

# Pregnancy-Related Mortality in the United States, 2006–2010

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**OBJECTIVE:** To update national population-level pregnancy-related mortality estimates and examine characteristics and causes of pregnancy-related deaths in the United States during 2006–2010.

**METHODS:** We used data from the Pregnancy Mortality Surveillance System and calculated pregnancy-related mortality ratios by year and age group for four race–ethnicity groups: non-Hispanic white, non-Hispanic black, Hispanic, and other. We examined causes of pregnancy-related deaths by pregnancy outcome during 2006–2010 and compared causes of pregnancy-related deaths since 1987.

**RESULTS:** The 2006–2010 pregnancy-related mortality ratio was 16.0 deaths per 100,000 live births (20,959,533 total live births). Specific race–ethnicity pregnancy-related mortality ratios were 12.0, 38.9, 11.7, and 14.2 deaths per 100,000 live births for non-Hispanic white, non-Hispanic black, Hispanic, and other race women, respectively. Pregnancy-related mortality ratios increased with maternal age for all women and within all age groups, non-Hispanic black women had the highest risk of dying from pregnancy complications. Over time, the contribution to pregnancy-related deaths of hemorrhage, hypertensive disorders of pregnancy, embolism, and anesthesia complications continued to decline, whereas the contribution of

cardiovascular conditions and infection increased. Seven of 10 categories of causes of death each contributed from 9.4% to 14.6% of all 2006–2010 pregnancy-related deaths; cardiovascular conditions ranked first.

**CONCLUSION:** Relative to previous years, during 2006–2010, the U.S. pregnancy-related mortality ratio increased as did the contribution of cardiovascular conditions and infection to pregnancy-related mortality. Although the identification of pregnancy-related deaths may be improving in the United States, the increasing contribution of chronic diseases to pregnancy-related mortality suggests a change in risk profile of the birthing population.

(*Obstet Gynecol* 2015;125:5–12)

DOI: 10.1097/AOG.0000000000000564

**LEVEL OF EVIDENCE: II**

Maternal mortality is a major global concern.<sup>1</sup> Although maternal deaths are rare in the United States, the maternal mortality ratio has not declined in over 25 years.<sup>2</sup> Two recent global reports found the United States among the few countries in the world where maternal mortality appears to have increased in recent times.<sup>3,4</sup> The Centers for Disease Control and Prevention (CDC) initiated national surveillance of pregnancy-related deaths in 1986.<sup>5</sup> The most recent surveillance report shows that the 1998–2005 U.S. pregnancy-related mortality ratio was 14.5 deaths per 100,000 live births,<sup>6</sup> higher than the corresponding ratios of 11.5 and 9.1 deaths per 100,000 live births for 1991–1997 and 1987–1990, respectively.<sup>7,8</sup> The same report notes the decline in the proportion of deaths attributable to hemorrhage, infection, and hypertensive disorders of pregnancy and the increase in that caused by other medical conditions, particularly cardiovascular conditions over time.<sup>6</sup> More recently, Callaghan et al<sup>9</sup> found that the prevalence of severe maternal morbidity during delivery hospitalizations more than doubled during 1998–2011 and that hemorrhage (ie, ascertained by blood transfusion), hysterectomy, and eclampsia accounted for approximately

See related editorial on page 2.

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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#### Financial Disclosure

The authors did not report any potential conflicts of interest.

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ISSN: 0029-7844/15



75% of severe morbidity, yet the most striking findings about both pregnancy-related mortality and severe maternal morbidity in the United States are the persistent racial-ethnic disparities.<sup>2,5,10,11</sup> This report provides the most recent national data on characteristics and causes of pregnancy-related deaths in the United States during 2006–2010, updating previous published reports using 1987–2005 pregnancy mortality surveillance data.<sup>6–8</sup>

