



# Maternal Mortalities and Severe Maternal Morbidity in Arizona

December 2020



ARIZONA DEPARTMENT OF HEALTH SERVICES



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## Dedication

Dedicated to Arianna Dodde and to all the women that have been lost during pregnancy, delivery, or postpartum; whose stories inspire us to continue fighting for the health of all mothers in Arizona.

## Acknowledgements

The Arizona Department of Health Services (ADHS) would like to acknowledge Dr. Robert Johnson, MD, who is a founding member and Chair of the Arizona Maternal Mortality Review Committee (MMRC); his time and commitment to this committee has supported ADHS in initiating the Maternal Mortality Review Program (MMRP) and conducting ongoing reviews of maternal mortalities in Arizona.

ADHS would also like to acknowledge the 33 members of the Arizona MMRC who completed the 134 case reviews included in this report. Despite evolving guidelines and processes, the focus and dedication of the MMRC has resulted in thorough case reviews and well-crafted recommendations to prevent future maternal mortalities and severe maternal morbidities in Arizona. A full list of MMRC members can be found in **Appendix A**.

Lastly, the MMRC acknowledges the twenty-two Native Nations who have stewarded this Land since time immemorial, and recognizes their People, culture, and history.



## Submitted To

The Honorable Douglas A. Ducey, Governor, State of Arizona  
The Honorable Karen Fann, President, Arizona State Senate  
The Honorable Russell Bowers, Speaker, Arizona State House of Representatives

This report is provided as required by Chapter 143 Senate Bill 1040.

## Prepared By

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## Intended Audience

This is a technical report on the analysis of the incidence and causes of Maternal Mortality and Severe Maternal Morbidity in Arizona. This report is aimed primarily at those actively involved in the care of and improvements to maternal health, including healthcare providers, community service providers, researchers, policymakers, and other stakeholders. While publicly available, the intended audience of this report is not the general public, and extra care in the use or interpretation of this report should be taken by those with limited background or subject-matter expertise in the areas of maternal health and complications of labor and delivery.



## How to Use This Report

This report describes the incidence of maternal mortality and severe maternal morbidity in Arizona, as well as a variety of risk factors contributing to these mortalities and severe morbidities among women giving birth in Arizona. The key findings presented in this report should assist in the identification of future targets for intervention and guide effective and evidence-based efforts towards the reduction of adverse maternal health outcomes.

## Disclaimer

### Use of Term: Maternal Mortality

The use of the term “Maternal Mortality” in this report may differ than use by other organizations, such as the World Health Organization, but is used interchangeably with “Pregnancy-Associated Deaths”. These definitions are described in **Section 1**.

### Previous ADHS Reports on Maternal Mortality

The findings in this report related to maternal mortality were derived from the [Review to Action](#) methods, which the Arizona Department of Health Services adopted in 2018. These methods differ from the methods used to review and report on maternal mortality in Arizona between 2012-2015. For this reason, maternal mortality findings between 2016-2017 should not be compared to findings reported in Arizona’s report on 2012-2015 maternal mortality, and instead, should be considered baseline data for future reporting.

### Arizona Health Status and Vital Statistics Annual Reports

The Bureau of Public Health Statistics (BPHS) in Arizona Department of Health Services publishes the [Arizona Health Status and Vital Statistics Annual Report](#), which includes maternal and infant health outcomes. Data in this report may differ from published data from BPHS as Severe Maternal Morbidity data is limited to hospital deliveries at a reporting facility with a linked birth certificate. Population level data for births of all Arizona residents can be found in the Arizona Health Status and Vital Statistics Annual Report.

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This publication can be made available in alternative formats. Contact the Maternal Mortality Review Program by emailing [maternalhealth@azdhs.gov](mailto:maternalhealth@azdhs.gov) or calling 480-404-1157.

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## Letter from the Chair of the Advisory Committee on Maternal Fatalities and Morbidity

Dear all,

Pursuant to Senate Bill 1040 which established the Advisory Committee on Maternal Fatalities and Morbidities in April 2019, we are pleased to present the Report on Maternal Fatalities and Morbidities in Arizona which summarizes maternal mortality in Arizona between 2016-2017 and severe maternal morbidity in Arizona between 2016-2019.

This report is a product of over one year of work to implement recommendations made by the Advisory Committee to improve Arizona's maternal mortality review process. The Arizona Department of Health Services Maternal Mortality Review Program and the Arizona Maternal Mortality Review Committee have worked tirelessly to strengthen their identification, records requesting, abstraction and review processes to align with national guidelines and to produce timely, actionable findings. Each of these improvements will help us more thoroughly disseminate maternal health data to prevent future deaths and improve overall maternal health in Arizona.

I would like to recognize and sincerely thank each of the Maternal Mortality Review Committee members for their time and commitment to participating in maternal mortality reviews each month and for putting forth thoughtful and robust recommendations to improve maternal health outcomes in our state. I would also like to thank the team at the Arizona Department of Health Services for their efforts and dedication to ensuring we are putting forth the most comprehensive and accurate data and reports to move this work forward.

Sincerely,



**Patricia Tarango, MS**

Bureau Chief

Bureau of Women's and Children's Health

Maternal and Child Health Director

Principle Investigator, Maternal Mortality Review Program

Arizona Department of Health Services





## Letter from the Chair of the Arizona Maternal Mortality Review Committee

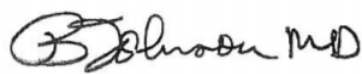
Dear Colleagues,

We are proud to share this report on maternal mortalities in Arizona between 2016-2017 and severe maternal morbidities in Arizona between 2016-2019. This report is the culmination of more than three years of work done by the Arizona Maternal Mortality Review Committee tasked with reviewing all maternal deaths that occur in the state, as well as the extensive analysis of severe maternal morbidity by Arizona Department of Health Services staff. The goal of this report is to identify statewide trends in maternal mortality and severe maternal morbidity in Arizona and, ultimately, to provide recommendations to prevent these outcomes and improve the health of Arizona residents.

The recommendations included in this report focus on five primary categories: patients and families, providers, facilities, systems, and the community. Each set of recommendations addresses specific areas of concern based on the committees' findings and proposes actions which, once implemented, are expected to reduce maternal mortalities and severe maternal morbidities.

There is nothing stronger than the heart of a volunteer. I want to extend my sincerest appreciation to those who serve on the Maternal Mortality Review Committee, as we have a duty to help every pregnant woman: past, present, and future. These members have contributed an incredible amount of their time and expertise to reviewing maternal deaths and developing this report. Together, I know we can prevent maternal mortality, decrease severe maternal morbidity, and improve the health of Arizona mothers and babies.

Sincerely,



**Robert (BJ) Johnson, MD**

Maternal Fetal Medicine

Chairman, Arizona Maternal Mortality Review Committee

Chairman, Board of Trustees, Arizona Perinatal Trust, Inc.

## Executive Summary

Each year in Arizona, approximately 70 women die within 365 days of pregnancy, of which 15-20 deaths are pregnancy-related cases (i.e., would not have died if she had not been pregnant). Additionally, approximately 900 women experience a severe maternal morbidity (SMM) during labor and delivery in an Arizona hospital (i.e., a severe and unexpected complication). While this report is considered a baseline report for maternal mortality (MM) and SMM outcomes occurring in Arizona, national rates of MM and SMM have steadily increased over the last decade, indicating a need for national, state, and local efforts to improve health outcomes for women before, during, and after pregnancy.<sup>1 2</sup> These outcomes can be attributed to a range of factors, including access to affordable, high quality, and coordinated maternal health care, social determinants of health such as financial security, housing, education, and food security, among others.<sup>3 4 5</sup>

Arizona's diverse demographic characteristics indicate the need for innovative and targeted strategies that address MM and SMM via biomedical and socio-cultural approaches. Arizona Vital Records reports that between 2016-2017, 41% of Arizona's births are to Latina women, 6% of births are to American Indian women, and 6% are to Black women.<sup>6</sup> These changing demographics place the state on its way to becoming a majority-minority state. The state has a unique geographic location as a frontier state with Mexico; is home to 22 federally recognized tribes; and has a combination of vast rural areas and some of the fastest growing urban areas in the United States.

In response to this growing diversity, Arizona has launched a series of initiatives to improve maternal health outcomes for all women of reproductive age in the state, many of which began or were enhanced in 2019. The Governor's Goal Council selected Maternal Mortality as a Breakthrough Project in early 2019 and a [Maternal Mortality Action Plan](#) was developed to improve maternal health in the state. The Advisory Committee on Maternal Fatalities and Morbidity was established in April 2019 following the signing of Senate Bill 1040 by Governor Doug Ducey. The Advisory Committee produced 26 recommendations to improve data collection for MM and SMM. Though the Arizona Revised Statute A.R.S. § 36-3501 established the Maternal Mortality Review Committee (MMRC) in 2011, the Arizona Department of Health Services (ADHS) was one of 24 states awarded the Preventing Maternal Deaths: Supporting Maternal Mortality Reviews Grant (i.e., ERASE MM grant) in the fall of 2019 to strengthen Arizona's maternal mortality review process and fund associated prevention efforts. Arizona also received an award from the US Department of Health and Human Services Health Resources and Services Administration's State Maternal Health Innovation Program to support the initiatives as defined in the Maternal Mortality Action Plan. Finally, Arizona participates in the Pregnancy Risk Assessment Monitoring System (PRAMS), which is a joint research project between ADHS and CDC to understand mothers' experiences before, during, and after pregnancy.





In effort to inform the growing body of maternal health programming in Arizona, ADHS is dedicated to ensuring that all efforts to improve maternal health outcomes are data driven. To this end, this report provides a comprehensive summary of all MM occurring between 2016-2017 and SMM between 2016 - 2019 occurring in Arizona. Descriptive statistics are used to present summary information about these adverse outcomes, including incidence, cause, contributing factors, and demographics such as age, race/ethnicity, and geographic location. As noted, the demographic and prevention information in this report should be considered baseline data for maternal mortality and severe maternal morbidity moving forward. Recommendations for prevention are also put forth by the MMRC based upon the individual reviews of maternal MM cases and aggregate reviews of SMM data. This data and associated recommendations will be used to help broadly inform public health and community initiatives aimed at improving health outcomes for Arizona's women and families.

## Maternal Mortality

MM is the death of a woman while pregnant or within 1 year of the end of pregnancy, regardless of the outcome, duration or site of the pregnancy. Causes of MM extend beyond natural causes of death (e.g., hypertensive disorders, infections, cardiac conditions). Conditions related to maternal mental health (e.g., suicide), drug use (e.g., overdose), domestic violence (e.g., homicide), and other causes of death can also be related to and/or aggravated by pregnancy and can result in MM. For this reason, Arizona reviews and reports on all deaths occurring within 365 days of a pregnancy in the state, regardless of manner of death, in effort to identify and prevent other risks women may face before, during or after pregnancy.

While the MMRC has been conducting MM reviews since 2011, in 2018, Arizona was among the first states to adopt the CDC's Review to Action protocols, including use of the Maternal Mortality Review Information Application (MMRIA), to align Arizona's review and reporting practices with other states. These processes, along with funding from the CDC ERASE MM award have resulted in both standardized and robust identification and reviews of MM in Arizona and has supported more timely dissemination of findings and recommendations.

**Section 2** of this report summarizes maternal mortalities occurring in Arizona between 2016-2017. Key findings from this report are included below. Following ADHS standards, any counts or rates based on fewer than 6 observations have been suppressed.

## Key Findings for Maternal Mortality

- ▮▮ **Pregnancy-Relatedness:** There were 134 deaths between January 1, 2016 and December 31, 2017, of which the MMRC determined that 23.1% (n = 31) were Pregnancy-Related deaths, with the remaining being either Pregnancy-Associated but not Related (70.9%, n = 95) or Unable to Determine Relatedness to Pregnancy (6.0%, n = 8).
- ▮▮ **Mortality Ratio:** The 2016-2017 Pregnancy-Associated Mortality Ratio was 79.1 deaths per 100,000 live births in Arizona for women ages 15-49. The Pregnancy-Related Mortality Ratio was 18.3 deaths per 100,000 live births in Arizona for women ages 15-49.
- ▮▮ **Preventability:** The MMRC determined that 83.6% of Pregnancy-Associated deaths were preventable. Of those preventable Pregnancy-Associated deaths, 55.4% were determined to have had a “Good Chance” to alter outcome while an additional 36.6% had “Some Chance” to alter outcome. Among the 31 deaths that were Pregnancy-Related, 80.6% were determined to be preventable. Of these preventable Pregnancy-Related deaths, 60.0% were considered to have had a “Good Chance” to alter the outcome and the other 40.0% were said to have had “Some Chance” to alter the outcome.
- ▮▮ **Timing of Death:** The majority of Pregnancy-Associated deaths (50.0%) occurred between 43 days to 365 days after the end of the woman’s pregnancy; of these 85.0% were determined to be preventable. Nearly a third of Pregnancy-Associated deaths (31.3%) occurred within 42 days of the end of pregnancy, and 76.0% of deaths during this period were considered preventable. Nearly 1 in 6 Pregnancy-Associated deaths (16.4%) occurred while the woman was still pregnant; this period had the highest proportion of preventable deaths at 91.0%. Among Pregnancy-Related deaths, the majority of deaths (64.5%) occurred within 42 days of the end of pregnancy, of which 80.0% were determined to be preventable.
- ▮▮ **Conditions Contributing to Death:** During each MM review, the MMRC determines whether Mental Health, Substance Use, and/or Obesity contributed to the death as indicated on the Committee Decisions Form (**Appendix E**). Among all Pregnancy-Associated deaths, Substance Use Disorder was identified as contributing to the death in 38.1% of cases, followed by Mental Health Conditions in 28.4% of cases and Obesity in 15.7% of cases. In Pregnancy-Related deaths, nearly a third (32.3%) were said to have had Obesity contribute to their death, and over a quarter (25.8%) were said to have had a contributing Mental Health Condition.
- ▮▮ **Manner of Death:** Natural deaths, such as those occurring in the course of nature and from natural causes (as age or disease), accounted for 42.5% of Pregnancy-Associated deaths, followed by accidents (31.1%), and intentional injuries such as suicide (7.5%) and homicide (10.4%), according to the death certificate. Among Pregnancy-Related deaths, natural deaths



accounted for 74.2%, while suicides accounted for another 19.4%, according to the death certificate.

