

# Maternal Mortality in the United States

## Recent Trends, Current Status, and Future Considerations

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Rigorous studies carried out by the National Center for Health Statistics show that previously reported increases in maternal mortality rates in the United States were an artifact of changes in surveillance. The pregnancy checkbox, introduced in the revised 2003 death certificate and implemented by the states in a staggered manner, resulted in increased identification of maternal deaths and in reported maternal mortality rates. This Commentary summarizes the findings of the National Center for Health Statistics reports, describes

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temporal trends and the current status of maternal mortality in the United States, and discusses future concerns. Although the National Center for Health Statistics studies, based on recoding of death certificate information (after excluding information from the pregnancy checkbox), showed that crude maternal mortality rates did not change significantly between 2002 and 2018, age-adjusted analyses show a temporal reduction in the maternal mortality rate (21% decline, 95% CI 13–28). Specific causes of maternal death, which were not affected by the pregnancy checkbox, such as preeclampsia, showed substantial temporal declines. However, large racial disparities continue to exist: Non-Hispanic Black women had a 2.5-fold higher maternal mortality rate compared with non-Hispanic White women in 2018. This overview of maternal mortality underscores the need for better surveillance and more accurate identification of maternal deaths, improved clinical care, and expanded public health initiatives to address social determinants of health. Challenges with ascertaining maternal deaths notwithstanding, several causes of maternal death (unaffected by surveillance artifacts) show significant temporal declines, even though there remains substantial scope for preventing avoidable maternal death and reducing disparities.

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The recent change in the maternal mortality narrative in the United States likely surprised many obstetricians, epidemiologists, and public health experts. For more than a decade, several articles and publications from reputable organizations documented temporal increases in maternal mortality rates, and maternal mortality rates in the United States that were higher than those in many other countries.<sup>1–5</sup> More recently, detailed reports published by the National Center for Health Statistics have contradicted these assessments.<sup>6–8</sup> The latter reports showed that there had been no temporal increase in overall maternal death rates in the United States; the rising

trend in maternal mortality rates was entirely an artifact of changes in maternal death surveillance.

This Commentary provides the background to the National Center for Health Statistics reports, summarizes their findings, describes temporal trends and the current status of maternal mortality in the United States, identifies surveillance and clinical concerns, and discusses issues related to the prevention of maternal death. These topics merit consideration especially because the current literature<sup>9–12</sup> fails to recognize the full import of the National Center for Health Statistics reports.

## BACKGROUND TO THE NATIONAL CENTER FOR HEALTH STATISTICS REPORTS

Studies carried out before 2003 showed that identification of maternal deaths based solely on death certificate information resulted in substantial numbers of missed maternal deaths.<sup>13–16</sup> These studies led the National Center for Health Statistics to introduce a standard pregnancy checkbox on the revised 2003 death certificate. Individual states began using this pregnancy checkbox at different times,<sup>6</sup> and the National Center for Health Statistics discontinued its official publication of the national maternal mortality rate from 2007 to 2019.<sup>8</sup> The staggered implementation of the pregnancy checkbox by the states resulted in a progressive increase in the number of reported maternal deaths (Fig. 1A<sup>17</sup>). The identification of late maternal deaths (International Classification of Diseases, Tenth Revision [ICD-10] code O96, O97) increased substantially as did maternal deaths from some less clearly defined causes of death, such as “Other specified pregnancy-related conditions” (ICD-10 O268; Fig. 1B).

The discontinuation of authoritative National Center for Health Statistics reports on maternal mortality rates in the United States in 2007 resulted in many publications on maternal mortality that did not adequately address the surveillance implications of the newly introduced pregnancy checkbox. Journalists and researchers implicated diverse factors as the cause for the temporal increase in maternal mortality rates, including rising cesarean delivery rates,<sup>18,19</sup> excessive use of ultrasonography,<sup>19</sup> systemic racism,<sup>20</sup> reduced access to abortion services, and lack of funding for Planned Parenthood.<sup>21</sup>

