipalities had a higher MMR, but also a slightly higher ratio of maternal indirect deaths (Fig. 2). Fig. 3 and Fig. 4 show the MMR by direct and indirect causes between the wealthiest and poorest quintiles by year. Between 2006 and 2013, direct causes of maternal deaths among women residing in the poorest municipalities have nearly halved, going down from 119.1 to 72.7 deaths per 100 000 live births (Fig. 3). The decline in MMR due to direct causes of maternal death in the wealthiest municipalities was 23.5%, going down from 35.2 to 26.9 deaths per 100 000 live births (Fig. 3). For each year and in both poorest and wealthiest quintiles, MMRs for indirect death causes were lower than the MMRs for direct causes. It is only in 2008 and 2010 that the poorest quintile had a statistically significant higher MMR due to indirect causes than the wealthiest quintile (Fig. 4). In 2009, there was a peak in indirect deaths among the wealthiest municipalities, presumably due to the H1N1 epidemic (Fig. 4).
Discussion

This paper presents the results of a review and reclassification of causes of maternal death in Mexico, for the period 2006 to 2013. The identified 13% increase in the number of maternal deaths after the BIRMM review suggests that this type of exercise is one approach to correct misclassification of maternal cause-of-death data. There is progress in Mexico towards achieving a reliable assessment of the causes of death in women of reproductive age, with the aim of generating improved data on the causes of maternal mortality.

Our findings show that MMR from direct maternal deaths has been declining between 2006 and 2013; it nearly halved among the poorest women. However, there was no such change in indirect deaths. Given the increase in the burden of noncommunicable diseases and associated risk factors, indirect deaths may continue to account for an increasing proportion of maternal deaths. Despite the overall decline in MMR from direct deaths, socioeconomic disparities among the poor persist. However, for indirect deaths, women residing in both poor and wealthy areas are affected. These findings are consistent with other studies that examined the obstetric death transition from direct to indirect causes.

Similar projects to the BIRMM have been implemented in other settings as well; however there is a wide variation in the level of maternal death underreporting between settings. Correction factors for the number of maternal deaths range from 1.9 in north-east Brazil to 3.2 in Menoufia, Egypt. In high-income countries the correction factor ranges between 0.9 and 2.2. This observed variation limits our ability to generalize the extent of underreporting or misclassification across settings.

Our review also highlighted the importance of the maternal death review to explain an unusual disease pattern, such as the 2009 H1N1 epidemic in Mexico. This type of temporary change in the pattern of maternal deaths has also been observed in Rwanda and South Africa. Such increases should be anticipated during an epidemic.

The feasibility of a project that focuses on reclassifying maternal death causes in a given country is dependent on the level of maternal death misclassification or under-coding. In countries with relatively few maternal deaths, extensive review of suspected cases may be feasible. For example, the reproductive age mortality study (RAMOS) investigates all reported deaths in women of reproductive age. In our study, we applied a cost-saving approach which uses expert opinion to identify a subset of maternal death cases. Most maternal health interventions are timed around the delivery period of the pregnancy and they focus mainly on skilled birth attendance or emergency obstetric care. These interventions have an impact on direct deaths and subsequently on the reduction of overall maternal mortality. However, except in cases where complications arise during labour, indirect deaths may not be averted through these delivery-focused interventions. To reduce indirect deaths, obstetricians and other health-care personnel interacting with pregnant women

Fig. 2. Direct and indirect maternal deaths by municipality-level development index, Mexico, 2006–2013

| Quintile | Indirect | Direct | 95% CI |
|----------|---------|-------|--------|
| 1-poorest |         |       |        |
| 2        |         |       |        |
| 3        |         |       |        |
| 4        |         |       |        |
| 5-wealthiest |     |       |        |

CI: confidence interval. Note: Pooled number of indirect and direct deaths per 100,000 live births, by quintile of municipality-level development index, 2006–2013.

