

2022

# Oklahoma Maternal Health Morbidity and Mortality Annual Report



OKLAHOMA  
State Department  
of Health

## Table of Contents

<b>Introduction .....</b>	<b>3</b>
<b>Women’s Health Overview: Oklahoma .....</b>	<b>3</b>
Postpartum Visits .....	4
Postpartum Depression .....	4
<b>Severe Maternal Morbidity (SMM) .....</b>	<b>7</b>
<b>Maternal Mortality.....</b>	<b>10</b>
Summary of National Data.....	10
Oklahoma Maternal Mortality.....	11
Definitions and Methodology .....	11
Data Analysis Improvements .....	12
Maternal Mortality Rate .....	14
Race/Ethnicity .....	16
Education Level .....	17
Age at Time of Death .....	18
County of Residence .....	19
<b>Maternal Mortality Review Committee.....</b>	<b>20</b>
Pregnancy-Related Deaths.....	23
Definitions .....	23
Pregnancy-Related Mortality Rate.....	24
Race/Ethnicity .....	24
Education Level .....	25
Age at Time of Death .....	26
Top Causes of Pregnancy-Related Deaths .....	27
Contributing Factors to Pregnancy-Related Death.....	28
MMRC Case Review Conclusions and Recommendations .....	32
<b>Report Summary .....</b>	<b>36</b>
<b>References .....</b>	<b>38</b>

## Introduction

Maternal death continues to be an international standard to measure a nation's commitment to maternal health and access to quality health care. The Common Wealth Fund reported the maternal mortality rate for the U.S. was more than double the rate for other developed countries.<sup>1</sup>

Every maternal death is a tragedy. Historically, over 700 women died each year in the United States as a result of pregnancy or delivery complications. According to the National Center for Health Statistics, in 2020 this number rose to 861 deaths per 100,000 live births, raising the national maternal mortality rate from 20.1 in 2019 to 23.8 in 2020.<sup>2</sup> The Oklahoma maternal mortality rate for 2018-2020 was 25.2, which is down from 29.5 in the previous reporting period (2017-2019) but still above the national rate of 23.8. Despite national and local efforts to address maternal morbidity and mortality, disparities still exist in relation to race, age, and education level. Nationwide, Maternal Mortality Review Committees have determined that the majority of pregnancy-related deaths are preventable, necessitating efforts to stop the current trajectory by improving education for providers and families and increasing access to quality health care before, during, and after pregnancy.<sup>3</sup>

## Women's Health Overview: Oklahoma

As reported in the Census Bureau's Current Population Survey, Oklahoma has the second highest uninsured rate among the nonelderly population at 17.2% in 2020 (behind Texas at 20.0%), compared to the national uninsured rate of 10.2%.<sup>4</sup> Additionally, according to the Behavioral Risk Factor Surveillance System (BRFSS), among women aged 18 to 44 years in Oklahoma during 2020, 10.9% reported their health status as fair or poor and 21.0% felt that within the past year, a doctor visit was too costly to be able to attend. Approximately 4.5% of women aged 18-44 reported ever receiving a diabetes diagnosis, and 3.1% reported gestational diabetes. In addition, 1.5% of women aged 18-44 reported having been told by a doctor they suffered a stroke and 0.6% reported experiencing a heart attack. Among women of reproductive age, 68.3% were considered to be overweight or obese. Smoking also continues to be a public health concern: among women in this age group, 17.6% reported being a current smoker, 13.3% reporting smoking daily, and 17.5% reported being a former smoker.<sup>5</sup>

## Postpartum Visits

According to the most recent Pregnancy Risk Assessment Monitoring System (PRAMS) data (2016-2019), 88.0% of new mothers in Oklahoma attended their postpartum visit. Native American mothers reported the highest postpartum visit rate at 90.5%, compared with 87.7% of Hispanic mothers, 85.1% of Non-Hispanic Asian or Pacific Islander mothers, 84.0% of Non-Hispanic White mothers, and 82.9% of Non-Hispanic Black mothers.<sup>6</sup>

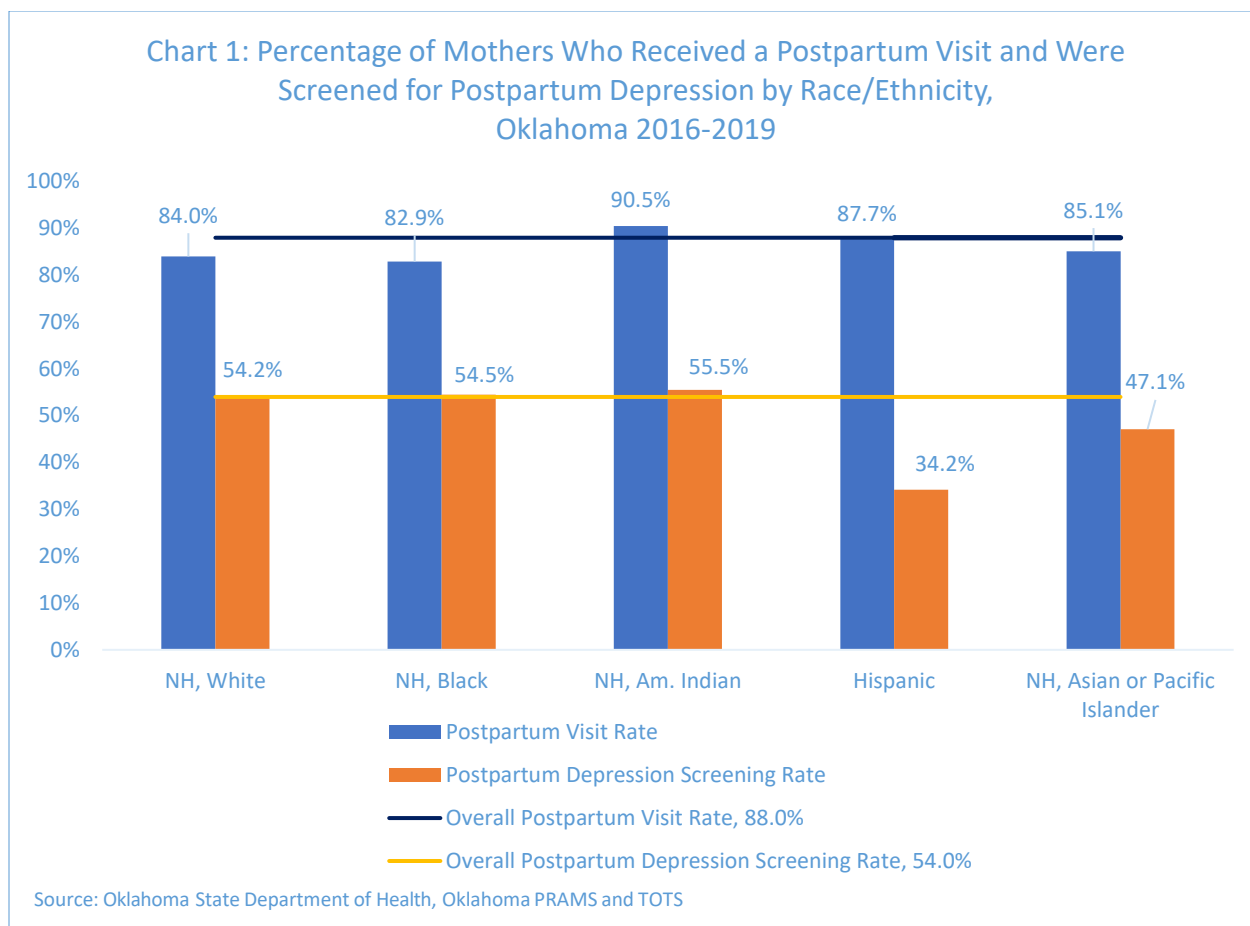
Postpartum visit rates also increased with increasing education level. Only 76.7% of mothers with less than a high school education attended their postpartum visit, compared with 85.1% of mothers with a high school diploma or GED completed, 90.4% of mothers with some college completed or an Associate's degree, and 95.4% of mothers with a Bachelor's or advanced degree. Oklahoma PRAMS data for 2020 was not available at the time of this report.

## Postpartum Depression

According to the CDC, postpartum depression (PPD) occurs in an estimated 1 in 8 women that give birth every year.<sup>7</sup> The onset of depressive, sad, or pessimistic feelings that may interfere with daily activities usually occurs during the six months after giving birth, but onset of symptoms can happen up to one year postpartum.

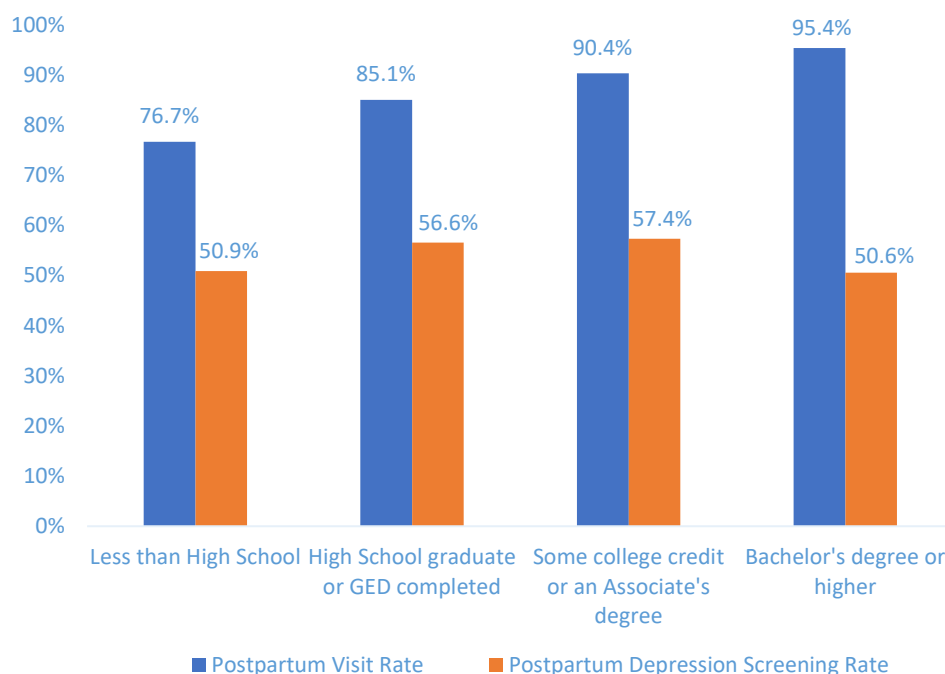
Nationally, according to the CDC's PRAMS data in 2020, 13.4% of women experienced depressive symptoms or feelings of hopelessness following pregnancy and delivery.<sup>8</sup> Oklahoma PRAMS, for years 2016-2019, reported 16.1% of new mothers had experienced symptoms of postpartum depression. Almost 19% of Non-Hispanic Black mothers reported symptoms compared to 16.7% of Non-Hispanic White mothers, 14.8% of Non-Hispanic American Indian mothers, and Hispanic mothers at 11.7%.

According to the most recent data (2018-2019) from The Oklahoma Toddler Survey (TOTS), 54.0% of new mothers were screened for postpartum depression. 54.2% of Non-Hispanic White mothers and 55.5% of Non-Hispanic American Indian mothers reported having been screened, compared with 54.5% of Non-Hispanic Black mothers and 47.1% of Non-Hispanic Asian or Pacific Islander mothers. Hispanic mothers reported the fewest screenings at 34.2% (Chart 1 on next page). TOTS data for 2020 was not available at the time of this report.



While the percentage of mothers who received a postpartum visit increased with higher levels of education, this trend was not observed for postpartum depression screening (Chart 2 on next page). In fact, women with a Bachelor's degree or higher reported the lowest rate of postpartum depression screening at 50.6%, despite reporting the highest postpartum visit rate. Women who received some college credit or an Associate's degree had the highest screening rate, with 57.4% reporting receiving a postpartum depression screening. Comparatively, 56.6% of women who graduated from high school or completed a GED and 50.9% of women with less than a high school education reported being screened for postpartum depression.