## MATERIALS AND METHODS

We used 2006–2010 data from the CDC's Pregnancy Mortality Surveillance System. Fifty-two reporting areas (ie, 50 states, New York City, and Washington, DC) are asked to submit to the CDC's Division of Reproductive Health deidentified copies of death certificates for all deaths occurring during or within 1 year of pregnancy, regardless of the cause of death or the duration of pregnancy. In addition, reporting areas are asked to provide matching birth or fetal death certificates, when available. Information found on vital records represents the core information set for the surveillance system. Additional, although less systematic, sources of information for the Pregnancy Mortality Surveillance System include reports by public health agencies, state-based maternal mortality review committees, professional organizations, individual health care providers as well as media reports, including computerized searches of Lexis Nexis (ie, database comprising legal, news or media, business and public records). The sociodemographic information is entered in the surveillance database by a trained data coder. A trained medical data coder checks the sociodemographic data and enters the medical data for each case. During the review phase, all information available for each case is reviewed and discussed by the medical coder with one to three clinically trained medical epidemiologists, discrepancies are resolved, and the information in the database is updated accordingly. Thus, key information available for each case includes the underlying cause of death, pregnancy outcome, associated medical conditions, and demographic and obstetric variables available in vital records. Cause-of-death coding is based on a system developed in 1986 by the American College of Obstetricians and Gynecologists and the CDC Maternal Mortality Study Group,<sup>6</sup> which includes 10 categories of causes of death as follows: hemorrhage, infection, amniotic fluid embolism, thrombotic pulmonary or other embolism, hypertensive disorders of pregnancy, anesthesia complications, cerebrovascular accidents, cardiomyopathy, cardiovascular disease (eg, congenital heart disease, ischemic heart disease,

cardiac valvular disease, hypertensive heart disease, congestive heart failure), and noncardiovascular medical conditions (eg, endocrine, hematologic, immunologic, renal).

For surveillance purposes, a pregnancy-related death is defined as "the death of a woman during or within 1 year of pregnancy that was caused by a pregnancy complication, a chain of events initiated by pregnancy, or the aggravation of an unrelated condition by the physiologic effects of pregnancy."<sup>5</sup> Thus, the Pregnancy Mortality Surveillance System requires that a pregnancy-related death meets both temporal and causal relationships with the pregnancy<sup>5</sup>; methods of ascertainment of these relationships are described in detail elsewhere.<sup>6</sup>

Information about the women and their pregnancies was obtained from death certificates and, when available, matched birth or fetal death certificates. Maternal age was categorized as younger than 19, 20–24, 25–29, 30–34, 35–39, or 40 years or older. Race-ethnicity was categorized as non-Hispanic white, non-Hispanic black, Hispanic, or other. Maternal education was categorized as less than 12, 12, or more than 12 completed years. Marital status was categorized as married or living together and unmarried. Live birth order was reported as one, two, three, four, or five or more. Onset of prenatal care was grouped as no prenatal care, first, second, or third trimester. Pregnancy outcomes were grouped as undelivered, abortion, live birth, stillbirth, ectopic pregnancy, molar pregnancy, and unknown. In addition, timing of death was categorized as before delivery, day of delivery (0 days), 1–6, 7–41, 42–182, or 183–364 days postpartum. Data about race or ethnicity were missing for nine women; in each of these cases, we used state-specific and year-specific birth data and assigned race-ethnicity according to the predominant maternal racial-ethnic group in the state where the woman died during the year of her death. Overall, data were missing for several variables as follows: 0.5% for marital status, 6.4% for education, 48.0% for onset of prenatal care, and 59.4% for live birth order. Because we did not have the matching birth or fetal death certificate for all cases where such a certificate exists, we were unable to determine if some pregnancies had ended in a live birth or a stillbirth; information on pregnancy outcomes was missing in 10.1% of cases. Molar pregnancy was the recorded pregnancy outcome for only one death during the period and, for analysis purposes, we included this case in the undelivered category.