Fig. 3. Direct maternal deaths for the wealthiest and poorest quintile, Mexico, 2006–2013

| Year | Q1-poorest | Q5-wealthiest | 95% CI |
|------|------------|---------------|--------|
| 2006 |            |               |        |
| 2007 |            |               |        |
| 2008 |            |               |        |
| 2009 |            |               |        |
| 2010 |            |               |        |
| 2011 |            |               |        |
| 2012 |            |               |        |
| 2013 |            |               |        |

CI: confidence interval; Q: quintile. Note: Number of direct deaths per 100,000 live births, by year, for the wealthiest and poorest quintile of the municipality-level development index.
During the postpartum period need to be trained to treat the entire woman and not just her pregnancy. Planning for such training requires the development, dissemination and adoption of clinical guidelines. Effective implementation of such guidelines requires collaboration and the establishment of referral systems between specialties that deal with the major causes of indirect deaths. For example obstetricians need to be able to effectively communicate with chronic disease specialists regarding at-risk cases. There is a need for additional surveillance of pregnant women to identify at-risk pregnancies to respond to them appropriately. A health education programme focused on addressing indirect obstetric death risk factors, particularly for women with pre-existing conditions, is needed as well. Access to and use of effective contraception and safe abortion remains a key strategy to reduce maternal mortality worldwide.

The Mexican Ministry of Health, recognizing the need for quality and state-level maternal mortality estimates, used its authority to ensure cooperation from states for the BIRMM project. While integration of the BIRMM as part of the vital statistics system treats the maternal mortality review as a core public health function, there is no separate specific budget for it from the ministry of health. The project is being implemented as a non-routine activity, subsidized by committed individuals and interested groups of public health practitioners. Annual results from the BIRMM are used to adjust official estimates of MMR. The adoption of electronic death registration would allow real-time reporting and validation of suspected maternal deaths.

This study has several limitations. First, the review process did not target all deaths in women of reproductive age, but a subset identified based on the registered cause of death. While the codes used to identify cases capture most misclassified or miscoded maternal deaths, there may be some missed and not investigated. Second, the review process relies on the availability and quality of additional mortality data sources beyond the death certificate. For some deaths, the additional available information to make a reclassification decision was quite limited. Third, the role of improved ascertainment and categorization must not be overlooked when examining the trends in this analysis. Since the same search procedures have been used each year, it seems unlikely that the observed increase in indirect deaths would be solely due to improved ascertainment. Fourth, a few causes of death, considered to be indirect obstetric causes such as ICD-10 code Q26.6 (liver disorders), are subsumed within chapters of the ICD broadly considered for direct maternal deaths. Full ICD-10 codes to the 4-digit level were not available for all deaths so the broader 3-digit categories were used and these cases were considered to be of questionable quality. This means that some rare causes of indirect deaths may have been grouped with direct causes, and if so, the analysis may have underestimated the contribution of indirect deaths. Fifth, missing data in the covariates is another limitation. Sixth, when examining socioeconomic disparities, the use of the municipality-level development index may hide within group differences. It is likely that the individual women dying of maternal deaths across all quintiles of the development index are the poorest women within those municipalities. The area-level nature of this component of the analysis does not allow for commentary about how an individual’s access to resources affects her risk of maternal death.

**Conclusion**

This study presents a useful strategy towards achieving a relatively complete and accurate assessment of the causes of maternal mortality in a country with complete vital registration. It provides useful lessons for other countries looking to improve maternal mortality measurement and highlights the importance of developing an appropriate health system response to address indirect maternal deaths.

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Reclassification of causes obstétricales de décès au Mexique: une étude transversale répétée

Objectif Décrire les causes de mortalité maternelle au Mexique sur une période de huit ans, en s'intéressant particulièrement aux décès dus à des causes obstétricales indirectes ainsi qu'à diverses disparités socio-économiques.

Méthodes Nous avons réalisé une étude transversale répétée à l'aide des données de l’outil Búsqueda Intencionada y reclasificación de muertes maternas (BIRMM) 2006–2013. Nous nous sommes basés sur les fréquences pour décrire les nouveaux cas, la répartition des causes et la reclassification des cas de mortalité maternelle selon la procédure BIRMM. Nous avons utilisé des tests statistiques pour analyser la différence, sur le plan des caractéristiques sociodémographiques, entre les décès pour cause directe et indirecte, ainsi que les différences dans la proportion globale de décès pour cause directe et indirecte, par année et par niveau de pauvreté des municipalités.