Chart 2: Percentage of Mothers Who Received a Postpartum Visit and Were Screened for Postpartum Depression by Education Level, Oklahoma 2016-2019



Source: Oklahoma State Department of Health, Oklahoma PRAMS and TOTS

Additionally, 14.1% of mothers with toddlers indicated they had been diagnosed with PPD sometime after their toddler was born. The prevalence of mothers who reported being diagnosed with PPD by race are not included due to numbers per category of less than 30. The Oklahoma TOTS is a two-year follow-up survey to the Oklahoma PRAMS survey which evaluates the health and well-being of Oklahoma's toddler population and their health experiences from birth to age two.

## Severe Maternal Morbidity (SMM)

Oklahoma is one of the original nine states that received the State Maternal Health Innovation Program (SMHIP) Grant to increase access to health care, improve health education, and address social determinants of health for pregnant and postpartum women and their families. This program is designed to improve disparities in maternal health outcomes and focuses on reducing both maternal mortality and severe maternal morbidity.<sup>9</sup>

The Alliance for Innovation on Maternal Health (AIM) provides support to states to improve work being done toward the goal of reducing SMM and maternal mortality. Both the CDC and Oklahoma utilize an SMM definition from AIM characterized by identifying in-hospital deliveries where a mother develops severe complications during labor and delivery based on a list of 21 indicators that correspond to applicable ICD-10 codes.<sup>10</sup> For reporting purposes, blood transfusion codes are included in this working definition of SMM. Rates for SMM are reported as per 10,000 deliveries.

Nationally, in 2014 (the most recent data available) SMM rates have been continually increasing, affecting more than 50,000 women annually.<sup>11</sup> The CDC reports that from 1993 to 2014 SMM rates increased by nearly 500% from 24.5 per 10,000 in-hospital deliveries to 144.0 in 2014. Most of these complications involved blood transfusions. Hysterectomy and ventilation or temporary tracheostomy were the next most frequent complications experienced.

Of note, only state-licensed facilities contribute to the collection of SMM data in Oklahoma, therefore there are limitations to the process of analyzing hospital discharge data to capture all of Oklahoma's potential SMM cases. Based on the most recent data (2016-2020), while the rate of SMM involving blood transfusions declined since 2017, from 2019 to 2020 the rate increased by 12.5% from 140.2 per 10,000 deliveries to 157.7. Rates of SMM excluding blood transfusions saw a similar trend, increasing 21.0% from 60.1 per 10,000 deliveries in 2019 to 72.7 in 2020 (Table 1). While hypertension numbers for years 2016-2019 have increased 20.2% from 1,447 to 1,739 cases, there was a decrease by 4.6% from 2019 to 2020. SMM-identified complication rates that include hypertension as well as transfusions fluctuated between 2016 and 2020, with rate of 28.6 per 10,000 deliveries in 2020 and a high of 37.1 in 2017.

Table 1: Oklahoma Hospital Discharge Data, 2016-2020							Per 10,000 deliveries			
Discharge Year	Deliveries	SMM including transfusion	SMM excluding transfusion	Hypertension (HTN)	SMM including transfusion + HTN	SMM excluding transfusion + HTN	SMM including transfusion	SMM excluding transfusion	SMM including transfusion + HTN	SMM excluding transfusion + HTN
2016	47106	800	305	1447	141	103	169.8	64.7	29.9	21.9
2017	45058	843	337	1700	167	121	187.1	74.8	37.1	26.9
2018	43730	682	282	1711	127	96	156.0	64.5	29.0	22.0
2019	43795	614	263	1823	137	95	140.2	60.1	31.3	21.7
2020	41276	651	300	1739	118	99	157.7	72.7	28.6	24.0

Source: Oklahoma State Department of Health, Center for Health Information



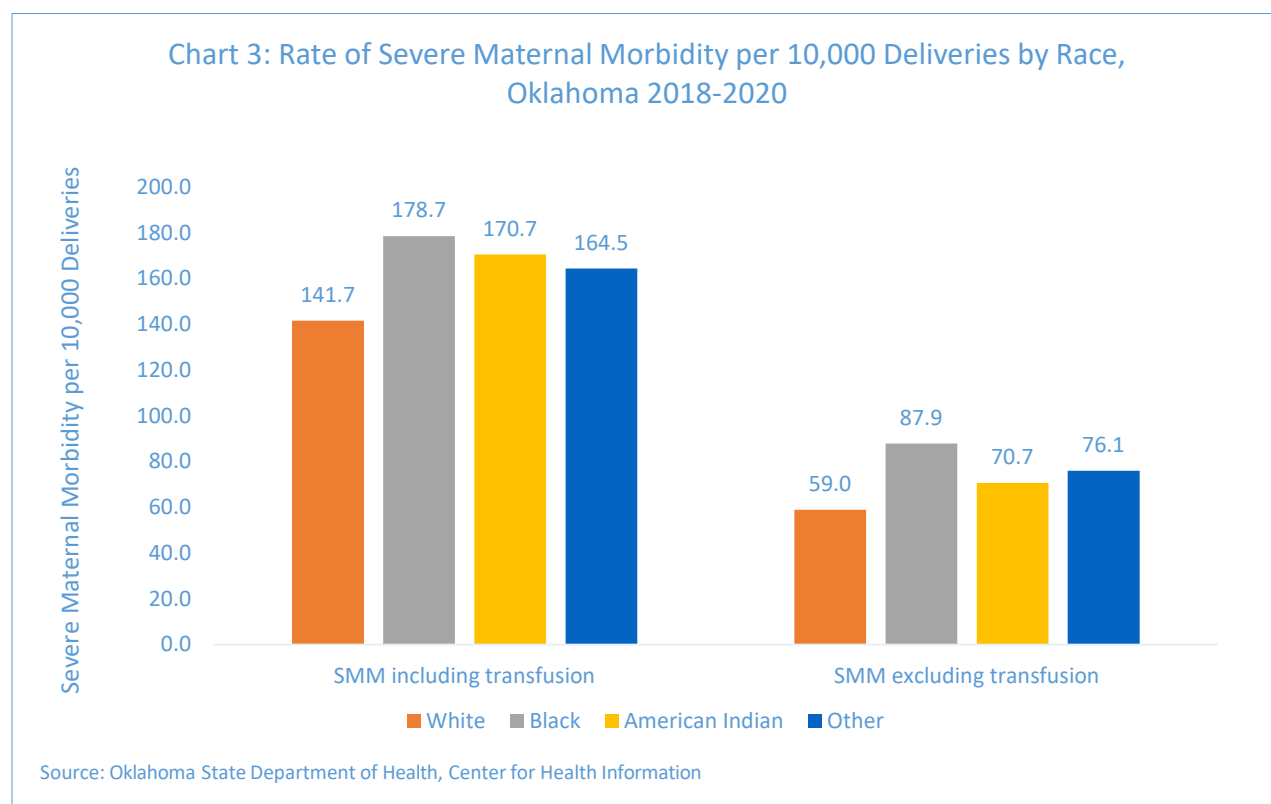
Among instances of SMM in Oklahoma, there are common diagnoses and procedures that contribute to SMM. For hospital discharges in Oklahoma in 2020, among SMM instances (157.7 per 10,000 deliveries) the top five most common diagnosis-based indicators were adult respiratory distress syndrome, acute renal failure, sepsis, disseminated intravascular coagulation, and pulmonary edema, at 15.5, 14.3, 12.6, 12.4, and 10.7 instances per 10,000 deliveries. Comparatively, for procedure-based indicators, blood transfusion was the most common indicator associated with SMM in 2020 at 91.1 instances per 10,000 deliveries, followed by hysterectomy and ventilation at 8.5 and 6.5 respectively (Table 2).

Table 2: Rates of SMM by Diagnosis-Based Indicators and Procedure-Based Indicators, Oklahoma 2020		Rate per 10,000 Deliveries
<i>Diagnosis-based Indicators</i>		
	Adult respiratory distress syndrome	15.5
	Acute renal failure	14.3
	Sepsis	12.6
	Disseminated intravascular coagulation	12.4
	Pulmonary edema	10.7
	Eclampsia	8.5
	Shock	7.5
	Puerperal cerebrovascular disorders	3.4
	Thrombotic embolism	2.7
	Acute myocardial infarction	1.2
	Amniotic fluid embolism	1.2
	Sickle cell anemia with crisis	0.7
	Severe anesthesia complication	0.5
	Aneurysm	0
	Cardiac arrest/ventricular fibrillation	0
	Heart failure during procedure or surgery	-
<i>Procedure-based Indicators</i>		
	Blood transfusion	91.1
	Hysterectomy	8.5
	Ventilation	6.5
	Conversion of cardiac rhythm	1.2
	Temporary Tracheostomy	-
<b>SMM Rate Overall</b>		<b>157.7</b>
Source: Oklahoma State Department of Health, Center for Health Information		



Additionally, severe maternal morbidity varied by race/ethnicity in Oklahoma from 2018-2020 (Chart 3). The SMM rate for this time period, including transfusion, was 141.7 per 10,000 deliveries for White women. Comparatively, Black women had a rate of SMM 1.3 times higher, American Indian women 1.2 times higher, and women of other race 1.2 times higher than White women at 178.7, 170.7, and 164.5 per 10,000 deliveries respectively.

Considering SMM excluding transfusions, the rate of SMM was 59.0 per 10,000 deliveries for White women. Comparatively, Black women had a rate of 1.5 times higher, American Indian women 1.2 times higher, and women of other race 1.3 times higher than White women at 87.9, 70.7, and 76.1 per 10,000 deliveries respectively.



## Maternal Mortality

### Summary of National Data

A maternal death is defined by the World Health Organization (WHO) as the death of a woman “from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy”.<sup>12</sup>

Maternal mortality rates are defined as the number of maternal deaths per 100,000 live births. The Centers for Disease Control and Prevention (CDC) estimates for 2020 show the U.S. had a statistically significant increase in maternal death rates with 23.8 maternal deaths per 100,000 live births, compared with 20.1 reported in 2019. The actual number of identified maternal deaths in 2020 was 861, compared to 754 in 2019.<sup>2</sup> In 2020 among race/ethnic categories, maternal mortality rates were: Non-Hispanic White (19.1), Non-Hispanic Black (55.3), and Hispanic (18.2). All groups experienced a rate increase in maternal mortality since 2019. The rate increases for Non-Hispanic Black and Hispanic women were considered statistically significant while the increased rate among Non-Hispanic White women was not considered statistically significant. Health equity continues to be of concern, with a widening disparity of maternal mortality rates between race/ethnicity groups. In 2020, Non-Hispanic Black women had a significantly higher maternal mortality rate (by approximately three times) than both Non-Hispanic White women and Hispanic women.<sup>2</sup>

From 2019 to 2020 maternal mortality rates increased in every age group. For women between 25 and 39 years of age there was a statistically significant increase from 19.9 deaths per 100,000 live births in 2019 to 22.8 in 2020. Women 40 years of age and older saw an even greater increase, from 75.5 to 107.9 deaths per 100,000 live births, representing a 43% relative increase from 2019, which was statistically significant. The 2020 maternal mortality rate for women 40 years of age or older was significantly higher than women under 25 (7.8 times) and women 25-39 (4.7 times). Among women under 25 years of age the maternal mortality rate in 2020 was 13.8, compared with 12.6 in 2019, however the increase was not statistically significant.

## Oklahoma Maternal Mortality

### Definitions and Methodology

The Oklahoma definitions for maternal death and maternal-related conditions are adapted from the definitions of the WHO and the National Center for Health Statistics (NCHS) within the CDC. Both organizations define a maternal death as “the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes”.<sup>2, 12</sup> To compute national estimates of maternal deaths, the NCHS uses data from the National Vital Statistics System (NVSS) and “does not include all deaths occurring to pregnant or recently pregnant women, but only those deaths with the underlying cause of death assigned to International Statistical Classification of Diseases (ICD), 10th Revision code numbers A34, O00–O95, and O98–O99”.<sup>2</sup> Oklahoma’s definition of a maternal-related condition is consistent with these ICD codes.

- **Maternal Death:** The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes.
- **Maternal Mortality Ratio:** The number of maternal deaths per 100,000 live births. Also referred to as maternal mortality rate.
- **Maternal-Related Condition:** A condition assigned to code numbers A34, O00–O95, and O98–O99 of the International Classification of Diseases, 10th Revision.