- ▮▮ **Committee Identification of Suicide and Homicides:** Among all Pregnancy-Associated deaths, the MMRC identified 9.7% as a suicide or probable suicide, of which firearms were the means of fatal injury in 46.2%. The MMRC also identified 12.7% as being a homicide or probable homicide, of which firearms were the means of fatal injury in 70.6%, and 41.2% were perpetrated by a current or ex-partner. The MMRC identified 19.4% of Pregnancy-Related deaths as suicides or probable suicides, but there were a suppressible number (six or less deaths) of Pregnancy-Related homicides as well as suicides by means of fatal injury.
- ▮▮ **Underlying Cause of Pregnancy-Related Deaths:** For Pregnancy-Related deaths, the MMRC assigned an underlying cause of death, or the disease or injury that initiated the chain of events leading to death or the circumstances of the accident or violence which produced the fatal injury. The two most common underlying cause categories among Pregnancy-Related deaths were Cardiovascular, Coronary, or Cerebrovascular Conditions (25.8%) and Conditions of Pregnancy (22.6%), which includes Amniotic Fluid Embolism, Preeclampsia, and Eclampsia.
- ▮▮ **Maternal Race and Ethnicity:** Half of the reviewed Pregnancy-Associated deaths (50.0%) were of White, non-Hispanic women, 32.8% were of Hispanic or Latina women, 9.7% were American Indian or Alaska Native, and 5.2% were of Black or African American women; Asian or Pacific Islander women had a suppressible number of reviewed cases. American Indian or Alaska Native women had the highest Pregnancy-Associated Mortality Ratio (PAMR) at 128.3 deaths per 100,000 live births (based on fewer than 20 cases; interpret with caution). The next highest were the PAMR for White, non-Hispanic women at 90.3, Black or African American at 77.5 (based on fewer than 20 cases; interpret with caution), and Hispanic or Latina women at 63.4. White, non-Hispanic women had a Pregnancy-Related Mortality Ratio (PRMR) of 21.6 and Hispanic or Latina women had a PRMR of 14.4. Among White, non-Hispanic Pregnancy-Related deaths 93.8% were preventable, and 60.0% of Hispanic or Latina Pregnancy-Related deaths were preventable. Pregnancy-Related deaths among American Indian or Alaska Native, Asian or Pacific Islander, and Black or African American women have been suppressed.
- ▮▮ **Maternal Age:** Pregnancy-Associated deaths were comprised of 6.0% women 15-19 years old, 39.6% women 20-29 years old, 46.3% women 30-39 years old, and 8.2% women 40-49 years old. Women 40-49 years old had the highest Pregnancy-Associated Mortality Ratio (PAMR) at 225.0 Pregnancy-Associated deaths per 100,000 live births (based on fewer than 20 cases; interpret with caution), followed by 30-39 years old at 96.7, 15-19 years old at 75.8 (based on fewer than 20 cases; interpret with caution), and 20-29 at 58.9. The highest proportion of preventable Pregnancy-Associated deaths was among women 20-29 years at 90.6%, then women 15-19



years old (87.5%), women 40-49 years old (81.8%), and finally women 30-39 years old (77.4%). Women 20-29 years old had a Pregnancy-Related Mortality Ratio (PRMR) of 8.9 and women 30-39 years old had a PRMR of 26.5 (both based on fewer than 20 cases; interpret with caution). Among Pregnancy-Related deaths to women 20-29 years old, 75.0% were preventable, and 88.2% of Pregnancy-Related deaths to women 30-39 years old were preventable. Pregnancy-Related deaths among women 15-19 years old and 40-49 years old have been suppressed.

▀▀ **Maternal Education:** When grouped by level of highest education achieved, as reported on the birth certificate, women with less than a high school diploma, women with a high school diploma or GED, and women with some college or an Associate degree each made up 28.4% of Pregnancy-Associated deaths. Deaths of women with a Bachelor's degree or more made up 14.2% of Pregnancy-Associated deaths. Women without a high school diploma or GED had the highest Pregnancy-Associated Mortality Ratio (PAMR) at 129.2 Pregnancy-Associated deaths per 100,000 live births, followed by women with a high school diploma or GED (87.9), women with some college without a degree or with an Associate degree (70.5), and women with a Bachelor's degree or more (46.0; based on fewer than 20 cases). The proportion of Pregnancy-Associated deaths that were preventable ranged from 73.7% among women with some college or an Associate degree to 89.5% among both groups of women with up to a high school diploma or GED. Women with some college education or an Associate degree had the lowest Pregnancy-Related Mortality Ratio (PRMR) at 13.0 deaths per 100,000 live births (of which 100.0% were considered preventable), increasing to 16.2 among women with a high school diploma or GED (85.7% preventable), 23.8 among women with no high school diploma (percent preventable suppressed), and 24.2 among women with a Bachelor's degree or more (80.0% preventable). There were less than 20 Pregnancy-Related deaths in each group; interpret ratios with caution.

▀▀ **Maternal Residence:** Women living in urban counties (Maricopa, Pima, Pinal, and Yuma) made up 82.1% of Pregnancy-Associated deaths, while women living in rural counties (Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Mohave, Navajo, Santa Cruz, and Yavapai) had 15.7% of Pregnancy-Associated Deaths. Women who lived in a rural county had a higher Pregnancy-Associated Mortality Ratio than women who lived in an urban county (PAMR 94.0 versus 76.6, respectively; rural PAMR based on fewer than 20 cases and should be interpreted with caution). Each county type had similar proportions of preventable Pregnancy-Associated deaths, with 81.0% of rural Pregnancy-Associated deaths and 83.6% of urban Pregnancy-Associated deaths deemed preventable. The Pregnancy-Related Mortality Ratio for women in urban counties was 20.2, and 82.8% of these deaths were considered preventable. Pregnancy-Related deaths to women in rural counties have been suppressed. *Definitions for Urban and Rural are based on definitions used by the [ADHS Bureau of Public Health Statistics](#).*



- ▮▮ **Deaths by Region of Residence, Occurrence, and Injury:** Deaths were disproportionately higher among women living in the Northern region of Arizona, compared to the proportion of births to women in that region. Similarly, deaths disproportionately occurred in the Northern and Southeastern regions, and injuries resulting in death disproportionately occurred in the Northern, Southeastern, and Western regions. The Central region had disproportionately fewer deaths by region of residence, occurrence, and injury compared to the proportion of births to women living in the Central region. These regions are based on the boundaries used by the [ADHS Bureau of Emergency Medical Services and Trauma System](#).
- ▮▮ **Contributing Factors to Death:** While a variety of contributing factors were identified across reviewed deaths, there were four main areas of contributing factors identified in over half of all reviewed deaths: continuity of care, communication, assessment, and clinical skill or quality. These four factors were the top four among Pregnancy-Related deaths and Pregnancy-Associated deaths. Continuity of care and communication both included care providers without access to women’s complete records or who did not communicate women’s status sufficiently, a lack of continuity between prenatal, labor and delivery, and postpartum providers, and other fragmented care among or between healthcare facilities or units that was uncoordinated or not comprehensive. Assessment included lack of recognition by providers of risk factors for poor clinical outcomes and women not being transferred to a provider or facility for risk-appropriate care. Lastly, clinical skill or quality included personnel not appropriately skilled or prepared for situations, or providers not exercising clinical judgement consistent with current standards of care.

## Severe Maternal Morbidity

SMM includes unexpected outcomes of labor and delivery that lead to significant short- or long-term consequences to a woman’s health and wellbeing.<sup>7</sup> Some of these unexpected pregnancy, delivery and postpartum complications include but are not limited to hemorrhage, organ failure and stroke.<sup>8 9</sup> Experiencing SMM may result in an extended hospital stay, major surgery, other medical interventions, and death.<sup>10 11</sup> SMM is often a sentinel measure used in understanding the causes and gaps leading to poor maternal health outcomes, including maternal mortality.<sup>12</sup>

As a central component of Arizona’s initiatives to improve maternal health outcomes in the state, ADHS has embarked on a new effort to improve surveillance of SMM to inform quality improvement efforts to implement maternal safety protocols during labor and delivery, as well as other prevention efforts for Arizona women before, during, and after pregnancy.<sup>13</sup> Beginning in 2019, ADHS conducted a study to identify and review events of SMM utilizing the Hospital Discharge Database (HDD) and birth certificate data, based on an enhanced version of an algorithm developed by the American College of





Gynecologists and Obstetrician's (ACOG) Alliance for Innovation in Maternal Health Initiative (AIM) and used by the New York City's Department of Health and Mental Hygiene.<sup>14 15</sup>

**Section 3** of this report focuses on the findings from the study of SMM among Arizona resident births in reporting hospitals from 2016 through 2019, presented in full as a table in **Appendix F**. See **Appendix G** for a complete list and definition of SMM indicators.

## Key Findings for Severe Maternal Morbidity

- ▮▮ **SMM Rate:** In 2016-2019 there were 3547 delivery events with SMM and the overall SMM rate for Arizona was 119.4 per 10,000 delivery hospitalizations, with annual rates of SMM ranging from 109.9 to 128.1 (809-995 events per year).
- ▮▮ **Indicators of SMM:** The majority of SMM events (83.9%) had one indicator out of a total of 21 indicators; 9.3% of events had two indicators and a smaller proportion of events (6.9%) had 3 or more indicators. Most of the SMM events (76.4%) had at least one of the 5 procedure indicators, with 65.5% having procedure indicators only, and 10.9% having both procedure and diagnosis indicators. The most common SMM diagnosis indicators were adult respiratory distress syndrome (299, 8.4%), acute renal failure (272, 7.7%), and sepsis (270, 7.6%). The most common SMM procedure indicators were blood transfusion (2397, 67.6%), hysterectomy (275, 7.8%), and ventilation (161, 4.5%).
- ▮▮ **Qualifying Conditions for SMM:** Over a third of SMM events had only one of the five qualifying conditions (39.8%), while 43.4% of SMM events met 2 qualifying conditions, 16.4% had 3 qualifiers, and 0.4% had 4 qualifiers. The most common qualifier was the presence of a procedure indicator (76.4% of SMM events), predominantly due to transfusions. Events with a qualifying length of stay (LOS) made up 63.2% of SMM events; qualifying events for LOS were in or above the 90<sup>th</sup> percentiles by method of delivery (5 or more days for primary cesarean, 4 or more days for repeat cesarean, and 3 or more days for vaginal deliveries).
- ▮▮ **Maternal Race and Ethnicity:** The SMM rate for American Indian or Alaska Native women was the highest at 303.0 SMM events per 10,000 delivery hospitalizations, or over 3.5 times the SMM rate for non-Hispanic White women (83.3). Black or African American women had an SMM rate of 163.8 (nearly 2x the rate among non-Hispanic White women), followed by 133.0 among Hispanic or Latina women and 132.3 among Asian or Pacific Islander women (both over 1.5x the rate among non-Hispanic White).
- ▮▮ **Maternal Age:** The highest rates of SMM were for women 40 and over (197.7) and women 19 and younger (159.0). Women between 20-29 years old (108.5) and 30-39 years old (122.7) had much lower rates.



- Payer Type:** Over 51% of delivery hospitalizations were paid primarily through Medicaid (the Arizona Health Care Cost Containment System (AHCCCS)), and had an SMM rate of 138.2. Women with private insurance or who paid out of pocket for their deliveries had lower rates of SMM at 90.7 and 121.4, respectively. The SMM rate was highest among births paid primarily by the Indian Health Service (IHS) at 339.3 SMM events per 10,000 delivery hospitalizations.
- Socioeconomic Status:** Women who lived in the quartile of Primary Care Areas (PCA) with the highest proportion of adults living below the Federal Poverty Line had an SMM rate of 154.2, or 1.6 times the rate of women who lived in the most affluent quartile of PCAs (lowest proportion below the Federal Poverty Line), which was 93.5. SMM increased as the relative poverty level increased. Women living in the quartile of PCAs with the most income inequity (highest Gini indexes) had the highest rate of SMM at 145.5, 1.4 times the rate of women living in the quartile of PCAs with the least income inequality (lowest Gini indexes) whose SMM rate was 106.4.
- Insurance Status:** Women who lived in the quartile of PCAs with the lowest levels of health insurance coverage had the highest SMM rate of 137.9, or 1.6 times the rate of women living in the quartile of PCAs with the highest levels of health insurance coverage (87.9). Rates of SMM increased across all four quartiles of PCAs inversely to the relative proportion of women with health insurance.
- Maternal Education Level:** The rate of SMM decreased with increasing maternal education. Women who never received a high school diploma or GED had the highest SMM rate at 163.6. Women with a Bachelor’s degree had the lowest SMM rates at 83.5 and women with a Master’s or Doctorate degree had a similar SMM rate of 86.6.
- Maternal Residence:** Overall, the SMM rate was higher for women living in rural counties with a rate of 155.6, compared to women living in urban counties whose SMM rate was 114.8.
- Parity:** Women with one previous live birth had the lowest rates of SMM at 89.4 SMM events per 10,000 delivery hospitalizations. This was lower than the SMM rate of women without a previous live birth (134.0). Women with only one previous live birth also had a lower SMM rate than women with 2 previous live births (97.8), 3 previous live births (141.0) and 4 or more previous live births (203.3).
- Pregnancy Interval:** For women with at least one previous live birth, SMM rates were increased among the shortest and longest interpregnancy intervals. The intervals with the highest SMM rates were 60 months or longer (137.5), less than 6 months (135.9), and between 6 and 11 months (128.3). Women who got pregnant between 18 and 23 months and between 24 and 35 months after a previous live birth had the lowest rates of SMM (90.4 and 87.9, respectively).