Résultats Un total de 9043 décès maternels a été examiné. Nous avons constaté une augmentation de 13% du nombre de décès maternels classés comme décès maternels indirects à chaque période de trois ans (2006–2013). Sur la période d’étude, le nombre de décès dus à des causes obstétricales directes a diminué, mais il n’a pas observé aucun changement dans le nombre de décès dus à des causes obstétricales indirectes. Les décès pour cause directe étaient concentrés chez les femmes vivant dans les municipalités les plus pauvres. En comparaison des femmes décédées de causes directes, les femmes décédées de causes indirectes avaient plus de grossesses et étaient légèrement plus jeunes, plus instruites et plus susceptibles de vivre dans des municipalités plus riches.

Conclusion La procédure BIRMM est une approche qui permet de rectifier les statistiques sur les décès maternels dans les zones ayant peu de ressources. Cette approche pourrait permettre de repenser la stratégie du système de santé en vue de réduire le nombre de décès maternels dus à des causes obstétricales indirectes, notamment la prévention des grossesses non désirées et l’amélioration des soins prénataux et post-obstétricaux.
Indirect and direct obstetric deaths in Mexico

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Rезюме

Повторная классификация причин акушерских смертей в Мексике: повторное одномоментное поперечное исследование

Цель: Описать причины материнской смертности в Мексике за восемь лет, уделяя особое внимание акушерским смертям по непрямым причинам, а также из-за социально-экономического неравенства.

Методы: Было проведено одноименное поперечное исследование с использованием набора данных Búsqueda intencionada y reclasificación de muertes maternas (BIRMM) 2006–2013 гг. Для описания новых случаев, распределения причин и повторной классификации случаев материнской смертности с помощью процедуры BIRMM использовались данные о частотности. С помощью статистических критериев были проанализированы различия в социально-демографических характеристиках рожениц, умерших по прямым и непрямым причинам, и различия в долю, которую эти причины составляли в общем количестве смертей по прямым и непрямым причинам, в зависимости от года и уровня бедности муниципального образования.

Результаты: В ходе исследования было изучено 9043 случая смертей среди матерей. Общее количество определенных материнских смертей увеличилось на 13% (с 7 829 до 9 043), а доля материнских смертей, классифицированных как поздняя материнская смерть, увеличилась в три раза (с 2,1 до 6,9%). На протяжении исследования количество акушерских смертей по прямым причинам снизилось, однако количество смертей по непрямым акушерским причинам не изменилось. Смерть по прямым причинам в большинстве случаев наступала среди женщин, проживавших в беднейших муниципальных образованиях. По сравнению с роженицами, умершими по прямым причинам, женщины, чья смерть наступила по непрямым причинам, имели меньше беременностей и были несколько младшие, лучше образованны и с большей вероятностью проживали в более зажиточных поселениях.

Вывод: Процедура BIRMM представляет собой один из подходов к получению правильной статистики по материнской смертности в условиях ограниченности ресурсов. С помощью этого подхода специалисты системы здравоохранения могли бы пересмотреть свою стратегию по сокращению количества материнских смертей по непрямым акушерским причинам, включая предупреждение неестественной беременности и повышение качества дородовой и постбеременной помощи.

Resumen

Reclasificación de las causas de muerte obstétrica en México: un estudio transversal repetido

Objetivo: Describir las causas de la mortalidad materna en México durante ocho años, con especial atención a las muertes obstétricas indirectas y a las desigualdades socioeconómicas.

Métodos: Se realizó un estudio transversal repetido utilizando el conjunto de datos Búsqueda intencionada y reclasificación de muertes maternas (BIRMM) de 2006-2013. Mediante el proceso de la BIRMM, se utilizaron frecuencias para describir nuevos casos, las distribuciones de las causas y la reclasificación de los casos de mortalidad materna. Se utilizaron pruebas estadísticas para analizar las diferencias en cuanto a las características sociodemográficas entre las muertes directas e indirectas y las diferencias en el porcentaje del total de muertes directas e indirectas, por año y por nivel de pobreza de los municipios.

