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Suggested Reviewers:

**Review, replication, and re-analysis of a recent study on the impact of abortion
law on maternal mortality in Mexico – Maintaining rigor and research integrity**

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ABSTRACT

This report provides a review, replication, and re-analysis of an study by Darney *et al* (Contraception. 2017;95(1):105-111) on the association between maternal mortality ratio (MMR, number of maternal deaths per 100,000 live births) and abortion legislation in Mexico City compared with 31 other states. In their study, Darney *et al* disputed evidence from our study (Koch *et al*, BMJ Open 2015;5(2):e006013), which found a null association between abortion laws and MMR, and reported their own conclusion of a negative association between abortion availability and MMR. After replicating their dataset and statistical analysis, we found that the beta coefficient (effect size) for abortion legislation was apparently misinterpreted by Darney *et al* to support the conclusion that legislation allowing abortion on request in Mexico City was associated with a 22.49-unit *decrease* in MMR. In fact, their analysis showed the opposite result: after multivariable adjustments, Mexico City was associated with a 22.49-unit *increase* in MMR compared with the 31 states with restricted access to abortion. Moreover, Darney *et al* did not report the initial time-adjusted effect size, where the 95% CI supports the hypothesis of null association (beta = 4.17; 95%CI -7.19 to 15.54; $p=0.470$). In our re-analysis of their data, estimates were highly unstable in multiple regression models, and the initial effect size (4.17) for the association between abortion legislation and the MMR was inflated up to 5-fold (22.49) as a result of a ‘tipping effect’ on coefficients and multicollinearity among covariates. In conclusion, our reanalysis of Darney *et al*’s study provides evidence of serious methodological flaws, faulty statistical analysis and misinterpretation of regression coefficients, ultimately resulting in an invalid conclusion. **(269 words)**

Introduction

In a criticism and rebuttal [1] of our paper [2], “Abortion legislation, maternal healthcare, fertility, female literacy, sanitation, violence against women and maternal deaths: a natural experiment in 32 Mexican states”, Darney, Saavedra-Avendano, and Lozano have explored differences in all-cause maternal mortality in the Mexico City compared to 31 other Mexican states between 2006 and 2013 [1]. Their stated goal is to rebut our findings regarding the null association between abortion legislation and maternal mortality trend presented in Koch *et al* [2]. The authors proposed an alternative statistical analysis based on the allegation that our findings utilized flawed methodology. After multivariable adjustments Darney *et al.* concluded that Mexico City (the only federal state with wide access to pregnancy termination on demand) “is associated with a 22.5-unit *decrease* in MMR compared with the 31 states with restricted access”. Their conclusion is that there is possibly a beneficial impact of the current abortion law allowing abortion on request in Mexico City, even after controlling for multiple confounders. Nevertheless, after a thorough review of their article and replication of their analyses, major flaws in their paper have been detected. These include faulty statistical analysis, fundamental misinterpretation of regression coefficients, and potential improper interpretation and reporting of results, which might have the results of causing readers and reviewers to arrive at an invalid conclusion.

Correlation does not imply causation

The first needed clarification for an intelligent academic discussion of this controversial subject is related to the conclusions of our study. Darney *et al* state that the paper by Koch *et al* makes “false causal claims about abortion law” and maternal mortality ratio (MMR, number of maternal deaths per 100,000 live births). In our study, the average 10-year trend in MMR by women’s place of residence was 23% lower for Mexican federal states grouped as less permissive with respect to abortion legislation, than for states grouped as more permissive (38.3 vs 49.6 per 100,000 live births; $p < 0.001$ by z-test). The gap between groups of states decreased over time, mainly because the group with more permissive legislation displayed a downward trend for MMR (-1.77 per 100,000 live births each year, p for trend < 0.001). As repeatedly stated in our paper, these findings do not mean that abortion legislation is the cause of such differences. In epidemiology, correlation does not imply causation [3,4].

In our paper, when we assert that the group of states with less permissive legislation “exhibited consistently lower maternal mortality rates over the last decade”, we are describing an epidemiologic observation based on the data distribution –not making a causal inference. It is of note that Darney *et al* replicated the MMR trends observed in our study confirming that our descriptive results were correct. This problem of differentiating causality from association, correlation, or even simple descriptive data distribution is common in the literature [5-9]. Much more than simple correlation or statistical difference in magnitude is required to argue that abortion laws have a causal effect, whether it is to increase or decrease the MMR. In order to infer causation, the epidemiologic association should be independent of other factors known to have a

direct impact on the outcome [6-10]. In fact, we addressed this issue directly in our study [2]. We found that the initial estimate of a 7.31-unit lower MMR (beta -7.31; 95%CI -13.7 to -0.91; $p<0.01$), associated with states which had less permissive legislation, disappeared after statistical adjustment for confounders (-1.48, 95%CI -5.89 to 2.98; $p=0.50$). In other words, when we took into account the influence of inter-state differences in the distribution of factors such as women's education level, availability of maternal healthcare, fertility rate, water, sanitation, access to emergency obstetric care, violence against women, and individual risk factors, we did not find evidence for an independent association, whether positive or negative, between abortion laws and the MMR at the state level.

Differences in definition of the exposure

The assignment or classification of the population under study into groups by exposure, in this case where the exposure is abortion legislation, is perhaps one of the most difficult issues to be addressed by the epidemiologic research on this subject. In our study, 32 Mexican states were grouped according to the presence or absence of a legal exception for pregnancy termination in cases of serious fetal anomaly, in combination with any other legal exemption [2]. This method allowed us to reach a relatively balanced distribution of states in terms of sample size and variance in each comparison group: 18 states were classified as 'less permissive' and 14 states were classified as 'more permissive' (Figure 1A). In contrast, Darney *et al* [1] compare the MMR for Mexico City, where there is 'wide access' to abortion, with other 31 states where there is 'restricted access' to abortion (Figure 1B). This latter approach overlooks the diversity of legal codes between states as criterion of availability. In addition, it should be stressed

that our criterion was used exclusively as a proxy for exposure to a greater or lesser ‘permissiveness’ in the legal and healthcare systems (*i.e.* the impact of the legal code by itself), and not as a measure of ‘increased or decreased’ access to abortion. Darney *et al* appear to conflate these very different concepts, which provide very different definitions between studies for the exposure. For example, states’ legislation may be similarly permissive, but a woman’s access to abortion facilities or providers may differ by multiple unmeasured factors (e.g. distance, transportation, cost, number and type of providers, education level, etc.), which differ between states, even between those with similar legal codes [11-14].

Why consider abortion for fetal anomalies?

Darney *et al* stated in their paper that we did not present “a transparent justification for which of the indications translate into ‘more permissive’ laws”. In doing so, they apparently ignore our clearly stated criterion above (Figure 1A). The presence or absence of legal exceptions or exemptions for pregnancy termination in cases of fetal anomalies is not a trivial issue. Most pregnancy terminations for anomalies are performed in the second trimester of pregnancy because many genetic or congenital diseases cannot be diagnosed before 12-14 weeks of pregnancy [15-18]. In our view, it is readily apparent (and transparent) that states allowing second trimester pregnancy terminations are more permissive from the legal perspective than those that do not. In addition, there is evidence from other countries that this particular exemption has a substantial impact on abortion utilization, making it a useful measure of both the legal and cultural climate related to abortion [19-25]. Bartlett *et al.* showed that the relative risk of maternal abortion-related mortality, using first trimester abortion as the reference

group, increases to 14.7 at 13-15 weeks of gestation, 29.5 at 16-20 weeks, and 76.6 at or after 21 weeks of gestational age (95% CI 32.5 – 180.8). [26] Hence, a relatively small number of late pregnancy terminations may contribute significantly to higher rates of complications or maternal deaths. Additional evidence supporting the latter possibility was provided by Rolnick and Vorgies[27] in a recent study which used hospital discharge data on abortion complications from 23 states in the United States. This study showed that after controlling for socio-economic characteristics and pregnancy complication rates, regions with legal restrictions were associated with lower abortion complication rates: 21% lower rate for states with mandatory delays (OR 0.79 (0.65–0.95)) and 24% lower rate for states with restricted Medicaid funding (OR 0.74 (0.61–0.90)). According to the authors, this suggests that states without legal restrictions perform a higher percentage of second-trimester abortions [27]. However, although in our study we observed increased rates of maternal deaths in Mexican states without legal restrictions on abortion for fetal anomalies, abortion legislation was ultimately ruled out as an independent predictor of maternal mortality in our multivariable models [2].

The natural experiment design

Darney *et al* dispute the concept of ‘natural experiment’ used in the title of our study. Indeed, the term ‘natural experiment’ lacks a precise definition. Most epidemiologists agree that a natural experiment or quasi-experiment may be defined as an empirical or observational study where the researcher cannot manipulate the population’s exposure to the event or intervention of interest [6, 28-30]. By default, a natural experiment is a non-random study in a population [6]. According to a recent review by Craig et al [29], natural experiments are often recommended as a way of understanding the health

166 impact of policies, environmental exposures, and other large-scale interventions. All
167 natural experiments require a comparison between exposed and unexposed groups in
168 the population (or subgroups of a population with varying levels of exposure, as in the
169 case of Mexican states), to identify the impact of one or more exposure variables on
170 one outcome of interest. Design elements include the use of before/after measures to
171 control for secular changes in the same population, as in a segmented time series
172 design [30,31]; two exposed/unexposed groups that differ according to one or more
173 variables that may modify the relationship between exposure and outcome; and
174 accurate measurement of multiple potential confounders, use of instrumental variables,
175 and combinations of regression methods to address different sources bias [6,29].