- Pre-Pregnancy Body Mass Index:** Among women with a singleton, term delivery, those with a pre-pregnancy Body Mass Index (BMI) in the normal weight range (BMI 18.5-24.9) had the lowest rate of SMM at 84.6. Women who were overweight, but not obese, before pregnancy (BMI 25.0-29.9) had the second lowest rate of SMM (88.7), while women who were underweight prior to getting pregnant (BMI less than 18.5) had an SMM rate of 96.4. Women who had an obese pre-pregnancy BMI (30.0 or greater) had an SMM rate of 98.4, which varied by class: 96.1 for women in obese class 1 (BMI 30.0-34.9), 102.0 for women in obese class 2 (BMI 35.0-39.9), and 100.5 in obese class 3 (BMI 40 or greater).
- BMI and Weight Gain:** Of all weight gain and BMI combinations, underweight women with excess weight gain had the highest rate of SMM at 120.0, higher than underweight women who gained either inadequate weight (86.0) or recommended weight (84.7). For women of normal weight and overweight BMI before pregnancy, gaining inadequate weight was higher than other weight gain groups: among women of normal weight BMI, those with inadequate weight gain had an SMM rate of 98.2 compared to 85.0 for those that had excess weight gain and 74.3 for those with recommended weight gain, and among women with an overweight BMI, those with inadequate weight gain had an SMM rate of 104.0 compared to 87.3 among excess weight gain and 83.6 for recommended weight gain. Among the group of women with an obese BMI (including all three classes of obesity) those who gained inadequate weight had the lowest SMM rate (87.0), with increased rates among obese women with both recommended weight gain (99.1) and excess weight gain (102.3).
- Chronic Conditions:** Women with pre-existing diabetes had an SMM rate 2.6 times that of women without pre-existing diabetes, with rates of 301.9 versus 117.6, respectively. Similarly, women with chronic hypertension had an SMM rate 2.7 times that of women without chronic hypertension; the SMM rate for chronic hypertension was 313.1 and the rate without chronic hypertension was 116.8. Women with gestational diabetes had an increased SMM rate (144.5 with versus 117.3 without), while women with a hypertensive disorder of pregnancy (including pregnancy-induced hypertension, pre-eclampsia, and eclampsia) had 3.4 times the SMM rate of women without a hypertensive disorder of pregnancy (349.5 with versus 101.7 without).
- Tobacco Use:** Non-smokers had an SMM rate of 118.2, while mothers who smoked tobacco at all before or during pregnancy had an SMM rate of 129.8.
- Prenatal Care:** SMM increased with delayed initiation of prenatal care, with the highest rate among women without any prenatal care (339.3). Prenatal care begun in the second trimester had an SMM rate of 128.1, increasing to 149.0 among women who began prenatal care in their last trimester. In comparison, women who began prenatal care in their first trimester of pregnancy had the lowest rate of SMM (105.2). Rates of SMM also differed by adequacy of



prenatal care utilization. Women with adequate prenatal care had the lowest SMM rate at 81.0, followed by women with intermediate levels of prenatal care (106.2). Women who had more than adequate prenatal care had an SMM rate of 141.5, possibly indicative of higher risk pregnancies. Women with inadequate levels of prenatal care had an SMM rate of 151.8.

▀▀ **Method of Delivery:** Women with cesarean section deliveries had a higher overall SMM rate than women who delivered vaginally (248.7 for cesarean versus 70.7 for vaginal). Women with a primary cesarean delivery had the highest rate of SMM at 283.5, even compared to women with a repeat cesarean delivery (203.8). Women with a vaginal delivery after cesarean (VBAC, SMM rate 116.1) had a similar SMM rate as the state overall SMM rate (119.4). Vaginal deliveries without previous cesareans had the lowest SMM rate at 69.1. Overall, women with a history of a previous cesarean delivery had an SMM rate (189.0) higher than women without a previous cesarean (107.8). Among women with a previous cesarean, trial of labor was attempted in 21.5% of deliveries, with 78.7% of these attempts resulting in VBAC (16.9% of all previous cesareans) and repeat cesareans for the other 21.3% (4.6% of all previous cesareans). Women with a VBAC delivery had an SMM rate of 116.1, while women with an unsuccessful trial of labor that resulted in a repeat cesarean had an SMM rate of 296.7. Over three quarters of women with a previous cesarean (78.5%) had a repeat cesarean delivery without a trial of labor, and an SMM rate of 198.4.

▀▀ **Level of Care:** Women who delivered in an Arizona Perinatal Trust (APT) certified level II facility had the lowest rate of SMM (86.9), followed by level IIE facilities (125.2) and level I facilities (127.4). Women who delivered at level III facilities, usually indicative of high-risk pregnancies or deliveries needing the most intensive care services, had the highest rate of SMM among APT-certified facilities at 129.7. Among those facilities not currently certified by the APT, women had an SMM rate of 171.7, which includes deliveries in non-birth facilities.

▀▀ **Distance to Care:** The rates of SMM varied by driving distance and driving time to care, with SMM rates highest among women who lived more than 60 minutes or 50 miles away from their birth facility. Among term, singleton deliveries, women living more than 60 minutes away had an SMM rate of 125.3 compared to 86.9 among women who lived closer, and women living more than 50 miles away had an SMM rate of 134.9 compared to 87.3 for women who lived closer.

▀▀ **Infant Health Outcomes:** Women who had a preterm delivery (before 37 weeks gestation) had considerably higher rates of SMM than women who delivered at or after term: all preterm births had an SMM rate of 411.6 versus 92.1 for term deliveries (37-41 weeks). Women delivering prior to 32 weeks gestation (extremely/very preterm) had the highest SMM rate of 826.2, followed by women delivering between 32-36 weeks (moderately/late preterm) with an SMM



rate of 731.6. Full term deliveries (39-40 weeks) had an SMM rate of 82.3, which was lower than both early term (37-38 weeks) at 108.8 and late term or post-term (41 weeks or more) at 118.9. While the SMM rate for singleton deliveries was 113.9, the SMM rate among twins was 441.6 and for other higher order multiples was 707.1. Among deliveries with an SMM, 23.1% had a low birthweight or very low birthweight infant (less than 2500 grams), compared to 6.5% among all non-SMM hospital deliveries. At 5 minutes after delivery, 8.2% of SMM events had an Apgar score of 6 or less indicating distress, compared to 1.6% of non-SMM deliveries. Lastly, 26.4% of SMM events had a baby admitted to the NICU, compared to 6.6% of non-SMM deliveries.

## Overarching Recommendations

In response to the MM and SMM rates as described above, the Arizona MMRC has identified the following recommendations to improve maternal health outcomes within the state. A more detailed list of these recommendations addressing MM and SMM can be found in **Section 4**.

### Recommendations

#### Patient/Family Recommendations

- ▶▶ With the establishment of Patient and Family Advisory Councils among Arizona’s healthcare facilities and other mechanisms (e.g., patient navigators, Community Health Workers) to support and educate patients and families, patients and families would strive to be **active participants in shared decision-making** for their healthcare needs and **communicate in a timely manner** to their healthcare providers any health concerns and/or symptoms of complications, disclose any pregnancy within the last year during all healthcare encounters, report barriers they may face in accessing care or adhering to provider recommendations, and disclose and/or seek support for patient risks or instabilities including financial, housing, or food insecurity, substance use disorders, or experience of domestic violence.
- ▶▶ With the use of evidence-based patient tools and strategies to ensure patient/family comprehension and engagement, patients and families would adhere to recommendations and education to ensure timely care can be provided. This includes recommendations or education for **early prenatal care, postpartum warning signs, management of chronic conditions, treatment for perinatal mood disorders, and substance use disorders.**

#### Provider/Facility Recommendations

- ▶▶ Healthcare systems and providers should establish **continuity of care** through integrated or family levels of care models by 1) **assessing** all women to determine **special healthcare needs of**

vulnerable populations using an **Individual Patient Risk Assessment** tool; 2) ensuring that proper **communication** occurs to convey these needs; 3) **referring** women to appropriate levels of care, services, and/or resources, including conducting a warm hand-off and confirmation of follow up; and 4) facilitating **continuity of care** as needed between the overlap of special healthcare needs for these populations using **case management** or **other navigation support** mechanisms (e.g., doulas, community health workers, home visitation). Specific vulnerable populations or circumstances that have been identified as frequently underserved in the perinatal period are included in **Section 4**.

- ▶▶ All healthcare facilities/providers should develop and implement 1) standardized **policies/procedures** for assessing patient **knowledge** and education needs (including monitoring compliance with these policies) and 2) tools for properly and effectively **communicating** individualized pertinent health information in an effective manner to the patient (including preferred language). Knowledge assessment and education needs of women before, during, and after pregnancy which should be included are listed in **Section 4**.
- ▶▶ In accordance with the recommendations and guidelines from the [Arizona Perinatal Trust](#) and [Alliance for Innovation on Maternal Health](#), all healthcare facilities/providers should develop, implement, and monitor compliance with evidence-based, **standard of care** bundles/policies for comorbidities before, during, and after pregnancy. Bundles/protocol suggestions are included in **Section 4**.
- ▶▶ All Arizona hospitals with obstetrical services should participate in Arizona’s state-wide implementation of the **Alliance for Innovation on Maternal Health (AIM) Severe Hypertension in Pregnancy Patient Safety Bundle** and future implementation of other AIM Patient Safety Bundles.
- ▶▶ All facilities should adopt **perinatal consultation, transport guidelines** (required for [Arizona Perinatal Trust](#) and the [ADHS High-Risk Perinatal Program](#) facilities), and **Levels of Care** guidelines to ensure women are cared for at facilities with the appropriate level of care.
- ▶▶ To support women who live in [Maternity Care Deserts](#), or counties with no hospitals offering obstetric care and no OB/GYN or certified nurse-midwife providers, providers and facilities should explore opportunities to **expand telemedicine services** to ensure women and their care providers have access to timely and risk-appropriate care before, during, and after pregnancy.
- ▶▶ Enhance **state-wide workforce development opportunities** to **advance provider skills and awareness** of conditions across perinatal periods. This includes bolstering existing provider consultation or collaboration initiatives between Maternal Fetal Medicine specialists and other providers (including emergency department and urgent care providers), educating providers (e.g., pediatricians, emergency department, primary care) of conditions requiring





immediate/emergent stabilization and perinatal transport for obstetric emergencies, and training maternity care providers in suboxone treatment.

- DD In accordance with the [Arizona Health Improvement Plan](#), all hospital/healthcare systems should adopt a **health equity framework** (e.g., [Institute for Healthcare Improvement Health Equity Framework](#)) that prioritizes health equity as a strategic priority. This includes conducting organizational assessments, providing equity and inclusion trainings for providers, adopting equitable hiring and retention practices, promoting healthy behaviors and opportunities to address social determinants of health of patients and workers, and establishing an equitable physical environment.

## System Recommendations

### *Regulatory or State Policy*

- DD In accordance with the [Helping MOMS Act \(H.R. 4996\)](#), **expand Medicaid coverage** of women to one year postpartum while reducing overall barriers to enrollment upon initial positive pregnancy test.
- DD In accordance with the [Arizona State Loan Repayment Program](#) and other national and state workforce development programs, create more opportunities to expand and diversify **Arizona's healthcare workforce** for providers of all levels caring for women before, during, and after pregnancy. This includes a particular focus on diversification of race and ethnicity, and provider types (e.g., OB/GYN, midwifery, mental or behavioral health providers, Community Health Workers, doulas, certified peer support specialists) that serve Arizona's Maternity Care Deserts or areas with limited access to maternity care.
- DD Collaborate with the Arizona Medical Board or other licensing agencies to establish **continuing education requirements** to ensure providers (especially emergency department providers) caring for women during and after pregnancy are educated about **perinatal conditions requiring immediate/emergent stabilization** and perinatal transport for obstetric emergencies.
- DD Identify opportunities to better leverage [Health Current](#) (the Arizona Health Information Exchange) to achieve a statewide, **universal medical record and prescription drug monitoring/medication reconciliation platform** to ensure timely communication and sharing of patient health information, particularly for sharing of records between mental health providers and other providers caring for women before, during, and after pregnancy.

### *Payers*

- DD **Integrated care, patient-centered medical homes, and/or family levels of care models** need to be adopted or strengthened to foster trust in patient/provider relationships, enhance **communication**, improve **quality of care**, and maintain **continuity of care**. This includes a need



for sustainable reimbursement for all levels of providers that address the diverse needs of patients, including midwifery, doulas, Community Health Workers, and others. Suggestions for various areas of integrated care are included in **Section 4**.

- ▶▶ In accordance with the [American College of Obstetricians and Gynecologists](#), [National Institute for Children’s Health Quality](#), and [National Academy for State Health Policy](#), payers should adopt **maternity care incentive plans** to **optimize** both **family planning** and **postpartum care**. This includes postpartum visits via telemedicine, postpartum home visiting, and screenings for mothers during Early and Periodic Screening, Diagnostic and Treatment (EPSDT) visits for infants, as recommended by the [American Academy of Pediatrics Bright Futures Guidelines](#).
- ▶▶ Similar to the [AHCCCS American Indian Medical Home](#) model, payers should adopt an **American Indian Medical Home concept** for care coordination before, during, and after pregnancy, including intensive postpartum follow-up and peer support programs for Arizona’s indigenous populations.
- ▶▶ Ensure **reproductive resources**, including preconception counseling, family planning, contraception, preventative screenings, HPV vaccination, prenatal care, postpartum care, and interpregnancy co-morbidity care are available to all women. This includes ensuring reimbursement eligibility for all OB/GYN providers placing long acting reversible contraception (LARC) during inpatient postpartum stays. Special populations to consider further facilitating access to these resources are included in **Section 4**.
- ▶▶ Ensure patients who are uninsured or underinsured have access to **affordable and appropriate services or supplies**, including supplies to manage their conditions (e.g., glucose monitors, insulin), access to dental services, healthy food (particularly to support appropriate weight gain during pregnancy), housing assistance programs, and mental health or substance use services.
- ▶▶ All health plans should improve **transparency of their prescription drug formularies and pricing** to facilitate appropriate prescribing by providers and to eliminate patient barriers in obtaining medications.
- ▶▶ Establish community models of **peer support** across the perinatal period that are reimbursed by health care payers or other funding sources. These support services should include voluntary access and referral to appropriate resources for women experiencing conditions listed in **Section 4**.

#### *Law Enforcement*

- ▶▶ In accordance with the [Arizona Opioid Action Plan](#), establish a supportive **harm reduction environment** for individuals experiencing **substance use disorders** by ensuring law enforcement officers and court systems coordinate with substance use prevention or diversion programs, including teen diversion programs, step down programs for those recently incarcerated (e.g.,

AHCCCS Justice in Reach Program), mentorship/peer support programs, and resources geared towards families aiming to support those with substance use disorder or people in recovery.

- DD In accordance with the [American College of Obstetricians and Gynecologists Statement on Gun Violence and Safety](#), establish supportive environments for women experiencing **domestic violence** by identifying funding options for law enforcement to dispatch a social worker or mental health professional on domestic violence calls and enacting stricter enforcement of laws and/or punishments for individuals with multiple offenses of domestic violence or other violent crimes, including offering therapy or diversion programs for domestic violence offenders and providing periodic injury prevention evaluations and counseling regarding weapons.