For consistency with the national maternal mortality estimates from NCHS, Oklahoma also computes maternal mortality estimates from vital statistics. The following variables on a death certificate are considered when counting maternal deaths: state residence, age, pregnancy status at time of death, the underlying cause of death, and manner of death. Deaths will only be included if the maternal residence is in the state of Oklahoma. Individuals who died in Oklahoma but resided out-of-state are not included in Oklahoma maternal mortality estimates. Individuals must be in a plausible age range for childbearing, in order to reduce the potential for misclassification of maternal association. To assess relation to pregnancy and pregnancy status at time of death, deaths are further considered if the underlying cause of death contains a maternal-related condition and the pregnancy checkbox indicates that the death occurred while pregnant, within 42 days of pregnancy termination, or the pregnancy status is unknown (see *Data Analysis Improvements* for further information). Lastly, to rule out accidental or incidental causes, deaths are excluded if the manner of death is accident, suicide, or homicide.

Therefore, to identify maternal deaths for reporting a state-wide maternal mortality rate, Oklahoma selects all death certificates of individuals where:

- The state of maternal residence is Oklahoma *and*
- Age at time of death is between 10 and 59 *and*
- The underlying cause of death contains a maternal-related condition *and*
- The pregnancy checkbox indicates that the death occurred while pregnant, within 42 days of pregnancy termination, or pregnancy status is unknown *and*
- The manner of death was not determined to be an accident, suicide, or homicide.

### *Data Analysis Improvements*

For this report and future reports which include maternal mortality estimates, Oklahoma has taken steps to improve and standardize the methods for estimating maternal mortality. Estimates from prior years included a larger emphasis on manual selection and review of potential maternal deaths. In an effort to make estimates more consistent with national data as well as more easily reproducible, Oklahoma has shifted to estimating maternal mortality solely by the variables noted above on death certificates in the state vital statistics system. Notably, as a result of these changes, the estimates in this year's report differ from the estimates in reports from prior years.

Additionally, Oklahoma investigated deaths from 2011-2020 among women with pregnancy status marked as unknown on the death certificate who also had a maternal-related condition as an underlying cause of death. Due to the definition of maternal death specifying deaths that occur while pregnant or within 42 days of pregnancy termination, only including deaths where the pregnancy checkbox indicates those two statuses can give a clear temporality of those deaths. However, there were 15 deaths between 2011 and 2020 with a pregnancy status of unknown but with a maternal-related condition as the underlying cause of death. Of these 15 deaths, the majority suggested death while pregnant or within 42 days of pregnancy termination based on underlying cause of death (e.g., cause of death of ectopic or tubal pregnancy, complications of labor and delivery, conditions with direct reference to the puerperium). For this reason, we chose to include deaths in our maternal mortality estimate if pregnancy status was unknown but met the other criteria to be counted as a maternal death. It is possible that by including deaths with unknown pregnancy status, we will include deaths that occurred more than 42 days from pregnancy termination and could overcount maternal deaths. However, based on our investigation into deaths with unknown pregnancy status, we believe

excluding such deaths would result in an undercount of maternal deaths by a larger margin, and so have chosen to include them in our estimate.

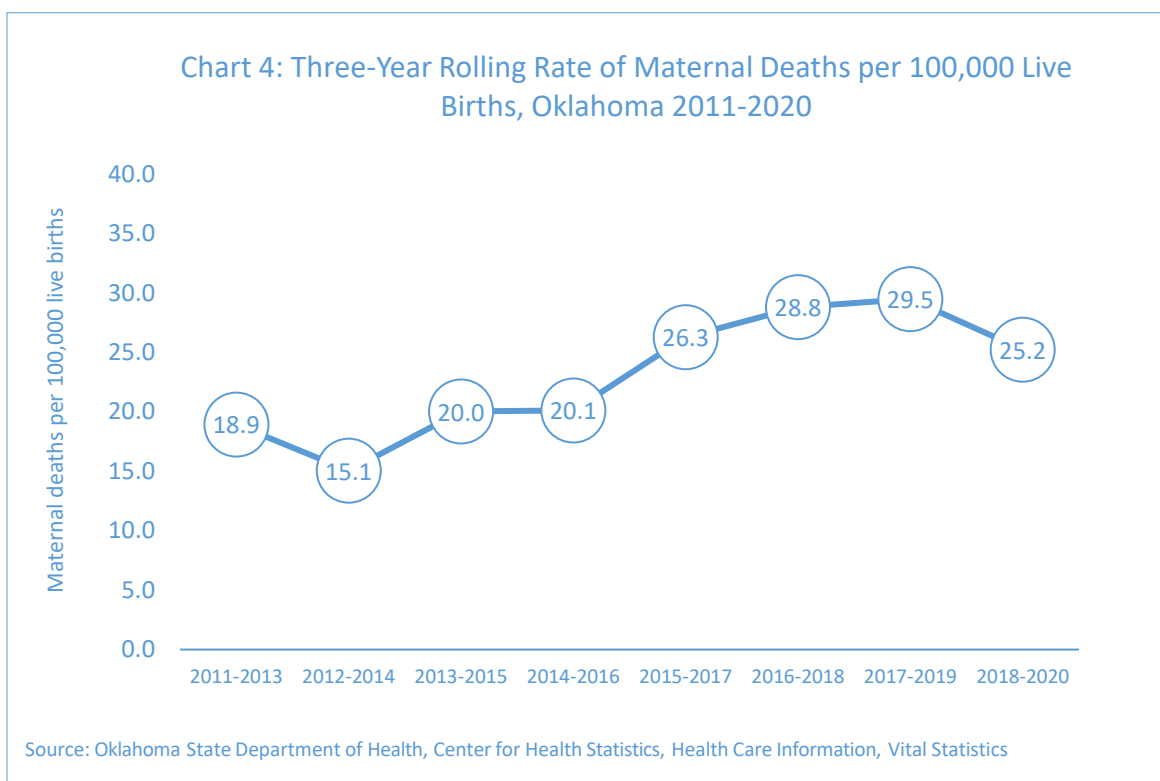
There are multiple strengths to our updated approach. Using similar methodology to the NCHS allows us to produce estimates which can be used for national, state, and potentially international comparisons. By using death certificates and ICD codes as the source and method of classification for maternal deaths, we are able to use data which is more standardized across the state, as well as more readily available than other records. Further, having a standardized method and defined criteria for estimating maternal mortality allows us to investigate trends over time in Oklahoma with more reliability.

It is also important to note that there are possible limitations of our updated approach. Though death certificates provide a more standardized and available data source, they are not immune to error. Errors on the death certificate, specifically regarding underlying cause of death or pregnancy status, could impact our maternal mortality estimates since they are the sole source of identification. These errors could potentially bias estimates in either direction, as deaths could be included in or excluded from our counts of maternal death depending on the nature of the error. Given the multiple conditions for inclusion, it is potentially more likely for errors to result in more deaths being excluded than appropriate, which could result in an underestimate. Additionally, as discussed above, the inclusion of deaths with unknown pregnancy status could affect our estimates if deaths are included that occurred more than 42 days from pregnancy termination.



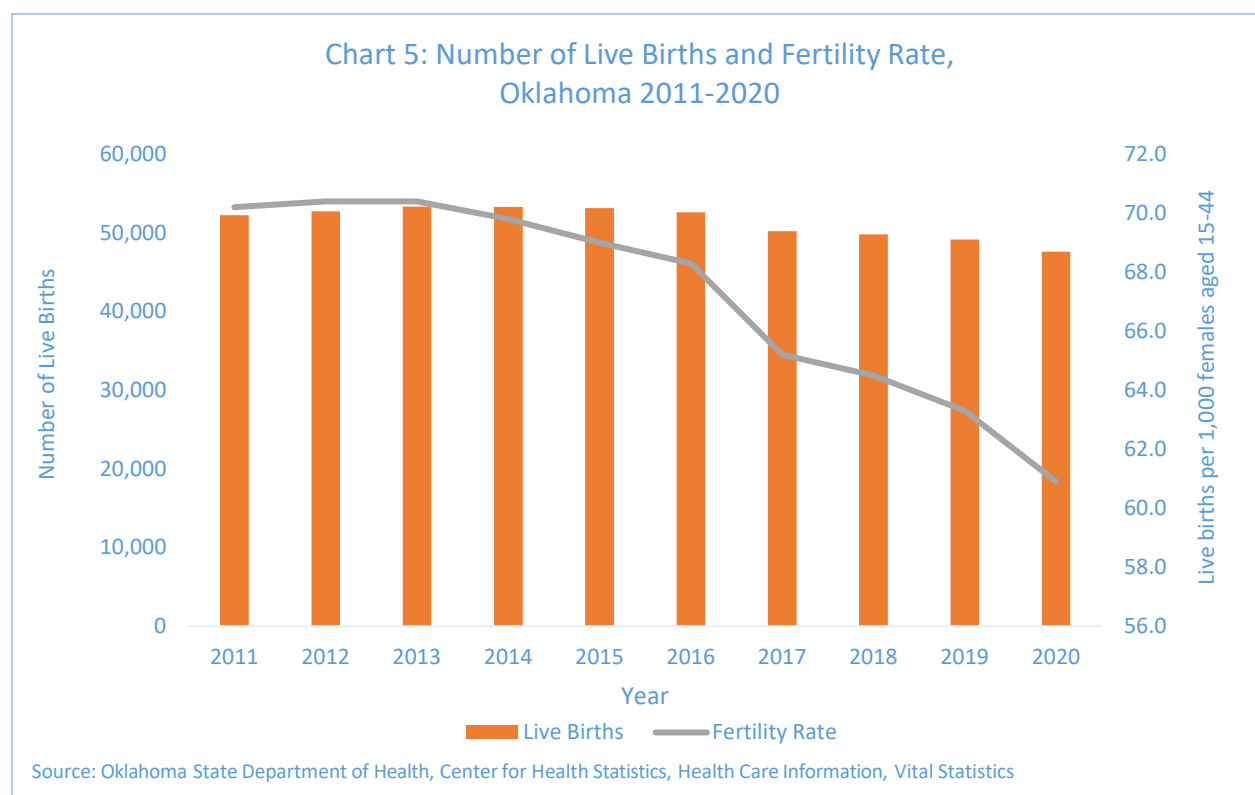
## Maternal Mortality Rate

From 2018 to 2020, Oklahoma had a maternal mortality rate of 25.2 maternal deaths per 100,000 live births (Chart 4). Of note, a three-year average is used for reporting maternal mortality in Oklahoma, for stability of rates based on low numbers of maternal deaths each year. The maternal mortality rate steadily increased from 2013 to 2019, before showing a 14.6% decrease from 29.5 in the 2017-2019 time period to 25.2 in the 2018-2020 time period.



While the Oklahoma maternal mortality rate has increased in recent years, the number of live births and the fertility rate for the state have been steadily declining (Chart 5). On average since 2011, there have been approximately 51,415 births per year in the state. However, each year from 2013 to 2020, the state has witnessed a decrease in the annual number of live births, declining by 10.7% over that time period. Likewise, the fertility rate has decreased by 13.5% from 70.4 births per 1,000 females aged 15-44 in 2013 to 60.9 in 2020. While maternal mortality has worsened in Oklahoma over time, it is also doing so in a time where childbearing is falling among Oklahoma's women.

