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Original Research

Identifying Maternal Deaths in Texas Using an Enhanced Method, 2012

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OBJECTIVE: To more accurately estimate the 2012 maternal mortality ratio for Texas using an enhanced method for identifying maternal deaths.

METHODS: This population-based descriptive study used both data matching and record review to verify pregnancy or delivery within 42 days for 147 deaths with obstetric cause-of-death codes, and used data matching alone to identify additional maternal deaths within the same timeframe. Crude maternal mortality ratios were calculated for confirmed maternal deaths overall, by race and ethnicity, and by age. These maternal mortality ratios were compared with maternal mortality ratios computed using obstetric cause-of-death codes alone (standard method).

RESULTS: Fifty-six maternal deaths were confirmed to have occurred during pregnancy or within 42 days postpartum. Using our enhanced method, the 2012 maternal mortality ratio for Texas was 14.6 maternal deaths per 100,000 live births, less than half that obtained using the standard method (n=147). Approximately half (50.3%) of obstetric-coded deaths showed no evidence of pregnancy within 42 days, and a large majority of these incorrectly indicated pregnancy at the time of death. Insufficient information was available to determine pregnancy for 15 obstetric-coded deaths, which were excluded from the 2012 maternal mortality ratio estimate; however, had these deaths been included, the resulting maternal mortality ratio would still be significantly lower than that reported using the standard method.

CONCLUSION: Relying solely on obstetric codes for identifying maternal deaths appears to be insufficient and can lead to inaccurate maternal mortality ratios. A method enhanced with data matching and record review yields more accurate ratios. Results likely have national implications, because miscoding of obstetric deaths with the standard method may affect the accuracy of other states' maternal mortality ratios.

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Maternal death, a major marker of the health of a nation or state,[1,2] is defined as "the death of a woman while pregnant or within 42 days of the end of pregnancy, regardless of duration and site of the pregnancy, from any cause related to or aggravated by pregnancy or its management, but not from accidental or incidental causes."[3] The standard method for identifying maternal death relies on an obstetric cause-of-death code on the official death record.[4] Cause-of-death narrative and pregnancy status on a woman's death certificate are used by the Centers for Disease Control and Prevention (CDC) National Center for Health Statistics to determine whether to assign an obstetric code.[5]

A significant increase in Texas' maternal mortality ratio was reported from 2010 to 2012 using the standard method for maternal death identification.[6] As with the national rise in the maternal mortality

ratio,[6–9] this could be the result of an increase in chronic conditions or better case identification; however, data quality issues may also be responsible. Inconsistencies among cause-of-death codes, narratives, and pregnancy status on the death record have been observed for a number of maternal deaths in Texas.[10] Potential errors in identifying maternal deaths and their effect on state and national maternal mortality ratios, especially among women of advanced maternal age, have also been investigated.[2,11,12] These errors could result in either an overestimate or an underestimate of the maternal mortality ratio.

Because of potential inaccuracies in the standard method, we used a method enhanced with data matching and record review to confirm maternal deaths in 2012, the year with the highest observed Texas maternal mortality ratio. Study objectives were to obtain an accurate count of confirmed maternal deaths in 2012 and to estimate a corresponding Texas maternal mortality ratio.

MATERIALS AND METHODS

This was a population-based, descriptive epidemiologic study. Data sources included death records for all 2012 female Texas resident deaths with an obstetric cause-of-death code obtained from CDC National Center for Health Statistics, Texas Department of State Health Services vital statistics and hospital discharge data, medical records, and death investigation reports. All female Texas residents who died between January 1, 2012, and December 31, 2012, were evaluated for inclusion in the study. Female non-Texas residents were excluded. There is a data-sharing program among all U.S. states, developed by the National Association for Public Health Statistics and Information Systems, called the State and Territorial Exchange of Vital Events system. Using this system, states send vital records that pertain to residents in other states so that these important data are included in the home state's reports and statistics. Our analysis did not exclude residents based on citizenship status; as long as Texas was listed as the state where the decedent resided at the time of death, the death was counted.