#### *Other Systems or Policies*

- DD Support **medical examiners** to collaborate with health systems or facilities to confirm qualifying conditions or situations requiring an autopsy and automatic qualifications for toxicology testing, including identifying and addressing facility-level (e.g., training, protocols) or patient/family-level (e.g., financial, cultural) barriers to conducting them.
- DD In accordance with the [Arizona Department of Transportation FY2020 Strategic Plan](#), ensure **roadways and highways** where pedestrians may be located are well lit and have sidewalks and crosswalks.
- DD In accordance with the [Arizona Adverse Childhood Experience Consortium](#), Arizona should become a **trauma-informed state** to recognize and respond to toxic stress and trauma experienced by women and families, and support women and families in overcoming them.
- DD ADHS and other entities in Arizona should regularly prepare and **disseminate maternal morbidity and mortality data** that ensures health systems, facilities, and providers have feedback mechanisms about health outcomes for Arizona women before, during, and after pregnancy. In turn, communities should conduct periodic **community needs assessments** (e.g., every 5 years) to understand how maternal morbidity and mortality impact women and families in their area, and leverage resources such as the Arizona Health Improvement Plan to implement recommendations to prevent these in the future.
- DD In accordance with the strategies identified by Governor Ducey's [Executive Order](#) to expand telemedicine coverage for Arizonans and [Tribal Connect Act of 2020 \(H.R.7973\)](#), support Arizona residents and providers in **expanding access to telehealth services**, particularly through expansion of low-cost broadband and telephone services on tribal lands and remote areas of the state.



- DD Identify systems or **other funding opportunities to support community-based recommendations** included below.

### Community Recommendations

- DD Develop and provide community-based **outreach** and **education** via text or other communications to enhance awareness of the topics listed in **Section 4** to support women and families before, during, and after pregnancy.
- DD Support schools in enhancing **behavioral health services** for students experiencing depression or other mental health concerns.
- DD Ensure women in all regions of the state have access to **faith-based services** (e.g., Catholic Social Services) or **other services** (e.g., public health services) to support women in completing their education, issues of life instability, lack of resources for child care, and/or access to healthy foods, etc.
- DD Establish community models of **peer support** across the perinatal period that includes voluntary access and referral to appropriate resources for women experiencing conditions listed in **Section 4**.

# Section 1: Overview of Maternal Health

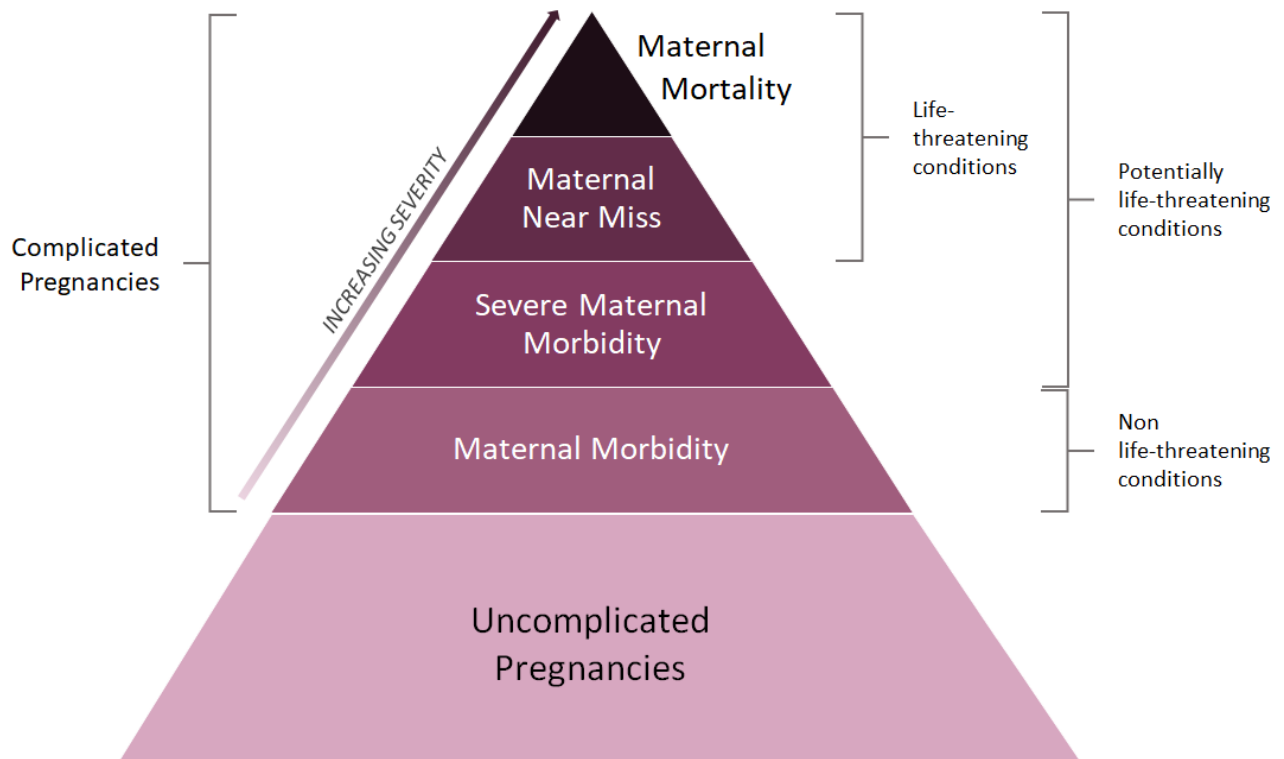
This section provides an overview of maternal health, including a description of the spectrum of maternal health outcomes, rates and implications of maternal mortality (MM) and severe maternal morbidity (SMM) on women of childbearing age, and a description of the Arizona Department of Health Services' (ADHS) activities to prevent MM and SMM in the future. **Sections 2 and 3** provide deeper analyses of MM and SMM among Arizona women, followed by recommendations to prevent these outcomes (**Section 4**), a discussion of these findings (**Section 5**), and limitations for the data presented in this report (**Section 6**).

## Spectrum of Maternal Health Outcomes

Maternal health outcomes can be described as a continuum from uncomplicated pregnancies to life-threatening events, or even death, that can occur prior to, during, or after childbirth. **Figure 1** depicts the spectrum of maternal health outcomes of all pregnancies, including those without complications progressing to MM as the level of severity increases during or after pregnancy.

**Figure 1.**

Spectrum of Maternal Health Outcomes



Adapted from: Vandenberghe G, Roelens K, Van Leeuw V, et al., The Belgian Obstetric Surveillance System to monitor severe maternal morbidity. *Facts, Views & Vision in Obgyn.* 2017;9(4):181-188.

## Uncomplicated Deliveries and All Pregnancies

The first layer of the Spectrum of Maternal Health Outcomes (Figure 1) is uncomplicated deliveries. In Arizona, approximately 80,000 women have a live birth each year, and the large majority of these deliveries occur with

little to no complications.<sup>16</sup> There is an even greater number of women in Arizona with pregnancies each year that can be at risk of complications, which includes those that do not result in a live birth (e.g., spontaneous abortion, therapeutic abortion, stillbirth), though data related to these outcomes are inconsistent and unreliable.

## Maternal Morbidity, Severe Maternal Morbidity, and Maternal Near Miss

Maternal morbidities range from minor complications to near-miss events that without timely identification and treatment could lead to death.<sup>17</sup> SMM is the unexpected conditions or outcomes of pregnancy, delivery, or postpartum that aggravate or lead to significant negative effects on a woman's health and wellbeing.<sup>18 19 20</sup> This can include both physical or psychological conditions, and can have impacts in either the short- or long-term.<sup>21 22 23</sup> It has been shown that SMM has a persistent effect on the functioning of women even up to 5 years later.<sup>24</sup> SMM may also affect fetuses/neonates with adverse outcomes such as premature birth, low birth weight, failure to thrive, increased need for medical intervention, or death.<sup>25</sup> Additionally, women who experience an SMM event are at higher risk of postpartum mental illness or emotional distress, including Post-Traumatic Stress Disorder (PTSD), which can affect their ability to parent or bond with their infant.<sup>26 27</sup>

## Maternal Mortality

The Centers for Disease Control (CDC) National Center for Health Statistics and the World Health Organization describe a maternal death as the death of a woman while pregnant or within 42 days of termination of pregnancy.<sup>28 29</sup> Arizona uses a more inclusive definition to include deaths of women while pregnant or within 1 year of the end of a pregnancy – regardless of the outcome, duration or site of the pregnancy. **Figure 2** demonstrates that while all deaths (shown as leaves on the tree) of women within 1 year are considered Pregnancy-Associated, only a smaller portion are directly related to that pregnancy.<sup>30</sup>

These two categories of maternal mortality include:

- ▶▶ **Pregnancy-Related:** The death of a woman during pregnancy or within one year of the end 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:** The death of a woman during pregnancy or within one year of the end of pregnancy, regardless of the cause.<sup>31</sup>

Causes of MM extend beyond natural causes of death (e.g., hypertensive disorders, infections, cardiac conditions). Conditions related to maternal mental health (e.g., suicide), drug use (e.g., overdose), domestic violence (e.g., homicide), and other

**Figure 2.** Pregnancy-Associated vs Pregnancy Related Deaths



Source: Review to Action. Pregnancy-Associated Deaths.

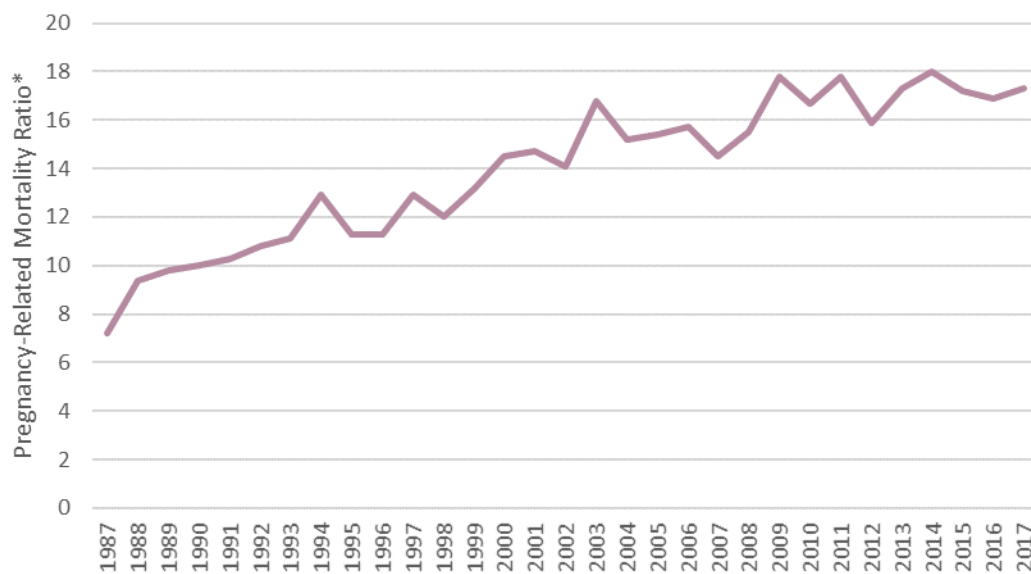
causes of death can also be related to and/or aggravated by pregnancy and can result in a maternal death. To this end, thorough and standardized case reviews conducted by the Arizona MMRC are essential to determining the pregnancy-relatedness of deaths occurring among Arizona women within 365 days of a pregnancy.

## Rates and Implications of Maternal Mortality and Severe Maternal Morbidity

While maternal mortality in other developed countries has decreased, the maternal mortality ratio in the United States (U.S.) has continued to rise with the U.S. Pregnancy-Related Mortality Ratio (PRMR) for 2017 was 17.3, up from 7.2 in 1987 as shown in **Figure 3**.<sup>32 33</sup> While this ratio is influenced by a range of factors, significant disparities in the US PRMR are apparent. Women of color carry a disproportionate burden of MM.<sup>34</sup> <sup>35</sup> Non-Hispanic Black women are three (3) times as likely as non-Hispanic White women to experience MM in the U.S.<sup>36 37</sup> Similarly, a [report](#) from the Arizona MMRP found among pregnancy-related maternal mortalities, American Indian or Alaska Native women died at four (4) times the rate compared to Non-Hispanic White women despite Non-Hispanic American Indian or Alaska Native Women representing only 6.0% of births for the same data years.<sup>38</sup>

**Figure 3.**

Trends in Pregnancy-Related Mortality in the United States: 1987-2017



\*Number of pregnancy-related deaths per 100,000 live births per year

Source: Centers for Disease Control and Prevention. Pregnancy Mortality Surveillance System.

<https://www.cdc.gov/reproductivehealth/maternal-mortality/pregnancy-mortality-surveillance-system.htm>. Accessed November 2, 2020.

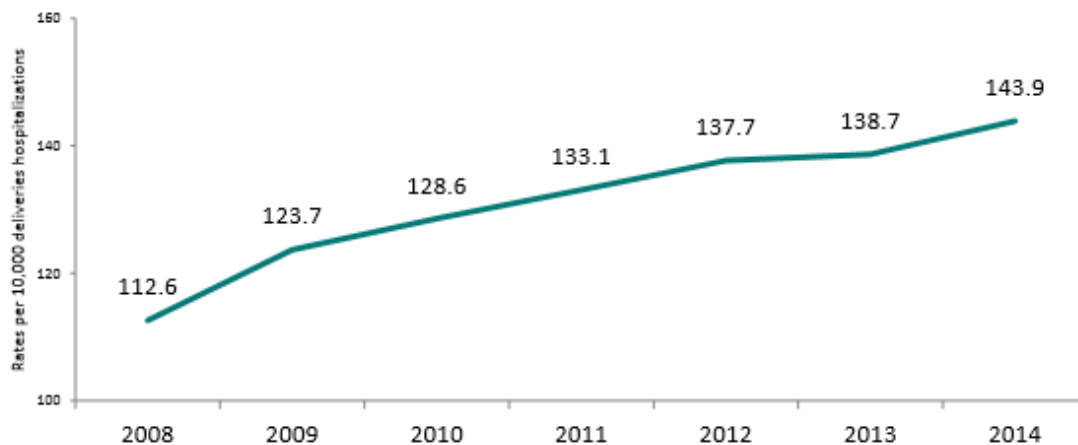
As seen in **Figure 4** below, SMM in the U.S. has also been steadily increasing in recent years with an almost 200% increase since 1993, driven largely by increases in blood transfusions.<sup>39</sup> In 2014, the last full year of data available nationally, SMM affected more than 50,000 women in the U.S.<sup>40</sup>



SMM in **Figure 4** is defined as the “number of delivery hospitalizations with an indication of severe morbidity from ICD-9 diagnosis or procedure codes (e.g. heart or kidney failure, stroke, embolism, hemorrhage) over the number of delivery hospitalizations.”

**Figure 4.**

Severe Maternal Morbidity Rates, United States, 2008-2014



Source: Healthcare Cost and Utilization Project State Inpatient Databases; Adapted from: HRSA National Outcome Measures Dashboard. <https://mchb.tvisdata.hrsa.gov/PrioritiesAndMeasures/NationalOutcomeMeasures>. Accessed October 30, 2020.