## SUMMARY OF THE NATIONAL CENTER FOR HEALTH STATISTICS REPORTS

The National Center for Health Statistics reports<sup>6–8</sup> were based on detailed studies of original death certificates and included recoding and reclassification

of the underlying cause of death both with and without information from the pregnancy checkbox. These investigations showed that there was no temporal increase in maternal mortality rates. When pregnancy checkbox information was not used, maternal mortality rates were 8.9 per 100,000 live births in 2002, 8.7 in 2015, 8.7 in 2016, 11.5 in 2017, and 8.7 in 2018.<sup>8</sup>

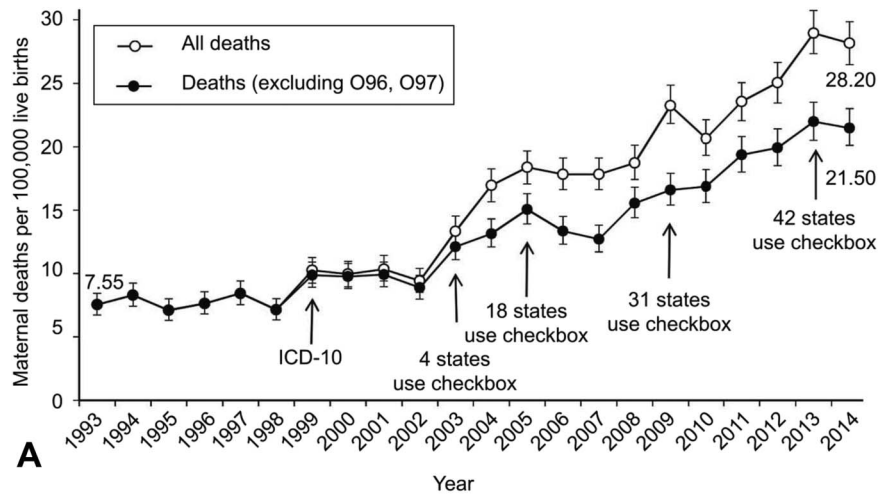
The pregnancy checkbox led to an increase in maternal mortality rates by about 9.6 maternal deaths per 100,000 live births between 2003 and 2017.<sup>7</sup> However, the effect of the checkbox differed by maternal age, race and Hispanic origin, and underlying cause of death.<sup>7</sup> The contribution of the pregnancy checkbox was negligible for several cause-of-death categories, though death rates within some such categories increased or decreased due to unrelated factors.<sup>7</sup> On the other hand, the pregnancy checkbox profoundly increased the identification of some less informative causes of death (eg, “Other specified pregnancy-related conditions” [ICD-10 O268] and “Other obstetric conditions not elsewhere classified” [ICD-10 O99]) and late maternal deaths.

Although the pregnancy checkbox improved the detection of some maternal deaths, it also incorrectly identified some deaths to nonpregnant women as maternal deaths or late maternal deaths. The most egregious checkbox errors occurred among older women; for example, in 2013, 187 women aged 85 years or older were identified by the checkbox as pregnant at the time of death or within 1 year of death.<sup>8</sup> For 2018 data, the National Center for Health Statistics addressed such false positive maternal deaths by restricting use of pregnancy checkbox information for determining the underlying cause of death to women aged 10–44 years.<sup>8</sup>

## TEMPORAL TRENDS IN MATERNAL MORTALITY RATES

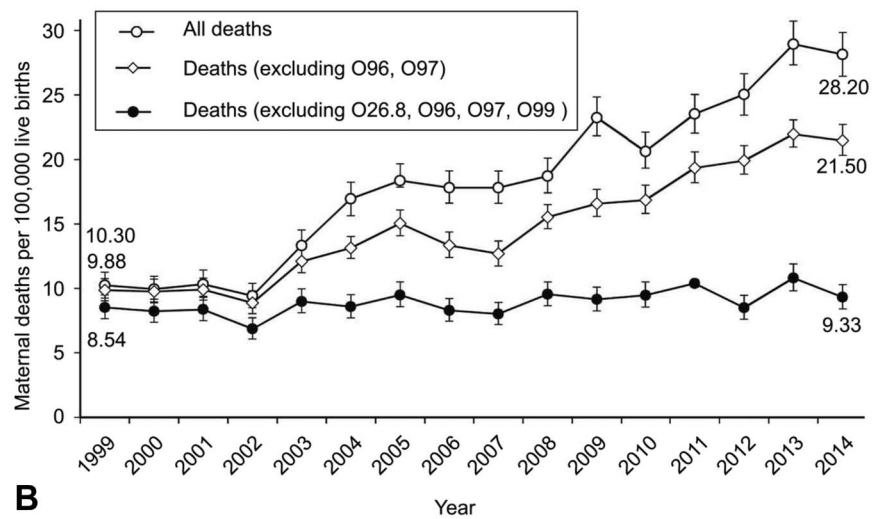
The National Center for Health Statistics investigation showed that maternal mortality rates did not increase significantly between 2002 and 2015–2016 and 2018 when all rates were estimated without using information from the pregnancy checkbox.<sup>6–8</sup> In fact, between 2000 and 2018, maternal mortality rates (calculated without checkbox information) showed a significant 21% decline after adjustment for maternal age (standardized mortality ratio 0.79, 95% CI 0.72–0.87; Appendix 1, available online at <http://links.lww.com/AOG/C281>).