176
177 The diversity of abortion laws among Mexican states offers a valuable opportunity to
178 study differences between entire subgroups of a population exposed to different
179 abortion-related laws. The availability of standardized data for a number of covariates
180 makes it possible to address the impact of other factors known to be strongly associated
181 with the MMR, including residual confounding. Overall, the term 'natural experiment'
182 appears to be an appropriate description for both studies [1,2] conducted in Mexico.
183 Nevertheless, because it is never possible to control for all influencing variables in
184 ecological studies, results should be carefully considered in the context of causal
185 inference.[31, 32]

186 187 **Different sources of data on live births**

188 The availability of several sources for the number of live births in Mexico makes the
189 construction and comparison of health indicators somewhat difficult. Our study used

official data from the National Institute of Statistics and Geography (INEGI) that represents records of observed live births by residence and occurrence from the civil registration system in Mexico. We agree with Darney *et al* that these may overestimate actual figures in some states due to lags in registration, double registration or population mobility [34]. Darney *et al* proposed the use of population estimates of live births from the National Population Council (CONAPO) as the denominator to compute MMR. This official agency estimates large time series of live births recalculated for demographic surveys during intercensal periods [35]. Therefore, figures from CONAPO cannot provide a formal correction for problems such as double registration, time lags in registration, or population mobility on a year-by-year basis, as Darney *et al.* assert [1].

Recent reviews of data sources from Mexico have concluded that data from CONAPO have underestimated the number of actual live births since 2002, and as a result these have overestimated the MMR for several Mexican states [35-37]. Recently estimates have been recalculated by CONAPO, which have reduced the differences between INEGI records and CONAPO estimates. Table 1 illustrates the difference of total live births between CONAPO and INEGI in each state. In addition, pairwise correlations (r) for the entire period 2006 to 2013 are included. Low correlation coefficients (< 0.40) were observed for 11 states, moderate (0.40 to 0.69) for 12 states, high (0.70 to 0.89) for 8 states, and very high (≥ 0.90) for one state. Inverse correlations were observed for 9 states. In contrast, the MMR showed high and very high positive correlations for all states (≥ 0.95 for 29 states, and ≥ 0.90 for all 32 states). In our opinion, INEGI records of live births reflect actual year-by-year fluctuations and inter-state differences better than CONAPO intercensal estimates.

214

215 **Comparison of statistical approaches**

216 Although Darney *et al*/ stated that they performed their analysis using our multivariable
217 models, there are readily apparent differences between the analyses, which contradict
218 this assertion. Table 2 presents a direct *vis-à-vis* comparison of both statistical
219 approaches using a simple methodological checklist. The statistical analyses in our
220 study address the problems of autocorrelation in time series, multicollinearity,
221 heterogeneity of variance among states, diagnostic outliers, assessment of stability of
222 beta coefficients, statistical refinement, theoretical frame to drive the inclusion of
223 variables, and specification of explanatory models looking for the lowest number of
224 predictors, minimal collinearity, and maximal goodness-of-fit. In contrast, the regression
225 model by Darney *et al*/ is inadequately specified and violates important statistical
226 assumptions for linear regression [38-40]. The authors do not provide sufficient
227 information to examine the validity of the model (Table 2 in Darney *et al*/ article); neglect
228 to present the initial or basal effect sizes (betas) for each variable (key to assessing
229 stability in regression coefficients), and overlook a problem with multicollinearity that
230 frequently distorts the effect sizes and result in spurious associations [41]. In addition,
231 most covariates utilized by Darney *et al*/ correspond to incomplete time series with
232 missing values imputed by duplicating existing observations in the dataset (*e.g.* the
233 clean water, female literacy, and physical violence variables have only one or two
234 available observations over time) This imputation method may result in a near-singular
235 matrix or strong linear interdependence among variables, which would skew
236 significantly beta coefficients. This is one of the most important structural flaws in the
237 study design, which renders their analysis questionable and potentially invalid.

238

239 **A fatal error**

240 During our review of Darney *et al*'s analysis [2], we identified a fatal error of
241 interpretation. In Table 2 of their article, authors present the results of a multiple
242 regression analysis, which they claim supports the hypothesis of an independent
243 association between 'wide access' to abortion and decreasing MMR in Mexico City. To
244 provide evidence supporting this conclusion, the authors include the explanatory
245 variable 'Abortion legislation (=1 restricted access)' in Table 2, and state in the Results
246 section: "we see further evidence of a *decline* in MMR in Mexico City, the only state
247 classified as having *wide access* to abortion (beta=-22.5; 95% CI=-38.9; -5.99) (Table
248 2)". However, this statement is an erroneous interpretation of the true result shown in
249 their table. The latter indeed presents the beta coefficient associated with 'restricted
250 access' to abortion, and not with 'wide access' to abortion as the authors assert.

251

252 **Formal demonstration**

253 The equation for a multiple linear regression model is expressed as:

254

$$255 \quad Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots \beta_n X_n + \varepsilon$$

256

257 The β_0 represent the origin or constant in the model. Each beta coefficient β_n represents
258 the average change in the dependent variable or outcome Y (*e.g.* MMR) per unit of
259 increment for each explanatory variable X_n (*e.g.* year, abortion legislation, fertility rate,
260 etc) including a term of error μ . Although it is not described in their paper, in the dataset
261 used by Darney *et al* the variable 'abortion legislation' is a binary term and utilizes the

code 0 for *wide access* to abortion (Mexico City) and the code 1 for *restricted access* (31 Mexican states). Table 2 of the paper by Darney *et al.* shows essentially that when the variable “abortion legislation” has a value of 1, representing the 31 states with *restricted access* in the dataset, the MMR *declines* by 22.49 per 100,000 live births (*i.e.* replacing the signs $\beta_1 = -22.49$ and $X_1 = 1$ for restricted access, $Y = \beta_0 + \beta_1 X_1$ then $MMR = \beta_0 - 22.49 \times 1$). Surprisingly, throughout their article, Darney *et al* interpreted this beta coefficient in the opposite direction from the correct results.

In order to correctly interpret the beta coefficients of any explanatory variable or predictor included a regression model, the values or codes used to define the reference group and exposure of interest must be known. However, the assignment of the binary code (0 and 1, 0 representing the reference group) to the variable ‘abortion legislation’ was not accurately described in Darney *et al*’s paper. For instance, the explicit aim in Darney’s study was to assess the association between abortion legislation and MMR in the direction of an *increased access* to abortion. However, they codified the variable in reverse, that is, in the direction of a *restricted access* to abortion using ‘wide access’ as the reference group and ‘restricted access’ as the exposure. Thus, when the coefficient has a negative sign in Table 2 (beta -22.49) of Darney *et al*’s paper, it must be interpreted as an *inverse* association between restricted access and the MMR. In order to avoid confusion, and according to the explicit aim of Darney’s article, states with wide access to abortion (*i.e.* México City) should have been coded with the value 1, and states with restricted access (*i.e.* the rest of the 31 Mexican states) with the value 0 as the reference group. When these codes are used in Darney *et al*’s dataset, the sign of

the beta coefficient for abortion legislation turns positive (beta 22.49), *i.e.* it represents a direct or positive association between abortion availability and the MMR.

Replication study

In order to reproduce and re-analyze the data, we completely reconstructed the database (supplementary material), strictly relying on the sources listed in the article and the supplementary Table A2 from Darney *et al.* Indeed, the time trends for the MMR reported by the authors were successfully replicated (Figures A1 and A2, supplementary material) and the average change per year in mortality trends estimated by linear regression were remarkably similar between the two studies (Table 3).

In order to re-analyze the impact of every independent variable on the MMR, we used the same nomenclature as Darney *et al.*, but the variable 'abortion legislation' was recoded as 0 for restricted access and 1 for wide access to avoid any confusion in interpretation. Table 4 illustrates the results of an initial bivariate model for each explanatory variable controlled by time-trends, including a column reproducing the results reported by Darney *et al.* The first important observation is that the initial or basal time-adjusted effect size (beta) for abortion legislation is substantially lower than the effect size reported by Darney *et al.* after multivariate adjustment (4.17 vs 22.49 per 100,000 live births of MMR increase for Mexico City). The 95% confidence interval includes the null hypothesis (beta = 4.17; 95%CI -7.19 to 15.54; $p = .470$), thus in the initial model there is not a significant association between abortion legislation and MMR.

Other variables exhibit significant correlations with MMR in the expected direction. For instance, as expected, low birth weight (LBW) shows a positive or direct association with MMR (each 1% increase in LBW ratio is associated with a 1.79-unit increase in MMR). In contrast, Darney *et al* reported a beta coefficient with the opposite sign (-0.88-unit decrease in MMR per 1% increase in LBW), *i.e.* an inverse correlation, which may well be a spurious correlation due to multicollinearity in the model. Other significant predictors such as female literacy, known to be a strong predictor for the MMR [6], disappear in the multivariate model (beta from -1.69 to -0.10), likely for the same reason. In addition, the 5-fold increase in effect size for abortion legislation and the large reduction in beta coefficients for other covariates, suggest that this may be the result of a statistical artifact known as ‘tipping effect’ [41]. Since the initial model was not presented in the paper, peer reviewers and readers could hardly realize these inconsistencies.