**Technical note:** This measure follows the CDC-developed definition of severe maternal morbidity identified from hospital discharge procedure and diagnosis codes that indicate a potentially life-threatening condition or maternal complication. Specific ICD-9-CM diagnosis and procedure codes have been reduced to 18 in preparation for the transition to ICD-10-CM:

<http://www.cdc.gov/reproductivehealth/MaternalInfantHealth/SevereMaternalMorbidity.html>

With the exception of hospitalizations with in-hospital mortality, transfer, or severe complications identified by procedure codes (e.g., hysterectomy, blood transfusion, ventilation), events of severe maternal morbidity identified by diagnostic codes were reclassified as hospitalizations without severe maternal morbidity if they had an implausibly short length of stay ( $\leq 3$  days for vaginal,  $< 4$  days for primary cesarean, and  $< 5$  days for repeat cesarean deliveries). Delivery hospitalizations were identified by diagnosis codes for an outcome of delivery, diagnosis-related group delivery codes, and procedure codes for selected delivery-related procedures.

U.S. estimates are calculated using the available state data and are not nationally weighted; therefore, U.S. estimates may not be comparable across years due to the different states included in any given year.

Consistent with MM, non-Hispanic Black women and other women of color also have higher rates of SMM.<sup>41 42</sup> A study of 2008-2010 delivery hospitalizations in 7 states found that Non-Hispanic Black, Hispanic/Latina, Asian or Pacific Islander, and Non-Hispanic American Indian or Alaska Native women had 2.1, 1.3, 1.2, and 1.7 times, respectively, higher rates of SMM compared with non-Hispanic White women.<sup>43</sup>

The financial implications of SMM using hospital discharge data have not been studied in Arizona. However, a 2016 economic analysis on SMM in 13,505 events from 2008-2012, completed by the New York City Health Department of Health and Mental Hygiene, discovered that the average cost of delivery increased when a woman had an SMM. After adjusting for other maternal, clinical, and hospital level factors, the average cost of delivery with SMM was \$15,714 compared to \$9,357 for deliveries without SMM in New York City. This reflects a 68% increase in the cost of delivery possibly due to longer hospital stays, emergency surgeries, and unplanned medical interventions needed to treat an SMM case to prevent mortality. According to the analysis, SMM events had an adjusted difference in cost of \$6,357 per case, with the total excess costs related to SMM

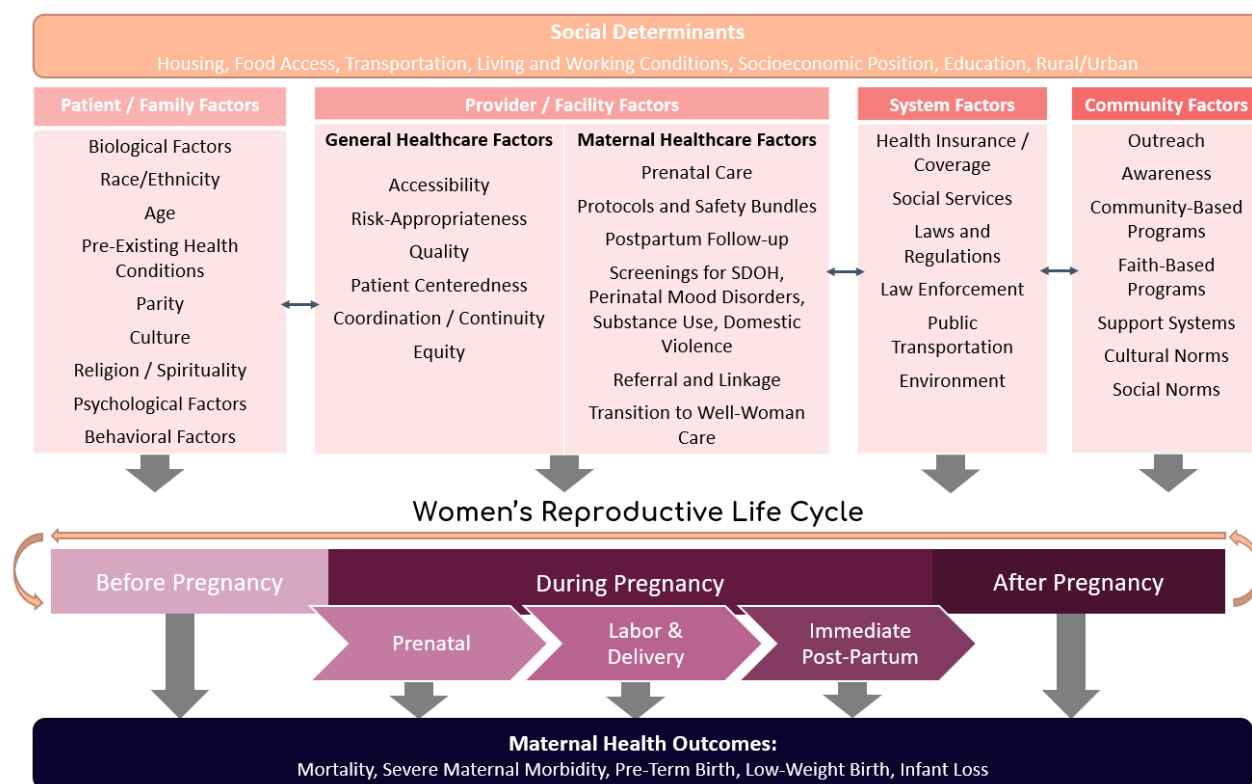
exceeding \$85 million.<sup>44</sup> Though SMM is not entirely avoidable, it does indicate additional rationale for preventing SMM among Arizona women.

## Factors Influencing Maternal Health Outcomes

While the reason for this increase in MM and SMM is not entirely understood, there are a variety of determinants or factors that affect maternal health outcomes before, during, and after pregnancy. These factors interplay at varying levels, including among patients and families, providers or facilities, overall systems, and within the community. **Figure 5** displays factors that affect maternal mortality and morbidity adapted from the World Health Organization’s Commission on Social Determinants of Health conceptual framework, the Centers for Medicare and Medicaid Services Improving Access to Maternal Health Care in Rural Communities issue brief, as well as other sources found in the literature.<sup>45</sup>

**Figure 5.**

Diagram of Factors that Affect Maternal Mortality and Morbidity



**Adapted From:** Manyazewal, T. Using the World Health Organization health system building blocks through survey of healthcare professionals to determine the performance of public healthcare facilities.<sup>46</sup> | Solar, O, Irwin, A. A Conceptual Framework for Action on the Social Determinants of Health.<sup>47</sup> | Centers for Medicare and Medicaid Services. Improving Access to Maternal Health Care in Rural Communities Issue Brief.<sup>48</sup>

Social determinants of health, or factors in the environment in which people live and function that can affect health, risk, and quality of life such as poverty, inadequate housing, lower educational attainment, and lack of access to healthcare services, exacerbate the risk for women to experience MM and SMM in their communities.<sup>49</sup> For example, women living in rural areas experience worse maternal health outcomes for SMM and MM than women in urban areas, which can be attributed to a range of clinical and individual factors.<sup>50</sup> Most notably, rural residents experience unique barriers to care due to rural healthcare workforce shortages and/or rural hospital closures, longer drive-times to receive care, and other barriers related to health insurance, housing, transportation and other social determinants of health.<sup>51 52 53 54</sup> Nearly three quarters of Arizona's 15 counties are considered rural. Of these, two counties (i.e., Greenlee and La Paz) have no access to maternal care within the county, and two counties (i.e. Graham and Cochise) have limited access to maternal care, according to a recent report by the March of Dimes on 2018 birth data.<sup>55</sup>

Among patients and families, decreasing overall health among women giving birth, including those with chronic conditions such as diabetes, cardiovascular disease, and hypertension, as well as increasing maternal age and multiple gestational births, may be partly responsible for worsening maternal health outcomes; however, there are other factors at play.<sup>56 57</sup> Maternal mental health disorders, substance use disorders, and domestic violence also influence health outcomes among women of reproductive age.<sup>58 59 60</sup>

Provider, facility, and systemic factors likely contribute to MM and SMM as well, including delay in diagnosis and treatment, lack of care coordination, limited access to care or health insurance, method of delivery, and adherence to standard of care protocols.<sup>61 62 63</sup> Implicit bias and racism in healthcare, both at the healthcare delivery and system levels, can also contribute to adverse maternal health outcomes.<sup>64</sup> Lastly, community-level factors related to cultural or social norms, access to available resources and/or support systems, and overall awareness of positive health behaviors and risk factors before, during, and after pregnancy may also influence maternal health outcomes.<sup>65 66</sup>

Given these factors, the data presented in this report is intended to continue conversations on how Arizona can effectively design and implement statewide interventions aimed at improving women's overall health and directed at populations disproportionately burdened by MM and SMM.

## **Arizona Department of Health Services Activities to Prevent Maternal Morbidity and Mortality in Arizona**

Arizona's diverse demographic characteristics indicate the need for innovative and targeted strategies that address MM and SMM via biomedical and socio-cultural approaches. Arizona Vital Records reports that between 2016-2017, 41% of Arizona's live births are to Latina women, 6% of live births are to American Indian women, and 6% are to Black women.<sup>67</sup> These changing demographics place the state on its way to becoming a majority-minority state. The state has a unique geographic location as a frontier state with Mexico; is home to 22 federally recognized tribes; and has a combination of vast rural areas and some of the fastest-growing urban areas in the U.S.

ADHS's maternal health programs have continued to evolve over the past decade to respond to the diversifying population and range of maternal health outcomes in Arizona. Most notably, the Governor's Goal

Council selected MM as a Breakthrough Project in early 2019, and a [Maternal Mortality Action Plan](#) was developed to improve maternal health in the state with an emphasis on five goal areas:

1. Improve knowledge and education for pregnant and postpartum women on warning signs and when to seek care;
2. Improve access to care;
3. Support workforce and workforce capacity;
4. Improve surveillance of morbidity and mortality; and
5. Support systems of care.

Also in 2019, the [Advisory Committee on Maternal Fatalities and Morbidity](#) was established following the signing of Senate Bill 1040 by Governor Doug Ducey. The Advisory Committee was tasked with recommending improvements to the processes for collecting information on maternal fatalities and morbidities. The Committee convened multiple times from August to December 2019 to discuss the topics prescribed by Senate Bill 1040. A [report](#) summarizing the Committee's findings and recommendations was published in December 2019 and the MMRP has focused on implementing those recommendations since that time.

The following describes ADHS's three key maternal health programs, their associated funding, and their efforts relating to accomplishing the Maternal Mortality Action.

## Maternal Mortality Review Program

The Arizona MMRP was created by Senate Bill 1121 (**Appendix B**) which was passed in April of 2011. Arizona Revised Statute (ARS) was amended to establish the MMRP as a component to the Child Fatality Review (CFR) Program which is outlined in ARS 36-35014.<sup>68</sup> The amendment authorized the CFR program to create a subcommittee dedicated to the review of maternal deaths occurring within the State. The MMR subcommittee was established in July of 2011 and has been reviewing all identified pregnancy-associated deaths. This multidisciplinary team reviews cases in order to identify preventative factors with the intent to provide recommendations for systems-level changes.

In 2019, ADHS was one of 24 states awarded the Preventing Maternal Deaths: Supporting Maternal Mortality Reviews Grant (i.e., ERASE MM grant) from the CDC. This grant funds the Arizona MMRP with \$450,000 per year for 5 years, not only supporting Arizona's maternal mortality review process but also associated prevention efforts (e.g., Alliance for Innovation on Maternal Health safety bundle implementation, media campaign to educate about postpartum warning signs) as identified by the MMRC. The aim of this funding is to better understand and prevent pregnancy-related deaths by gathering detailed, complete data on causes and circumstances surrounding maternal deaths to develop recommendations for prevention. The outcomes of the grant are:

1. Timely, accurate, and standardized information available;
2. Increased awareness of the existence and recommendations of the MMR Committee;
3. Implementation of data-driven recommendations;
4. Widespread adoption of patient safety bundles and/or policies; and
5. Reduction in maternal complication of pregnancy.

## Maternal Health Innovation Program

ADHS, in partnership with the Arizona Chapter of the March of Dimes and Arizona Perinatal Trust, launched a Maternal Health Task Force (MHTF) in October 2018 to discuss MM and SMM in Arizona. ADHS continued to host meetings of the MHTF which spurred several initiatives to improve maternal health outcomes in Arizona, including participation in the Alliance for Innovation on Maternal Health safety bundle implementation and reporting on incidence and causes of SMM in the state.

In 2019, ADHS applied for and was awarded funding to support this work through the US Department of Health and Human Services Health Resources and Services Administration's State Maternal Health Innovation Program. ADHS received \$2.2 million per year for 5 years to fund efforts of the MHTF and the Maternal Mortality Action Plan, with emphasis on reducing health disparities and improving access to care through the use of technology. The program is designed to assist states in collaborating with maternal health experts and optimizing resources to implement state-specific actions that address disparities in maternal health and improve maternal health outcomes, including the prevention and reduction of MM and SMM. There are three main components of the Maternal Health Innovation Program:

1. Utilize the state-focused MHTF to create and implement a strategic plan that incorporates activities outlined in the state's most recent Title V Needs Assessment;
2. Improve the collection, analysis, and application of state-level data on maternal mortality and SMM; and
3. Promote and execute innovation in maternal health service delivery, such as improving access to maternal care services, identifying and addressing workforce needs, and/or supporting postpartum and interception care services, among others.



## Pregnancy Risk Assessment Monitoring System

The Pregnancy Risk Assessment Monitoring System (PRAMS) is a joint research project between ADHS and CDC to understand mothers' experiences before, during, and after pregnancy. Each month, Arizona PRAMS conducts questionnaires (both phone and mailed surveys) with 1 in 30 new mothers in the state about prenatal care, health insurance coverage, mental health and/or substance use during pregnancy, pre- and inter-conception care, and infant health. The purpose of this data collection is to inform future ADHS efforts to improve health outcomes for mothers and their babies in Arizona.

More information about how ADHS, the MMRC, MHTF, PRAMS, and other partners are working to improve maternal health can be found at <http://azdhs.gov/maternalhealth>.

## Section 2: Maternal Mortality, 2016-2017

### Overview of the ADHS Maternal Mortality Review Program

#### Authorization

The A.R.S. § 36-3501 was amended in April 2011 to establish the Arizona MMRC as a subcommittee to the CFR Program. Since its establishment in July 2011, the subcommittee convened by the Arizona MMRP has been reviewing all identified maternal deaths in the state.

#### Structure and Membership

The MMRP is implemented and coordinated by ADHS staff in the Bureau of Women's and Children's Health (BWCH) Office of Assessment and Evaluation including a program manager (PM), nurse abstractor, epidemiologists, and administrative staff person. ADHS staff are responsible for identifying maternal mortalities, requesting records and developing case narratives, supporting the MMRC during reviews, and reporting maternal mortality data. Additional MMRP resources have included epidemiology and PM staff from the CFR program, volunteer clinical nurse abstractor, an MPH volunteer, and MPH/Nursing student interns to support case abstraction and reporting.