The enhanced method used involved two steps: A) review of records for all 2012 Texas resident deaths with obstetric cause-of-death codes for evidence of pregnancy within 42 days of death and B) identification of additional confirmed maternal deaths through data matching. Step B enabled us to confirm maternal deaths occurring within 42 days of a delivery event that were not assigned an obstetric cause-of-death code. The enhanced method used is not a novel one; similar methods have been used by maternal mortality review committees to verify maternal deaths.[13,14] However, this method for maternal death identification has not been regularly used in the calculation of maternal mortality ratios, likely because of the time-intensive nature of the process.

Individual-level data for all 2012 female Texas resident deaths with an International Statistical Classification of Diseases and Related Health Problems (ICD-10) obstetric cause-of-death code indicating maternal death while pregnant or within 42 days postpartum (A34, O00–O95, or O98–O99) were requested and obtained from the National Center for Health Statistics (n=147). Codes O96–O97 were excluded, because these are specific to late maternal death (up to and beyond 1 year postpartum). These deaths were matched to 2011–2012 Texas live birth and fetal death event data using deterministic linkage analysis with the following fields: decedent's Social Security number; decedent's first, maiden, and last names; decedent's date of birth; and decedent's county of residence. This data matching allowed for immediate pregnancy verification and calculation of days elapsed between the end of pregnancy and death. Texas vital events data are entered by certifiers and registrars and are validated by the software at the time of data entry as well as by several rounds of data quality edits by the Department of State Health Services Center for Health Statistics and the Department of State Health Services Vital Statistics Section.

Death records with ICD-10 obstetric cause-of-death codes that did not match with a birth or fetal death event were then matched with 2011 and 2012 inpatient hospital discharge records using the same linkage process. Texas hospital discharge data are submitted by facilities and are audited by the Department of State Health Services Texas Health Care Information Collection for accuracy. Hospitals also have a chance to review and certify final hospital discharge data. Facility information from matched hospital discharge records was used to request all medical records within 1 year before death. Certifier information obtained from the death certificate was used to request autopsy and death investigation reports, if available. Medical records and death investigation records were requested and obtained from hospitals and death certifiers between October 2016 and July 2017. Once received, these records were examined for evidence of pregnancy or delivery. All records were reviewed by two epidemiologists (S.B. and D.L.S.) to ensure accuracy. If medical records were not received or did not contain sufficient

information, death certifiers were contacted by phone or fax in another attempt to confirm maternal death while pregnant or within 42 days postpartum. In addition, the death certificate cause-of-death narrative was examined to determine whether an obstetric cause of death was indicated along with information on the timing of the death.

For all 147 obstetric-coded deaths, a woman was considered to have a confirmed maternal death while pregnant or within 42 days postpartum 1) if her death record could be matched with a live birth or fetal death occurring within 42 days of the date of death; 2) if her medical records, autopsy or other death investigation records, or information received from contacting the death certifier indicated either pregnancy at the time of death or pregnancy within 42 days of the date of death; or 3) to err on the side of caution, if the death certificate narrative indicated pregnancy at time of death or within 42 days of the date of death when sufficient medical records were not received.

All other obstetric-coded deaths were considered to be unconfirmed maternal deaths while pregnant or within 42 days postpartum. If an unconfirmed maternal death did not link to a recent live birth or fetal death, nor did any medical records, autopsy or death investigation records, or cause-of-death narrative on the death certificate indicate pregnancy at time of death, recent pregnancy, or recent childbirth, the death was determined to have no evidence of pregnancy and was excluded from further analyses. Findings from medical or autopsy records that were used to classify an obstetric-coded death as having no evidence of pregnancy included one or more of the following: a negative human chorionic gonadotropic (hCG) test result; no mention of a pregnancy, delivery event, or miscarriage within a year of death; a medical history of bilateral tubal ligation or hysterectomy; or absence of uterus or a fetus on autopsy (for women who were reported to be pregnant at the time of death). Additionally, for obstetric-coded deaths for which insufficient or no medical records were received, if a death certifier was contacted and indicated that the woman was not in fact pregnant at the time of death or within 42 days of death, the death was also determined to have no evidence of pregnancy. Maternal deaths that occurred 43 or more days postpartum were also excluded from analyses, because these deaths occurred after the timeframe of interest.