Correction of the estimates

In the light of the problems described above, we suspected that these statistical flaws skewed the true effect size for abortion legislation and likely skewed other variables as well. Table 5 shows the results of an unspecified model with all covariates entered simultaneously to test the stability of the beta coefficients. The problem of collinearity is assessed through the variance inflation factor (VIF). The adjusted R^2 is used as an indicator of goodness-of-fit in each model. We observed multicollinearity with $VIF > 3$ for most variables entered into the model. The significant change in the effect size for abortion legislation from the initial model (initial beta 4.17 [Table 4], which increased up to 20.87 [Table 5]) suggests the presence of a ‘tipping effect’ as noted skewing the

estimates. We conducted two successive stepwise regression models in an attempt to address this problem. In model 1, the effect size for abortion legislation was estimated at 14.59 maternal deaths per 100,000 live births associated with Mexico City. Interestingly, this model, with just five variables, had minimal collinearity and explained 42.4% of the variance (R^2), similar to the unspecified full model that included all 11 variables (42.7%, Table 5). In the second model, which excluded only significant variables from the primary model 1, the beta coefficient for abortion legislation decreased to 10.98. The model 2, with six variables, was less efficient than the model 1 and explained just 39.4% of the variance in the MMR. Large variability in the estimates between models confirms that the betas were highly unstable, which means that minimal changes in the number of variables included in the model can lead to large changes in regression coefficients. Although effect sizes were corrected to plausible levels for most covariates (*e.g.* beta for female literacy -1.93) and collinearity was reduced to acceptable levels, the ‘tipping effect’ (artefactually increasing betas for abortion legislation) persists due to other structural limitations in the dataset. For example, the duplication of observations for most variables in the dataset leads the covariance matrix toward singularity. The design proposed by Darney *et al* also requires the use of a sample size of only one state exposed to ‘wide access’ to abortion (*i.e.* 7 state-year observations compared with 249 observations). These problems ultimately translate into a very large difference in the variance of residuals. Consequently, betas for abortion legislation continue to be unstable and very sensitive to small changes in the specification of the model. Thus, the most reliable estimate for abortion legislation is the beta from a simple regression model in Table 4, which ultimately shows a null association with MMR (95%CI -7.19 to 15.54; $p=0.470$).

Discussion

Darney *et al*'s article does not achieve its goal of providing a valid scientific refutation for the findings in our previous paper [2]. There are some legitimate points of discussion or even valid differences of opinion, but ultimately the authors did not present evidence of any serious methodological flaws in our article. On the contrary, in this thorough review and reanalysis of their paper we have documented direct evidence of multiple errors, including a fatal error in interpretation that invalidates their conclusions.

The direction of the effect size of the association between abortion legislation and the MMR appears to have been either misunderstood or misinterpreted by Darney *et al* to support the conclusion that the implementation of a legislation allowing abortion on demand is apparently associated with decreasing maternal mortality in Mexico City. However, strictly interpreted, *restricted access* to abortion in the 31 other Mexican states is associated with a *decline* in MMR compared with Mexico City; or, reciprocally, Mexico City is associated with an *increase* rather than a decrease in MMR compared with the 31 states with restricted access to abortion. Given that this misinterpretation of their data is a pivotal result for the paper [2], it is immediately evident also that if the erroneous interpretation is corrected, the conclusions of Darney *et al*'s article will be completely reversed and the paper's main conclusion refuted.

Although any statistician or researcher with training in linear regression might at some point correctly interpret the beta coefficients in Darney *et al*'s article, we corroborated the misinterpreted result directly using the same authors' dataset during our statistical re-analysis. Therefore, a simple typesetting error in the label for abortion legislation (*i.e.*

‘1=restricted access’ instead of ‘1=wide access’) during the redaction of the manuscript seems unlikely. The question then arises as to whether this error was an oversight (which would seem unlikely or at least unexpected from these experienced and well-trained researchers), or whether it resulted from deliberate misinterpretation, or an extremely strong bias in support of a preferred outcome or pre-established conclusion. This major issue requires clarification by the authors.

As reviewed above, if the beta coefficient is correctly interpreted, Darney *et al*’s paper indeed demonstrates a positive or direct association between abortion availability and MMR (beta = 22.49, 95% CI= 5.99 to 38.9 for Mexico City). After re-analyzing Darney *et al*’s data and addressing some of their methodological flaws, as noted, we estimated that Mexico City, the only state with *wide access* to abortion, appears to be associated with an average 4.17 to 14.59-unit *increase* in MMR compared to the 31 states with *restricted access*. However, we must point out that structural limitations related to the database construction and study design by Darney *et al* could not be completely overcome in our statistical reanalysis, making these corrected estimates unreliable as well. Beta coefficients for abortion legislation were highly unstable in multivariable models, confirming the presence of a ‘tipping effect’ (as noted above), which significantly increased or decreased the coefficients. As a result, even the positive association found in our corrected models likely reflects a statistical artifact. Consequently, the most reliable estimate for the association between abortion legislation and the MMR from the Darney *et al*’s dataset is the beta coefficient from a simple bivariate regression model. This latter result supports the hypothesis of a null association and it is consistent with our findings in previous studies [1,31].

404

405 We must again emphasize that the aim of our study was not to argue for or against
406 abortion legislation, but to examine its association with the MMR in Mexico, regardless
407 of our personal opinions or biases. Confirmation or disconfirmation bias often tends to
408 immunize research articles against conflicting evidence or errors and is difficult to detect
409 even during peer review [42]. For instance, we may infer that Dr. Darney was speaking
410 of one or more of our studies when she used the term “anti-abortion junk science” in the
411 original research project abstract for the grant awarded by the Society of Family
412 Planning [43]. This might perhaps reflect an initial reluctance on the part of the author to
413 accept unexpected results. The erroneous attribution of a nonexistent causal claim to
414 our article, and the categorization of some legitimate differences of opinion as
415 ‘methodological flaws’ (*i.e.* different sources of live births, definition of the exposure, and
416 conceptualization of natural experiment) also appear to reflect the presence of some
417 kind of disconfirmation bias. Moreover, the authors’ failure to present relevant data
418 needed to assess the quality and robustness of their regression model precludes or
419 hinders the ability of peer reviewers and readers to detect statistical anomalies.

420

421 Finally – as noted in Darney *et al*’s paper – transparency and reproducibility in scientific
422 research is crucial, particularly in politically contentious topics such as abortion.
423 Accordingly, our previous article [1] was subjected to open peer review [44, 45] and the
424 complete process is publically available at BMJ Open. In addition, to facilitate
425 replication, or re-analysis with alternative approaches, the complete database utilized in
426 our study is publically accessible at the DRYAD Digital Repository [46]. Unfortunately,
427 this is not the case for Darney *et al*’s article. The reconstruction of the database was

laborious, and although we used strictly the data sources indicated in Table A2 from their article (included as supplementary material), we could not rule out some punctual differences, because the original database by Darney *et al* is not publically available. It should be stressed however, that small punctual discrepancies between databases might eventually explain some minor differences of magnitude in regression coefficients, but not in the direction or sign of beta coefficients estimated in this review.

In conclusion, Darney, Saavedra-Avendano, and Lozano did not refute our previous findings or demonstrate any serious methodological flaws in our study. Their suggestions that transparency or scientific rigor are lacking in our research are not supported. A critical question for both the authors and the editors of *Contraception* is whether responsibility will be taken for the serious flaws detected in this review, including an interpretation exactly the opposite of the actual results shown in their paper. There is always room for legitimate differences of opinion, but confirmation or disconfirmation biases, pre-established conclusions, or reluctance to accept unexpected results when they challenge long-held paradigmatic ideas, are detrimental to the scientific process.

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Figure 1. Segregation of 32 Mexican States based on criminal or legal exemptions from prosecution for abortion (A) in Koch *et al.* study [2], or according abortion availability in Darney *et al.* study [1].

Table 1. Comparison of two sources of live births and maternal mortality ratio calculation for 32 Mexican states from 2006 to 2013. Difference was computed as percentage (%) using INEGI as reference value. Pairwise correlation for 8-year trends between CONAPO and INEGI was computed by Pearson coefficient (r).