The current MMRC consists of 33 external clinical and non-clinical members who represent a range of maternal health practitioners (e.g., obstetricians, Maternal Fetal Medicine specialists, midwifery, registered nurses, doulas, home visitors), domestic violence service providers, behavioral health specialists, law enforcement, maternal child health advocacy organizations, public health professionals, and Indian Health Services. A full list of MMRC members can be found in **Appendix A**.

#### MMRC Meetings

The MMRC currently meets the first Monday of each month for three hours and reviews between four and eight cases each meeting. Typical attendance is around 25 people, including five to eight ADHS staff. These meetings were typically hosted in person with a virtual option, though during the Covid-19 pandemic meetings have been hosted entirely virtually.



## Methodology for Reviewing Maternal Mortalities

To maintain consistency in MM reviews, the Arizona MMRP applies the same methodologies to each review from identification to the dissemination of findings, as demonstrated in **Figure 6**. This process is derived from [Review to Action](#) which is used by CDC and other ERASE MM funded states. As shown, the Review to Action methodology is considered to be cyclical in that as the number of cases reviewed using this protocol increases, the consistency, and reliability of the data and recommendations being put forth increases as well. Ultimately, this process leads to a comprehensive snapshot of the risks and barriers women face that sometimes result in maternal mortality, and areas of opportunity to improve those outcomes.

Though the primary components of the Review to Action methodology have remained the same, some features evolved throughout the Arizona MMRP's review of 2016-2017 deaths, resulting in a few instances of missing or incomplete data.

This detailed flow chart of steps included in the Review to Action Process is included in **Appendix D**.

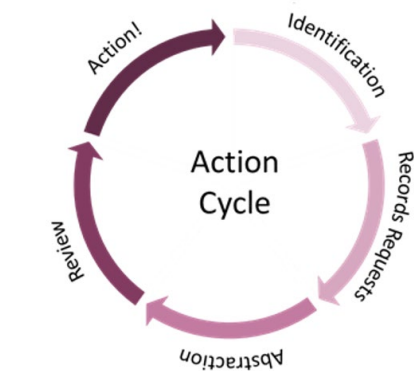
### Identification

The inclusion criteria for maternal mortalities reviewed by the Arizona MMRC are the following:

- ▶▶ The death must have occurred within 365 days of the end of a documented pregnancy, regardless of the outcome or viability of the pregnancy, the manner of death, or relatedness of the death to the pregnancy.
- ▶▶ The death must have occurred within the state of Arizona, regardless of residency.
- ▶▶ The decedent must have been between the ages of 15 and 49. For future reviews, the age range will expand to ages 10 to 60 in accordance with CDC recommendations.

For 2016-2017 maternal mortalities, the MMRP epidemiologist queried death records and identified cases where the pregnancy checkbox has been marked, indicating the woman was pregnant at the time of death, within 42 days of her death, or between 43 days and 1 year of her death. The epidemiologist also identified cases where the causes of death on the death certificate included maternal ICD-10 codes (O series or A34). In addition, the epidemiologist performed linkage analyses to link death certificates of women ages 15-49 to birth records, fetal death records, and hospital discharge data of obstetric encounters, regardless of the pregnancy checkbox on the death certificate or the cause of death. These linkages were manually cleaned for mismatches and/or duplicates, as well as those deaths beyond 365 days of a documented pregnancy. The final list of cases that occurred in Arizona and fell within the reproductive age criteria (15-49 years of age) was compiled into a spreadsheet and securely provided to the PM and nurse abstractor. Typically, approximately 20 decedents originally identified each year are

**Figure 6.**  
Review to Action Cycle



Source: Adapted from Berg, C.J. (2012). From identification and review to action—maternal mortality review in the United States. *Seminars in Perinatology*, 36(1), 7-13.

determined false positives and subsequently screened out during the abstraction or review process. The following table (**Figure 7**) includes a summary of the total cases identified and reviewed for 2016-2017.

**Figure 7.**

Total Identified Cases for 2016-2017 Maternal Mortalities

<i>Year for Review</i>	<i>Total Identified</i>	<i>Total False Positives (e.g., no indication of pregnancy within 365 days)</i>	<i>Final Number of Maternal Mortalities</i>
2016	95	20	75
2017	76	17	59

## Records Requests

The administrative assistant and other program staff are responsible for requesting records for all identified maternal mortalities. Primary records requested for each case include hospital or other medical care records, emergency medical records, law enforcement records, Department of Child Safety records, and medical examiner records (e.g., autopsy, toxicology). Hospital records are initially requested using the facilities where deaths occurred according to death certificate data, as well as a list of emergency department visits or inpatient hospitalizations as indicated in hospital discharge data. Upon receipt of hospital records, the nurse abstractor mines the record to identify any other providers the decedent may have seen, including primary care, obstetricians/gynecologists, specialists, and/or behavioral health providers, among others. As records are received, MMRP program staff securely store and track all received records to prepare for abstraction.

## Abstraction

The CDC established the Maternal Mortality Review Information Application (MMRIA) platform as the primary means of standardizing data collection/abstraction of clinical and non-clinical information surrounding maternal deaths. Arizona was one of the first states to adopt the MMRIA data system in April 2018. As cases are ready to be abstracted, the nurse abstractor begins entering pertinent information from each record into this system. The nurse abstractor also uses this information to create a 2 to 5-page de-identified case narrative about each decedent which is provided to the MMRC before each meeting for review.

## Review

As noted, the Arizona MMRC meets monthly to review maternal mortalities. The Committee Chair and the PM facilitate these meetings, though MMRC members are asked to take turns reading the de-identified case narratives out loud to start the review of each case. In accordance with the CDC Review to Action process format, the MMRC completes a Committee Decisions Form for each case, which is intended to standardize reviews across all participating states (**Appendix E**). The Committee Decisions Form guides the MMRC in making determinations about pregnancy-relatedness, manner of death, cause

of death, and preventability for each case. The MMRC also identifies Contributing Factors (e.g., assessment, knowledge, mental health) associated with each case and makes recommendations for the prevention of future deaths. Following the meeting, all committee decisions and recommendations are entered into the MMRIA database.

## Action!

Following the completion of MM reviews for each calendar year (e.g., 2016, 2017), the MMRP staff export case data from MMRIA to conduct quantitative and qualitative analyses and publish reports, such as this report summarizing 2016-2017 MM and 2016-2019 SMM in Arizona. The release of MM and SMM reports spark new and exciting opportunities to turn MM reviews into action. ADHS plans to disseminate these reports widely among key stakeholders in Arizona to identify opportunities to improve maternal health outcomes for Arizona's women and families.

The MMRIA platform is also used for national surveillance, monitoring, and examination of maternal mortality. To this end, ADHS completes Data Sharing Agreements with the CDC so they can include Arizona data in multi-state analyses as another mechanism of disseminating findings for action. Most recently, CDC produced a multi-state report that includes Arizona, entitled [Pregnancy-Related Deaths: Data from 14 US Maternal Mortality Review Committees, 2008–2017](#).<sup>69</sup>

## Definitions for Common Terminology in Maternal Mortality

The following are definitions for common terminology found in this section on Maternal Mortality in Arizona. Additional definitions can be found in the glossary located in **Appendix B**.

- **Natural Death:** A death occurring in the course of nature and from natural causes, such as age or disease.
- **Maternal Mortality (MM):** The death of a woman while pregnant or within 1 year of the end of a pregnancy – regardless of the outcome, duration, or site of the pregnancy – from any cause related to or aggravated by the pregnancy or its management. Though the CDC definition excludes accidental and incidental causes from maternal mortality reporting, the Arizona MMRP reviews, and reports on all maternal mortalities occurring in Arizona regardless of the manner of death.
- **Pregnancy-Associated:** The death of a woman during pregnancy or within one year of the end of pregnancy, regardless of the cause. All deaths that have a temporal relationship to pregnancy are included.
- **Pregnancy-Associated Mortality Ratio (PAMR):** An estimate of the number of pregnancy-associated deaths for every 100,000 live births.
- **Pregnancy-Related:** The death of a woman during pregnancy or within one year of the end 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. In addition to

having a temporal relationship to pregnancy, these deaths are causally related to pregnancy or its management.

- **Pregnancy-Related Mortality Ratio (PRMR):** An estimate of the number of pregnancy-related deaths for every 100,000 live births. This ratio is often used as an indicator to measure the nation's health.
- **Preventability:** A death is considered preventable if the committee determines that there was at least some chance of the death being averted by one or more reasonable changes to patient, community, provider, facility, and/or systems factors. MMRIA allows MMRCs to document preventability decisions in two ways: 1) determining preventability as a "yes" or "no", and/or 2) determining the chance to alter the outcome using a scale that indicates "no chance", "some chance", or "good chance". Any death with a "yes" response or a response that there was "some chance" or a "good chance" to alter the outcome was considered "preventable"; deaths with a "no" response or "no chance" were considered "not preventable".
- **Resident:** Arizona residency was determined by the county of residence as listed on the death certificate. This is not an indication of citizenship or legal residence in Arizona.
- **Underlying Cause of Death:** The disease or injury that initiated the chain of events leading to death or the circumstances of the accident or violence which produced the fatal injury. In addition to the listed causes of death from the death certificate, the MMRC assigns an underlying cause of death code for Pregnancy-Related cases.

## Findings for Maternal Mortality in Arizona, 2016-2017

The findings described in this section are derived from several sources, including death certificate data and committee decisions made during maternal mortality reviews. It is important to note that ADHS follows specific guidelines related to suppressing numbers less than six to protect confidentiality of rare cases and to eliminate bias or room for error in reporting numbers or rates. For this reason, the analyses below primarily report on Pregnancy-Associated deaths (all deaths reviewed). All analyses were also conducted for Pregnancy-Related deaths, and where possible, results for Pregnancy-Related deaths are included when reported numbers are larger than six. It is also important to note that recommendations from maternal mortality reviews are not suppressed, and therefore, recommendations from all cases, including those associated with suppressed findings in this section, are included in **Section 4**.

### MM by Pregnancy Relatedness

There were 134 deaths between January 1, 2016 and December 31, 2017 that were identified as Pregnancy-Associated deaths, or deaths in Arizona of women ages 15-49 with a pregnancy within the previous 365 days, regardless of the outcome of the pregnancy or the woman's residency in Arizona. The Arizona MMRC reviewed these 134 Pregnancy-Associated deaths in order to make determinations about the deaths' relatedness of pregnancy, the preventability of the death, and identify contributing factors and circumstances of the death.

Of the 134 Pregnancy-Associated deaths reviewed, the MMRC determined that 23.1% (n = 31) were Pregnancy-Related deaths, or “a death during pregnancy or within one year of the end 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” (definition from the [Review to Action guidelines](#)), as seen in **Figure 8**. The majority of reviewed deaths (70.9%, n = 95) were determined to be Pregnancy-Associated but not related to pregnancy, or “deaths during pregnancy or within one year of the end of pregnancy from a cause that is not related to pregnancy”.<sup>70</sup> The remaining 6% (n = 8) were deaths where the MMRC was unable to determine the relatedness of pregnancy to the death.

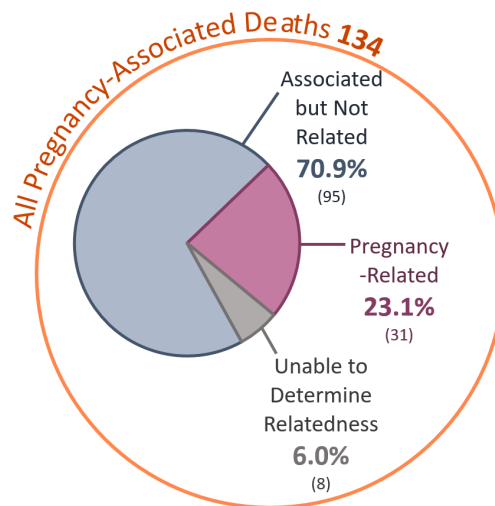
Following the determination of the relatedness of deaths to pregnancy, Mortality Ratios could be calculated using the number of Pregnancy-Associated deaths (all reviewed deaths regardless of relatedness to pregnancy) or the number of Pregnancy-Related deaths (the subset of reviewed deaths determined to be related to pregnancy). The 2016-2017 Pregnancy-Associated Mortality Ratio was 79.1 deaths per 100,000 live births in Arizona to women ages 15-49. The Pregnancy-Related Mortality Ratio was 18.3 deaths per 100,000 live births in Arizona to women ages 15-49. Both Mortality Ratios can be seen in **Figure 9**.

### MM by Preventability and Timing

During the MMRC review process, a death is considered preventable “if the committee determines that there was at least some chance of the death being averted by one or more reasonable changes to patient, family, provider, facility, system and/or community factors”.<sup>71</sup> If a death is determined to be preventable, the MMRC then also assesses the extent to which the outcome of the death could be altered.

Among all reviewed Pregnancy-Associated deaths, the MMRC determined that 83.6% were preventable. Of those preventable Pregnancy-Associated deaths, 55.4% were determined to have had a “Good Chance” to alter outcome while an additional 36.6% had “Some Chance” to alter outcome, as seen in **Figure 10**. The remaining preventable Pregnancy-Associated deaths were either “Unable to Determine”

**Figure 8.** Pregnancy-Relatedness among 2016-2017 Arizona MMRC Reviewed Deaths in Arizona of Women 15-49 Years Old with a Pregnancy in the Previous 365 Days



**Figure 9.** Pregnancy-Associated and Pregnancy-Related Mortality Ratios Deaths in Arizona of Women 15-49 Years Old with a Pregnancy in the Previous 365 Days, 2016-2017

**Mortality Ratio** (deaths per 100,000 births)

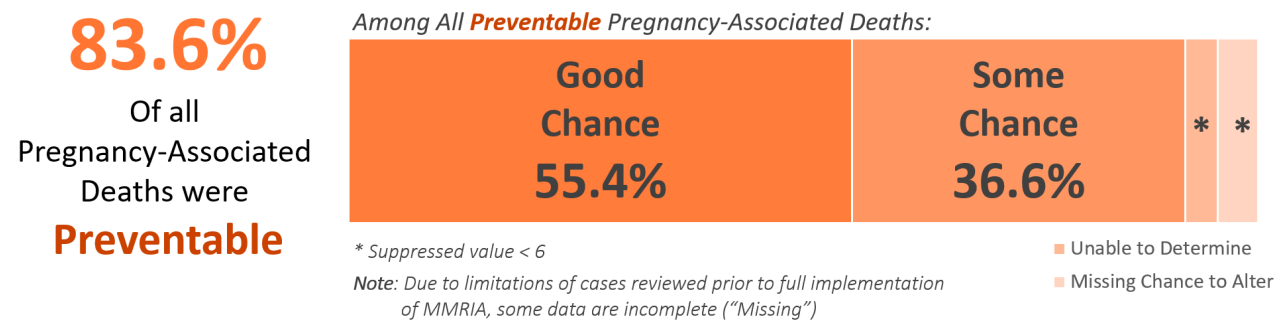
Pregnancy-Associated Mortality Ratio	<b>79.1</b>
Pregnancy-Related Mortality Ratio	<b>18.3</b>

the chance to alter outcome or had no option selected for this metric, although both of these categories had suppressible values less than 6.