The finding by the National Center for Health Statistics that some cause-of-death categories were not affected by the pregnancy checkbox<sup>7</sup> permits a cautious assessment of the temporal trends in the unaffected



**Fig. 1.** Temporal trends in maternal deaths in the United States, 1993–2014, showing a small increase in maternal mortality with the introduction of International Classification of Diseases, Tenth Revision (ICD-10 codes) in 1999, and larger increases after the staggered adoption of the pregnancy checkbox on death certificates. Maternal mortality rates, including and excluding late maternal deaths (ICD-10 codes O96, O97) (A) and all maternal deaths, maternal deaths excluding late maternal deaths, deaths due to “Other specified pregnancy-related conditions” (O268), and deaths due to “other maternal diseases classifiable elsewhere” (O99) (B). Reprinted from *Obstet Gynecol* 2017;129:91–100.

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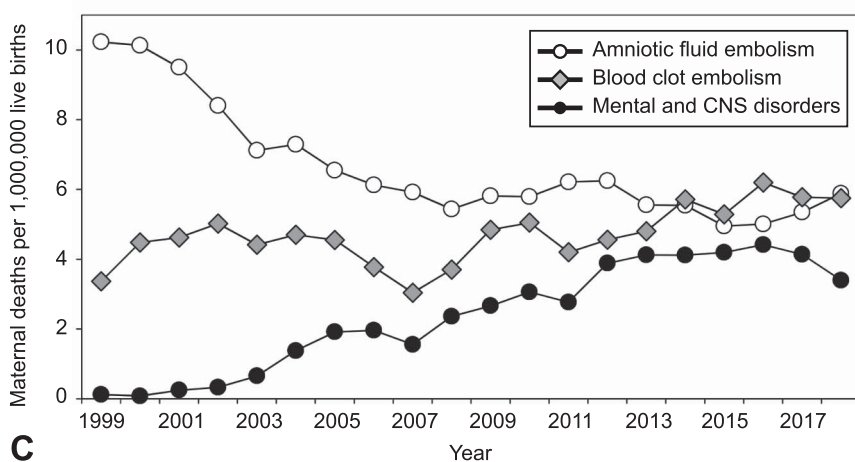
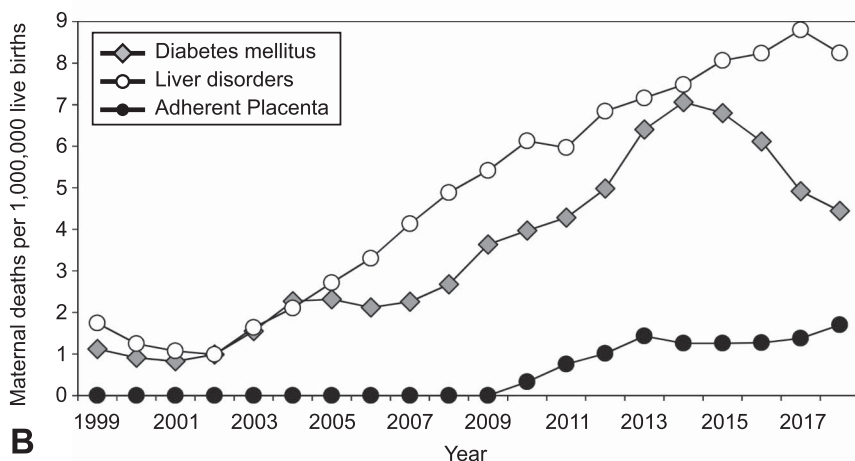
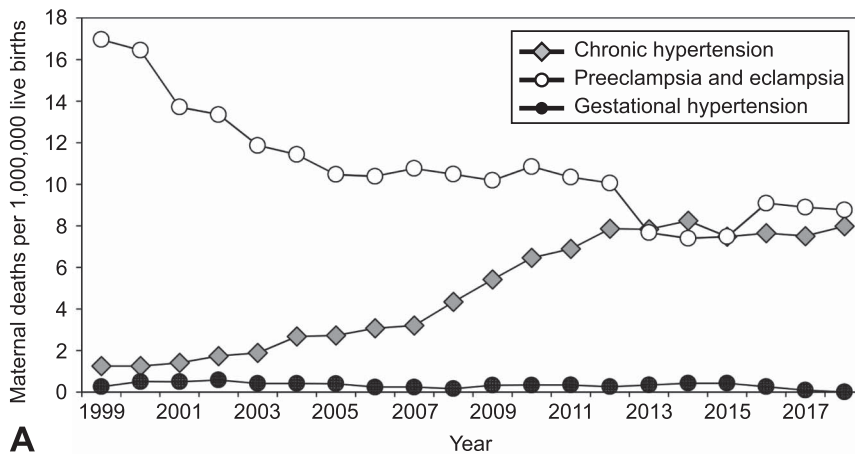