We calculated pregnancy-related mortality ratios (number of pregnancy-related deaths per 100,000 live

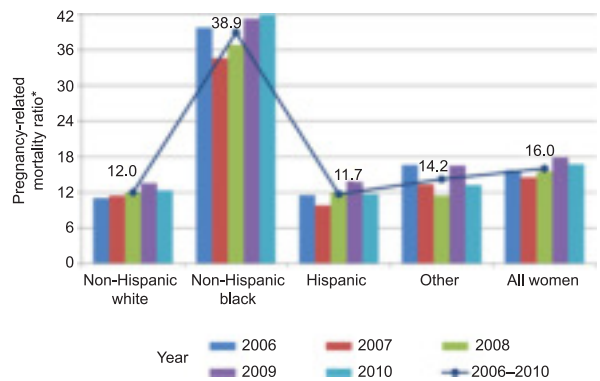


births) for 2006–2010 by year and by age group for all race–ethnicity groups. Denominator data (ie, live births) are from publicly available U.S. birth files from the National Center for Health Statistics; there were 20,959,533 live births during 2006–2010.<sup>12</sup> Characteristics of women who died from pregnancy complications were compared by race–ethnicity using  $\chi^2$  tests and corresponding *P* values. Analysis of cause-of-death data involved two steps: 1) we examined causes of pregnancy-related death by pregnancy outcome during 2006–2010; and 2) we calculated proportionate maternal mortality (ie, specific cause-of-death percentage of all pregnancy-related deaths) to explore changes in causes of pregnancy-related deaths since 1987 by using previously published Pregnancy Mortality Surveillance System data. All analyses are conducted using STATA 12. The Pregnancy Mortality Surveillance System data do not include any personal identifiers; thus, the CDC’s institutional review board deemed the study as research not involving human subjects and exempt from review.

## RESULTS

Data for 8,645 potential pregnancy-related deaths occurring during 2006–2010 were received by the CDC. Of these, 3,358 were found to be pregnancy-related (ie, occurring during or within 1 year of pregnancy and caused by pregnancy complications), 5,028 were pregnancy-associated but not pregnancy-related (ie, occurring during or within 1 year of pregnancy but not causally related to pregnancy), and 240 were not pregnancy-associated (ie, occurring more than 1 year after the end of pregnancy); for 19 cases, either the temporal or causal relationship between the death and pregnancy could not be determined. This report is restricted to the 3,358 pregnancy-related deaths.

Overall, more pregnancy-related deaths occurred in 2009 (*n*=737) than in the other 4 years studied here (annual range of 626–668). Over the years studied, the annual pregnancy-related mortality ratio ranged from 14.5 deaths per 100,000 live births in 2007 to 17.8 deaths per 100,000 live births in 2009 and the corresponding ratio for the entire 2006–2010 period was 16.0 deaths per 100,000 live births (Fig. 1). Forty percent of all pregnancy-related deaths during the period were among non-Hispanic white women, 35.5% among non-Hispanic black women, and 17.7% among Hispanic women with few year-to-year differences. For the 5-year period, specific race–ethnicity pregnancy-related mortality ratios were 12.0, 38.9, 11.7, and 14.2 deaths per 100,000 live births for non-Hispanic white, non-Hispanic black, Hispanic, and other race women, respectively (Fig. 1).



**Fig. 1.** Pregnancy-related mortality ratios by year and race and ethnicity: United States, 2006–2010. \*Number of pregnancy-related deaths per 100,000 live births.

*Creanga. Pregnancy-Related Mortality in the United States. Obstet Gynecol 2015.*

and other race women, respectively (Fig. 1). The ratio of the pregnancy-related mortality ratios between non-Hispanic black and non-Hispanic white women during 2006–2010 was 3.2 with an annual range of 3.0–3.6.

More than one-fourth (27.4%) of all women who died of pregnancy complications during the study period were aged 35 years or older, and this proportion was even larger for non-Hispanic white women (29.5%) and women of other race (30.6%; *P*<.05; Table 1). Pregnancy-related mortality ratios increased with maternal age for all women, but within age groups, non-Hispanic black women had the highest risk of dying from pregnancy complications (Fig. 2). The excess risk of death for non-Hispanic black compared with non-Hispanic white women was lowest among teenagers, increased monotonically with age, and reached its peak among women aged 40 years or older. Thus, during 2006–2010, the ratio of the pregnancy-related mortality ratios between non-Hispanic black and white women was 1.4 among teenagers, 2.8 among those aged 20–24 years, and more than 4.1 for all the other age groups.