Resultados: Un total de 9 043 muertes maternas fueron sujetas al proceso de revisión. En general, el número de muertes maternas identificadas aumentó un 13% (de 7 829 a 9 043) y el porcentaje de muertes maternas clasificadas como muertes maternas tardías se triplicó (de un 2,1% a un 6,9%). Durante el periodo de estudio, las muertes obstétricas directas se redujeron, mientras que las muertes derivadas de causas obstétricas indirectas se mantuvieron sin cambios. Las muertes directas se concentraron en mujeres que vivían en los municipios más pobres. En comparación con aquellas que fallecieron por causas directas, las mujeres que fallecieron por causas indirectas tuvieron menos embarazos y eran ligeramente más jóvenes, tenían una mejor educación y más posibilidades de vivir en municipios más adinerados.

Conclusión: La BIRMM es un enfoque cuyo objetivo es corregir las estadísticas de mortalidad materna en entornos con pocos recursos. El enfoque podría ayudar al sistema sanitario a reconsiderar su estrategia para reducir las muertes maternas por causas obstétricas indirectas, incluyendo la prevención de embarazos no deseados y la mejora del cuidado prenatal y postobstétrico.

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### Table 3. Cause of death reclassified as indirect maternal deaths, Mexico, 2006–2013

| ICD-10 block | Title                                                                 | No. of recorded cases (%) (n = 699) |
|--------------|----------------------------------------------------------------------|-------------------------------------|
| **Non-maternal** |                                                                      |                                     |
| A15–B49      | Infectious and parasitic diseases                                     | 96 (13.7)                           |
| C00–C14      | Malignant neoplasms of lip, oral cavity and pharynx                   | 1 (0.1)                             |
| C15–C96, D10–D48 | Other malignant, benign and uncertain or unknown behaviour neoplasms | 56 (8.0)                            |
| D00–D09      | In situ neoplasms (carcinoma)                                        | 1 (0.1)                             |
| D55–D89      | Diseases of blood and blood-forming organs                           | 8 (1.1)                             |
| E00–E90      | Endocrine, nutritional and metabolic diseases                         | 32 (4.6)                            |
| F50–F59      | Behavioural syndromes associated with physiological disturbances and physical factors | 1 (0.1)                             |
| G00–G99      | Diseases of the nervous system                                        | 21 (3.0)                            |
| I00–I99      | Diseases of the circulatory system                                    | 94 (13.4)                           |
| J00–J99      | Diseases of the respiratory system                                    | 70 (10.0)                           |
| K00–K93      | Diseases of the digestive system                                      | 37 (5.3)                            |
| L00–L08      | Infections of the skin and subcutaneous tissue                       | 1 (0.1)                             |
| M00–M99      | Diseases of the musculoskeletal system and connective tissue         | 7 (1.0)                             |
| N00–N99      | Diseases of the genitourinary system                                  | 9 (1.3)                             |
| Q00–Q99      | Congenital malformations, deformations and chromosomal abnormalities  | 20 (2.9)                            |
| R10–R19      | Symptoms and signs involving the digestive system and abdomen        | 1 (0.1)                             |
| R50–R69      | General symptoms and signs                                            | 7 (1.0)                             |
| R95–R99      | Ill-defined and unknown causes of mortality                           | 1 (0.1)                             |
| V01–Y98      | External causes                                                       | 16 (2.3)                            |
| **Maternal** |                                                                      |                                     |
| O01          | Hydatidiform mole                                                     | 1 (0.1)                             |
| O02–O08      | Other pregnancy with abortive outcome                                | 9 (1.3)                             |
| O10–O16      | Oedema, proteinuria and hypertensive disorders in pregnancy, childbirth and the puerperium | 40 (5.7)                            |
| O20, O45–O46, O67 | Premature separation of placenta and other haemorrhage of pregnancy or birth | 12 (1.7)                            |
| O21, O23–O31, O34 | Other complications of pregnancy                                   | 46 (6.6)                            |
| O22, O87     | Other maternal disorders predominantly related to pregnancy           | 2 (0.3)                             |
| O35–O43, O68–O69 | Fetal distress and other complications of pregnancy or birth         | 16 (2.3)                            |
| O47–O48, O60–O75 | Prolonged pregnancy, other complications of labour                   | 9 (1.3)                             |
| O72          | Postpartum haemorrhage                                                | 6 (0.9)                             |
| O88          | Obstetric embolism                                                    | 12 (1.7)                            |
| O89–O92      | Other complications during the puerperium                             | 46 (6.6)                            |
| O96–O97      | Late and sequelae maternal death                                      | 2 (0.3)                             |
| A34, O85–O86 | Obstetrical tetanus, complications predominantly related to the puerperium | 19 (2.7)                            |
Table 4. Characteristics of indirect and direct maternal deaths, Mexico, 2006–2013