categories (note: some such unaffected categories showed changes due to unrelated factors). This assessment reveals significant declines in maternal deaths from abortive outcomes and labor and delivery complications; significant increases in maternal deaths from other maternal disorders, mental and central nervous system disorders, and respiratory diseases; and stable patterns in maternal deaths from hypertensive disorders, conditions related to the fetus, amniotic cavity, and complications related to the puerperium (Appendix 2, available online at <http://links.lww.com/AOG/C281>).

Temporal trends in the above-mentioned underlying cause-of-death categories conceal some unexpected changes in cause-of-death subcategories. Figure 2A shows increases in deaths from chronic hypertension, declines in preeclampsia–eclampsia deaths, and low, stable rates of deaths from gestational hypertension. Figure 2B shows a rise and fall in maternal deaths due to diabetes mellitus, an increase in maternal deaths due to

liver disorders, and a small absolute increase in deaths from adherent placenta. Figure 2C shows declines in maternal deaths from amniotic fluid embolism, a small increase in maternal deaths from blood-clot embolism, and larger increases in maternal deaths from mental and central nervous system disorders. Discrepant patterns in related subcategories of maternal death (eg, preeclampsia–eclampsia vs chronic hypertension; amniotic fluid embolism vs blood clot embolism) may be indicative of misclassification problems (see below).

Other noteworthy temporal changes in cause of death subcategories included significant declines in maternal deaths from medical abortion and unspecified abortion; complications of anesthesia, malpresentation–disproportion, intrapartum hemorrhage, and other complications; and significant increases in maternal deaths due to other (incomplete) abortion, unspecified hypertension, genitourinary tract infections, malnutrition, other disorders of the amniotic fluid, placental



**Fig. 2.** Temporal trends in maternal mortality due to selected causes of death, United States, 1999–2018. Maternal deaths due to chronic hypertension, preeclampsia, and gestational hypertension (A); maternal deaths due to diabetes mellitus, adherent placenta, and liver disorders (B); maternal deaths due to amniotic fluid embolism, blood clot embolism, and mental and central nervous system (CNS) disorders complicating pregnancy, childbirth, or the puerperium (C). Note that all rates are moving averages.

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disorders, and antepartum hemorrhage (Appendix 3, available online at <http://links.lww.com/AOG/C281>).