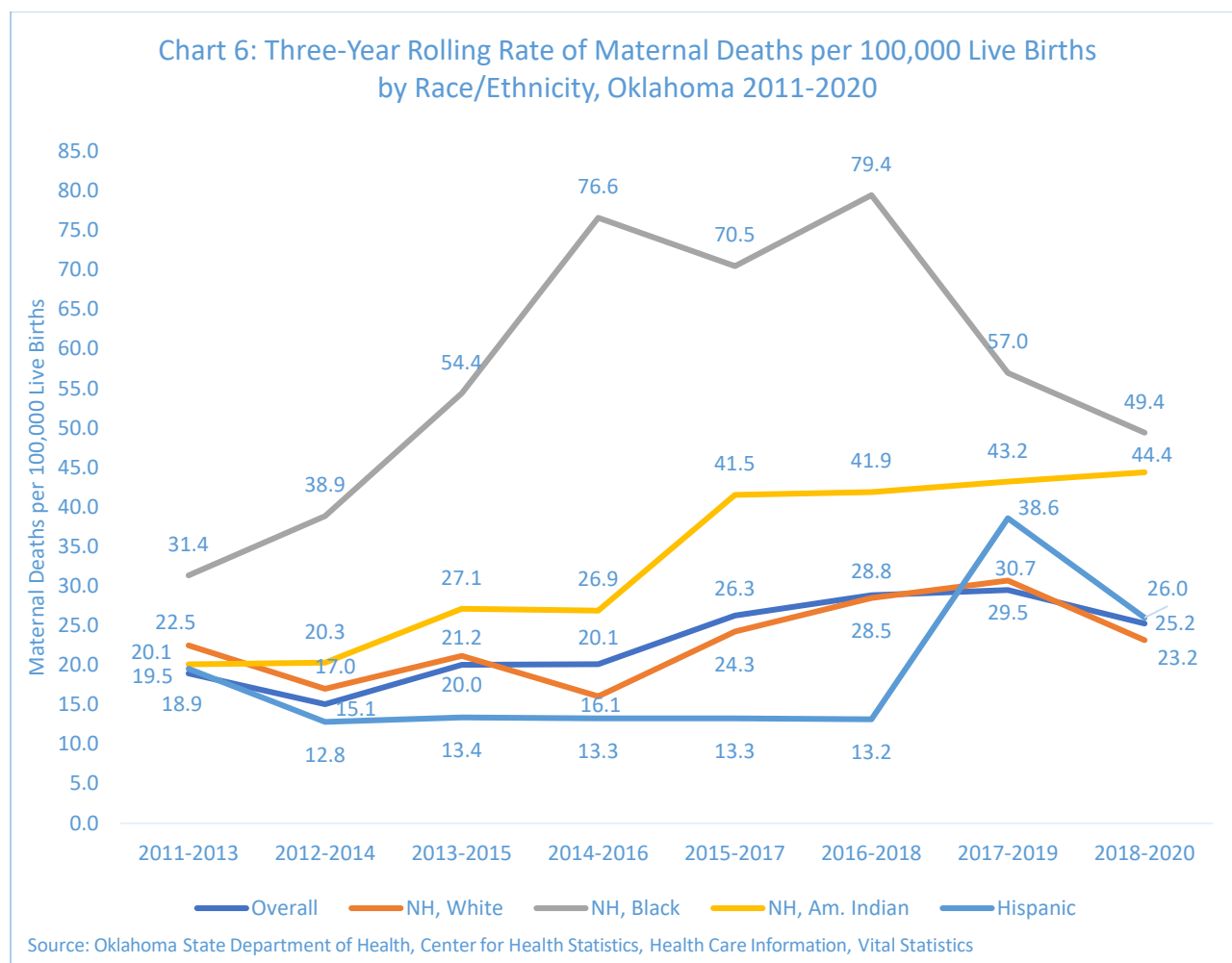
Birth rates additionally vary by age. In 2020, the age-specific birth rate for women less than 25 years of age was 39.3 births per 1,000 women, down 6% since 2019 and approximately 31% from 2011. The birth rate among women aged 25-39 has declined as well, but with a more modest rate of change, with only a 2% decrease from 2019 and a 3% decrease from 2011. Conversely, women aged 40 or older experienced an increase in birth rate, with a 2% increase from 2019 and a 30% increase from 2011.





## Race/Ethnicity

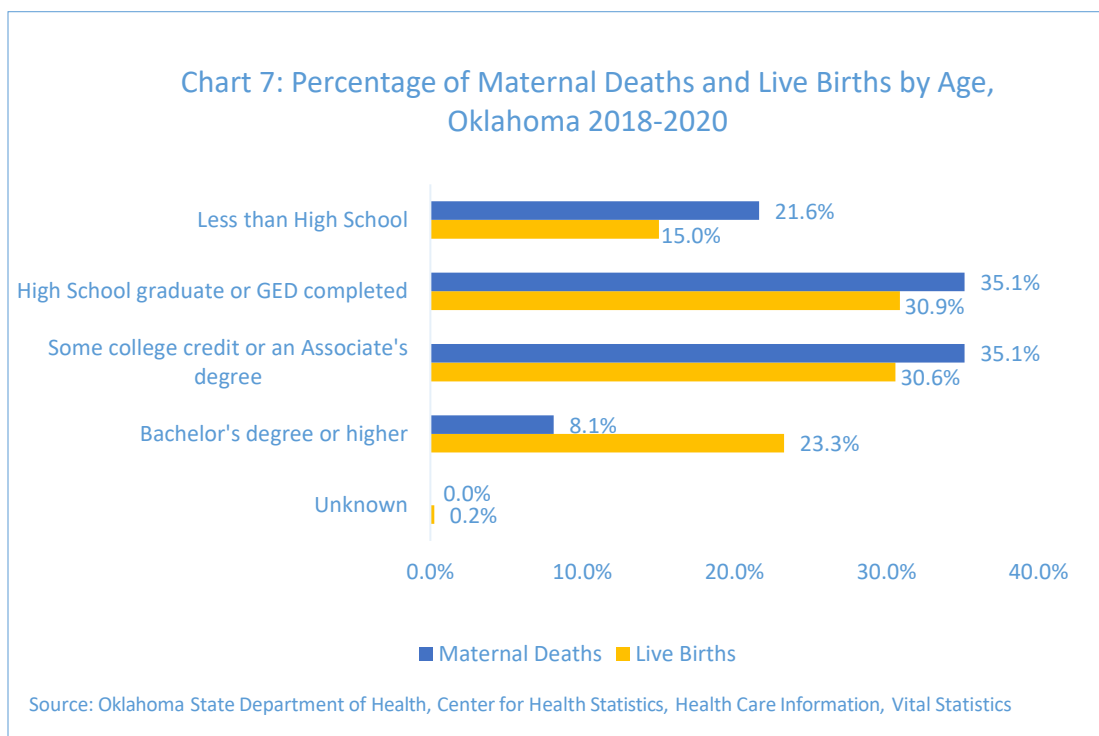
Maternal deaths by race in Oklahoma for 2018-2020 showed that the maternal mortality rate among Non-Hispanic White women was 23.2 maternal deaths per 100,000 live births, the lowest rate overall. The rates for both Non-Hispanic Black women and Non-Hispanic American Indian women were approximately two times higher than the rate for Non-Hispanic White women, at 49.4 and 44.4 respectively. This disparity in maternal mortality rate between Non-Hispanic White women and Non-Hispanic Black women has persisted consistently since 2012, with varying levels of magnitude. Comparatively, Hispanic women had a maternal mortality rate of 26.0 maternal deaths per 100,000 live births. From the 2017-2019 time period to the 2018-2020 time period, the maternal mortality rate decreased overall and in every racial/ethnic group apart from Non-Hispanic American Indian women, in which the maternal mortality rate increased by 2.8%. Of note, deaths among Non-Hispanic Asian women have been suppressed due to the small number of cases (Chart 6).



## Education Level

Of the women who gave birth between 2018-2020 in Oklahoma, 15.0% had less than a high school education, 30.9% earned a high school diploma or passed a General Educational Development Test (GED), 30.6% received some college credit or earned an Associate's degree, and 23.3% attained a Bachelor's degree or higher. Maternal education level was unknown for 0.2% of births in this time period.

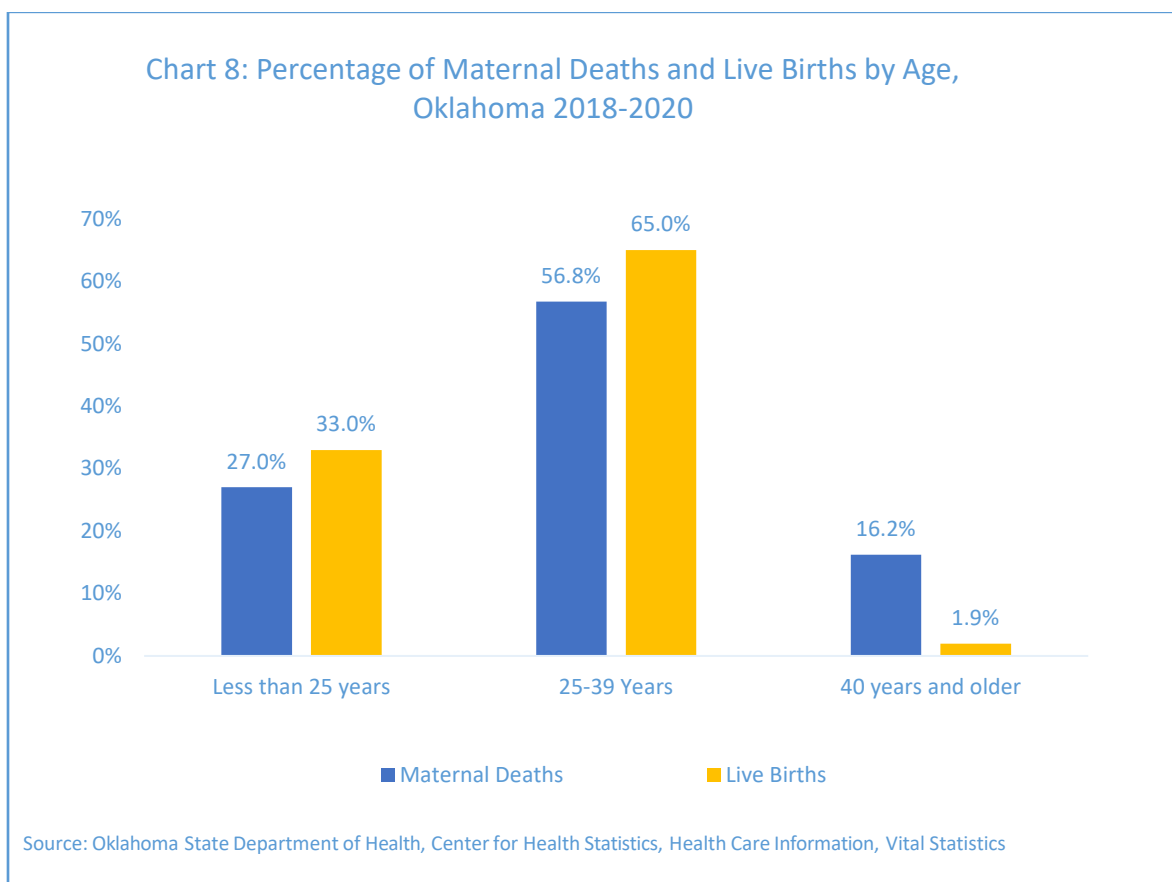
Comparatively, the majority of maternal deaths in Oklahoma from 2018-2020 occurred among women who received some college credit but did not obtain a degree or who had acquired an Associate's degree and women who graduated from high school or had passed a GED, both at 35.1% respectively. Women who had less than a high school education accounted for 21.6% of maternal deaths, followed by women who received a Bachelor's degree or higher at 8.1% (Chart 7).



## Age at Time of Death

From 2018-2020 in Oklahoma, the majority of women (65.0%) who gave birth were between the ages of 25 and 39, 33.0% were under the age of 25, and only 1.9% were 40 years of age or older. Comparatively, 56.8% of maternal deaths were among women between 25 and 39 years of age, 27.0% were among those less than 25 years of age, and 16.2% were among women 40 years of age and older (Chart 8).