Among women who died of pregnancy complications, a significantly higher proportion of Hispanic than non-Hispanic women had less than 12 years of education, and a significantly lower proportion of non-Hispanic black women than women in any other race group were married or living together (all *P*<.05). Of those with known live birth order (40.6% of total number of cases), higher proportions of non-Hispanic black and Hispanic than non-Hispanic white and other race women had three live births or more (all *P*<.005; Table 1). Of the 1,748 women with pregnancy-related deaths for whom the onset of

**Table 1. Sociodemographic Characteristics of Women with Pregnancy-Related Deaths: United States, 2006–2010**

Characteristic	Race–Ethnicity				All Women (N=3,358)
	Non-Hispanic White (n=1,352)	Non-Hispanic Black (n=1,192)	Hispanic (n=595)	Other (n=219)	
Maternal age (y)					
Younger than 19	92 (6.8)	81 (6.8)	37 (6.2)	10 (4.6)	220 (6.6)
20–24	248 (18.3)	265 (22.2)	114 (19.2)	18 (8.2)	644 (19.2)
25–29	291 (21.5)	300 (25.2)	149 (25.0)	53 (24.2)	794 (23.6)
30–34	322 (23.8)	246 (20.6)	141 (23.7)	71 (32.4)	780 (23.2)
35–39	280 (20.7)	202 (17.0)	108 (18.2)	55 (25.1)	645 (19.2)
Older than 39	119 (8.8)	98 (8.2)	46 (7.7)	12 (5.5)	275 (8.2)
Maternal education (y)					
Less than 12	195 (14.4)	225 (18.9)	243 (40.8)	41 (18.7)	704 (21.0)
12	507 (37.5)	469 (39.4)	187 (31.4)	60 (27.4)	1,223 (36.4)
Greater than 12	574 (42.5)	414 (34.7)	116 (19.5)	112 (51.1)	1,216 (36.2)
Missing	76 (5.6)	84 (7.1)	49 (8.2)	6 (2.7)	215 (6.4)
Marital status					
Married or living together	786 (58.1)	336 (28.2)	302 (50.8)	160 (73.1)	1,584 (47.2)
Unmarried	561 (41.5)	851 (71.4)	288 (48.4)	59 (26.9)	1,759 (52.4)
Missing	5 (0.4)	5 (0.4)	5 (0.8)	0 (0.0)	15 (0.5)
Live birth order					
1	81 (6.0)	63 (5.3)	14 (2.4)	13 (5.9)	171 (5.1)
2	239 (17.7)	136 (11.4)	85 (14.3)	39 (17.8)	499 (14.9)
3	108 (8.0)	105 (8.8)	63 (10.6)	32 (14.6)	308 (9.2)
4	64 (4.7)	65 (5.5)	45 (7.6)	8 (3.7)	182 (5.4)
5 or more	63 (4.7)	84 (7.1)	42 (7.1)	15 (6.9)	204 (6.1)
Missing	797 (59.0)	739 (62.0)	346 (58.2)	112 (51.1)	1,994 (59.4)
Onset of prenatal care					
No prenatal care	47 (3.5)	44 (3.7)	32 (5.4)	7 (3.2)	130 (3.9)
First trimester	578 (42.8)	392 (32.9)	192 (32.3)	98 (44.8)	1,260 (37.5)
Second trimester	107 (7.9)	96 (8.1)	68 (11.4)	24 (11.0)	295 (8.8)
Third trimester	16 (1.2)	29 (2.4)	13 (2.2)	5 (2.3)	63 (1.9)
Missing	604 (44.7)	631 (52.9)	290 (48.7)	85 (38.8)	1,610 (48.0)
Pregnancy outcome					
Undelivered	286 (21.2)	237 (19.9)	117 (19.7)	24 (11.0)	664 (19.8)
Abortion	22 (1.6)	39 (3.3)	22 (3.7)	7 (3.2)	90 (2.7)
Live birth	823 (60.9)	679 (57.0)	347 (58.3)	154 (70.3)	2,003 (59.7)
Stillbirth	67 (5.0)	55 (4.6)	25 (4.2)	11 (5.0)	158 (4.7)
Ectopic	26 (1.9)	57 (4.8)	16 (2.7)	4 (1.8)	103 (3.1)
Missing	128 (9.5)	125 (10.5)	68 (11.4)	19 (8.7)	340 (10.1)

Data are n (%).