### CURRENT STATUS

The National Center for Health Statistics reported 658 maternal deaths, 277 late maternal deaths, and 3,791,712 live births in 2018, yielding an maternal

mortality rate of 17.4 per 100,000 live births and a late maternal mortality rate of 7.2 per 100,000 live births.<sup>8</sup> There was a strong age-mortality gradient between age 20 and 44 years but no difference in death rates between women aged 40–44 compared with those aged 45–49 years (Appendix 4, available online at <http://links.lww.com/AOG/C281>). Maternal mortality rates

were 2.5 times higher among non-Hispanic Black women compared with non-Hispanic White women and lowest among Hispanic women (37.1, 14.7, and 11.8 per 100,000 live births, respectively<sup>8</sup>).

A majority of maternal deaths occurred due to direct obstetric causes (77.4%<sup>8</sup>). Figure 3A shows maternal deaths in 2018 by cause-of-death category. Less informative categories, namely, “Other specified pregnancy-related conditions” (ICD-10 O268) and “Other maternal diseases not elsewhere classified” (ICD-10 O99), were responsible for a large fraction of deaths, and hypertensive disorders, circulatory system diseases, and amniotic fluid and blood clot embolism were the most common clearly specified causes (Fig. 3A and B).

## SURVEILLANCE CONCERNS

### Misclassification of Deaths Among Women Aged 10–44 Years

There are several reasons to suspect continuing misclassification of some nonmaternal deaths (as maternal deaths) among women aged 10–44 years in 2018, including the lack of difference in maternal mortality rates between women aged 40–44 years compared with those aged 45–49 years (Appendix 5, available online at <http://links.lww.com/AOG/C281>). Discrepant temporal trends between related causes of death (Fig. 2A), and the high proportion of maternal deaths due to less informative causes of death are other indicators suggesting misclassification. Although obstetric causes of death on a death certificate (eg, preeclampsia and amniotic fluid embolism) would be unaffected by the incorrect use of the pregnancy checkbox, nonobstetric causes of death among nonpregnant women (eg, chronic hypertension and pulmonary embolism) would be misclassified as maternal deaths if the pregnancy checkbox was ticked erroneously. Nonmaternal deaths from hypertensive diseases among reproductive age women far exceed maternal deaths from chronic hypertension so that a small misclassification of nonmaternal deaths from hypertensive diseases (due to checkbox errors) would have a significant effect on maternal deaths from chronic hypertension (Appendix 5, <http://links.lww.com/AOG/C281>).

Evidence of misclassification of nonmaternal deaths as maternal deaths is also seen in multiple causes-of-death information. A large proportion of deaths due to chronic hypertension, liver disease, other specified maternal conditions (ICD-10 O268), and late maternal death in 2018 were identified as maternal deaths based solely on the pregnancy check-

box (without other indication of a pregnancy-related complication; Appendix 6, available online at <http://links.lww.com/AOG/C281>).

Several recent studies<sup>22–27</sup> support the need for introducing corrective measures aimed at minimizing the misclassification of nonmaternal deaths among women aged 10–44 years. Potential remedies include requiring the specification of at least one pregnancy-related cause of death for all cases where the pregnancy checkbox is ticked, and a manual review of the causes of death listed on the death certificate or on the corresponding medical record in a hospitalization database (“database autopsy”<sup>28</sup>). A related issue pertains to physician education regarding the “underlying cause of death” concept and the need for accurately completing death certificates.