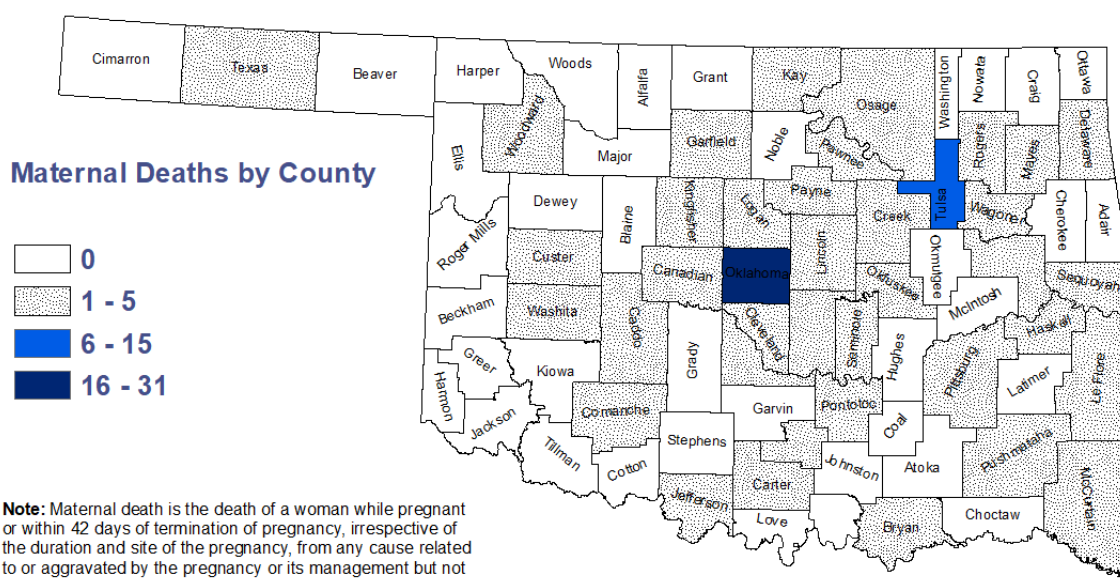
These findings reflect the well-documented differences in maternal mortality due to maternal age. Notably, while women 40 years of age or older represented less than two percent of live births between 2018 and 2020, over sixteen percent of maternal deaths were to women in this age group for the same time period, suggesting increased risk associated with increased maternal age.



## County of Residence

From 2011-2020, 38 of 77 counties in Oklahoma did not experience a maternal death. Thirty-seven counties reported less than 5 deaths in this time period. Oklahoma County and Tulsa, two of the most populous counties in Oklahoma, reported 31 and 15 maternal deaths respectively from 2011 to 2020. Oklahoma is considered a rural state in regards to land area and population density. The Census Bureau defines rural as encompassing “all population, housing, and territory not included within an urban area”.<sup>13</sup> An urban area is an area that contains at least 2,000 housing units or has a population of at least 5,000.<sup>13</sup> Maternal deaths by county of residence occurred 63.8% of the time in urban areas of the state with 36.2% occurring in rural areas. Comparatively, for maternal county of residence of live births between 2018 and 2020, 57.3% were in urban areas and 37.2% were in rural areas. (NOTE: This information was missing or unknown for 5.5% of births).

### Maternal Deaths by County of Residence, Oklahoma 2011-2020



**Data Source:** Oklahoma State Department of Health (OSDH), Center for Health Statistics, Health Care Information, Vital Statistics 2011 to 2020

Projected/Coordinate System: USGS Albers Equal Area Conic

## Maternal Mortality Review Committee

Oklahoma has a process to identify and explore the medical facts surrounding maternal deaths that has been designed to help improve health care for pregnant and postpartum women.

The Maternal Mortality Review Committee (MMRC) is an essential statewide effort that has been established through legislative action. The MMRC is a statutory committee with defined membership, responsibilities, and reporting criteria utilized to explore opportunities to enhance and improve services to women, infants, and their families. These qualitative, in-depth reviews investigate the causes and circumstances surrounding a maternal death.

Through communication and collaboration, the MMRC serves as a continuous quality improvement system that will result in a more complete understanding of maternal issues and identify challenges surrounding maternal health care services. The overall goal of the MMRC is prevention through understanding of causes and risk factors.

The Oklahoma MMRC operates under the auspices of the Oklahoma State Department of Health (OSDH). Through uniform procedures and defined processes, the OSDH initiates the MMRC process by identifying all pregnancy-associated cases. Deaths of women of childbearing age are reviewed to determine if the death is to be classified as pregnancy-related and whether the death could have been prevented.

The MMRC also makes a determination as to what extent the impact of timely and appropriate intervention could have had on the outcome of a particular case. Another aspect of the death review is to conclude what level of impact a committee recommendation or prevention strategy would have to the population at large during the primary, secondary, or tertiary stage.

The impact levels are defined as small (individual behavioral changes), medium, large, extra-large, and giant (population level changes) which are based on the Health Impact Pyramid (Figure 1 on next page).<sup>14</sup>

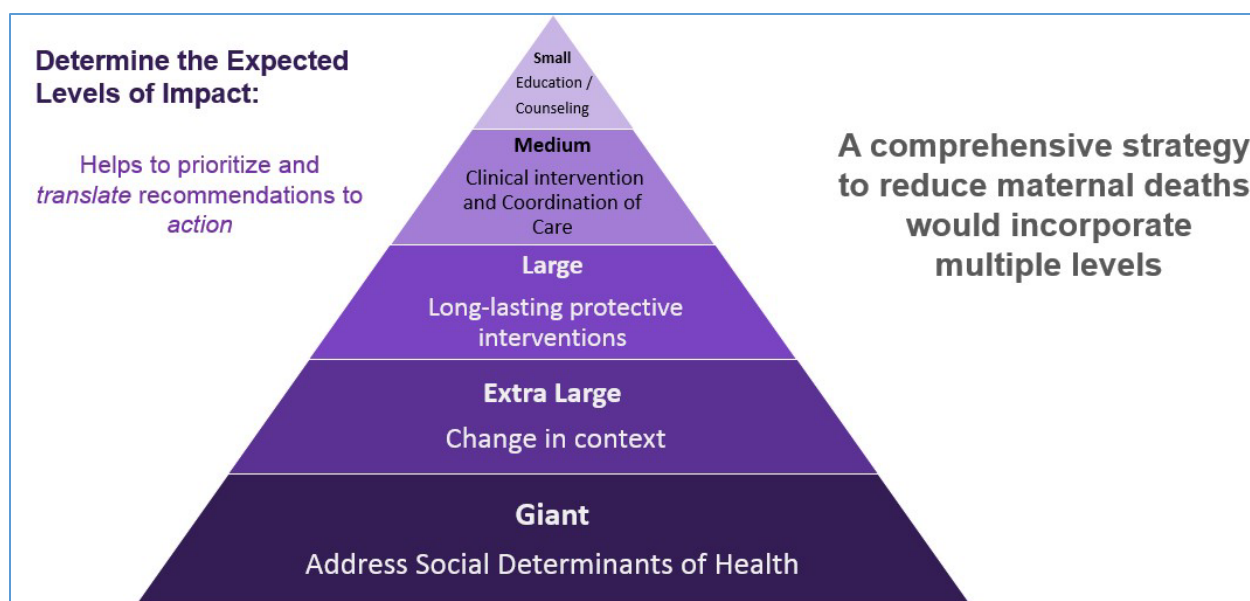


Figure 1: Health Impact Pyramid

The MMRC efforts are designed to:

- Improve and enhance public health efforts to reduce and prevent maternal death in Oklahoma.
- Improve identification of maternal deaths in order to interpret trends, identify high-risk groups, and develop effective interventions.
- Utilize review information to identify health care system issues and gaps in service delivery and care.
- Develop action plans and preventive strategies to implement recommendations in communities and provider networks.

Interventions, strategies, and the development of systems that increase knowledge and decrease pregnancy-related mortality will serve not only to improve the health of women and children, but will also provide overwhelming health-related benefits for all Oklahomans. Health benefits could include reduced rates of obesity, smoking during pregnancy, increased access to prenatal and well-woman care, and education for health care providers on postpartum warning signs.

The Oklahoma MMRC reviews all potential maternal deaths where on the official death certificate a pregnancy checkbox indicates that the death of the women aged 10-44 years occurred during pregnancy or within one year of pregnancy termination and an underlying cause of death is related to a maternal code. Women over age 44 years are included in MMRC reviews if their death certificate specifies a maternal-related condition as an underlying cause of death.

The MMRC reviewed 47 cases with deaths occurring from 2017-2019. The majority of the MMRC reviewed cases (57.5%) fall into the age range of 25-39 years, compared to 64.7% of live births that occurred among women of this age range during 2017-2019. Comparatively, 40.4% of maternal deaths reviewed occurred to women less than 25 years of age, with women in this age group contributing to 33.5% of live births from 2017-2019. Mothers considered to be of an advanced maternal age (35 years of age or older) comprised 19.2% of the reviewed cases. The fewest reviewed cases (2.1%) were for mothers 40 years and older, whereas 1.8% of all live births were to women aged 40 and older.

Among the 47 cases reviewed, the deaths occurred most among mothers not pregnant, but pregnant within 42 days of pregnancy termination (44.7%), followed by deaths of women who were pregnant at the time of death (42.6%). The remaining deaths (12.8%) were to mothers that died between 43 days and one year of pregnancy termination.

The committee also determined that 63.8% of the 47 deaths were preventable. In addition, it was determined that 34.0% and 19.2%, respectively, had some or a good chance to alter their outcome, and 10.6% had no chance to alter their outcome. For 12.8% of the cases reviewed, the committee was unable to determine chances to change the outcome given the data available at the time of review, and this data point was missing for 23.4% of cases reviewed.

The MMRC determined that 22 of the 47 cases reviewed (46.8%) were actually pregnancy-related, 21 (44.7%) were pregnancy-associated but not related, and 4 (8.5%) were unable to be determined.



## Pregnancy-Related Deaths

### Definitions

The definitions of the following key terms are established definitions from the Enhancing Reviews and Surveillance to Eliminate Maternal Mortality (ERASE-MM) Program.<sup>15</sup> MMRCs, including the Oklahoma MMRC, consider these definitions when reviewing cases and determining pregnancy-relatedness, preventability of death, and factors contributing to a death.

- **Pregnancy-Associated Death:** A death during or within one year of pregnancy, regardless of the cause. These deaths make up the universe of maternal mortality; within that universe are pregnancy-related deaths and pregnancy-associated, but not related deaths.
- **Pregnancy-Related Death:** A death during or within one year of pregnancy, from a pregnancy complication, a chain of events initiated by pregnancy, or the aggravation of an unrelated condition by the physiologic effects of pregnancy.
- **Pregnancy-Associated, but Not Related Death:** A death during or within one year of pregnancy, from a cause that is not related to pregnancy.
- **Pregnancy-Related Mortality Ratio:** The number of pregnancy-related deaths (using the above definition) per 100,000 live births. Also referred to as pregnancy-related mortality rate.
- **Preventability:** A death is considered preventable if there was at least some chance of the death being prevented by one or more reasonable changes to patient, family, provider, facility, system, and/or community factors. This definition is used by MMRCs to determine if a death they review is preventable.

### Contributing Factor Levels

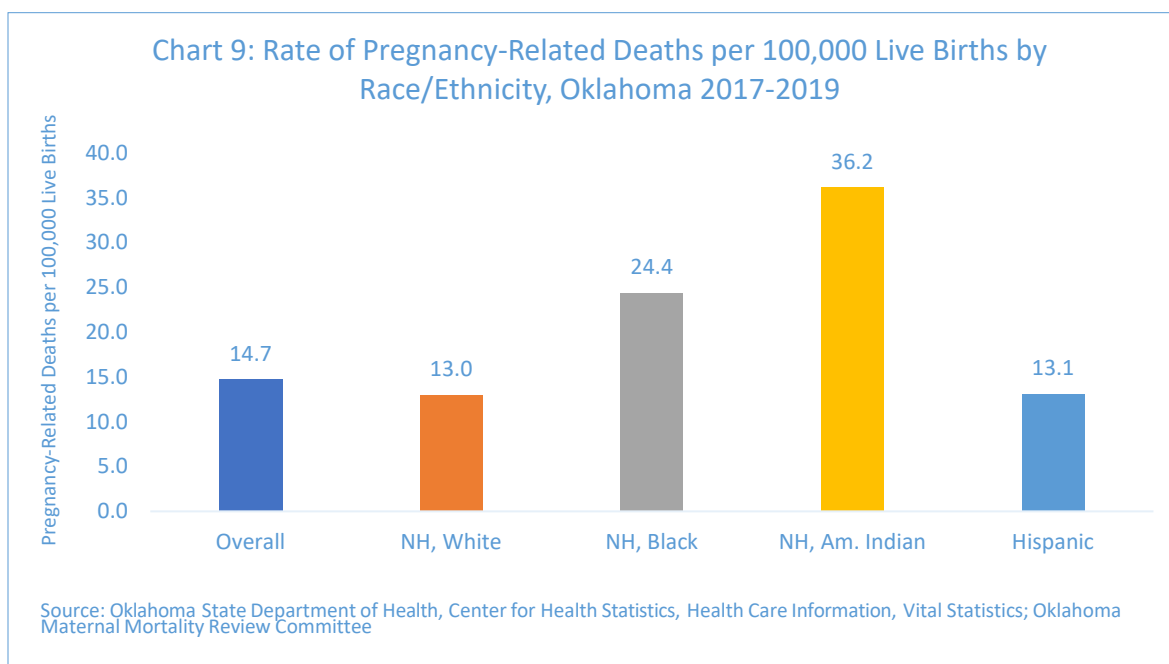
- **Patient/Family:** An individual before, during or after a pregnancy, and their family, internal or external to the household, with influence on the individual
- **Provider:** An individual with training and expertise who provides care, treatment, and/or advice.
- **Facility:** A physical location where direct care is provided - ranges from small clinics and urgent care centers to hospitals with trauma centers.
- **System:** Interacting entities that support services before, during, or after a pregnancy - ranges from healthcare systems and payors to public services and programs.
- **Community:** A grouping based on a shared sense of place or identity - ranges from physical neighborhoods to a community based on common interests and shared circumstances.