State	Live Births		Diff. (%)	r	MMR ³		Diff. (%)	r
	CONAPO ¹	INEGI ²			CONAPO ¹	INEGI ²		
Aguascalientes	212,578	210,942	0.8	-0.820*	34.3	34.6	-0.8	0.997**
Baja California	454,418	513,693	-13.0	-0.767*	40.9	36.2	11.5	0.975**
Baja California S	90,336	105,455	-16.7	-0.087	41.0	35.1	14.3	0.988**
Campeche	129,263	148,862	-15.2	0.585	49.5	43.0	13.2	0.951**
Coahuila	435,417	470,373	-8.0	-0.526	32.8	30.4	7.4	0.990**
Colima	105,190	105,256	-0.1	0.577	24.7	24.7	0.1	0.993**
Chiapas	922,270	1,239,076	-34.4	-0.562	63.1	47.0	25.6	0.899**
Chihuahua	555,136	587,138	-5.8	0.691	61.2	57.9	5.5	0.937**
Distrito Federal	1,111,244	1,245,591	-12.1	0.626	49.8	44.4	10.8	0.981**
Durango	273,651	321,739	-17.6	-0.503	50.4	42.9	14.9	0.994**
Guanajuato	931,834	988,238	-6.1	0.045	37.5	35.3	5.7	0.982**
Guerrero	617,891	852,338	-37.9	0.039	80.9	58.7	27.5	0.933**
Hidalgo	447,325	500,730	-11.9	0.451	44.9	40.1	10.7	0.980**
Jalisco	1,193,878	1,268,121	-6.2	-0.911**	34.3	32.3	5.9	0.999**
México	2,446,239	2,682,359	-9.7	-0.864**	44.8	40.9	8.8	0.980**
Michoacán	732,152	856,156	-16.9	-0.520	48.4	41.3	14.5	0.925**
Morelos	273,462	304,409	-11.3	0.110	44.2	39.7	10.2	0.986**
Nayarit	169,546	197,813	-16.7	0.315	40.7	34.9	14.3	0.995**
Nuevo León	681,017	738,242	-8.4	0.297	23.9	22.1	7.8	0.995**
Oaxaca	665,922	853,215	-28.1	0.738*	69.1	53.9	22.0	0.905**
Puebla	1,038,732	1,230,313	-18.4	0.717*	46.4	39.2	15.6	0.971**
Querétaro	301,999	332,644	-10.1	0.009	38.4	34.9	9.2	0.991**
Quintana Roo	208,829	229,881	-10.1	0.116	51.2	46.5	9.2	0.938**
San Luis Potosí	435,098	462,376	-6.3	0.725*	41.1	38.7	5.9	0.995**
Sinaloa	443,734	477,367	-7.6	0.631	32.5	30.2	7.0	0.996**
Sonora	419,476	433,589	-3.4	-0.058	36.2	35.1	3.3	0.997**
Tabasco	378,454	415,607	-9.8	0.521	42.5	38.7	8.9	0.984**
Tamaulipas	511,164	554,200	-8.4	0.841**	38.0	35.0	7.8	0.977**
Tlaxcala	203,158	221,522	-9.0	0.285	39.9	36.6	8.3	0.998**
Veracruz	1,149,010	1,395,334	-21.4	0.782*	57.8	47.6	17.7	0.979**
Yucatán	312,244	300,735	3.7	0.075	40.4	41.9	-3.8	0.993**
Zacatecas	253,742	283,366	-11.7	-0.542	39.8	35.6	10.5	0.987**
Country	18,104,410	20,526,680	-13.4	0.991**	46.2	40.8	11.8	0.951**

¹Live births estimates from population projections from the National Population Council (CONAPO), proposed by Darney et al; ²Official records of observed live births by place of residence were extracted from the National Institute of Statistics and Geography (INEGI), proposed by Koch et al. ³MMR: Maternal Mortality Ratio per 100,000 live births. *p<0.05 **p<0.01

625 **Table 2** A *vis-à-vis* comparison of the statistical approach used in each study.

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	Darney <i>et al</i> study	Koch <i>et al</i> study	Rationale
Statistical approach	Multiple Linear Regression model	ARIMA and 24 Panels of Multiple Regression Models	Approach according design, structure and characteristics of the data
Dependent variable specification	MMR by place of residence for every state, 8 time-dependent measures for each state (32 states, 8 repeated measures, 256 state-year measures) Live births from CONAPO	Average 10-year trend of MMR by place of residence for every state with 32 independent measures (one for each state) Live births from INEGI	Considerations for availability and reliability of the data and number of variables to be included in multiple regression models.
Sample size and exposure to different abortion legislation	1 state, City of Mexico (wide access) compared with other 31 states (restricted access) according first trimester pregnancy termination on request	18 states (less permissive) compared with 14 states (more permissive) according second trimester pregnancy termination by congenital or genetic fetal conditions	A balanced design for statistical comparison should be considered (i.e. adequate sample size by group, similar variance between groups, etc)
Autocorrelation problem in time series of each states	Not addressed	Durbin Watson statistic. ARIMA model for 1-order autocorrelation in time series of MMR for each state	At least 16 states present positive or negative autocorrelation in time series of MMR. This affects the p-values.
Covariates or confounders	11 covariates: year, literacy rate, TFR, skilled attendant at birth, contraception use, LBW, all-abortion hospitalization, physical violence, clean water, hospital beds, operating room.	10 covariates: literacy rate, TFR, skilled attendant at birth, contraception use, LBW, all-abortion hospitalization, intimate partner violence, clean water, sanitary sewer, constitutional amendments protecting unborn.	Imputing missing values by duplicating figures may seriously distort beta coefficients.
Theory that drives the relationship of every covariate with the MMR.	Not addressed	Addressed for every variable in supplementary Table S1	Necessary for a correct specification of multiple regression models, interpretation of effect sizes and detection of spurious associations
Collinearity Diagnostics	Not addressed	Assessed by variance Inflation Factor (VIF) for all covariates in the model	Multicollinearity may affect seriously the beta coefficients (effect sizes) provoking spurious associations or unstable estimates (tipping effect)
Selection procedure for significant predictors	Not declared	Backward stepwise method based on p values of 0.05 and 0.059 as criteria of entry and removal respectively.	Specification of the model selecting the minimal number of predictors and maximal goodness-of-fit.
Normal distribution assumption and homogeneity of variance	Not declared	Corroborated by Kolmogorov-Smirnov test. Most covariates meet normal distribution and homoscedasticity	Little sample size may present variance close to 0 or violate the linear assumption of homoscedasticity
Outliers diagnostic on MMR among states or group of states	Not addressed	Outliers diagnostic based on > 2 standard deviations for MMR	Presence of outliers generally inflates beta coefficients (effect sizes)
Evaluation of stability of beta coefficients and spurious effect sizes	Not addressed	Panel of 12 unrefined and 12 refined regression models excluding outliers with alternative models addressing highly collinear variables.	Change of magnitude or sign of the beta coefficient from an initial bivariate model may indicate spurious association.
Main Result	Wide access was associated to an <i>increasing</i> effect of 22.4 per 100,000 live births after adjustments for covariates.†	After adjustments for covariates no significant effect on MMR was observed for abortion legislation in any of the regression models.	Beta coefficient represent average change <i>ceteris paribus</i>
% Of the variance on MMR among states explained by the model	Not declared	Combination of relevant covariates explains up to 88% of the variance on MMR.	It is used for assessing the goodness-of-fit and quality of the explanatory model.

627 †This represents the correct interpretation of the beta coefficient presented in the article by Darney *et al*.

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Table 3. Average change per year in MMR by place of residence and occurrence comparing figures reported by Darney *et al* and those obtained in the replication study.

	Darney <i>et al</i> .			Replication study		
	Coefficient	SE	<i>p-value</i>	Coefficient	SE	<i>p-value</i>
Using Koch et al's classification						
By place of residence						
More restrictive legislation	-0.92	0.45	0.051	-0.95	0.45	0.038
Less restrictive legislation	-1.72	0.65	0.010	-1.78	0.68	0.010
All states	-1.27	0.40	0.002	-1.31	0.41	0.002
By place of occurrence						
More restrictive legislation	-0.99	0.46	0.034	-1.00	0.46	0.032
Less restrictive legislation	-1.86	0.73	0.013	-1.87	0.73	0.012
All states	-1.37	0.42	0.001	-1.38	0.42	0.001
Using Darney et al's classification						
By place of residence						
Restricted access	-1.25	0.41	0.003	-1.29	0.42	0.002
Wide Access (Mexico City)	-2.81	0.95	0.032	-2.82	0.95	0.032
All states	-1.27	0.40	0.002	-1.31	0.41	0.002
By place of occurrence						
Restricted access	-1.41	0.41	0.001	-1.43	0.41	0.001
Wide Access (Mexico City)	-3.20	1.21	0.046	-3.18	1.19	0.045
All states	-1.37	0.42	0.001	-1.38	0.42	0.001

MMR = maternal mortality ratio

Table 4. Initial effect sizes (β) for every variable adjusted for time-trends.
Comparison with the results reported by Darney *et al* in a multiple unspecified
regression model [1]

Explanatory Variable	Initial Bivariate Model				Multivariable Model by Darney <i>et al</i>	
	β	SE	95% CI	p-value	β	95% CI
Abortion legislation (1= wide access)	4.17	5.77	-7.19; 15.54	0.470	22.49	5.99; 38.9
Year	-1.33	0.41	-2.13; -0.52	< 0.001	-0.88	-1.64; -0.13
Clean water (%)	-1.03	0.09	-1.20; -0.86	< 0.001	-0.45	-0.83; 0.80*
Female literacy (%)	-1.69	0.15	-1.99; -1.39	< 0.001	-0.10	-0.83; 0.62
Low birth weight (%)	1.79	0.52	0.77; 2.82	< 0.01	-0.88	-2.12; 0.34
Skilled attendant at birth (%)	-1.32	0.15	-1.61; -1.02	< 0.001	-0.60	-1.06; -0.14
Total fertility Rate (TFR)	21.27	4.38	12.64; 29.89	< 0.001	1.36	-1.23; 25.01
Contraceptive use (%)	-0.87	0.17	-1.20; -0.54	< 0.001	-0.21	-0.66; 0.24
Physical Violence (%)	2.58	0.51	1.58; 3.58	< 0.001	1.94	0.89; 3.00
All-abortion hospitalization	-1.88	0.31	-2.50; -1.26	< 0.001	-1.05	-1.96; -0.13
Hospital Beds	-0.12	0.04	-0.19; -0.05	<0.01	-0.02	-0.15; 0.11
Operating room	-0.93	0.91	-2.72; 0.86	0.307	1.72	-1.45; 4.89

* Darney *et al* reported an upper limit for 95% CI of -0.80. This value is non plausible because the
punctual estimate (-0.45) falls out of the confidence interval.

657 **Table 5.** Change on effect sizes (β) after stepwise regression models addressing the problem of multicollinearity among
658 variables.