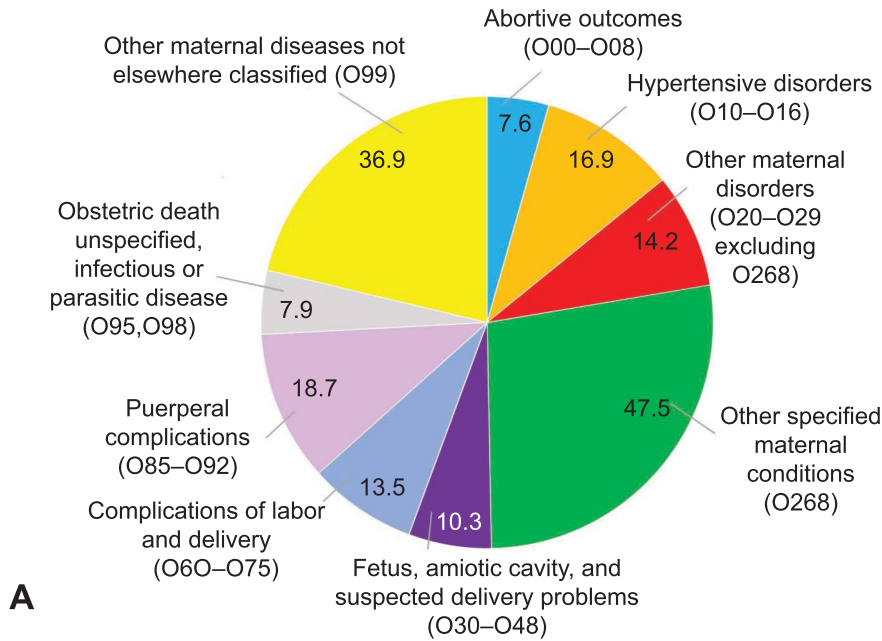
### Less Informative Causes of Death

The high rates of maternal death from less informative causes of death such as “Other specified pregnancy-related conditions” (ICD-10 O268) and “Disease of the circulatory system complicating pregnancy, childbirth and the puerperium” (ICD-10 O994) need to be addressed: Preventive insights can only be obtained with greater specificity in cause-of-death information. This concern, which also applies to late maternal deaths, may be addressed by requiring less informative pregnancy-chapter ICD-10 codes to be accompanied by codes from other chapters; for example, in cases of aortic dissection, the I chapter code for this condition (namely, ICD-10 I710) should accompany the less informative O chapter code (ICD-10 O994).

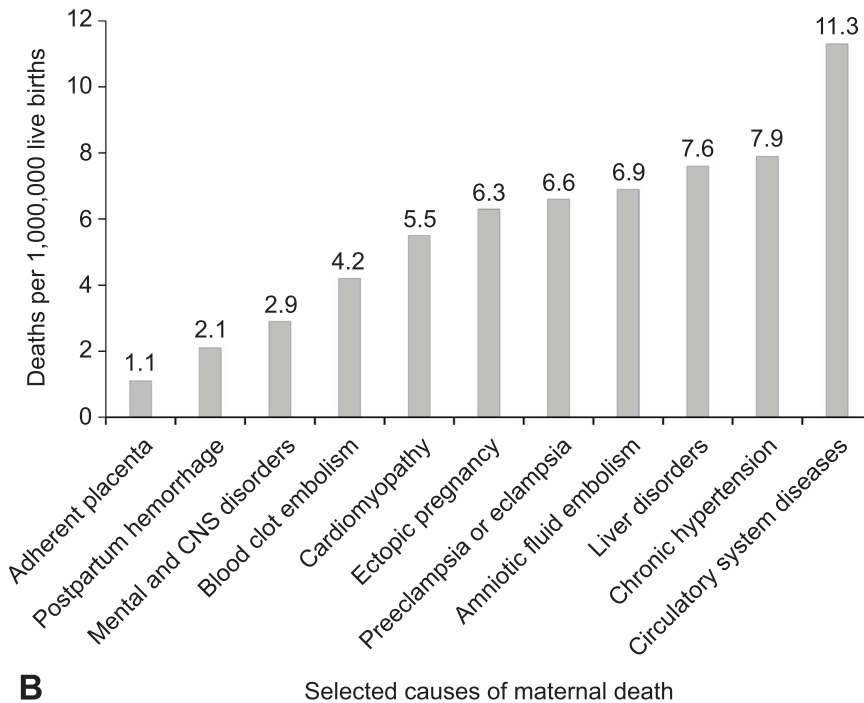
## CLINICAL CONCERNS

Figure 3 shows the frequency of all cause-of-death categories in 2018, and highlights the importance of hypertensive disorders of pregnancy, diseases of the circulatory system, obstetric embolism. The significant declines in deaths from preeclampsia-eclampsia (Fig. 2A), medical and unspecified abortion, complications of anesthesia, intrapartum hemorrhage, and amniotic fluid embolism (Appendix 3, <http://links.lww.com/AOG/C281>) are highly encouraging.