## Pregnancy-Related Mortality Rate

From 2017 to 2019, Oklahoma had 22 pregnancy-related deaths as determined by the MMRC, yielding a pregnancy-related mortality rate of 14.7 maternal deaths per 100,000 live births. Of note, a three-year average is used for reporting pregnancy-related mortality in Oklahoma, for stability of rates based on low numbers of pregnancy-related deaths each year.

### *Race/Ethnicity*

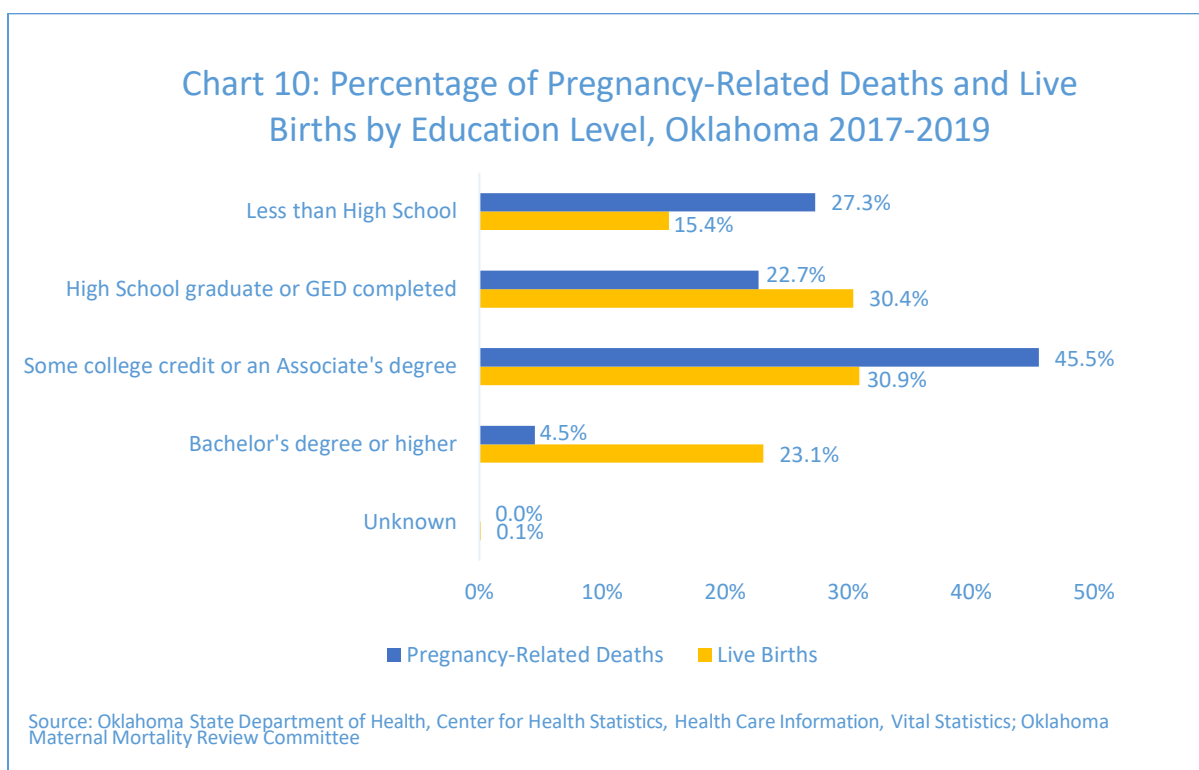
Pregnancy-related deaths by race in Oklahoma for 2017-2019 showed that the pregnancy-related mortality rate among Non-Hispanic White women was 13.0 pregnancy-related deaths per 100,000 live births, compared to the Non-Hispanic Black women, whose rate was 2.5 times higher at 24.4 pregnancy-related deaths per 100,000 live births. The Non-Hispanic American Indian rate for 2017-2019 was 2.8 times higher than the rate for Non-Hispanic White women at 36.2, while Hispanic women had a rate of 13.1 per 100,000 live births. There were no pregnancy-related deaths among Non-Hispanic Asian women for this time period (Chart 9).



## Education Level

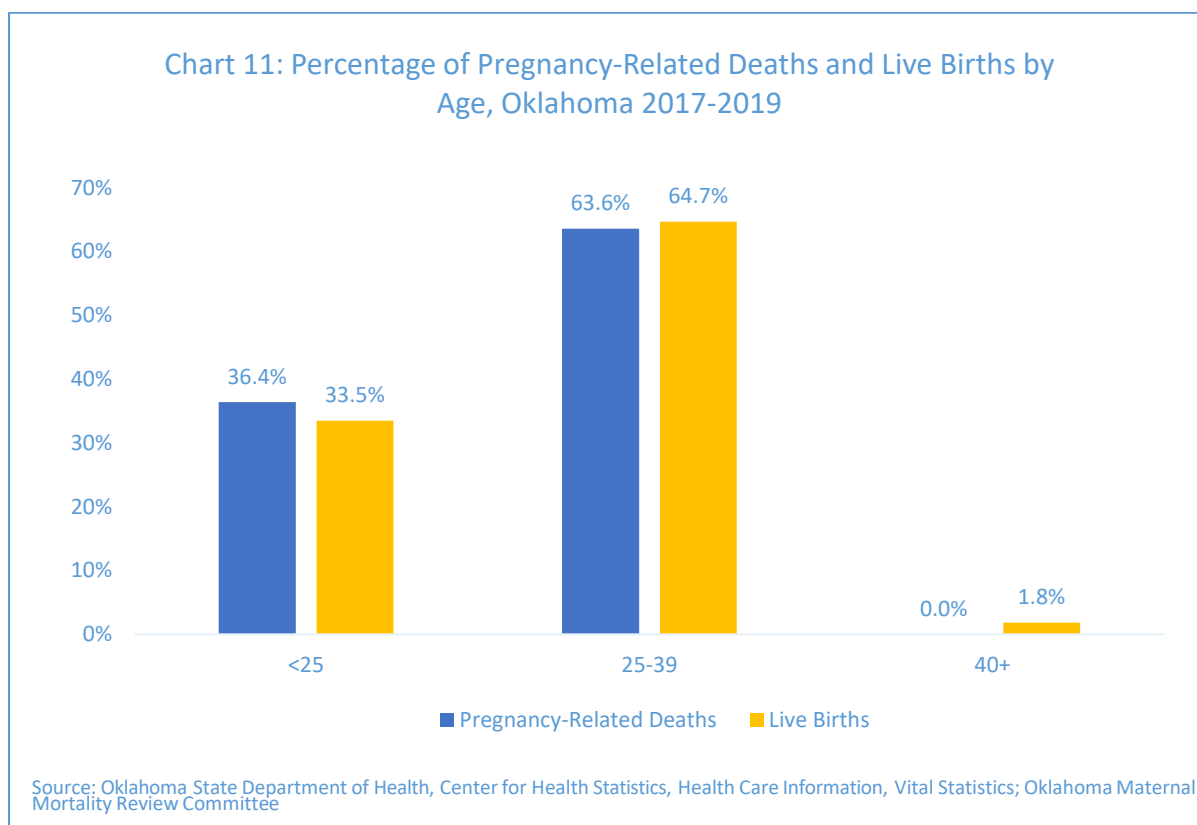
Of the women who gave birth between 2017-2019 in Oklahoma, 15.4% had less than a high school education, 30.4% earned a high school diploma or passed a General Educational Development Test (GED), 30.9% received some college credit or earned an Associate's degree, and 23.1% attained a Bachelor's degree or higher. Maternal education level was unknown for 0.2% of births in this time period.

Comparatively, the majority of pregnancy-related deaths in Oklahoma from 2017-2019 occurred among women who received some college credit but did not obtain a degree or who had acquired an Associate's degree at 45.5%, followed by women who had less than a high school education at 27.3% of pregnancy-related deaths. Women who graduated from high school or had passed a GED accounted for 22.7% of pregnancy-related deaths, followed by women who received a Bachelor's degree or higher at 4.5% (Chart 10).



## Age at Time of Death

From 2017-2019 in Oklahoma, the majority of women (64.7%) who gave birth were between the ages of 25 and 39, 33.5% were under the age of 25, and only 1.8% were 40 years of age or older. Similarly, 60.9% of pregnancy-related deaths were among women between 25 and 39 years of age, 39.1% were among those less than 25 years of age, and none were among women 40 years of age and older (Chart 11).



## Top Causes of Pregnancy-Related Deaths

According to the Center for Disease Control's Pregnancy Mortality surveillance system, the leading cause of pregnancy-related death in the United States from 2016 to 2018 was other cardiovascular conditions, followed by infection or sepsis, cardiomyopathy, non-cardiovascular conditions, and hemorrhage.<sup>16</sup>

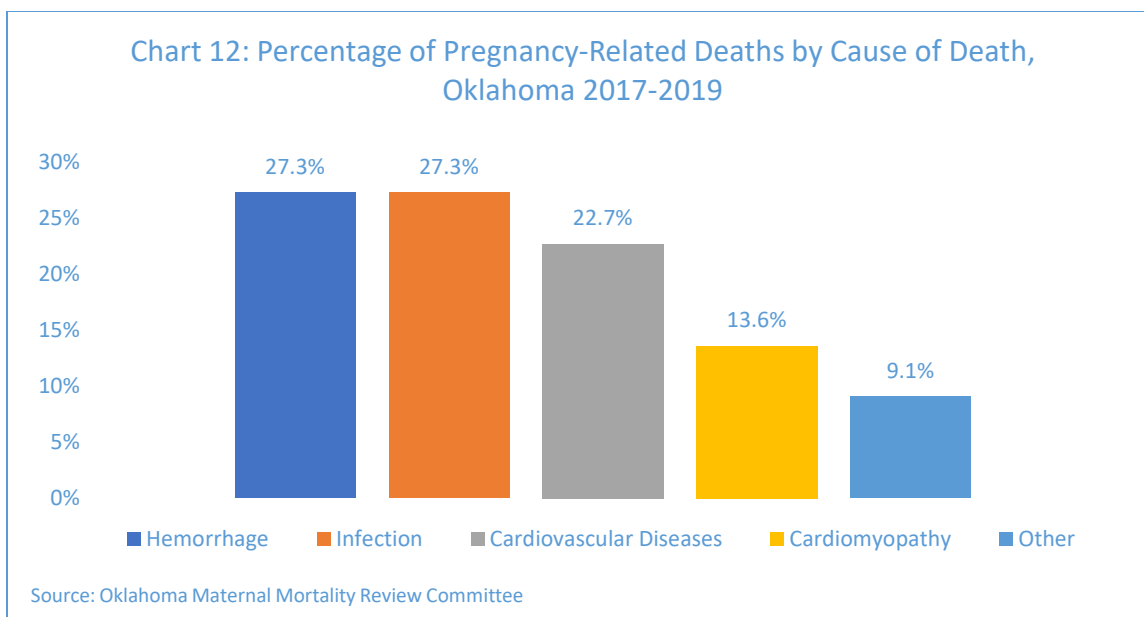
From 2017-2019, the top causes of pregnancy-related deaths in Oklahoma were (Chart 12 on next page):

- Hemorrhage
- Infections
- Cardiovascular conditions
- Cardiomyopathy

The Oklahoma MMRC determined that 22 deaths from 2017-2019 were pregnancy-related. Of these deaths, the leading causes of death were hemorrhage (excluding aneurysms or cerebrovascular accidents) and infections, each accounting for 27.3% of pregnancy-related deaths. Half of hemorrhage-related deaths were due to a ruptured ectopic pregnancy, with the other half due to uterine atony or postpartum hemorrhage. Deaths due to infection included sepsis and other infections.