Unconfirmed maternal deaths for which sufficient medical and death investigation information was not received by the study's cutoff deadline of July 2017, and for which we were unable to obtain additional information from the death certifier, were designated as having insufficient information to make a determination.

To identify additional maternal deaths that occurred in 2012, all other female Texas resident death records (without obstetric cause-of-death codes) were linked with 2011–2012 live birth and fetal death data using the same deterministic linking methodology. No "childbearing age" restrictions were set, because the intention was to examine all female deaths, regardless of age.

Excluding deaths resulting from motor vehicle crashes (considered to be a nonobstetric cause unrelated to pregnancy), all additional death records that were linked to a live birth or fetal death event within 42 days of the date of death were considered confirmed maternal deaths.

Crude (unadjusted) 2012 maternal mortality ratios (number of maternal deaths per 100,000 live births) and corresponding 95% CIs were calculated for Texas overall as well as by maternal race and ethnicity (white, black, Hispanic, other) and age group (24 years or younger, 25–34, 35 years or older). Because of small numbers, the gamma distribution was used to estimate 95% CIs for each maternal mortality ratio. Pearson χ^2 tests were conducted to examine whether significant differences in maternal mortality ratios were observed among different racial and ethnic groups and age groups. Confirmed maternal deaths were used as the numerator in calculating maternal mortality ratios. However, we also calculated more expansive maternal mortality ratios with the addition of those cases with insufficient information to make a determination. Resident live births reported by the Department of State Health Services Center for Health Statistics in 2012 were used as denominator data for maternal mortality ratio calculations.

One-sample tests of proportions were used to compare overall and subgroup 2012 maternal mortality ratios for confirmed maternal deaths using our enhanced method with corresponding maternal mortality ratio values based solely on ICD-10 cause-of-death codes (the standard method for maternal death identification). The accuracy of the standard method for identifying maternal deaths among females of childbearing age was assessed by calculating the sensitivity, specificity, and positive predictive value (PPV) of the standard method, using confirmed maternal deaths identified with our enhanced method as a proxy for true maternal deaths in Texas. For the purpose of this analysis only, ages 10–54 years were examined to ensure that potential errors at both ends

of the childbearing age spectrum were captured. Methods similar to our enhanced method (especially the data-matching component) are commonly used by maternal mortality review committees, including Texas's Maternal Mortality and Morbidity Task Force, to verify maternal deaths for review.[13,14] Thus, maternal death identification using our enhanced method is thought to more accurately reflect the true number of maternal deaths in Texas than the standard method. Finally, differences in pregnancy status reported on the death certificate (pregnant at the time of death, pregnant within 42 days of death, pregnant between 43 days and a year of death, not pregnant within a year of death, or unknown) were compared among confirmed maternal deaths identified using our enhanced method and obstetric-coded deaths with no evidence of pregnancy.

Data matching and statistical analyses were all performed using SAS 9.4. This study was approved by the Texas Department of State Health Services institutional review board (IRB#17-020). In addition, statutory authority, granted by Sections 34.008 and 161.0211 of the Texas Health and Safety Code, exists for Department of State Health Services staff to obtain data necessary to investigate maternal mortality and morbidity in Texas.[15,16]

RESULTS

Of 147 obstetric-coded Texas resident maternal deaths in 2012, 23 maternal deaths were confirmed to have occurred within 42 days postpartum by matching death records with live births or fetal deaths. Six additional obstetric-coded death records were linked, but occurred 43 or more days postpartum and were therefore excluded based on timing of death.