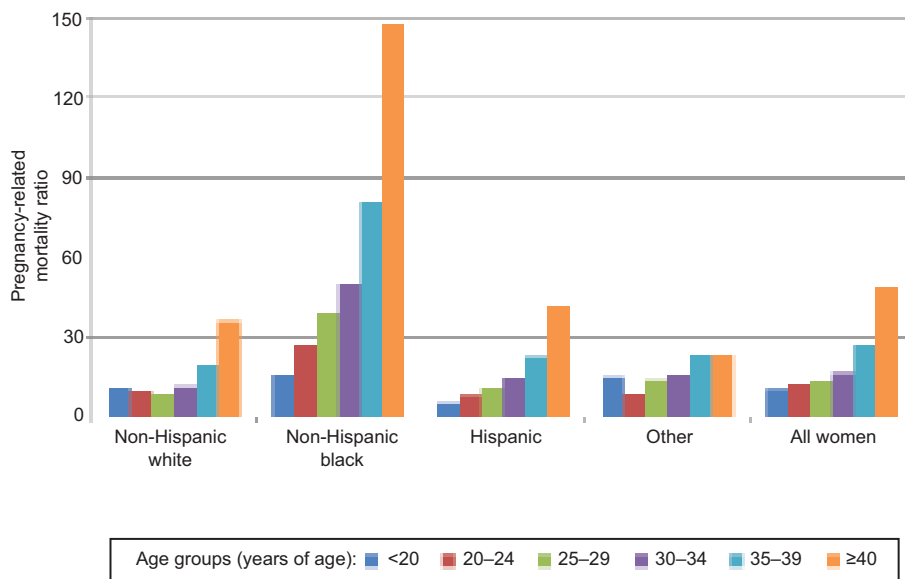
All pairwise comparisons are statistically significant at  $P < .05$  based on  $\chi^2$  tests.

prenatal care was known (52.0% of total number of cases), 130 (7.4%) had not received any prenatal care, whereas 358 (20.5%) started prenatal care during their second or third trimester.

Pregnancy outcomes were known for approximately 90% of the women in this series (Table 1). Approximately one of five women dying from pregnancy complications were undelivered, three of five had a live birth, 1 of 20 had a stillbirth, and approximately 6 of 100 had either an ectopic pregnancy or an induced or spontaneous abortion; one woman in our series was reported to have died after gestational

trophoblastic disease. Notably, smaller proportions of non-Hispanic white and other race women than non-Hispanic black and Hispanic women died after an ectopic pregnancy. The timing of death in relation to the end of the pregnancy was known for 87.2% of all women with pregnancy-related deaths during 2006–2010 (data not shown). Among women with known timing of death information in relation to the end of pregnancy, 22.7% died before delivery, 16.6% on the day of delivery or pregnancy termination, 20.8% during 1–6 days postpartum, and 26.6% during 7–41 days postpartum. Only 13.5% died after 42 days





**Fig. 2.** Pregnancy-related mortality ratios by age and race and ethnicity: United States, 2006–2010.

Creanga. *Pregnancy-Related Mortality in the United States*. *Obstet Gynecol* 2015.

postpartum; this latter proportion ranged from 9.6% among Hispanic to 15.0% among other race women.

Seven of the 10 groups of causes of death each contributed from 9.4% to 14.6% of all pregnancy-related deaths during the period of study: cardiovascular conditions ranked first (14.6%) followed by infection (13.6%), noncardiovascular medical conditions (12.7%), cardiomyopathy (11.8%), hemorrhage (11.4%), thrombotic pulmonary or other embolism (9.6%), and hypertensive disorders of pregnancy (9.4%; Table 2). The most common causes of death varied by pregnancy outcome. Among deaths after a live birth, embolism, cardiomyopathy, and other cardiovascular conditions were the three most common causes of death, whereas infection, noncardiovascular medical conditions, and hemorrhage were most commonly found with deaths after a stillbirth. Because 42 days postpartum represents the cutoff for the World Health Organization’s definition of maternal death,<sup>4</sup> as opposed to 1 year in our definition of pregnancy-related death, we used our data with known information about timing of death to examine which causes of death would be more likely undercounted by using the former definition. Almost all pregnancy-related deaths from hemorrhage, hypertensive disorders of pregnancy, and amniotic fluid embolism occurred within 42 days postpartum (98.4%, 98.3%, and 98.2%, respectively). However, a considerable proportion of deaths attributable to the remaining cause-of-death groups occurred after 42 days: 7.1% of deaths attributable to thrombotic pulmonary embolism, 9.8% of deaths attributable to cerebrovascular accidents, 10.9% of infection deaths, 13.0% of deaths