Despite the significant temporal increase in deaths due to adherent placenta, the absolute rate of such deaths was low, suggesting that obstetric care is addressing the rising frequency of this condition.<sup>29,30</sup> Increases in maternal deaths from chronic hypertension, genitourinary tract infection, diabetes mellitus, malnutrition, liver disorders, mental and central nervous system disorders and diseases of the respiratory system could represent



**A**



**B**

**Fig. 3.** Maternal deaths within International Classification of Diseases, Tenth Revision (ICD-10) cause-of-death categories, United States, 2018. **A.** Maternal mortality rates (per million live births) within each ICD-10 cause-of-death category (all O chapter codes except those for late maternal death included). **B.** Cause-specific maternal mortality rates (per million live births) for specific causes of death of obstetric interest. Note that numbers in **A** represent cause-specific maternal mortality rates per million live births. The components of the pie chart are mutually exclusive and all-inclusive and sum to an overall maternal mortality rate of 17.4 per 100,000 live births. CNS, central nervous system.

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true increases or (more likely) an increase in the misclassification of nonmaternal deaths from these conditions due to checkbox errors.

Concerns regarding the reported temporal increase in maternal deaths led the American College of Obstetricians and Gynecologists and others to support the creation of state-based Maternal Mortality Review Committees.<sup>31,32</sup> Reports

from such committees show that about half of all pregnancy-related deaths were caused by hemorrhage, cardiovascular and coronary conditions, cardiomyopathy, and infection, and that more than 60 percent of pregnancy-related deaths were preventable.<sup>33</sup> Patient-related factors, such as a lack of knowledge about warning signs (38%), health care professional-related issues including misdiagnosis

(34%), and system-related factors, such as a lack of coordination between health care professionals (22%), were the most commonly identified contributors to such deaths.<sup>33</sup>

Systematic reviews of maternal death are important because they can identify pertinent and emerging issues of concern. Some of the recent caveats emerging from the Confidential Enquiry into Maternal Deaths in the United Kingdom are notable, including the need for heightened awareness of cardiovascular diseases among women with chest pain, orthopnea or persistent tachycardia, and the unexpected number of deaths due to undiagnosed aortic dissection.<sup>34</sup>

## SOCIAL DETERMINANTS OF MATERNAL MORTALITY

Racial differences in the maternal mortality rate in the United States indicate longstanding health disparities. However, maternal mortality rate differentials by race are not exclusive to the United States; recent reports from England reveal maternal death rates among Black women that are fivefold higher than those among White women.<sup>35</sup> This comparison highlights the role of nonmedical determinants of maternal mortality—race-based maternal mortality rate differences in England persist despite the National Health Service's providing free, high-quality medical care to all.

Racial disparities in maternal mortality rates reflect many factors arising from racism<sup>36</sup> including closely connected social determinants of health such as income, social status, education, access to health care, housing, the physical environment, social supports, health behaviors, and culture.<sup>12,37–39</sup> The strong correlations and synergism between these factors ensure that vulnerable populations experience disproportionately high risks of outcomes such as maternal death.

Vulnerable segments of the population, especially non-Hispanic Black women, need to be supported through comprehensive and sustained public health programs that address preconceptional health and chronic conditions (at the individual level), implicit racial bias among health care professionals (at the interpersonal level), quality of care in hospitals predominantly serving non-Hispanic Black women (at the community level) and paid parental leave and extended health insurance (at the societal level).<sup>36</sup> Such initiatives are also required to support vulnerable women and address social determinants of health across the entire population. This need is highlighted by the distribution of maternal deaths in 2018: 287,

205, and 105 deaths occurred among non-Hispanic White, non-Hispanic Black and Hispanic women, respectively.<sup>8</sup>

## CONCLUSION

Seminal studies by the National Center for Health Statistics show that previously documented temporal increases in maternal mortality rates in the United States were an artifact of changes in maternal mortality surveillance. Although the pregnancy checkbox improved the identification of maternal deaths, there remains a need to address continued misclassification of nonmaternal deaths, and the proliferation of noninformative causes of death. Strengthening routine maternal death reviews at the hospital, state, and national level will lead to more informed and optimized obstetric practice, and diverse public health initiatives targeting the social determinants of health will reduce racial disparities. Although the state of maternal health in the United States is not as dire as portrayed until recently, there is substantial scope for preventing avoidable maternal death.

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