Medical records and death investigation reports were requested for the remaining 118 obstetric-coded deaths that were not linked with a live birth or fetal death. On review of these records and other information (death certificate narratives, contacting death certifiers), 24 additional deaths were confirmed to have occurred during pregnancy or within 42 days postpartum. Two of these 24 deaths were confirmed based on death certificate narrative indicating pregnancy at the time of death or within 42 days of death (because of missing or insufficient medical records). Review of medical and death investigation records and, in some cases, contacting death certifiers revealed no evidence of pregnancy (within a year of death) for 74 deaths and identified five deaths that occurred 43–365 days postpartum; these 79 deaths were excluded from further analyses. In the case of 15 obstetric-coded deaths, either incomplete or no medical records were received, and the death certifier could not provide further information needed to determine pregnancy status; these deaths were categorized as having insufficient information to make a determination.

Matching all other 2012 female Texas resident death records (regardless of ICD-10 cause-of-death code) with birth and fetal death data yielded an additional nine confirmed maternal deaths occurring during pregnancy or within 42 days postpartum. These confirmed maternal deaths were not captured using the standard method (were not part of the 147 deaths identified based on obstetric cause-of-death codes alone). Seven potential maternal deaths were excluded from the study because they were not Texas residents. These deaths occurred among women who were residents of states bordering Texas.

Using our enhanced method, we determined that a total of 56 Texas resident maternal deaths occurred during pregnancy or within 42 days postpartum in 2012. This number includes 47 (32.0%) of the 147 obstetric-coded deaths (23 [15.7%] determined by matching with live births and fetal deaths plus 24 [16.3%] determined by record review and other information) and nine additional maternal deaths identified through vital records matching alone (Table 1). Ages of confirmed maternal deaths ranged from 19 to 41 years.

One hundred of the 147 obstetric-coded deaths were unable to be confirmed as maternal deaths. Eleven of the 147 obstetric-coded deaths (7.5%) occurred 43 or more days postpartum (outside of the 42-day timeframe of interest), 74 (50.3%) showed no evidence of pregnancy after data matching and record review, and 15 (10.2%) had insufficient information to make a determination (Table 1).

Our 2012 maternal mortality ratio estimate for Texas, using our enhanced method for identifying maternal deaths during pregnancy or within 42 days postpartum (n=56), was 14.6 maternal deaths per 100,000 live births (Table 2). However, it is possible that a portion of the obstetric-coded deaths with insufficient information to make a determination (n=15) were also maternal deaths. Therefore, the Texas maternal mortality ratio for 2012 could potentially range from 14.6 per 100,000 (n=56) to 18.6 per 100,000 (n=71; includes 15 deaths with insufficient information).

Subgroup analyses of the 56 confirmed maternal deaths showed that black women had a higher

Table 1. Determinations of Confirmed and Unconfirmed Maternal Death Using an Enhanced Method for Maternal Death Identification

Determination	Confirmed Maternal Death* (Included in MMR)	Unconfirmed Maternal Death† (Excluded from MMR)
Step A. Evaluation of 147 obstetric-coded deaths		
Maternal death while pregnant or within 42 d after the end of pregnancy		
Matching with live births and fetal deaths	23 (15.7)	—
Review of records and other information‡	24 (16.3)	—
No evidence of pregnancy	—	74 (50.3)
Maternal death occurred 43 or more d postpartum (outside of timeframe of interest)	—	11 (7.5)
Insufficient information to make a determination	—	15 (10.2)
Total (Step A)	47 (32.0)	100 (68.0)
Step B. Additional confirmed maternal deaths identified through data matching		
Maternal death while pregnant or within 42 d after the end of pregnancy	9	
Total (Steps A + B)	56	