Following hemorrhage and infections, cardiovascular conditions were the third leading cause of death for this time period, accounting for 22.7% of pregnancy-related deaths. Deaths due to cardiovascular conditions included atherosclerotic cardiovascular disease, non-cerebral vascular dissection, hypertensive cardiovascular disease, and arrhythmias.

Postpartum or peripartum cardiomyopathy accounted for 13.6% of pregnancy-related deaths, as the fourth leading cause of pregnancy-related death. Other health issues contributing to the underlying causes of pregnancy-related death included hypertensive disorders of pregnancy (e.g., eclampsia) and mental health conditions.

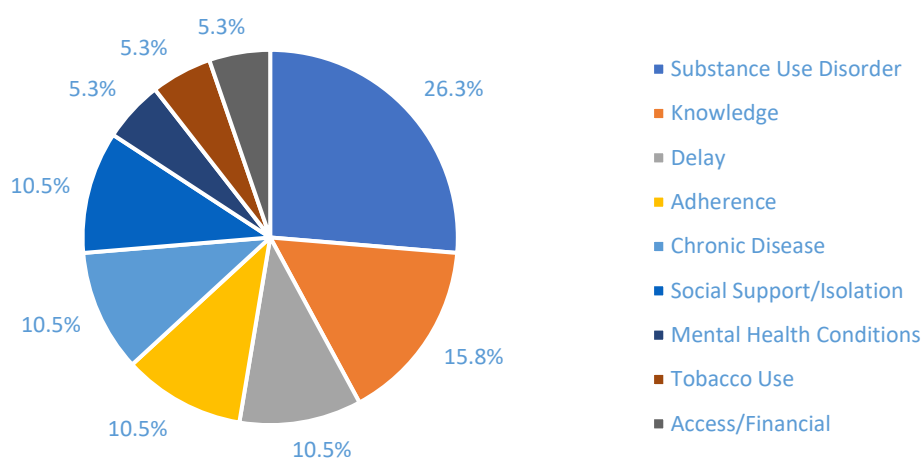


## Contributing Factors to Pregnancy-Related Death

Eighteen of the 22 pregnancy-related deaths identified by the MMRC from 2017-2019 had 52 contributing factors noted as being associated with the deaths. Of cases with contributing factors identified, each death had an average of three contributing factors, ranging from one to twelve contributing factors per death. When assessing contributing factors, the MMRC categorizes factors as being at the Patient/Family, Community, Provider, Facility, or System level. The most common contributing factors associated with pregnancy-related deaths from 2017-2019 in Oklahoma were Patient/Family and Provider factors, accounting for 36.5% and 30.8% of contributing factors respectively.

Contributing factors at the Patient/Family level included substance use disorders (SUDs), knowledge, delay of care, adherence to care, chronic diseases, mental health conditions, tobacco use, lack of access or financial resources, and social support (Chart 13 on next page). A large proportion of Patient/Family contributing factors were due to chronic conditions or delays in care. Chronic conditions noted included tobacco use, obesity, substance use, and mental health conditions; further, lack of social support for chronic conditions was also a contributing factor. Additionally, delays in care were noted as contributing factors for various reasons, with lack of insurance, lack of childcare, and substance use noted as potential barriers to seeking care.

Chart 13: Percentage of Patient/Family Contributing Factors to Pregnancy-Related Death by Factor Class, Oklahoma 2017-2019

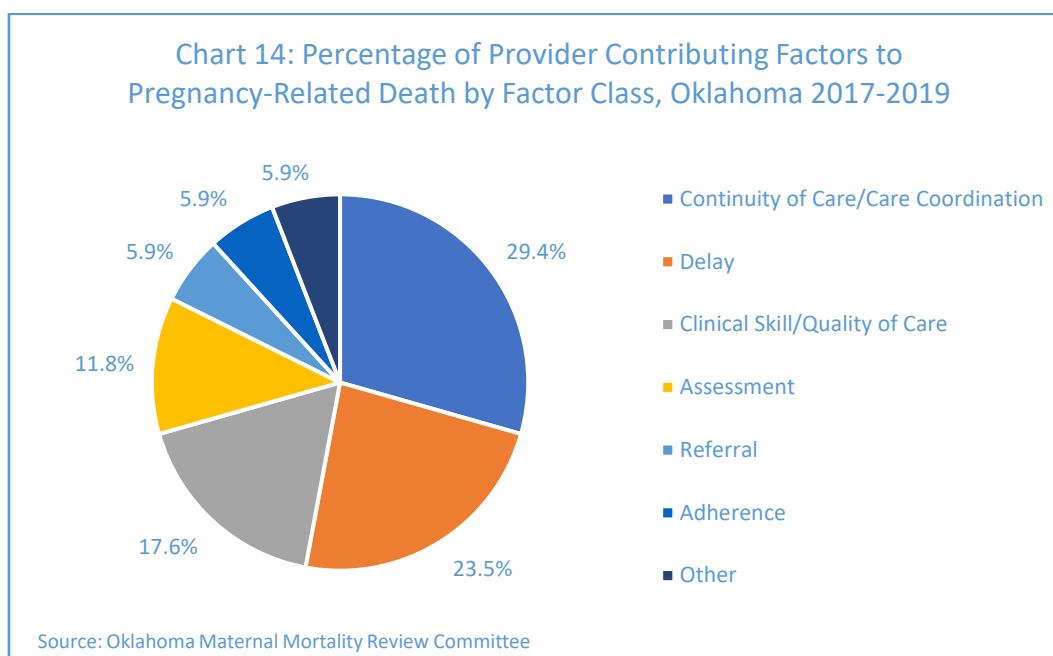


Source: Oklahoma Maternal Mortality Review Committee

Of note, the largest single factor contributing to pregnancy-related death was SUD, at 26.3% of the Patient/Family factors. In recent years, rates of SUDs and drug overdose have been increasing in the United States, including among pregnant women. According to data from the Oklahoma Department of Mental Health and Substance Abuse Services (ODMHSAS), “the number of pregnant women in Oklahoma diagnosed with a substance use disorder has increased by more than four times since 1999”.<sup>17</sup> This is especially concerning given that the use of tobacco, alcohol, or illicit drugs or misuse of prescription drugs while pregnant can result in poor health outcomes, such as stillbirth and neonatal abstinence syndrome.<sup>18</sup> The ODMHSAS, in partnership with the Oklahoma State Department of Health, the Oklahoma Department of Human Services, and the Oklahoma University Health Sciences Center, among others, leads the Substance use Treatment And Recovery Services program (STARS), which aims to provide and coordinate care for pregnant women with SUDs to increase the health and wellbeing of women, children, and families exposed to substance use.<sup>17</sup> While this program helps increase access to appropriate care and improve pregnancy outcomes for women with SUDs, its services are not yet available statewide. It is also possible that circumstances or stigma surrounding substance use (specifically during pregnancy) may prevent women from seeking out care, causing delays in or lack of care.



Contributing factors at the Provider level included continuity of care or care coordination, clinical skill or quality of care, delay of treatment, failure to screen or inadequate assessment of risk, adherence to protocol, and lack of standardized protocol (other). The majority of factors were related to continuity of care/care coordination and delay in treatment, at 29.4% and 23.5% of Provider factors. Clinical Skill/Quality of Care was also a common contributing factor, at 17.4% of Provider factors (Chart 14).



Factors contributing to pregnancy-related death also varied by cause of death (Table 3 on next page). The majority of contributing factors regarding deaths due to hemorrhage were at the provider, facility, or system level. Such factors included continuity of care, delay of care, lack of standardized policies, inadequate equipment availability, and quality of care. Contributing factors at the patient or family level included delay of care related to substance use disorder.

Deaths due to infection had the most contributing factors identified, with most being Patient/Family or Provider-level factors. Contributing factors at the Patient/Family level included delay of care, patient adherence to care, knowledge of when to seek care, delay of care related to culture or religion, mental health conditions, substance use disorder, tobacco use, chronic disease, and lack of access or financial resources. Contributing factors at the provider or facility level included adherence to protocol, delay in treatment, quality of care, continuity of care, and lack of assessment.

Factors contributing to deaths due to cardiovascular conditions were primarily Patient/Family factors, including chronic disease, delay of care, knowledge, mental health conditions, and substance use disorder. Contributing factors at the Provider level included continuity of care and inadequate assessment, and lack of social support/isolation was noted as a contributing factor at the System level.

Deaths due to cardiomyopathy included contributing factors mostly at the System level, including lack of access/financial resources, poor communication, and inadequate outreach. Continuity of care was again noted as a contributing factor at the Provider/Facility level, and lack of social support/isolation was noted as a Patient/Family-level factor.

<b>Table 3: Contributing Factors of the Top Causes of Pregnancy-Related Death by Factor Category and Class</b>		
<b>Causes of Death</b>	<b>Factor Category</b>	<b>Factor Class</b>
<b>Hemorrhage</b>	<i>Patient/Family</i>	Knowledge
		Substance Use Disorder
	<i>Provider/Facility</i>	Continuity of Care
		Delay of Care
		Lack of Standardized Policies
		Quality of Care
<b>Infection</b>	<i>Patient/Family</i>	Access/Financial
		Adherence to Care
		Chronic Disease
		Delay of Care
		Knowledge
		Social Support/Isolation
		Substance Use Disorder
		Tobacco Use
	<i>Community</i>	Mental Health Conditions
	<i>Provider/Facility</i>	Adherence to Protocol
		Assessment
		Communication
		Continuity of Care
		Delay in Treatment
		Lack of Education
		Lack of Referral
		Quality of Care
	<i>System</i>	Culture/Religion
		Policies/Procedures

Cardiovascular Conditions	Patient/Family	Chronic Disease
		Delay of Care
		Knowledge
		Mental Health Conditions
		Substance Use Disorder
	Provider/Facility	Continuity of Care
		Inadequate Assessment
	System	Social Support/Isolation
Cardiomyopathy	Patient/Family	Social Support/Isolation
	Provider/Facility	Continuity of Care
	System	Access/Financial
		Communication
		Outreach

## MMRC Case Review Conclusions and Recommendations

Through comprehensive case reviews, the MMRC generated recommendations identified to help improve access to quality pregnancy- related health care that will contribute to a reduction in the number of maternal deaths in Oklahoma.

Due to COVID-19 restrictions, the MMRC still had limited opportunities to act on some of the recommendations during 2021 and early 2022. Consequently, some of the following recommendations are being carried over from the prior report.

**Conclusion:** Many women enter pregnancy with health issues that impact pregnancy outcomes.

- **Recommendation:** Increase awareness in both public and private healthcare providers and reproductive age individuals about the importance of preconception health regardless of pregnancy intention since approximately half of all pregnancies are not intended at the time they occur.
- **Recommendation:** Ensure eligible, uninsured, reproductive age individuals are aware of expanded access to health care through Medicaid expansion and assist in completion of application for Medicaid if indicated. Work with Oklahoma Health Care Authority to ensure individuals covered by Medicaid access appropriate health care services. Healthcare providers can educate families on eligibility requirements, assist with Medicaid enrollment, and refer to primary care for chronic health issues or OB/GYN for prenatal care when indicated.
- **Recommendation:** Continue to expand access to quality prenatal care through county health departments and mobile clinics across the state.

**Conclusion:** Current ACOG recommendations do not support the long-term use of tocolytic agents to prevent preterm labor.

- **Recommendation:** Educate/ensure all obstetrical providers are aware of current ACOG recommendations.

**Conclusion:** Gaps exist in health care provider knowledge related to treating post-op infection.

- **Recommendation:** Quality improvement case reviews should be performed for individuals experiencing post-op infections through delivering entities, OHCA, or the MMRC to ensure accurate treatment of infections according to evidence-based guidelines.