	Full unspecified model				Stepwise model 1				Stepwise model 2			
	β	SE	95% CI	VIF	β	SE	95%CI	VIF	β	SE	95%CI	VIF
Abortion legislation (1=wide access)	20.87	8.45	4.22; 37.51*	3.61	14.59	4.54	5.66; 23.52*	1.04	10.98	5.96	-0.76; 22.71	1.70
Year	-1.02	0.38	-1.76; -0.26*	1.46	-0.97	0.34	-1.65; -0.31*	1.15	-1.37	0.35	-2.95; -0.68*	1.14
Clean water (%)	-0.48	0.20	-1.77; -0.26*	5.54	-0.76	0.12	-1.00; -0.51*	2.14	----	----	----	----
Female literacy (%)	-0.48	0.43	-1.32; 0.37	8.98	----	----	----	----	-1.93	0.23	-2.38; -1.48*	2.39
Low birth weight (%)	-0.49	0.67	-1.81; 0.82	2.70	----	----	----	----	----	----	----	----
Skilled attendant at birth (%)	-0.47	0.23	-0.93; -0.01*	3.38	-0.53	0.18	-0.89; -0.17*	2.11	----	----	----	----
Total fertility Rate (TFR)	4.49	6.73	-8.76; 17.75	3.99	----	----	----	----	----	----	----	----
Contraceptive use (%)	0.36	0.27	-0.17; 0.90	4.26	----	----	----	----	0.49	0.20	0.10; 0.89*	2.24
Physical Violence (%)	1.51	0.56	0.41; 2.62*	1.88	1.42	0.43	0.57; 2.28*	1.12	----	----	----	----
All-abortion hospitalization	-0.91	0.44	-1.79; -0.02*	2.99	----	----	----	----	-1.13	0.39	-1.89; -0.37*	2.12
Hospital Beds	-0.02	0.07	-0.16; 0.11	5.84	----	----	----	----	----	----	----	----
Operating room	1.54	1.67	-1.75; 4.83	5.68	----	----	----	----	2.40	1.08	0.27; 4.53*	2.26
Fit of the model R ² (%)	42.7%**				42.4%**				39.4%**			

659 VIF: Variance Inflation Factor; SE: Standard Error *p < 0.05; ** p for model < 0.001

Review, replication, and re-analysis of a recent study on the impact of abortion law on maternal mortality in Mexico – Maintaining rigor and research integrity

Elard Koch, Monique Chireau, Joseph Stanford, Sebastian Haddad, Miguel Bravo, Fernando Pliego and John Thorp

Submitted to Contraception

Appendix

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Table A3	Operational definition of independent variables.
Table A4	Time series for each co-variable included in linear regression model for state-level MMR.
Figure A1	Maternal mortality ratio by residence, access to abortion and year.
Figure A2	Maternal mortality ratio by occurrence, access to abortion and year.
Table A5	Average change per year in MMR by residence and occurrence.
References	References.

SUPPLEMENTARY METHODS AND RESULTS

In order to re-analyze the data, we performed a complete reconstruction of the database following strictly the sources listed in table A2 from the Darney *et al* article. The mortality database by year used herein has been submitted (Tables A1, A2) to check for possible differences with the original database constructed by Darney *et al*. Operational definition for every independent variable, expected association, source of data and year is presented in Table A3 and the raw data is presented in the Table A4. Most independent variables had only some punctual years with information. Therefore, for analytical purposes the missing years were imputed by using previous year data when available. An Excel spreadsheet with the analytical database is provided as supplemental file to facilitate reproducibility studies.

Descriptive results for the MMR trends are presented in figures A1 and A2. We replicate the trends for maternal mortality presented in Darney *et al*'s article. Although we use strictly the data sources indicated by Darney *et al* in Table A2 from their article, some punctual differences between the two databases may not be completely ruled out. Nevertheless, these possible punctual differences did not translate to any significant change in the MMR trends between Darney's paper and our replication. For instance, table A5 presents our replication of regression coefficients for the MMR trends using both Koch *et al*'s and Darney *et al*'s definitions for the exposure. The coefficients were remarkably similar between the two studies.

Table A1 Maternal mortality ratio (MMR) by place of residence in 32 Mexican states, according to INEGI and CONAPO, 2006-2013.

State	MMR (INEGI) ^a								MMR (CONAPO) ^b							
	2006	2007	2008	2009	2010	2011	2012	2013	2006	2007	2008	2009	2010	2011	2012	2013
Aguascalientes	47.2	15.5	34.0	50.4	37.6	18.2	48.3	26.5	44.8	15.0	33.7	48.8	37.8	18.9	49.2	26.5
Baja California	35.4	33.3	36.9	47.1	37.8	32.0	28.6	38.8	41.3	39.3	42.4	52.7	42.6	36.9	31.3	41.3
Baja California Sur	32.6	61.0	35.7	37.5	28.6	29.8	23.3	32.0	37.9	74.6	45.8	44.9	35.2	34.4	25.3	33.0
Campeche	60.1	17.7	38.7	46.2	39.3	45.2	38.2	57.9	63.2	18.8	43.7	49.6	49.4	61.4	42.7	66.8
Coahuila	24.8	22.1	32.4	25.8	42.1	37.4	33.4	25.6	25.4	23.7	34.8	27.6	44.3	40.7	37.0	29.6
Colima	51.0	15.7	31.4	22.3	0.0	35.6	22.4	22.6	46.5	15.4	30.5	22.9	0.0	37.9	22.5	22.4
Chiapas	62.0	50.0	59.8	48.9	39.3	35.7	47.1	37.8	69.5	66.7	79.2	61.5	60.2	52.6	59.8	54.7
Chihuahua	59.1	60.4	46.2	72.1	52.7	66.3	45.9	61.6	61.3	65.5	54.1	78.6	57.0	67.1	46.6	59.6
Distrito Federal	50.1	55.4	43.0	47.0	47.5	35.8	36.5	39.2	53.2	61.8	48.6	51.4	55.2	41.3	41.9	43.3
Durango	67.7	34.8	58.5	32.7	35.3	31.0	47.2	38.2	74.1	40.3	66.6	37.9	44.2	38.5	56.4	44.6
Guanajuato	36.4	31.4	31.2	47.9	33.1	33.9	34.3	34.4	36.2	33.9	33.3	51.4	36.2	36.4	36.5	35.7
Guerrero	82.4	55.2	61.1	68.7	44.2	60.7	57.0	43.1	103.9	80.4	78.9	87.5	69.4	91.3	74.8	59.3
Hidalgo	41.3	44.4	43.6	48.8	46.6	25.2	35.0	35.6	46.1	53.5	50.0	53.5	52.1	28.7	37.7	37.7
Jalisco	50.1	29.2	33.2	52.3	29.7	22.1	22.3	21.3	51.5	30.7	34.7	54.1	32.3	24.2	24.2	22.8
México	45.1	41.5	44.9	46.7	35.4	38.8	39.8	33.7	48.8	47.1	50.5	54.5	38.9	41.5	42.4	34.8
Michoacán	53.2	37.3	41.1	38.2	42.1	47.6	38.1	33.3	57.1	42.2	47.7	44.6	53.9	58.3	44.1	38.7
Morelos	49.9	37.4	39.2	62.6	24.9	32.3	34.7	40.2	50.3	44.4	44.1	67.2	29.3	37.9	37.7	43.3
Nayarit	28.9	20.4	36.0	48.8	32.5	40.1	38.9	33.1	34.2	24.1	42.9	56.7	37.8	46.7	46.1	36.5
Nuevo León	27.4	18.5	25.2	27.3	14.9	26.7	23.3	13.9	28.2	20.0	27.0	29.4	16.5	29.4	25.8	15.2
Oaxaca	50.5	57.1	56.6	60.6	53.8	50.6	55.5	44.3	63.3	82.9	79.9	79.1	71.3	60.7	64.6	50.2
Puebla	40.1	36.7	37.7	50.1	36.1	40.2	43.4	28.5	47.8	44.3	47.5	60.0	44.8	45.7	49.8	31.2
Querétaro	50.6	39.1	37.7	29.1	31.8	38.4	19.2	33.5	52.5	44.7	42.4	31.9	34.7	42.6	21.2	37.1
Quintana Roo	47.7	48.1	58.0	33.9	44.8	45.1	48.7	46.3	54.3	56.2	67.7	38.7	49.4	48.2	50.8	46.2
San Luis Potosí	32.7	49.8	28.6	48.0	37.6	41.7	39.4	31.2	34.4	54.7	31.1	51.3	40.6	44.4	40.8	31.6
Sinaloa	33.4	41.2	29.2	30.0	29.4	14.9	38.2	24.9	35.4	44.4	32.2	32.4	32.6	16.4	40.2	25.7
Sonora	46.9	36.0	25.3	38.9	22.2	40.2	31.6	39.8	47.8	38.1	26.6	40.0	23.0	42.1	32.4	39.9
Tabasco	40.0	41.8	53.9	41.5	28.1	42.4	34.8	26.7	43.6	48.0	58.7	48.5	29.7	44.8	36.4	30.2
Tamaulipas	48.9	32.7	44.3	33.2	37.6	14.9	25.3	41.7	53.3	37.9	50.9	37.6	41.3	15.9	25.6	40.0
Tlaxcala	50.9	24.1	21.8	40.3	51.7	25.1	56.7	22.2	54.6	27.4	23.6	43.4	55.3	27.7	63.3	23.7
Veracruz	44.0	53.7	52.2	53.7	44.8	47.3	43.9	39.7	53.8	68.1	67.9	64.7	54.7	56.9	50.7	45.2
Yucatán	27.3	52.8	38.9	39.3	31.8	38.0	54.9	51.8	26.1	51.9	38.7	38.4	30.7	35.6	50.6	50.4
Zacatecas	41.5	28.0	34.0	48.2	33.4	32.8	28.1	39.9	43.5	31.2	37.5	53.2	38.1	38.2	31.9	44.8