**Figure 10.**

Preventability and Chance to Alter Outcome of Pregnancy-Associated Deaths

Among MMRC Reviewed Pregnancy-Associated Deaths in Arizona of Women 15-49 Years Old, 2016-2017 (n=134)

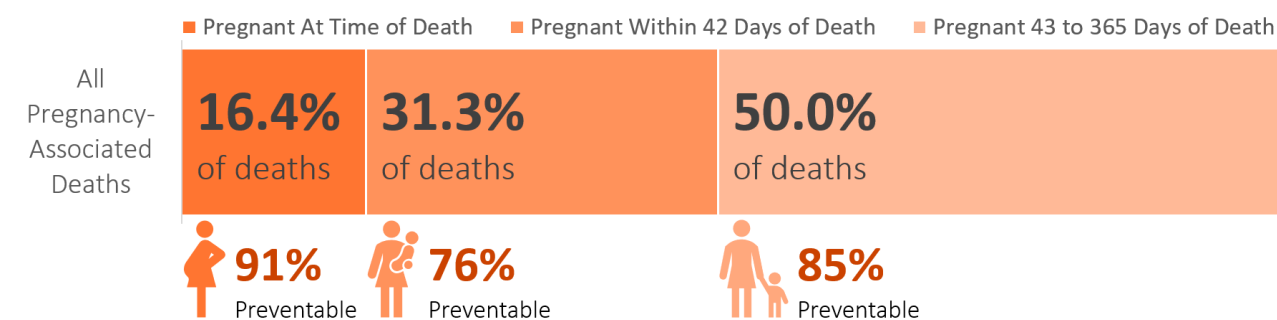


The timing of death in relation to the woman’s pregnancy among all Pregnancy-Associated deaths is captured in **Figure 11**. The majority of Pregnancy-Associated deaths (50.0%) occurred between 43 days to 365 days after the end of the woman’s pregnancy; of these 85%, were determined to be preventable. Nearly a third of Pregnancy-Associated deaths (31.3%) occurred following the end of pregnancy up to 42 days after, and 76% of deaths during this period were considered preventable. Nearly one in six Pregnancy-Associated deaths (16.4%) occurred while the woman was still pregnant; this period had the highest proportion of preventable deaths at 91%. The timing of the other 2.2% of deaths was unknown.

**Figure 11.**

Timing and Preventability of Pregnancy-Associated Deaths

Among MMRC Reviewed Pregnancy-Associated Deaths in Arizona of Women 15-49 Years Old, 2016-2017 (n=134)



Note: Due to limitations of cases reviewed prior to full implementation of MMRIA, some data are incomplete (2.2% of reviewed cases)

Among the 31 deaths that were Pregnancy-Related, 80.6% were determined to be preventable. Of these preventable Pregnancy-Related deaths, 60.0% were considered to have had a “Good Chance” to alter the outcome while the other 40.0% had “Some Chance” to alter the outcome (**Figure 12**). The majority of Pregnancy-Related deaths (64.5%) occurred within the first 42 days postpartum, of which 80% were determined to be preventable (not shown).



**Figure 12.**

### Preventability and Chance to Alter Outcome of Pregnancy-Related Deaths

Among MMRC Reviewed Pregnancy-Related Deaths in Arizona of Women 15-49 Years Old, 2016-2017 (n=31)



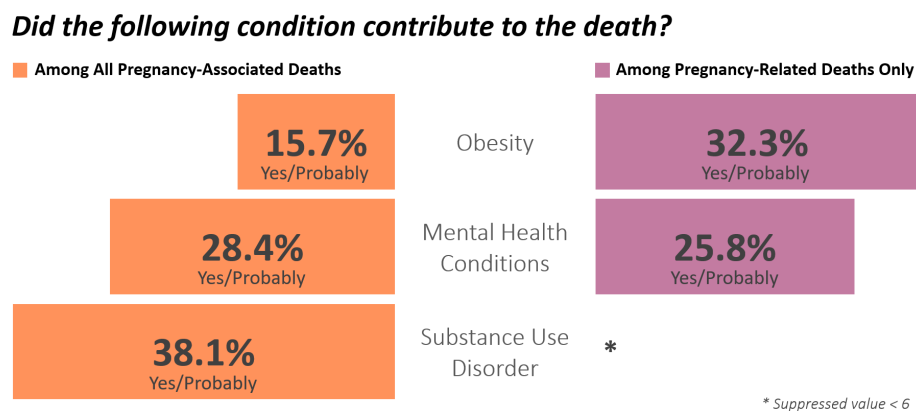
### MM by Manner and Conditions of the Death

Following the determination of both pregnancy-relatedness and preventability, the MMRC also determines if Obesity, Mental Health Conditions, or Substance Use Disorder contributed to the death. Among all Pregnancy-Associated deaths, Substance Use Disorder was identified as contributing to the death in 38.1% of cases, followed by Mental Health Conditions in 28.4% of cases and Obesity in 15.7% of cases (**Figure 13**). In Pregnancy-Related deaths, nearly a third (32.3%) were said to have had Obesity contribute to their death, and over a quarter (25.8%) were said to have had a contributing Mental Health Condition. The number of Pregnancy-Related deaths with a contributing Substance Use Disorder is suppressible with a value less than six.

**Figure 13.**

### Factors Contributing to Death

Among Pregnancy-Associated Deaths (n=134) and Pregnancy-Related Deaths (n=31) in Arizona, 2016-2017

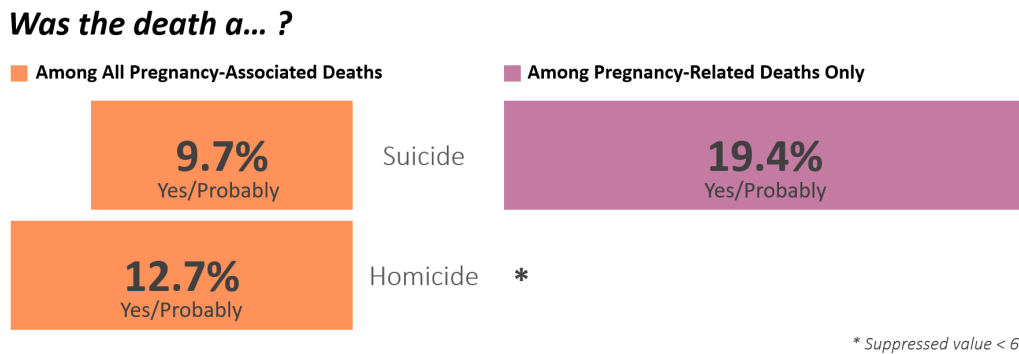


Regardless of the listed Manner of Death on the death certificate, the MMRC also determines whether the death was a suicide or homicide based on the information provided in the case narratives (**Figure 14**). Among all Pregnancy-Associated deaths, the MMRC identified 9.7% as a suicide or probable suicide, of which firearms were the means of fatal injury in 46.2% (not shown). The MMRC also identified 12.7% as being a homicide or probable homicide, of which firearms were the means of fatal injury in 70.6%, and 41.2% were perpetrated by a current or ex-partner (not shown). Among Pregnancy-Related deaths, the MMRC identified 19.4% as suicides or probable suicides. The number of Pregnancy-Related deaths

identified as being or probably being a homicide is suppressible with a value less than six, as were Pregnancy-Related suicides stratified by means of injury.

**Figure 14.**

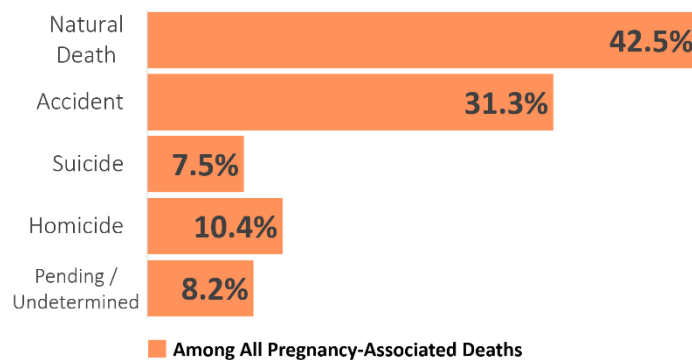
Suicide and Homicide among All Reviewed Pregnancy-Associated and Pregnancy-Related Deaths Among Pregnancy-Associated Deaths (n=134) and Pregnancy-Related Deaths (n=31) in Arizona, 2016-2017



In order to characterize the types of deaths that are reviewed through this process, **Figure 15** lists the distribution of all reviewed Pregnancy-Associated deaths by manner of death, as listed on the death certificates. The largest proportions of reviewed cases are natural deaths (42.5%), which is a death

**Figure 15.**

Manner of Death, per the Death Certificate Among MMRC Reviewed Pregnancy-Associated Deaths in Arizona of Women 15-49 Years Old, 2016-2017 (n=134)



occurring in the course of nature and from natural causes (as age or disease); followed by accidents (31.1%), which can include a variety of unintentional injuries such as motor vehicle accidents and unintended drug overdoses. Less common are intentional injuries such as suicide (7.5%) and homicide (10.4%); in some cases, a death identified by the MMRC as a suicide or homicide (**Figure 14 above**) may be listed as another manner of death on the death certificate in **Figure 15**. Among Pregnancy-Related deaths, 74.2% were natural deaths and 19.4% were suicides (not shown).

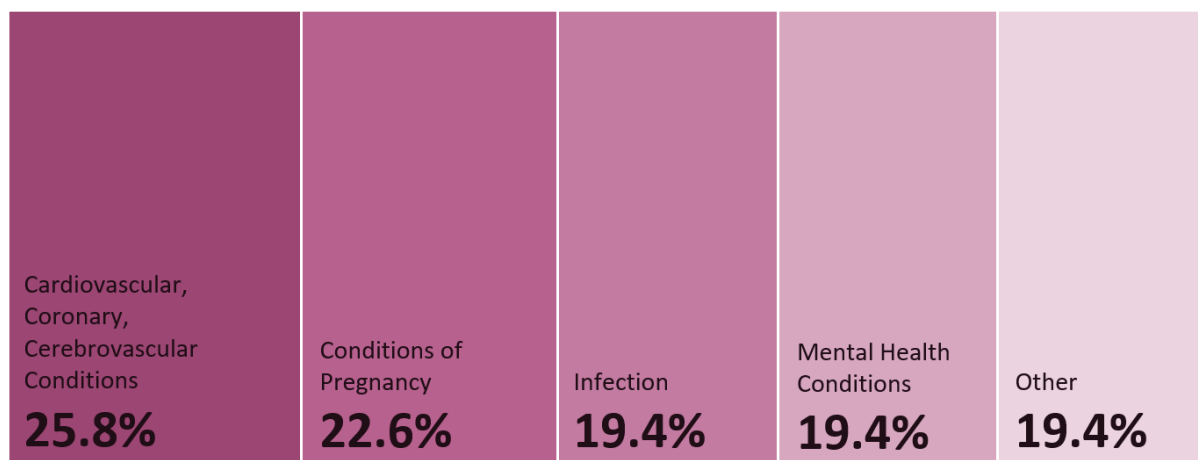
## MM by Underlying Cause of Death

For Pregnancy-Related deaths, the MMRC assigned an underlying cause of death, or the disease or injury that initiated the chain of events leading to death or the circumstances of the accident or violence which produced the fatal injury. As seen in **Figure 16** the most common underlying causes among Pregnancy-Related deaths were cardiovascular, coronary, or cerebrovascular conditions (25.8%), followed by conditions of pregnancy (22.6%), which includes amniotic fluid embolism, preeclampsia, and eclampsia. Infection and mental health conditions each accounted for 19.4% of Pregnancy-Related deaths. The other 19.4% of Pregnancy-Related deaths had underlying causes that included metabolic, endocrine, autoimmune, liver, gastrointestinal, pulmonary, and neurological conditions.

**Figure 16.**

### Underlying Cause of Death among Pregnancy-Related Deaths

Among MMRC Reviewed Pregnancy-Related Deaths in Arizona of Women 15-49 Years Old, 2016-2017 (n=31)



Note: Total will be more than 100% as 2 cases had multiple underlying cause codes

Conditions of Pregnancy includes amniotic fluid embolism, preeclampsia, and eclampsia.

Other includes metabolic, endocrine, autoimmune, liver, gastrointestinal, pulmonary, and neurological conditions.

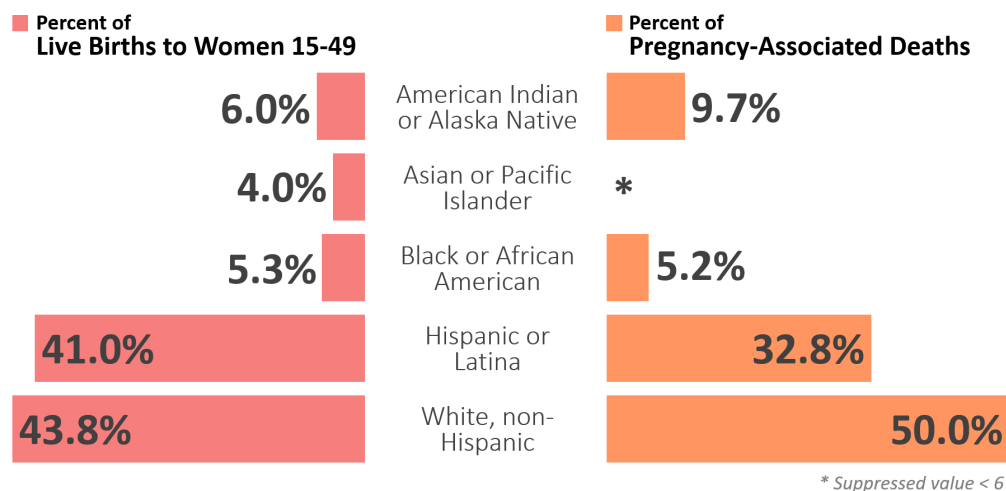
## MM by Maternal Race and Ethnicity

The distribution of Pregnancy-Associated deaths by the woman's race and ethnicity can be seen in **Figure 17**. A comparison distribution of all live births in Arizona to women ages 15-49 by race and ethnicity is also included as a way to highlight potential over- or underrepresentation of certain groups among these reviewed deaths, although no assessment of statistical significance has been done for these distributions.