resulting from cardiovascular conditions, 16.8% of deaths resulting from noncardiovascular medical conditions, and 42.1% of cardiomyopathy deaths.

We compared proportionate maternal death (ie, percentage of all pregnancy-related deaths) by cause of death for four periods: 1987–1990, 1991–1997, 1998–2005, and 2006–2010, keeping with previously published reports of our Pregnancy Mortality Surveillance System data (Fig. 3). The contribution of hemorrhage, hypertensive disorders of pregnancy, embolism, and anesthesia complications continued to decline, whereas that of cardiovascular conditions increased. Markedly different from all previous periods, the contribution of infection to pregnancy-related mortality increased during 2006–2010.

## DISCUSSION

Since the Pregnancy Mortality Surveillance System’s implementation, the U.S. pregnancy-related mortality ratio ranged from 7.2 to 17.8 deaths per 100,000 live births in 1987 and 2009, respectively.<sup>5</sup> Reasons for this increasing pattern in pregnancy-related mortality are not entirely clear because changes in case ascertainment occurred in concert with changes in women’s risk profiles. The transition between the International Classification of Diseases (ICD) 9th and 10th Revisions for cause-of-death coding in 1998 and the progressive addition of a pregnancy checkbox as states adopted new versions of death certificates have likely improved identification of pregnancy-related deaths over time. However, U.S. women have been delaying childbearing, and although less than 15% of live births are to women 35 years of age or