MMR: Maternal mortality ratio per 100,000 live births. Official records of maternal deaths (ICD-10 codes O00-O99, A34, B20-B24, and F53) by place of residence were extracted from the General Directorate of Health Information (DGIS),¹ excluding cases outside the United Mexican States. (a) Denominator for MMR was extracted from the INEGI.² (b) Denominator for MMR was extracted from CONAPO.³

Table A2 Maternal mortality ratio (MMR) by place of occurrence in 32 Mexican states, according to INEGI and CONAPO, 2006-2013

State	MMR (INEGI) ^a								MMR (CONAPO) ^b							
	2006	2007	2008	2009	2010	2011	2012	2013	2006	2007	2008	2009	2010	2011	2012	2013
Aguascalientes	43.3	17.9	31.7	69.1	35.5	17.7	44.6	24.5	44.8	18.7	33.7	71.3	37.8	18.9	49.2	26.5
Baja California	38.9	36.8	38.1	53.6	42.6	35.5	37.0	41.0	43.0	41.0	42.4	57.9	46.1	38.6	38.2	41.3
Baja California Sur	33.9	62.8	36.7	35.6	21.9	22.6	15.6	32.1	37.9	74.6	45.8	44.9	26.4	25.8	16.8	33.0
Campeche	63.9	18.6	40.4	48.2	43.0	53.1	35.7	62.1	63.2	18.8	43.7	49.6	49.4	61.4	36.6	66.8
Coahuila	29.8	23.7	32.3	30.9	35.0	33.9	35.0	28.8	30.9	25.6	34.8	33.1	36.9	37.0	38.8	33.2
Colima	31.6	21.8	37.0	21.3	6.9	20.0	20.9	14.1	31.0	23.0	38.1	22.9	7.6	22.7	22.5	14.9
Chiapas	57.6	47.1	54.5	43.5	37.1	32.6	44.6	35.1	65.3	64.1	74.0	54.6	56.7	48.2	56.3	50.3
Chihuahua	58.4	56.0	47.0	72.8	52.3	67.3	45.6	62.9	61.3	61.2	55.5	80.0	57.0	68.6	46.6	61.0
Distrito Federal	64.0	59.8	52.7	60.3	57.5	54.0	44.1	62.6	88.0	84.7	73.9	82.2	80.6	71.5	59.1	68.4
Durango	53.2	33.1	57.1	28.4	34.2	22.5	38.5	28.6	57.0	37.4	63.7	32.1	41.3	26.6	44.5	32.7
Guanajuato	37.0	26.8	31.1	50.0	31.1	33.4	34.7	32.3	37.9	29.7	34.1	53.2	33.6	35.5	36.5	34.0
Guerrero	80.0	53.6	58.4	69.5	43.5	55.8	57.5	45.2	98.9	76.6	73.8	86.2	66.8	82.0	73.4	60.6
Hidalgo	37.3	42.1	39.8	46.1	41.2	20.5	33.0	31.4	42.5	51.7	46.4	51.7	46.7	23.3	35.9	32.4
Jalisco	49.6	30.5	32.5	47.6	31.5	24.4	25.3	23.2	50.8	32.1	34.1	49.5	34.3	26.9	27.5	24.8
México	38.2	39.1	42.1	40.7	30.3	32.5	37.7	25.0	35.7	39.0	42.0	42.3	29.8	32.3	36.8	26.7
Michoacán	50.8	32.8	41.2	39.2	41.6	49.6	34.5	32.3	52.8	35.7	45.6	43.5	50.6	57.2	37.5	35.3
Morelos	40.1	39.6	38.5	66.5	22.1	32.4	34.3	37.6	41.5	47.3	44.1	73.1	26.3	37.9	37.7	40.4
Nayarit	31.5	18.0	44.9	48.6	26.3	48.7	38.7	36.5	34.2	19.3	47.7	52.0	28.4	51.4	41.5	36.5
Nuevo León	29.3	23.6	25.9	29.0	24.1	34.8	25.1	19.0	30.6	25.8	28.2	31.7	27.1	38.8	28.2	21.1
Oaxaca	50.1	54.7	57.0	58.9	54.3	50.7	51.7	45.2	62.2	78.2	78.7	75.5	71.3	60.7	59.7	50.2
Puebla	37.4	38.6	37.9	52.4	38.0	40.8	43.5	29.4	44.0	45.8	46.7	60.8	45.6	45.0	48.2	31.2
Querétaro	53.6	46.8	36.6	25.8	32.7	34.4	18.5	33.2	57.8	55.2	42.4	29.2	37.3	39.9	21.2	37.1
Quintana Roo	37.1	41.9	52.7	30.7	38.2	41.6	48.9	42.5	41.8	48.2	59.7	34.8	41.8	44.5	50.8	42.6
San Luis Potosí	35.1	49.1	27.7	48.3	40.3	38.5	38.8	32.2	36.2	52.8	29.2	49.5	42.5	40.7	39.0	31.6
Sinaloa	38.4	44.5	27.7	30.3	29.5	16.5	38.4	26.8	40.7	48.0	30.4	32.4	32.6	18.2	40.2	27.5
Sonora	42.9	37.8	25.4	31.6	20.3	40.2	26.2	40.0	44.0	40.0	26.6	32.4	21.1	42.1	26.7	39.9
Tabasco	43.4	47.1	60.8	53.0	36.6	43.9	42.8	34.5	47.7	54.2	67.1	63.3	40.3	49.0	47.1	40.9
Tamaulipas	65.1	28.8	50.9	39.7	32.7	16.1	33.6	41.5	71.6	33.3	58.6	45.4	36.6	17.5	35.1	41.6
Tlaxcala	50.0	22.2	15.2	30.3	45.2	29.3	60.8	19.0	50.7	23.5	15.7	31.5	47.4	31.6	67.2	19.8
Veracruz	43.1	54.9	52.0	53.7	46.1	47.1	43.0	36.3	51.1	67.4	65.1	62.6	54.7	54.8	47.9	39.5
Yucatán	34.4	56.5	43.0	38.4	33.8	37.2	56.4	53.3	33.9	57.1	43.9	38.4	33.3	35.6	53.1	52.9
Zacatecas	49.0	31.8	40.8	46.3	33.9	36.8	35.7	46.2	49.7	34.3	43.7	50.1	38.1	41.4	38.3	48.0

MMR: Maternal mortality ratio per 100,000 live births. Official records of maternal deaths (ICD-10 codes O00-O99, A34, B20-B24, and F53) by place of occurrence were extracted from the General Directorate of Health Information (DGIS),¹ excluding cases outside the United Mexican States. (a) Denominator for MMR was extracted from the INEGI.² (b) Denominator for MMR was extracted from CONAPO.³

Table A3 Operational definition of independent variables.

Independent variable (abbreviated name)	Description	Expected relationship with the MMR*	Source of data
Clean water	Percentage of occupied private dwellings with water availability	Inverse correlation	INEGI. 2005, 2010. Census of Population and Housing (4)
Female literacy	Percentage of the female population of ages 12 and above who can read and write	Inverse correlation	INEGI. 2010. Census of Population and Housing (4)
Low birth weight	Percentage of live births with low birth weight (<2500g)	Direct correlation	INEGI. Society. Nutrition (5)
Skilled attendance at birth	Proportion of births attended by a physician	Inverse correlation	National Survey of Demographics Dynamics 2006, 2009, 2014 (6)
TFR	Total fertility rate per year according to estimates for each state.	Direct correlation	CONAPO. Estimates and projections of population (3)
Contraceptive use	Percentage of current users of contraceptive methods in women 15 to 49 years	Inverse correlation	National Survey of Demographics Dynamics 2006, 2009, 2014 (6)
Physical violence	Percentage of married or in-union women of ages 15 and above who have suffered physical violence by their partner in last 12 months	Direct correlation	INEGI. Society. Gender statistics (7)
All-abortion hospitalization	Ratio of all-abortion related hospitalizations in each state between 2000 and 2008 per 100 live births estimated	Inverse or direct correlation	Schiavon et al.: Series of all-abortion hospitalizations (8) and births estimated by CONAPO (3)
Hospital beds	Rate of hospital beds in institutions of the National Health System by 100 thousand inhabitants	Inverse or direct correlation	INEGI. Society. Resources for health (9)
Operating room	Rate of operating rooms in institutions of the National Health System by 100 thousand inhabitants	Inverse or direct correlation	INEGI. Society. Resources for health (9)

* MMR = maternal mortality ratio

Table A4 Co-variables included in linear regression model for state-level MMR by place of residence, 2006-2013

