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# Epidemiology of maternal morbidity and mortality



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## ABSTRACT

Maternal morbidity and mortality remains a significant health care concern in the United States, as the rates continue to rise despite efforts to improve maternal health. In 2013, the United States ranked 60th in maternal mortality worldwide. We review the definitions, rates, trends, and top causes of severe maternal morbidity and mortality, as well as risk factors for adverse maternal outcomes. We describe current local and national initiatives in place to reduce maternal morbidity and mortality and offer suggestions for future research.

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## Introduction

Despite national and international efforts to improve maternal outcomes, maternal morbidity and mortality rates remain a large health care concern, with rising rates in the United States. In 2013, the United States ranked 60th in maternal mortality worldwide.<sup>1</sup> Between 2003 and 2013, the United States was one of only eight countries, which had an increase in maternal mortality. Additionally, maternal morbidity is estimated to occur at an even higher rate,<sup>2,3</sup> suggesting a need to standardize definitions, systematically review cases, and implement institutional changes to decrease future morbidity and mortality events.<sup>4,5</sup>

## Definitions and rates

### Maternal mortality

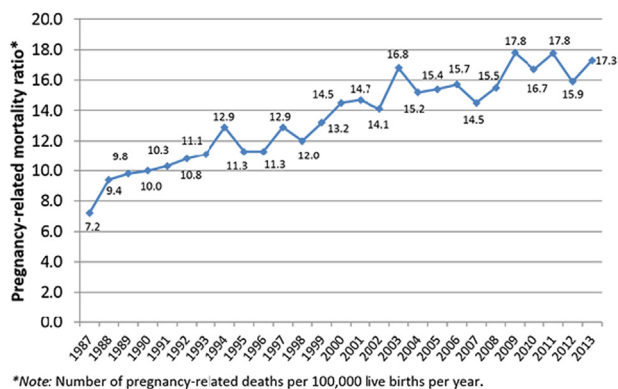
Pregnancy-related deaths are defined as death of a woman during or within one year of pregnancy that was caused by a pregnancy complication, a chain of events initiated by pregnancy, or worsening of an unrelated condition due to the

physiologic effects of pregnancy, understanding that a substantial proportion of pregnancy-related events occur in the postpartum period.<sup>2</sup> The pregnancy-related mortality ratio is the number of pregnancy-related deaths per 100,000 live births. To determine the number of pregnancy deaths, 52 reporting areas (50 states, New York city, and Washington, DC) send copies of death certificates of women who died during pregnancy or within one year of pregnancy to the Center for Disease Control (CDC).<sup>6</sup> Epidemiologists determine the cause and timing of death in relation to pregnancy. Based on information from the Pregnancy Related Mortality Surveillance System, a program designed by the Centers for Disease Control and Prevention and the American College of Obstetricians and Gynecologists to better track maternal mortality, it appears that pregnancy-related deaths are rising in this country.

In the last century, the pregnancy-related mortality ratio declined significantly, due to medical and technological advances such as the discovery of antibiotics and sterile techniques, improvement in anesthesia, increase in in-hospital births, and improvements in blood transfusions processes.<sup>7</sup> However, in the United States, in the last 3 decades, this ratio has more than doubled, rising from 7.2 deaths per

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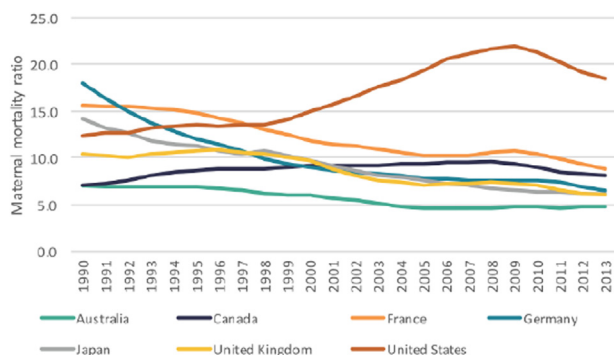
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**Fig. 1 – Trends in pregnancy-related mortality in the United States: 1987–2013.**<sup>6</sup>

100,000 births in 1987 to 17.3 deaths per 100,000 births in 2013 (Fig. 1).<sup>6</sup> Peak ratio of 17.8 deaths per 100,000 live births occurred in 2009 and 2011, believed to be due to the influenza A pandemic at the time.<sup>2</sup> When looking at maternal mortality rates worldwide from 1990 to 2013, the United States was the only country to experience an increase over this time period of approximately 1.7%.<sup>1,5</sup> Comparison of the trends in maternal mortality ratio in the United States to other developed countries is depicted in Figure 2.<sup>8</sup> Currently, approximately 600 women a year are estimated to die due to pregnancy in the United States.<sup>5</sup>