MMR, maternal mortality ratio.
Data are n (%).
* Texas resident maternal deaths occurring while pregnant or within 42 days after the end of pregnancy were confirmed through either data matching or records review in step A or through data matching in step B. Confirmed maternal deaths were used as numerator values in the calculation of MMRs in this study.
† The MMRs for this study were calculated based on confirmed maternal deaths (n=56). However, more expansive MMRs were also calculated with the addition of those cases for which there was insufficient information to make a determination.
‡ In addition to review of medical records and other death investigation records indicating a maternal death, to err on the side of caution, two cases with missing or insufficient medical records were considered confirmed maternal deaths based on death certificate narrative indicating pregnancy at the time of death or within 42 days of death.

maternal mortality ratio (27.8/100,000 live births) than did women of other racial and ethnic groups. Overall, no significant differences in maternal mortality ratio by race and ethnicity were observed, likely because of small numbers (Table 2). The maternal mortality ratio increased with age (Cochran-Armitage $Z=3.4$; $P<.001$).

The overall 2012 Texas maternal mortality ratio calculated using the enhanced method was statistically significantly lower than when using the standard method for identifying maternal death (14.6/100,000 vs 38.4/100,000; $P<.001$). Enhanced method maternal mortality ratios for women aged 25–34 years and aged 35 years or older, as well as for white, Hispanic,

Table 2. Enhanced Maternal Mortality Ratio Estimates for Confirmed Maternal Deaths Overall and by Racial and Ethnic Group and Age Group, Texas, 2012

Maternal Characteristic	No. of Live Births	No. of Confirmed Maternal Deaths	MMR* (95% CI)	χ^2 (*P*)
Overall	382,438	56	14.6 (11.1–19.0)	
Race and ethnicity				7.1 (*P*=.07)
White	132,288	18	13.6 (8.1–21.5)	
Black†	43,100	12	27.8 (14.4–48.6)	
Hispanic	182,855	21	11.5 (7.1–17.6)	
Other	24,195	5	20.7‡ (6.7–48.2)	
Age (y)				13.9 (*P*=.001)
24 or younger	138,566	12	8.7 (4.5–15.1)	
25–34	194,183	28	14.4 (9.6–20.8)	
35 or older	49,684	16	32.2 (18.4–52.3)	

MMR, maternal mortality ratio.
* Enhanced MMR estimates are calculated using Texas resident confirmed maternal deaths occurring while pregnant or within 42 days after the end of pregnancy per 100,000 live births.
† Although no significant differences in MMR by race and ethnicity were observed overall (*P*=.07), when comparing maternal deaths among black and white women only, black women had a significantly higher MMR than white women ($\chi^2=3.9$, *P*=.050).
‡ A small number of maternal deaths for this subgroup resulted in a wide CI, indicating unreliability of this estimate.

Table 3. Comparison of Enhanced Texas Maternal Mortality Ratio Estimates With Estimates Calculated Using the Standard Method for Maternal Death Identification, 2012

Maternal Characteristic	No. of Live Births	Enhanced Texas MMR* (n)	Standard Method Texas MMR† (n)	P‡	Evaluation of Accuracy of Standard Method§		
					Sensitivity (%) (95% CI)	Specificity (%) (95% CI)	PPV (%) (95% CI)
Overall	382,438	14.6 (56)	38.4 (147)	<.001	83.9 (71.7–92.4)	99.0 (98.7–99.2)	32.0 (24.5–40.2)
Race and ethnicity							
White	132,288	13.6 (18)	38.6 (51)	<.001	72.2 (46.5–90.3)	99.2 (98.9–99.4)	25.5 (14.3–39.6)
Black	43,100	27.8 (12)	106.7 (46)	<.001	91.7 (61.5–99.8)	98.2 (97.4–98.7)	23.9 (12.6–38.8)
Hispanic	182,855	11.5 (21)	25.2 (46)	<.001	95.2 (76.2–99.9)	99.0 (98.5–99.3)	43.5 (28.9–58.9)
Other‖	24,195	20.7 (5)	16.5 (4)	.61	60.0 (14.6–94.7)	99.6 (98.0–100)	75.0 (19.4–99.4)
Age (y)							
24 or younger	138,566	8.7 (12)	13.0 (18)	.16	91.7 (61.5–99.8)	99.1 (98.2–99.6)	61.1 (35.7–82.7)
25–34	194,183	14.4 (28)	26.3 (51)	.001	82.1 (63.1–93.9)	97.6 (96.6–98.4)	45.1 (31.1–59.7)
35 or older	49,684	32.2 (16)	157.0 (78)	<.001	81.3 (54.4–96.0)	99.1 (98.9–99.3)	16.7 (9.2–26.8)