**Table 2. Causes of Pregnancy-Related Death by Outcome of Pregnancy: United States, 2006–2010**

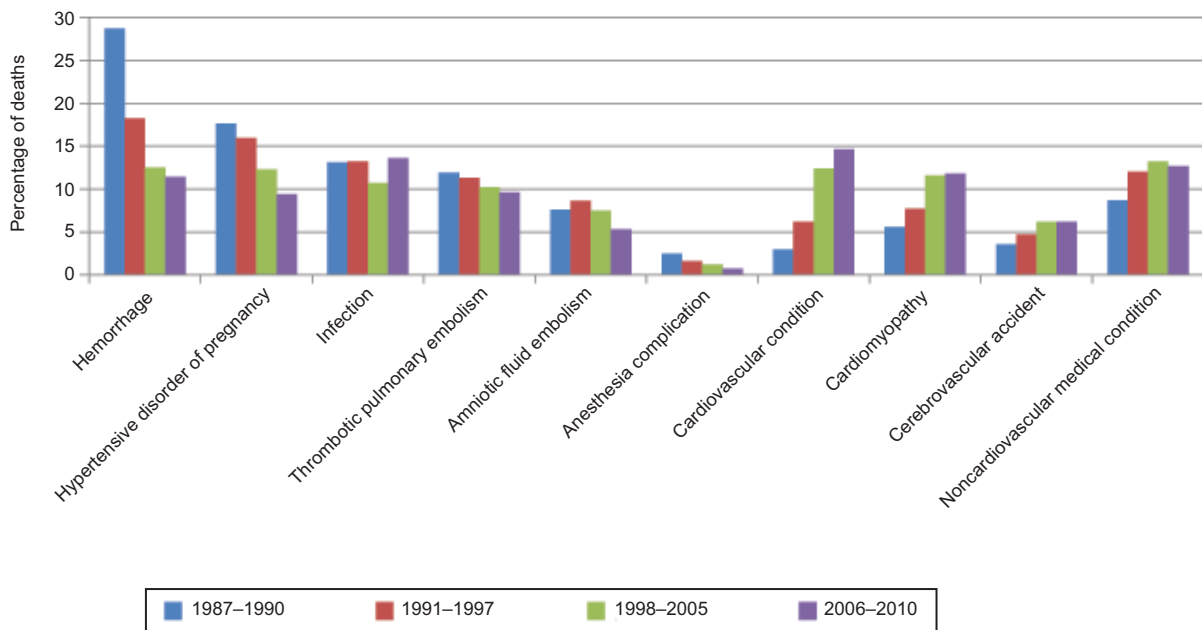
Cause of Death	Pregnancy Outcome						Total
	Live Birth	Stillbirth	Ectopic	Abortion	Undelivered	Unknown	
Hemorrhage	176 (8.8)	28 (17.7)	100 (97.1)	16 (17.8)	30 (4.5)	32 (9.4)	382 (11.4)
Ruptured ectopic	0	0	100	0	0	1	101 (3.0)
Uterine rupture or laceration	11	8	0	6	8	4	37 (1.1)
Abruptio placenta	15	12	0	0	7	4	38 (1.1)
Placenta previa	5	1	0	0	1	4	11 (0.3)
Placenta accreta, increta, or percreta	34	1	0	2	6	5	48 (1.4)
Retained products of conception	4	0	0	2	0	2	8 (0.2)
Coagulopathy	4	1	0	0	2	1	8 (0.2)
Atony or other uterine bleeding	49	0	0	5	2	4	60 (1.8)
Other or unspecified	54	5	0	1	4	7	71 (2.1)
Embolism	329 (16.4)	17 (10.8)	0 (0.0)	11 (12.2)	107 (16.1)	37 (10.9)	501 (14.9)
Thrombotic pulmonary embolism	179	9	0	8	90	27	313 (9.3)
Amniotic pulmonary embolism	145	6	0	2	15	10	178 (5.3)
Other embolism	5	2	0	1	2	0	10 (0.3)
Hypertensive disorders	227 (11.3)	19 (12.0)	0 (0.0)	0 (0.0)	42 (6.3)	29 (8.5)	317 (9.4)
Preeclampsia	113	12	0	0	22	13	160 (4.8)
Eclampsia	98	7	0	0	16	16	137 (4.1)
Other or unspecified hypertension	16	0	0	0	4	0	20 (0.6)
Infection	251 (12.5)	35 (22.2)	1 (1.0)	42 (46.7)	80 (12.1)	47 (13.8)	456 (13.6)
Chorioamnionitis	5	6	0	3	6	2	22 (0.7)
Genital tract	34	2	0	6	2	4	48 (1.4)
Sepsis	63	19	0	30	22	10	144 (4.3)
Other or unspecified	149	8	1	3	50	31	242 (7.2)
Anesthesia complications	13 (0.7)	0 (0.0)	1 (1.0)	7 (7.8)	0 (0.0)	1 (0.3)	22 (0.7)
Cardiomyopathy	292 (14.6)	2 (1.3)	0 (0.0)	0 (0.0)	33 (5.0)	70 (20.6)	397 (11.8)
Cerebrovascular accident	122 (6.1)	3 (1.9)	0 (0.0)	0 (0.0)	53 (8.0)	29 (8.5)	207 (6.2)
Cardiovascular conditions	288 (14.4)	18 (11.4)	0 (0.0)	7 (7.8)	134 (20.2)	43 (12.7)	490 (14.6)
Noncardiovascular conditions	208 (10.4)	29 (18.4)	0 (0.0)	5 (5.6)	149 (22.4)	37 (10.9)	428 (12.8)
Unknown	97 (4.8)	7 (4.4)	1 (1.0)	2 (2.2)	36 (5.4)	15 (4.4)	158 (4.7)
<b>Total</b>	<b>2,003 (100.0)</b>	<b>158 (100.0)</b>	<b>103 (100.0)</b>	<b>90 (100.0)</b>	<b>664 (100.0)</b>	<b>340 (100.0)</b>	<b>3,358 (100.0)</b>

Data are n or n (%).

older, 27.4% of pregnancy-related deaths were among this age group (both proportions have not changed considerably during 2006–2010). Studies show that an increasing number of pregnant women in the

United States have chronic health conditions such as hypertension,<sup>13</sup> diabetes,<sup>14</sup> chronic heart disease,<sup>15</sup> and obesity,<sup>16</sup> these conditions put pregnant women at risk of adverse outcomes.