There are 3 potential explanations for the observed increase in the pregnancy-related mortality ratio. First, it may be explained by an increase in ascertainment, due to the addition of pregnancy checkbox to the standard United States death certificate and changes in ICD-10 coding.<sup>2,7</sup> Prior studies suggest that more than half of pregnancy-related deaths are not identified through routine surveillance methods.<sup>9</sup> A study evaluating the addition of check boxes to the Maryland death record to collect information on pregnancy status in the year preceding death showed that more than 98% of maternal deaths occurring in the years 2001–2008 were identified on death records, compared to only 62% in the eight-year period before check boxes were added to the Maryland death certificate, suggesting that pregnancy-related deaths were being missed prior to the addition of the checkbox.<sup>10,11</sup> Similarly, another study evaluating maternal mortality reporting found that nearly one-third (29%) of cases were determined to be



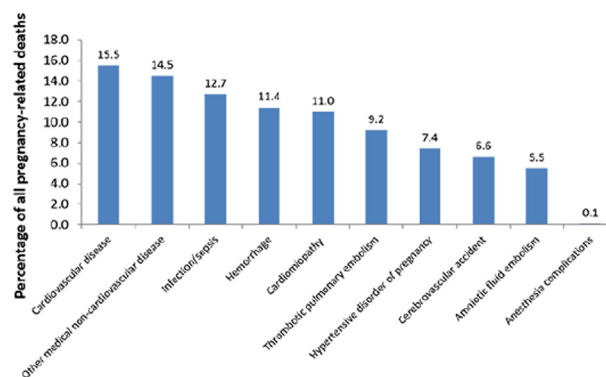
**Fig. 2 – Maternal mortality ratio in the United States, Australia, Canada, France, Germany, Japan, and the United Kingdom between 1990 and 2013.**<sup>8</sup>

pregnancy-related deaths only because of the pregnancy status information provided in the checkbox, while 55% were determined to be pregnancy-related based on the death certificate including both a pregnancy keyword and information in the checkbox.<sup>9</sup> This suggests that nearly 30% of pregnancy-related deaths would have been missed on review of death certificates without the pregnancy status information provided by the checkbox. Additionally, in ICD-10, the definition of maternal death is the same as in ICD-9, defined as those occurring within 42 days after the end of pregnancy. However, ICD-10 has a new category of “late maternal deaths,” defined as deaths from any cause related to or aggravated by pregnancy that occur more than 42 days but less than one year after termination of pregnancy, thereby allowing for ascertainment of these later deaths.<sup>9</sup> Second, the rates in the United States may not be comparable and may be higher than other countries due to international and World Health Organization definitions, who report deaths within only 42 days, or six weeks, of delivery compared to one year.<sup>2,5</sup> Third, the rise in US maternal mortality may be due to an actual increase in mortality thought to be due in part to the changing maternal demographics such as maternal age and comorbidities, discussed in the next section.<sup>2,5,7</sup> Most likely, however, the observed rise is a combination of the aforementioned reasons.<sup>2,7</sup>

Conventional causes of obstetrical mortality are hemorrhage, hypertensive disorders, infection, and thromboembolic events. Despite the rise in observed maternal mortality, these conventional events have declined in recent years. Cardiovascular conditions have become the leading cause of pregnancy-related deaths, accounting for 15.5% of pregnancy-related deaths in 2011–2013, with cardiomyopathy accounting for another 11% (Fig. 3).<sup>6</sup> In contrast, due to improved recognition and management of hemorrhage, hypertensive disorders, infection, and prophylaxis against thromboembolic events, these indicators accounted for 11.4%, 7.4%, 12.7%, and 9.2% of deaths, respectively. Although increase in number, maternal deaths are overall rare events, and are outnumbered significantly by severe maternal morbidity (SMM).

**Maternal morbidity**

SMM is more prevalent than maternal mortality, with some studies estimating that SMM affects 50,000 women per year in the United States, or about 0.5–1.3% of pregnancies.<sup>3,5</sup>



**Fig. 3 – Causes of pregnancy-related death in the United States: 2011–2013.**<sup>6</sup>

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