MMR, maternal mortality ratio; PPV, positive predictive value.
All MMRs shown are per 100,000 live births.
* Based on identification of confirmed maternal deaths among Texas residents using our enhanced method, which includes vital statistics data matching and review of medical and death investigation records.
† The MMRs calculated using the standard method are based on Texas resident maternal deaths with obstetric cause-of death codes. MMRs were calculated based on 147 obstetric-coded death records provided to the Texas Department of State Health Services by the National Center for Health Statistics instead of 148 deaths reported using Centers for Disease Control and Prevention WONDER.
‡ *P* values for one-sample tests of proportions were calculated, comparing MMRs for confirmed maternal deaths using our enhanced method with corresponding estimates using the standard method.
§ Sensitivity, specificity, and PPV of the standard method for identifying maternal deaths among females of childbearing age were assessed using confirmed maternal deaths identified with our enhanced method as a proxy for true maternal deaths in Texas. Exact 95% CIs were also calculated for each of these measures.
‖ A small number of maternal deaths for this subgroup resulted in wide CIs, indicating unreliability of MMR estimates and accuracy measures.

and black women, were also statistically significantly lower than corresponding maternal mortality ratio estimates based on the standard method for identifying maternal death (Table 3).

Adding deaths with insufficient information into the maternal mortality ratio calculation yielded similar results; the resulting overall Texas maternal mortality ratio (18.6/100,000) was still statistically significantly lower than the maternal mortality ratio obtained using the standard method for maternal death identification ($P<.001$).

Overall, sensitivity and specificity of the standard method for identifying maternal deaths were high (83.9% and 99.0%, respectively) when compared with confirmed maternal deaths identified using our enhanced method. However, the PPV (percent of maternal deaths identified by the standard method that were confirmed maternal deaths) was low. Less than half (32%) of maternal deaths identified using the standard method were confirmed using our enhanced method for identification (Table 3). In particular, the PPV of the standard method was statistically significantly lower for women older than 35 years of age (16.7%) than for women of younger ages.

To determine which pregnancy status on the death certificate was most often reported in error, we compared differences in reported pregnancy status among confirmed maternal deaths and deaths for which we found no evidence of pregnancy using our enhanced method. A majority of the 56 confirmed maternal deaths (83.9%, n=47) had a correct pregnancy status. In contrast, 82.4% of the 74 deaths found to have no evidence of pregnancy had a false-positive status indicating pregnancy at the time of death or within 42 days of death (n=61).

DISCUSSION

Using our enhanced method resulted in a 2012 Texas maternal mortality ratio that was less than half that obtained using the standard method. This substantial reduction indicates that a large number of obstetric-coded deaths in Texas were miscoded. This method also discovered several confirmed maternal deaths that were not captured by the standard approach. Compared with our results, the standard method for identifying maternal deaths had a relatively high sensitivity but low PPV, suggesting an overestimation of the true number of maternal deaths in Texas in 2012. Our results are noteworthy in light of MacDorman et al,[6] who reported a historically high Texas maternal mortality ratio in 2012. Given the significant reduction in the maternal mortality ratio when using confirmed maternal deaths, this high estimate reported was likely the result of data error.