**Fig. 3.** Cause-specific proportionate pregnancy-related mortality: United States, 1987–2010. Creanga. *Pregnancy-Related Mortality in the United States*. *Obstet Gynecol* 2015.

During 2006–2010, the contribution of traditional causes of pregnancy-related deaths (hemorrhage, hypertensive disorders of pregnancy, embolism) continued to decline, whereas that of cardiovascular conditions, including cardiomyopathy, increased to 26.4% of pregnancy-related deaths. Addressing cardiovascular disease during pregnancy will require early identification of disease, ideally before pregnancy; women can then benefit from thorough assessment, disease stabilization, appropriate referrals, and counseling. A notable difference from the preceding Pregnancy Mortality Surveillance System report is the rise in proportionate mortality from infection: 10.7% during 1998–2005 compared with 13.6% during 2006–2010.<sup>6</sup> The higher pregnancy-related mortality ratios in 2009 and 2010 than previous years were driven by the 2009 H1N1 influenza pandemic, a condition embedded in our infection category that disproportionately affected pregnant women.<sup>17–19</sup> Prevention of influenza infection and related mortality during pregnancy can be achieved through continuous efforts by health care providers and health agencies to increase the influenza vaccine uptake in pregnant women.

Racial disparities in pregnancy-related mortality persisted during 2006–2010; non-Hispanic black women contributed 14.6% of live births but 35.5% of pregnancy-related deaths, thus having a 3.2 times higher risk of dying of pregnancy complications than non-Hispanic white women. Non-Hispanic black

women dying of pregnancy-related causes were younger, less educated, more likely to be unmarried, start prenatal care in the second and third trimesters of pregnancy, and die of ectopic pregnancy complications than non-Hispanic white women; the latter two characteristics also describe Hispanic women. These findings are in line with current hypotheses as to why the risk of pregnancy-related death is higher for non-Hispanic black than white women; other hypotheses include higher rates of preexisting medical conditions and severe maternal morbidity and lower insurance coverage for non-Hispanic black than white women.<sup>11</sup> However, there remains a critical need to better understand social determinants of health to address medical and contextual factors affecting health outcomes.

Some maternal deaths are preventable.<sup>20</sup> The National Partnership for Maternal Safety brings together stakeholders in women’s health to address the three most common preventable causes of maternal death and disease: obstetric hemorrhage, hypertensive disorders of pregnancy, and venous thromboembolism.<sup>21,22</sup> There is an action plan to provide evidence-based patient safety bundles for these three conditions and institute three obstetric unit-improvement bundles: an approach to recognize early warning signs or symptoms, internal case reviews to identify improvement opportunities, and support tools for patients, families, and staff experiencing adverse outcomes.<sup>21,22</sup> Research



has shown that when protocols and clinical policies are implemented systematically, adverse maternal outcomes are reduced significantly.<sup>23,24</sup>

This analysis has limitations. Pregnancy-related deaths may be undercounted. Not all states send linked maternal death and birth and fetal certificate data to the CDC, and state implementation of death certificate pregnancy checkboxes occurred at different times. The Pregnancy Mortality Surveillance System contains limited clinical details and data on preexisting medical conditions (eg, obesity); data on key study variables (live birth order, prenatal care) are missing for a number of cases. However, the Pregnancy Mortality Surveillance System is able to provide a more detailed picture of pregnancy-related deaths than ICD-10 codes on death certificates alone given that most states provide death certificate and birth and fetal death certificate information; the cause-of-death coding system in the Pregnancy Mortality Surveillance System is more granular than ICD-10 codes and provides information that more closely reflects the woman's clinical course, yet the Pregnancy Mortality Surveillance System cannot approach the level of information that can be collected at the state and local levels. Only approximately half of U.S. states currently have functional maternal mortality review committees.<sup>25</sup> State-based review of all pregnancy-related deaths and expansion into review of severe maternal morbidity could help improve the quality of maternity care for U.S. women.

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