| Characteristics                              | Cause of death |
|----------------------------------------------|----------------|
|                                               | Indirect       | Direct         |
| Number of pregnancies (mean, SD)              | 2.45 (0.04)    | 3.03 (0.03)**  |
| Age (mean, SD)                               | 27.40 (0.14)   | 28.70 (0.09)** |
| Number of prenatal visits (mean, SD)          | 3.26 (0.07)    | 2.86 (0.04)**  |
| Marital status, n                            | 2208           | 6022           |
| Single, n (proportion)                       | 394 (0.18)     | 900 (0.15)     |
| Common law, divorced or widowed, n (proportion) | 869 (0.39)     | 2415 (0.40)    |
| Married, no. (%)                             | 945 (0.43)     | 2707 (0.45)**  |
| Education, n                                 | 2131           | 5807           |
| Primary, no. (%)                             | 849 (0.40)     | 2660 (0.46)    |
| Secondary, no. (%)                           | 726 (0.34)     | 1851 (0.32)    |
| High school or more, no. (%)                 | 557 (0.26)     | 1296 (0.22)**  |
| Place of death, n                            | 1732           | 4331           |
| Secretaria de Salud, no. (%)                 | 903 (0.52)     | 2143 (0.49)    |
| IMSS/ISSSTE/SEDENA, no. (%)                  | 511 (0.30)     | 1010 (0.23)    |
| Private medical unit, no. (%)                | 92 (0.05)      | 410 (0.09)     |
| Home, street, other, no. (%)                 | 226 (0.13)     | 768 (0.18)**   |
| Place of delivery, n                         | 1657           | 5329           |
| Secretaria de Salud, no. (%)                 | 901 (0.54)     | 2603 (0.49)    |
| IMSS/ISSSTE/SEDENA, no. (%)                  | 491 (0.30)     | 1048 (0.20)    |
| Private medical unit, no. (%)                | 150 (0.09)     | 833 (0.16)     |
| Home, street, other, no. (%)                 | 115 (0.07)     | 845 (0.16)**   |
| Place of care for first complication, n      | 1875           | 5129           |
| Secretaria de Salud, no. (%)                 | 1044 (0.56)    | 2864 (0.56)    |
| IMSS/ISSSTE/SEDENA, no. (%)                  | 533 (0.28)     | 1069 (0.21)    |
| Private medical unit, no. (%)                | 285 (0.15)     | 1104 (0.22)    |
| Home, street, other, no. (%)                 | 13 (0.01)      | 92 (0.02)**    |
| Development index, (municipality), n         | 2237           | 6145           |
| Quintile 1 – Poorest, no. (%)                | 202 (0.09)     | 1094 (0.18)**  |
| Quintile 2, no. (%)                          | 194 (0.09)     | 666 (0.11)     |
| Quintile 3, no. (%)                          | 197 (0.09)     | 604 (0.10)     |
| Quintile 4, no. (%)                          | 317 (0.14)     | 773 (0.13)     |
| Quintile 5 – Wealthiest, no. (%)             | 1327 (0.599)   | 3008 (0.49)    |
| Skilled birth attendant, n                   | 1910           | 5477           |
| Doctor, no. (%)                              | 1361 (0.71)    | 4267 (0.78)    |
| Nurse/auxiliary/midwife, no. (%)             | 43 (0.02)      | 460 (0.08)     |
| Relative/other, n (proportion)               | 20 (0.01)      | 231 (0.04)     |
| No delivery, n (proportion)                  | 486 (0.25)     | 519 (0.09)     |

IMSS: Instituto Mexicano del Seguro Social, ISSSTE: Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado, SEDENA: Secretaría de la Defensa Nacional, SD: standard deviation.
* P < 0.05; **P < 0.01.
† Tested using differences in mean
‡ Tested using an overall Pearson χ².