Women aged 35 years or older had a higher enhanced maternal mortality ratio than any other age group, consistent with previous research.[2,17–20] However, it is worth noting that our estimate for women aged 35 years or older was substantially lower than the corresponding estimate reported using the standard method (32.2/100,000 vs 157.0/100,000; $P<.001$). This is because a majority (52 [66.7%]) of the 78 obstetric-coded deaths among women aged 35 years or older showed no evidence of pregnancy, resulting in a low standard method PPV (16.7%). These findings are consistent with literature suggesting that recent large increases in the maternal mortality ratio among women of older maternal age could be the result of data quality issues.[2,11]

Positive pregnancy status on the death certificate is one of the primary factors considered in assigning an ICD-10 obstetric cause-of-death code.[4,5] Consistent with previous research,[2] our results indicate error in reported pregnancy status was likely the main contributor to an inflated 2012 maternal mortality ratio for Texas using the standard method for identifying maternal death. A false-positive pregnancy status was reported for 67 (45.6%) of all 147 obstetric-coded deaths in 2012.

In Texas, unintentional user error in reporting pregnancy status may be responsible. Texas' current electronic death registration system displays pregnancy status options as a dropdown list. The "pregnant at the time of death" option is directly below the "not pregnant within the past year" option; this could have led to erroneous selection and could explain why pregnancy at the time of death was reported for nearly 76% (n=56) of the 74 obstetric-coded deaths with no evidence of pregnancy on review. The percentage of death certificates submitted electronically increased from 63% in 2010 to 91% in 2012[21]; therefore, data error among new users could have contributed to the increase in maternal mortality ratios seen during this time. In the future, separate radio buttons for each pregnancy status option are recommended, along with user training for death certificate completion and promotion of best practices for data reporting to prevent user error and ensure data accuracy.

Study strengths include rigorously examining all Texas obstetric-coded deaths in 2012 using vital records matching, medical and death investigation record review, and other information. Data matching also helped to identify several additional maternal deaths.

However, certain study limitations should be taken into consideration. For 15 obstetric-coded deaths (10.2%), insufficient information was available to determine recent pregnancy. These deaths were excluded from calculation of enhanced maternal mortality ratio estimates, potentially resulting in a slight underestimate of the maternal mortality ratio. However, had these deaths been included, the resulting maternal mortality ratio would still be significantly lower than that obtained using the standard method (18.6/100,000 vs 38.4/100,000; $P<.001$).

Additional maternal deaths not captured by the standard method were identified through data matching. However, it is possible that a few nonobstetric-coded maternal deaths during early pregnancy might have been missed using our enhanced method because there was no matching birth or fetal death record. In the future, we will modify our enhanced method to include a review of medical records for all nonobstetric-coded deaths with a pregnancy status indicating pregnancy at the time of death or within 42 days.

Finally, because this enhanced method is different from the method used by others to calculate maternal mortality numbers and ratios, our 2012 Texas maternal mortality ratio cannot be compared with other states' maternal mortality ratios or with Texas estimates for other years. However, we will use this new method to confirm maternal deaths and calculate maternal mortality ratios for additional years so that trends can be assessed. The Texas Maternal Mortality and Morbidity Task Force will also use this enhanced methodology going forward to identify cases for review. We do know that when using the standard method for identifying maternal deaths, the Texas maternal mortality ratio has decreased from 2012 to 2015.[22,23]

In conclusion, results indicate that relying solely on obstetric cause-of-death codes for identifying maternal deaths is insufficient and can lead to inaccurate maternal mortality ratios. A method enhanced with data matching and review of relevant medical and death investigation records yields more accurate ratios. Although labor-intensive to implement, we feel that this enhanced method is a necessary step to understand and improve maternal death reporting. Our results likely have national implications, because miscoding of obstetric deaths may occur in other states and affect the accuracy of their maternal mortality ratios.

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