State	Clean water		Female literacy		Low birth weight						Skilled attendance at birth			
	2005	2010	2005	2010	2006	2007	2008	2009	2010	2011	2012	2006	2009	2014
Aguascalientes	97.6	98.0	95.7	96.2	7.2	7.7	5.2	5.0	6.6	5.0	5.3	94.9	97.1	97.4
Baja California	94.1	95.3	96.3	96.2	4.6	5.0	5.2	5.2	6.9	5.0	5.7	88.1	94.0	96.9
Baja California Sur	86.5	88.1	95.8	96.0	4.4	5.0	3.9	4.1	6.0	5.1	5.2	95.6	98.0	95.7
Campeche	85.3	85.0	88.9	90.3	5.3	6.3	5.7	6.3	7.2	6.9	6.8	86.3	92.3	93.7
Coahuila	96.0	96.8	96.7	96.7	4.0	4.6	5.1	5.5	8.0	5.5	5.8	93.7	96.6	95.5
Colima	97.1	97.3	93.9	94.5	4.9	5.4	5.0	5.0	5.4	4.7	5.2	92.6	97.4	97.3
Chiapas	71.7	73.8	76.0	79.2	6.9	8.6	8.0	7.8	8.6	8.4	8.6	71.6	73.9	67.7
Chihuahua	93.5	94.9	95.5	95.5	5.4	5.5	5.2	5.3	7.6	5.6	5.5	84.7	96.5	95.8
Distrito Federal	98.1	97.5	96.4	96.4	10.1	10.9	10.6	11.0	14.0	11.4	11.8	97.9	98.8	97.7
Durango	91.3	92.9	95.5	95.8	4.9	6.4	6.3	6.6	8.0	6.7	6.4	90.2	95.7	96.7
Guanajuato	92.7	91.9	89.1	90.8	6.9	7.9	7.4	8.0	8.9	7.8	7.8	92.6	96.2	96.8
Guerrero	64.5	62.0	79.1	81.4	7.2	8.7	8.2	8.5	9.3	9.0	8.8	76.7	87.0	82.1
Hidalgo	85.9	87.2	86.2	88.1	7.5	8.1	7.7	8.7	8.5	8.4	8.1	89.2	95.6	95.9
Jalisco	93.4	94.6	94.3	95.1	6.0	6.7	6.4	6.6	9.0	6.8	6.8	93.5	96.7	97.1
México	93.2	92.2	93.4	94.0	7.9	10.1	8.6	9.4	10.9	10.8	11	93.1	97.8	96.3
Michoacán	88.7	88.1	87.7	89.2	6.7	8.0	7.8	7.5	8.6	7.9	7.9	91.8	95.7	97.3
Morelos	89.6	87.6	91.3	92.3	7.6	8.8	8.5	9.0	10.5	9.1	9.0	93.5	95.0	95.6
Nayarit	89.9	88.3	92.3	93.4	4.2	5.5	5.1	5.6	6.8	5.6	5.5	90.4	96.3	95.1
Nuevo León	95.5	96.9	96.7	96.0	5.0	5.8	5.7	5.3	8.6	6.0	6.0	95.6	97.3	98.3
Oaxaca	71.4	69.8	78.5	80.9	6.0	7.5	7.2	6.9	7.8	7.3	7.4	81.7	89.1	86.8
Puebla	84.4	83.8	85.8	87.7	7.8	9.0	8.5	8.5	9.6	9.2	9.2	86.1	92.5	92.8
Querétaro	90.6	91.9	90.8	92.2	7.2	8.8	7.5	7.9	9.2	8.5	8.1	92.1	96.1	95.7
Quintana Roo	93.7	91.7	92.5	92.8	6.4	7.4	7.2	6.6	8.3	6.8	6.4	83.3	88.9	92.6
San Luis Potosí	82.4	83.1	89.8	91.2	6.1	7.1	6.6	7.3	8.1	7.6	7.7	86.9	94.6	94.3
Sinaloa	90.4	90.3	94.3	95.0	4.5	4.9	4.5	5.0	6.1	4.6	4.7	91.7	97.8	97.3
Sonora	94.2	94.4	96.5	96.5	4.4	4.7	4.1	4.3	6.2	4.4	4.4	91.5	98.1	97.4
Tabasco	75.2	73.8	90.4	91.5	6.8	7.8	7.3	7.5	8.4	7.2	7.6	87.3	93.8	94.0
Tamaulipas	94.0	95.1	95.2	94.5	5.3	6.0	5.3	5.6	7.4	6.1	6.0	92.9	97.7	96.8
Tlaxcala	96.5	95.6	92.2	93.3	8.9	10.5	8.9	9.3	10.1	9.2	9.9	92.1	96.5	97.9
Veracruz	73.8	76.3	85.5	86.9	5.7	6.5	5.9	6.1	7.1	6.5	6.3	85.3	91.5	91.8
Yucatán	93.6	94.4	88.2	89.3	8.3	8.9	8.4	8.0	10.7	9.2	9.5	87.1	91.0	93.2
Zacatecas	92.2	91.7	93.1	94.1	5.8	7.0	7.1	7.9	8.6	7.9	8.0	92.4	96.3	96.9

Table A4 Co-variables included in linear regression model for state-level MMR by place of residence, 2006-2013 (continued)

State	TFR								Contraceptive use			Physical violence	All-abortion hospitalization ratio
	2006	2007	2008	2009	2010	2011	2012	2013	2006	2009	2014	2006	2000-2008
Aguascalientes	2.75	2.70	2.65	2.60	2.55	2.51	2.48	2.45	43.2	46.4	48.4	13.3	10.4
Baja California	2.11	2.08	2.07	2.05	2.01	2.00	1.99	1.99	57.9	56.2	56.2	11.5	10.4
Baja California Sur	2.10	2.07	2.05	2.02	2.00	1.98	1.96	1.95	58.7	56.6	58.1	12.1	12.7
Campeche	2.22	2.19	2.17	2.16	2.14	2.12	2.11	2.10	51.4	52.9	51.6	15.8	8.6
Coahuila	2.42	2.39	2.36	2.34	2.31	2.28	2.27	2.25	54.0	54.2	55.9	11.5	8.3
Colima	2.40	2.38	2.35	2.30	2.26	2.25	2.23	2.22	48.8	54.4	56.7	15.3	17.4
Chiapas	3.00	2.92	2.84	2.77	2.70	2.64	2.58	2.53	36.7	37.4	40.4	11.8	6.3
Chihuahua	2.44	2.43	2.41	2.38	2.31	2.31	2.30	2.29	54.6	55.9	59.3	14.5	7.3
Distrito Federal	1.82	1.81	1.80	1.80	1.80	1.80	1.79	1.79	50.8	54.7	52.7	13.6	15.7
Durango	2.59	2.54	2.49	2.44	2.38	2.35	2.31	2.29	47.0	51.5	52.5	13.6	9.5
Guanajuato	2.55	2.50	2.45	2.41	2.37	2.34	2.32	2.29	37.8	43.9	47.3	14.9	7.3
Guerrero	3.03	2.94	2.86	2.78	2.69	2.63	2.57	2.51	35.8	40.9	47.8	15.8	4.5
Hidalgo	2.53	2.49	2.45	2.43	2.38	2.36	2.34	2.31	48.0	49.1	53.6	15.5	7.1
Jalisco	2.46	2.42	2.39	2.36	2.32	2.30	2.28	2.26	45.7	47.6	48.2	12.5	7.8
México	2.33	2.31	2.28	2.25	2.23	2.21	2.20	2.18	49.9	53.4	55.4	16.1	4.9
Michoacán	2.54	2.50	2.46	2.42	2.38	2.36	2.34	2.32	39.1	40.2	46.2	15.7	7.2
Morelos	2.28	2.26	2.24	2.22	2.20	2.19	2.18	2.17	47.5	51.7	54.6	15.4	9.7
Nayarit	2.37	2.35	2.33	2.30	2.25	2.24	2.23	2.22	56.4	56.5	57.7	15.1	8.8
Nuevo León	2.19	2.18	2.16	2.15	2.13	2.12	2.11	2.10	52.4	55.9	53.2	11.0	6.9
Oaxaca	2.77	2.72	2.67	2.62	2.56	2.52	2.48	2.45	35.2	41.8	42.8	14.8	5.1
Puebla	2.72	2.67	2.62	2.57	2.53	2.49	2.46	2.43	39.6	45.2	50.2	15.0	5.0
Querétaro	2.43	2.39	2.33	2.28	2.24	2.22	2.19	2.17	42.5	45.5	51.0	13.6	9.5
Quintana Roo	2.10	2.11	2.06	2.06	2.05	2.05	2.05	2.04	56.8	54.7	55.2	14.5	11.1
San Luis Potosí	2.66	2.62	2.57	2.53	2.48	2.45	2.41	2.38	44.8	45.3	50.3	15.9	7.1
Sinaloa	2.41	2.39	2.36	2.33	2.29	2.27	2.25	2.24	50.6	53.9	54.6	10.2	9.0
Sonora	2.44	2.43	2.40	2.37	2.32	2.30	2.28	2.27	51.9	52.9	55.5	10.2	9.3
Tabasco	2.44	2.40	2.37	2.34	2.31	2.28	2.26	2.24	51.8	47.2	50.0	13.6	7.7
Tamaulipas	2.37	2.37	2.31	2.26	2.21	2.20	2.18	2.17	49.3	50.8	54.4	11.6	11.2
Tlaxcala	2.55	2.51	2.47	2.43	2.39	2.36	2.33	2.31	47.7	43.4	53.2	15.4	8.3
Veracruz	2.31	2.28	2.25	2.22	2.19	2.17	2.15	2.14	50.1	53.3	51.0	15.4	6.1
Yucatán	2.34	2.32	2.30	2.29	2.27	2.26	2.25	2.24	50.0	50.7	51.4	14.0	7.1
Zacatecas	2.62	2.58	2.55	2.51	2.46	2.43	2.41	2.39	43.9	47.0	49.6	15.1	9.1

Table A4 Co-variables included in linear regression model for state-level MMR by place of residence, 2006-2013 (continued)