**Conclusion:** Delays in medical intervention occurred when complications developed during pregnancy and the postpartum period contributing to mortality.

- **Recommendation:** Expand education to healthcare providers, pregnant women, and their families about pregnancy and postpartum warning signs and how to seek care.
- **Recommendation:** Continue to promote the use of the AIM maternal safety bundles in all Oklahoma birthing hospitals.

**Conclusion:** Awareness and personal responsibility are also important factors in the occurrence of a maternal death.

- **Recommendation:** Increasing awareness of possible pregnancy and post-delivery complications and educating pregnant women and their families to seek medical care sooner, thereby limiting the risks for maternal mortality and morbidity and increasing time for medical intervention.
- **Recommendation:** Promote the CDC “Hear Her” Campaign to encourage pregnant women and their families to speak up and to encourage healthcare providers to listen and respond.
- **Recommendation:** Encourage compliance with follow-up care and postpartum visits.
- **Recommendation:** Promote the Oklahoma Perinatal Quality Improvement Collaborative (OPQIC) Empowering Pregnant and Postpartum Patients Toolkit.
- **Recommendation:** Encourage providers and hospitals to adopt the TeamBirth initiative.<sup>19</sup>

**Conclusion:** Potentially relevant information is still missing from case review data when an autopsy is not performed for a maternal death.

- **Recommendation:** Continue to collaborate with community partners to pass legislation requiring all maternal deaths be referred to the Medical Examiner's office (any death of a woman while pregnant or within 365 days of pregnancy termination) for consideration of a potential autopsy.

**Conclusion:** Lack of societal and familial support found in case reviews contributes to maternal mortality and morbidity.

- **Recommendation:** Watch for opportunities to address the social determinants of health including improved access to care, access to affordable insurance, access to reliable transportation, and expansion/extension of Medicaid coverage, especially for those women experiencing pregnancy complications that require continued medical follow-up post-delivery.
- **Recommendation:** Support the Oklahoma Health Care Authority with Medicaid expansion and transition to managed care model of services.
- **Recommendation:** Encourage emergency rooms and labor and delivery triage units to make a follow-up phone call for pregnant and postpartum women within 24 hours of discharge.
- **Recommendation:** Support OSDH and OPQIC in facilitating TeamBirth across the state.

**Conclusion:** Lack of education and/or lack of simulation exercises for postpartum hemorrhage and hypertension/preeclampsia may contribute to maternal morbidity and mortality.

- **Recommendation:** Continue to encourage all birthing hospitals and prenatal care providers to implement AIM maternal safety bundles, hold emergency simulation drills with staff, and ensure the presence and utilization of chain of command procedures in emergencies.
- **Recommendation:** Provide education/simulation exercises for non-birthing hospitals for emergency delivery, hemorrhage, and hypertension.

**Conclusion:** Healthcare providers responding to crisis situations often do not have access to all relevant health care information.

- **Recommendation:** Improve coordinated efforts among medical providers to increase access to medical history through inter-compatibility of electronic medical records.

**Conclusion:** Health inequity can contribute to poor maternal outcomes.

- **Recommendation:** Promote enrollment and completion in the Speak Up training for health care professionals providing obstetrical care.
- **Recommendation:** OSDH will complete Train-the-Trainer option for health equity education that can be utilized in delivering facilities and provider offices.
- **Recommendation:** Promote acceptance and utilization of midwifery and doula care.

The impact of implementing recommendations made by the MMRC should help to reduce maternal mortality in Oklahoma. The MMRC agrees that the increase in shared knowledge and education among professionals and non-professionals will encourage more women and their families to seek health care prior to any pregnancy, during pregnancy, and after pregnancy to improve birth outcomes.



## Report Summary

Women's health in Oklahoma is a challenge, with the second highest uninsured rates in the U.S. at 17.2%. Obesity and smoking rates, along with other chronic health issues, continue to burden the health status of women in Oklahoma and are contributing factors to adverse pregnancy outcomes. Specifically, women 35 years of age and older tend to experience more difficult pregnancies as well as adverse birth outcomes.

Additionally, Oklahoma estimates show significant racial disparities in rates of severe maternal morbidity, maternal mortality, and pregnancy-related mortality, similar to the United States as a whole. Specifically, Non-Hispanic American Indian women and Non-Hispanic Black women in Oklahoma have higher rates of poor maternal health outcomes compared to Non-Hispanic White women, by 20 to 50% for severe maternal morbidity and by 200 to 300% for maternal and pregnancy-related mortality. These disparities in maternal health continue to persist and highlight the ever-present need to address health equity in maternal health.

Severe maternal morbidity is also a challenge for women's healthcare not only in Oklahoma, but nationally. Most cases of SMM involve blood transfusions. In Oklahoma, many hospitals have adopted the use of AIM maternal safety bundles to address issues of delivery complications and thus declines have been observed in the rates of SMM related to blood transfusions. While the rate of SMM declined from 2017 to 2019, there was an increased incidence noted from 2019 to 2020. This trend was observed both in SMM rates including and excluding transfusions.

According to the CDC, Oklahoma consistently ranks among the states with the worst rates (44th) of maternal deaths in the U.S.<sup>20</sup> The national maternal mortality rate increased 18.4% from 20.1 maternal deaths per 100,000 live births in 2019 to 23.8 during 2020. Though the three-year maternal mortality rate steadily increased in Oklahoma from 2012 to 2019, the rate decreased from 29.5 maternal deaths per 100,000 live births in the 2017-2019 time period to 25.2 in the 2018-2020 time period.

Maternal deaths during 2018-2020 in Oklahoma most often occurred among women between the ages of 25 and 39, who resided in urban areas, and among women who graduated from high school or had passed a GED, or had received some college credit but did not obtain a degree or who had acquired an Associate's degree.

The Oklahoma MMRC reviewed 47 deaths which occurred during the years 2017-2019, 19.2% of which occurred among women of an advanced age ( $\geq 35$  years). Of these deaths, 30 (63.8%) were determined to have been preventable and 22 (43.8%) were determined to have been pregnancy-related. An encouraging improvement is the increase in the number of birthing hospitals adopting the AIM maternal safety bundles, as well as the increase to 88.0% of new mothers attending their postpartum visit.

Of the 22 pregnancy-related deaths from 2017-2019, the top causes of death were hemorrhage, infection, cardiovascular conditions, and cardiomyopathy. Pregnancy-related deaths occurred most often among women between the ages of 25 and 39 and among women who had received some college credit but did not obtain a degree or who had acquired an Associate's degree. Common contributing factors to pregnancy-related death included factors at various levels of care, such as substance use disorders, chronic health issues, delay of treatment, poor continuity of care, and inadequate quality of care. Maternal morbidity and mortality related to labor and delivery is specifically increasing among women that present with poor health or chronic health-related conditions prior to becoming pregnant. Chronic health conditions most often cited among maternal deaths include tobacco use, obesity, substance use, and mental health conditions.

The MMRC decisions indicated that most women who died within one year of a pregnancy ending could possibly have had a better outcome had particular health-related issues been better managed prior to, during, or after the pregnancy. Such health-related issues include receiving preconception health screenings, increased access to appropriate prenatal care, increased awareness of possible complications post-delivery and seeking medical intervention as soon as warning signs are identified.



## References

1. Roosa Tikkanen et al., [Maternal Mortality and Maternity Care in the United States Compared to 10 Other Developed Countries](#) (Commonwealth Fund, Nov. 2020).  
<https://doi.org/10.26099/411v-9255>
2. Hoyert DL. Maternal mortality rates in the United States, 2020. NCHS Health E-Stats. 2022. DOI:  
<https://dx.doi.org/10.15620/cdc:113967>
3. Trost SL, Beauregard J, Njie F, et al. Pregnancy-Related Deaths: Data from Maternal Mortality Review Committees in 36 US States, 2017-2019. Atlanta, GA: Centers for Disease Control and Prevention, US Department of Health and Human Services; 2022. Accessed September 26, 2022.  
<https://www.cdc.gov/reproductivehealth/maternal-mortality/erase-mm/data-mmrc.html>
4. KFF's State Health Facts. Data Source: Census Bureau's March Current Population Survey (CPS: Annual Social and Economic Supplements), 2017-2021. Accessed July 11, 2022.  
<https://www.kff.org/other/state-indicator/health-insurance-coverage-of-nonelderly-0-64/>
5. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. BRFSS Prevalence & Trends Data [online]. 2015. [accessed July 12, 2022]. <https://www.cdc.gov/brfss/brfssprevalence/>
6. Oklahoma Pregnancy Risk Assessment Monitoring System (PRAMS), Oklahoma State Department of Health.
7. Identifying Maternal Depression: Missed opportunities to support moms. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Reproductive Health. Accessed September 2, 2022.  
[https://www.cdc.gov/reproductivehealth/vital-signs/identifying-maternal-depression/VS-May-2020-Maternal-Depression\\_h.pdf](https://www.cdc.gov/reproductivehealth/vital-signs/identifying-maternal-depression/VS-May-2020-Maternal-Depression_h.pdf)
8. Prevalence of Selected Maternal and Child Health Indicators for All Pregnancy Risk Assessment Monitoring System (PRAMS) Sites, 2016–2020. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Reproductive Health. Accessed July 18, 2022. <https://www.cdc.gov/prams/prams-data/mch-indicators/states/pdf/2020/All-Sites-PRAMS-MCH-Indicators-508.pdf>.
9. Health Resources & Services Administration, Grants, State Maternal Health Innovation Program. Accessed July 12, 2022. <https://www.hrsa.gov/grants/find-funding/hrsa-19-107>
10. Severe Morbidity Indicators and Corresponding ICD-9-CM/ICD-10- CM/PCS Codes during Delivery Hospitalizations. Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion. Accessed July 18, 2022.  
<https://www.cdc.gov/reproductivehealth/maternalinfanthealth/smm/severe-morbidity-ICD.html>

11. Severe Maternal Morbidity in the United States. Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion. Accessed July 18, 2022. <https://www.cdc.gov/reproductivehealth/maternalinfanthealth/smm/severe-morbidity-ICD.htm>
12. World Health Organization, Maternal, Newborn, Child and Adolescent Health and Ageing Data Portal. Accessed July 11, 2022. <https://www.who.int/data/gho/indicator-metadata-registry/imr-details/4622>
13. Urban Area Criteria for the 2020 Census-Final Criteria. Accessed July 11, 2022. <https://www.federalregister.gov/documents/2022/03/24/2022-06180/urban-area-criteria-for-the-2020-census-final-criteria>
14. Frieden TR. A framework for public health action: the health impact pyramid. *Am J Public Health*. 2010;100(4):590-595. <https://doi.org/10.2105/AJPH.2009.185652>
15. Review to Action. Definitions. Accessed September 1, 2022. <https://reviewtoaction.org/learn/definitions>
16. Causes of pregnancy-related death in the United States: 2016-2018. Accessed July 15, 2022. <https://www.cdc.gov/reproductivehealth/maternal-mortality/pregnancy-mortality-surveillance-system.html>
17. Oklahoma Department of Mental Health and Substance Abuse Services, STARS Program. Accessed September 1, 2022. <https://oklahoma.gov/odmhsas/treatment/children-youth-and-family-services/stars-program.html>
18. NIDA. Substance Use While Pregnant and Breastfeeding. National Institute on Drug Abuse website. Accessed September 1, 2022. <https://nida.nih.gov/publications/research-reports/substance-use-in-women/substance-use-while-pregnant-breastfeeding>
19. Oklahoma Perinatal Quality Improvement Collaborative. TeamBirth Initiative. Accessed September 26, 2022. <https://opqic.org/teambirth/>
20. Centers for Disease Control and Prevention, National Center for Health Statistics. National Vital Statistics System, Mortality 1999-2020 on CDC WONDER Online Database, released in 2021. Data are from the Multiple Cause of Death Files, 1999-2020, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Accessed on Jul 12, 2022. <http://wonder.cdc.gov/ucd-icd10.html>

This project is supported by the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services (HHS) under grant number U7A33713 for the State Maternal Health Innovation Program. The contents are those of the authors and do not necessarily represent the official views of, nor an endorsement by HRSA/HHS, or the U.S. Government.