State	Hospital beds							Operating room						
	2006	2007	2008	2009	2010	2011	2012	2006	2007	2008	2009	2010	2011	2012
Aguascalientes	75.0	79.3	76.0	74.9	74.0	70.4	71.2	3.7	3.3	3.5	3.8	3.4	3.2	2.9
Baja California	54.7	66.0	59.4	61.5	61.1	65.9	65.1	3.2	2.0	1.9	2.4	1.9	2.7	2.3
Baja California Sur	92.1	88.0	86.9	86.3	82.3	99.3	96.8	6.4	5.0	4.5	5.3	4.6	4.3	4.5
Campeche	88.3	88.2	86.4	86.6	121.1	104.6	99.3	3.9	3.6	3.4	3.8	4.9	4.3	4.0
Coahuila	90.7	98.3	99.6	97.0	96.5	95.8	93.1	4.4	3.5	3.5	3.9	3.6	3.8	3.7
Colima	83.4	92.8	88.3	95.2	88.8	79.7	85.1	4.0	3.6	3.7	3.8	3.7	4.3	4.4
Chiapas	43.0	46.1	42.2	42.4	45.4	45.3	41.1	2.2	2.8	2.3	2.4	2.2	2.6	2.4
Chihuahua	62.8	74.6	79.0	78.6	75.7	77.2	76.9	3.0	2.3	2.2	3.1	2.9	3.3	3.1
Distrito Federal	170.8	174.6	170.2	169.9	175.6	176.5	180.7	7.0	6.6	6.5	6.9	7.0	7.6	7.2
Durango	83.8	90.4	87.1	92.0	90.0	89.6	91.8	3.7	3.3	3.8	4.1	3.9	3.5	3.2
Guanajuato	50.3	59.7	60.0	60.7	53.4	54.9	54.1	2.5	2.3	2.5	2.7	2.2	2.5	2.5
Guerrero	45.8	52.9	51.6	49.5	49.5	51.5	51.6	2.6	3.8	3.8	3.9	3.6	3.3	3.6
Hidalgo	52.0	54.8	55.5	55.8	50.5	49.7	47.7	2.1	1.8	2.0	2.2	2.0	2.1	1.7
Jalisco	84.3	92.1	86.9	85.2	81.1	85.1	83.8	3.6	2.8	2.7	3.1	2.7	3.3	3.0
México	44.6	46.6	45.6	45.1	47.6	48.3	49.1	1.6	1.4	1.5	1.6	1.6	1.8	1.7
Michoacán	48.6	56.3	56.0	58.1	54.1	54.2	56.4	2.7	2.4	2.5	2.9	2.6	2.6	2.4
Morelos	54.2	47.1	49.4	49.0	52.2	52.8	60.1	2.3	2.1	2.4	2.4	2.7	2.9	3.1
Nayarit	62.9	69.2	67.8	68.7	61.6	60.3	62.9	3.6	3.0	3.1	4.2	3.4	3.4	3.1
Nuevo León	83.2	86.9	84.4	81.1	84.6	84.4	70.7	3.3	3.0	3.3	3.3	3.1	3.0	2.5
Oaxaca	48.3	50.2	51.0	50.4	49.2	53.5	53.1	2.1	1.9	2.1	2.3	2.1	2.3	2.5
Puebla	61.5	63.5	61.1	62.4	61.2	60.9	60.4	2.7	2.4	2.6	2.7	2.7	2.8	2.7
Querétaro	44.4	46.2	45.7	47.3	45.6	44.4	46.3	2.1	1.7	1.9	2.0	2.1	2.3	2.2
Quintana Roo	44.1	43.0	55.7	59.9	59.1	70.1	67.2	3.3	2.5	2.8	2.8	2.5	3.9	3.5
San Luis Potosí	56.1	64.8	63.0	59.6	63.5	65.5	74.9	2.6	2.1	2.2	2.3	2.4	2.6	2.7
Sinaloa	74.3	84.2	79.7	78.5	77.6	79.1	70.7	4.2	3.3	3.5	4.4	3.9	4.5	4.0
Sonora	90.3	97.1	101.4	103.5	100.9	97.4	88.8	4.4	4.1	3.7	4.2	4.0	4.0	3.3
Tabasco	63.1	80.1	77.4	76.2	72.4	69.3	65.1	3.1	3.5	3.9	3.7	3.8	3.7	3.4
Tamaulipas	80.2	87.2	87.4	87.9	86.2	87.0	88.3	3.4	2.8	3.0	3.2	2.7	3.2	3.4
Tlaxcala	50.2	55.1	53.9	54.5	55.5	54.3	42.1	2.6	2.2	2.1	2.3	2.3	2.7	2.6
Veracruz	64.6	66.6	65.7	64.5	61.2	62.7	63.5	3.2	2.7	2.9	3.2	2.8	2.9	3.0
Yucatán	76.1	82.6	78.4	87.2	76.3	88.4	90.2	3.2	2.6	2.6	2.6	2.4	2.6	2.7
Zacatecas	50.5	63.4	60.6	62.7	62.7	69.0	65.5	3.5	3.0	3.0	3.3	3.1	3.6	3.4

Figure A1 Maternal Mortality Ratio^a by place of residence, access to abortion and year

a. Using Koch et al's state classification

Absolute numbers of maternal deaths by year and access to abortion.

Less rest.	679	704	707	715	604	589	593	507
More rest.	486	393	412	492	388	382	367	354

b. Using Darney et al's state classification

Absolute numbers of maternal deaths by year and access to abortion.

Wide acc.	78	89	69	72	76	56	56	57
Rest. acc.	1087	1008	1050	1135	916	915	904	804

^a MMR denominator is the birth estimate from CONAPO.

*Koch et al study ends in 2011.

Figure A2 Maternal Mortality Ratio^a by place of occurrence, access to abortion and year

a. Using Koch et al's state classification

Absolute numbers of maternal deaths by year and access to abortion.

Less rest.	667	705	700	710	597	577	584	500
More rest.	499	392	419	497	394	394	376	361

b. Using Darney et al's state classification

Absolute numbers of maternal deaths by year and access to abortion.

Wide acc.	129	122	105	115	111	97	79	90
Rest. acc.	1037	975	1014	1092	880	874	881	771

^a MMR denominator is the birth estimate from CONAPO.

*Koch et al study ends in 2011.

Table A5 Average change per year in MMR by place of residence and occurrence comparing Darney *et al.* report with Koch et al. replication study.

Using Koch et al's classification	Darney et al.			Koch et al. replication study		
	Coefficient	SE	p-value	Coefficient	SE	p-value
By place of residence						
More restrictive legislation	-0.92	0.45	0.051	-0.95	0.45	0.038
Less restrictive legislation	-1.72	0.65	0.010	-1.78	0.68	0.010
All states	-1.27	0.40	0.002	-1.31	0.41	0.002
By place of occurrence						
More restrictive legislation	-0.99	0.46	0.034	-1.00	0.46	0.032
Less restrictive legislation	-1.86	0.73	0.013	-1.87	0.73	0.012
All states	-1.37	0.42	0.001	-1.38	0.42	0.001
Using Darney et al's classification						
By place of residence						
Restricted access	-1.25	0.41	0.003	-1.29	0.42	0.002
Wide Access (Mexico City)	-2.81	0.95	0.032	-2.82	0.95	0.032
All states	-1.27	0.40	0.002	-1.31	0.41	0.002
By place of occurrence						
Restricted access	-1.41	0.41	0.001	-1.43	0.41	0.001
Wide Access (Mexico City)	-3.20	1.21	0.046	-3.18	1.19	0.045
All states	-1.37	0.42	0.001	-1.38	0.42	0.001

MMR = maternal mortality ratio

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ID_State	ID_Correl	State	Correlative_year	Year	MaternalM_r
1	1	1 Aguascalientes	1	2006	12
1	2	2 Aguascalientes	2	2007	4
1	3	3 Aguascalientes	3	2008	9
1	4	4 Aguascalientes	4	2009	13
1	5	5 Aguascalientes	5	2010	10
1	6	6 Aguascalientes	6	2011	5
1	7	7 Aguascalientes	7	2012	13
1	8	8 Aguascalientes	8	2013	7
2	9	9 Baja California	1	2006	23
2	10	10 Baja California	2	2007	22
2	11	11 Baja California	3	2008	24
2	12	12 Baja California	4	2009	30
2	13	13 Baja California	5	2010	24
2	14	14 Baja California	6	2011	21
2	15	15 Baja California	7	2012	18
2	16	16 Baja California	8	2013	24
3	17	17 Baja California Sur	1	2006	4
3	18	18 Baja California Sur	2	2007	8
3	19	19 Baja California Sur	3	2008	5
3	20	20 Baja California Sur	4	2009	5
3	21	21 Baja California Sur	5	2010	4
3	22	22 Baja California Sur	6	2011	4
3	23	23 Baja California Sur	7	2012	3
3	24	24 Baja California Sur	8	2013	4
4	25	25 Campeche	1	2006	10
4	26	26 Campeche	2	2007	3
4	27	27 Campeche	3	2008	7
4	28	28 Campeche	4	2009	8
4	29	29 Campeche	5	2010	8
4	30	30 Campeche	6	2011	10
4	31	31 Campeche	7	2012	7
4	32	32 Campeche	8	2013	11
5	33	33 Coahuila	1	2006	14
5	34	34 Coahuila	2	2007	13
5	35	35 Coahuila	3	2008	19
5	36	36 Coahuila	4	2009	15
5	37	37 Coahuila	5	2010	24
5	38	38 Coahuila	6	2011	22
5	39	39 Coahuila	7	2012	20
5	40	40 Coahuila	8	2013	16
6	41	41 Colima	1	2006	6
6	42	42 Colima	2	2007	2