**Figure 17.**

### Live Births and Pregnancy-Associated Deaths by Race and Ethnicity

Among Live Births in Arizona to Women 15-49 Years Old and MMRC Reviewed Pregnancy-Associated Deaths in Arizona of Women 15-49 Years Old, 2016-2017 (n=134)



\* Suppressed value < 6

Half of the reviewed Pregnancy-Associated deaths (50.0%) were of White, non-Hispanic women, who made up 43.8% of live births to women 15-49 in Arizona in 2016-2017. Hispanic or Latina women accounted for 32.8% of MMRC-reviewed deaths and 43.8% of live births, while American Indian or Alaska Native women accounted for 9.7% of Pregnancy-Associated deaths and only 6.0% of live births. Black or African American women represented nearly identical proportions in both groups, with 5.2% of Pregnancy-Associated deaths and 5.3% of live births. Lastly, while Asian or Pacific Islander women had 4.0% of live births in 2016-2017, they had a suppressible number of Pregnancy-Associated deaths.

Pregnancy-Associated and Pregnancy-Related Mortality Ratios by race and ethnicity are included in **Figure 18**, as are the percent of both Pregnancy-Associated and Pregnancy-Related deaths that were determined to be preventable. American Indian Alaska Native women had the highest Pregnancy-Associated Mortality Ratio (PAMR) at 128.3 deaths per 100,000 live births; it should be noted that this ratio is based on fewer than 20 deaths and should be interpreted with caution. This is over 40% higher than the next highest PAMR for White, non-Hispanic women at 90.3. Black or African American women had a PAMR of 77.5 (interpret with caution, fewer than 20 cases), and Hispanic or Latina women had a PAMR of 63.4. American Indian or Alaska Native women also had the highest percent considered preventable at 100.0%, followed by 85.7% among Black or African American women, 85.1% among White, non-Hispanic women, and 77.3% among Hispanic or Latina women.

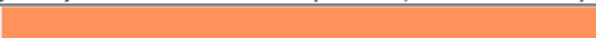



Nearly a quarter of White, non-Hispanic deaths were Pregnancy-Related (23.9%, not shown) and had a PRMR of 21.6 (**Figure 18**). Hispanic or Latina women had a PRMR of 14.4, with 22.7% of deaths Pregnancy-Related (not shown). Among White, non-Hispanic Pregnancy-Related deaths 93.8% were preventable, and 60.0% of Hispanic or Latina Pregnancy-Related deaths were preventable. There were fewer than 6 Pregnancy-Related deaths for American Indian or Alaska Native women, Asian or Pacific Islander women, and Black or African American women, and thus these PRMR and proportion of preventability are suppressed.

**Figure 18.**





Mortality Ratios and Preventability of Deaths by Race and Ethnicity

Among Pregnancy-Associated Deaths (n=134) and Pregnancy-Related Deaths (n=31) in Arizona, 2016-2017



**Pregnancy-Associated Mortality Ratio (Pregnancy-Associated Deaths per 100,000 live births)**

American Indian or Alaska Native	128.3†	
Asian or Pacific Islander	**	
Black or African American	77.5†	
Hispanic or Latina	63.4	
White, non-Hispanic	90.3	



**% Preventable of all Pregnancy-Associated Deaths**

American Indian or Alaska Native	100.0%†	
Asian or Pacific Islander	**	
Black or African American	85.7%†	
Hispanic or Latina	77.3%	
White, non-Hispanic	85.1%	

**Pregnancy-Related Mortality Ratio (Pregnancy-Related deaths per 100,000 live births)**

American Indian or Alaska Native	**	
Asian or Pacific Islander	**	
Black or African American	**	
Hispanic or Latina	14.4†	
White, non-Hispanic	21.6†	

**% Preventable of Pregnancy-Related Deaths**

American Indian or Alaska Native	**	
Asian or Pacific Islander	**	
Black or African American	**	
Hispanic or Latina	60.0%†	
White, non-Hispanic	93.8%†	

\*\* suppressed rate based on value < 6; † rate based on value < 20, interpret with caution

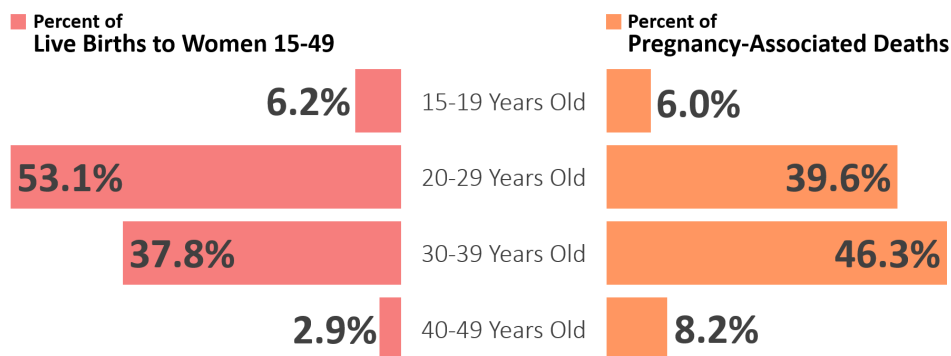
## MM by Maternal Age

A distribution of Pregnancy-Associated deaths and live births by the woman's age at death can be seen in **Figure 19**. Women 15-19 years old represented similar proportions of both live births (6.2%) and Pregnancy-Associated deaths (6.0%). While 53.1% of live births were to women 20-29 years old, only 39.6% of Pregnancy-Associated deaths were to this age group. Conversely, women 30-39 had 37.8% of live births but 46.3% of Pregnancy-Associated deaths, and women 40-49 had only 2.9% of live births but 8.2% of Pregnancy-Associated deaths. Again, no statistical analysis was done to measure significance across these distributions.

**Figure 19.**

**Live Births and Pregnancy-Associated Deaths by Age**

Among Live Births in Arizona to Women 15-49 Years Old and MMRC Reviewed Pregnancy-Associated Deaths in Arizona of Women 15-49 Years Old, 2016-2017 (n=134)

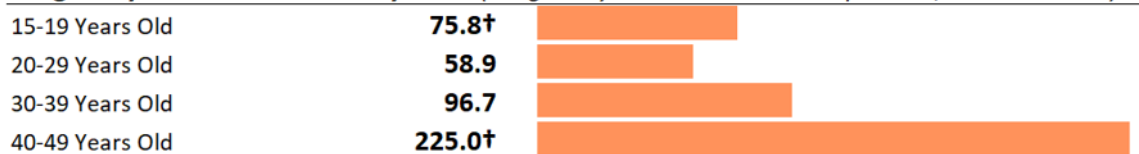


**Figure 20.**

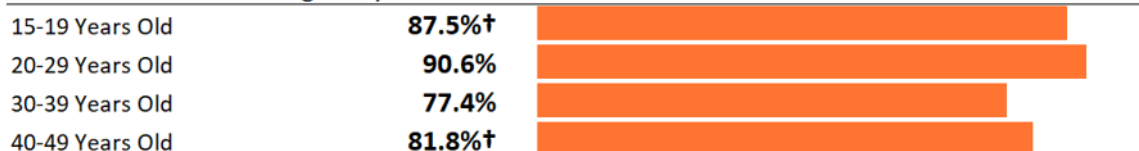
**Mortality Ratios and Preventability of Deaths by Age**

Among Pregnancy-Associated Deaths (n=134) and Pregnancy-Related Deaths (n=31) in Arizona, 2016-2017

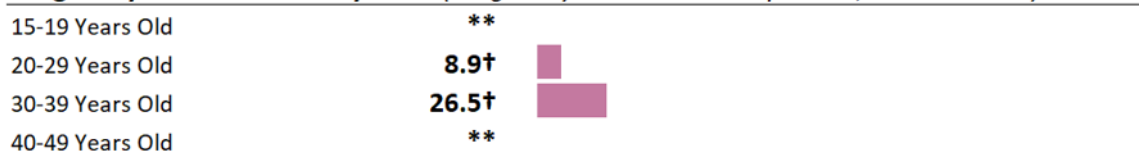
**Pregnancy-Associated Mortality Ratio (Pregnancy-Associated Deaths per 100,000 live births)**



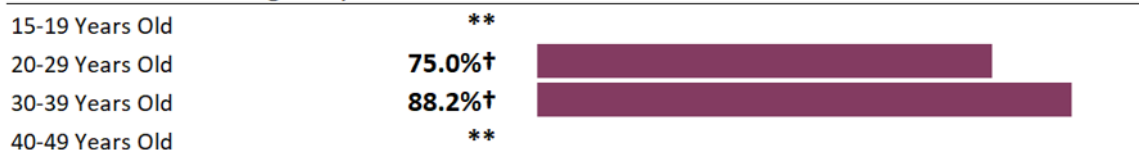
**% Preventable of all Pregnancy-Associated Deaths**



**Pregnancy-Related Mortality Ratio (Pregnancy-Related deaths per 100,000 live births)**



**% Preventable of Pregnancy-Related Deaths**



\*\* suppressed rate based on value < 6; † rate based on value < 20, interpret with caution

The Pregnancy-Associated and Pregnancy-Related Mortality Ratios for each age group can be seen in **Figure 20**, along with the percent of preventable Pregnancy-Associated and Pregnancy-Related deaths.



Women 40-49 years old had the highest Pregnancy-Associated Mortality Ratio (PAMR) at 225.0 Pregnancy-Associated deaths per 100,000 live births, although this ratio is based on fewer than 20 cases and should be interpreted with caution. Women 30-39 years old were second highest with a PAMR of 96.7. Women in their teens (15-19 years old) had a PAMR of 75.8 (fewer than 20 cases, interpret with caution), with the lowest PAMR (58.9) among women 20-29 years old. The highest proportion of preventable Pregnancy-Associated deaths was among women 20-29 years at 90.6%, followed by women 15-19 years old (87.5%), women 40-49 years old (81.8%), and finally women 30-39 years old (77.4%).

Women 30-39 years old had a Pregnancy-Related Mortality Ratio (PRMR) of 26.5, although this is based on fewer than 20 cases and should be interpreted with caution; 27.4% of deaths to women 30-39 years old were Pregnancy-Related (not shown) and 88.2% of these deaths were considered preventable. Women 20-29 years old had a PRMR of 8.9, and 15.1% of Pregnancy-Associated deaths of women 20-29 years old were Pregnancy-Related (not shown); 75.0% of these deaths to 20-29 years old were considered preventable. Pregnancy-Related deaths to women 15-19 years old and 40-49 years old were suppressible with fewer than 6 cases.

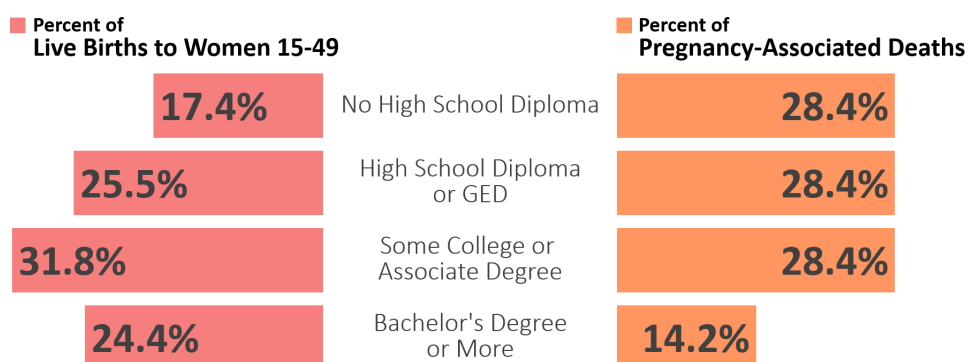
### MM by Maternal Education

The distribution of Pregnancy-Associated deaths and live births by the woman’s education level can be seen in **Figure 21**. Women with a high school diploma or GED represented similar proportions of both live births (25.5%) and Pregnancy-Associated deaths (28.4%), as did women with some college education without a degree and women with an Associate degree (31.8% of live births and 28.4% of Pregnancy-Associated deaths). Women with a Bachelor’s degree or more education made up a much smaller percent of Pregnancy-Associated deaths than live births (14.2% and 24.4%, respectively), while women with no high school diploma or GED made up a larger percent of Pregnancy-Associated deaths than live births (28.4% and 17.4%, respectively).

**Figure 21.**

Live Births and Pregnancy-Associated Deaths by Education

*Among Live Births in Arizona to Women 15-49 Years Old and MMRC Reviewed Pregnancy-Associated Deaths in Arizona of Women 15-49 Years Old, 2016-2017 (n=134)*



The Pregnancy-Associated and Pregnancy-Related Mortality Ratios for each group by education level can be seen in **Figure 22**, along with the percent of preventable deaths for each group. Women without a high school diploma or GED had the highest Pregnancy-Associated Mortality Ratio (PAMR) at 129.2





Pregnancy-Associated deaths per 100,000 live births. As education level increased, the PAMR decreased: women with a high school diploma or GED had a PAMR of 87.9, women with some college without a degree or with an Associate degree had a PAMR of 70.5, and women with a Bachelor’s degree or more had a PAMR of 46.0 (although this ratio is based on fewer than 20 cases and should be interpreted with caution). The proportion of Pregnancy-Associated deaths that were determined to be preventable ranged from 73.7% among women with some college or an Associate degree to 89.5% among both groups of women with up to a high school diploma or GED.

**Figure 22.**





Mortality Ratios and Preventability of Deaths by Education

Among Pregnancy-Associated Deaths (n=134) and Pregnancy-Related Deaths (n=31) in Arizona, 2016-2017





**Pregnancy-Associated Mortality Ratio (Pregnancy-Associated Deaths per 100,000 live births)**

No High School Diploma	<b>129.2</b>	
High School Diploma or GED	<b>87.9</b>	
Some College or Associate Degree	<b>70.5</b>	
Bachelor's Degree or More	<b>46.0†</b>	




**% Preventable of all Pregnancy-Associated Deaths**

No High School Diploma	<b>89.5%</b>	
High School Diploma or GED	<b>89.5%</b>	
Some College or Associate Degree	<b>73.7%</b>	
Bachelor's Degree or More	<b>78.9%†</b>	

**Pregnancy-Related Mortality Ratio (Pregnancy-Related deaths per 100,000 live births)**

No High School Diploma	<b>23.8†</b>	
High School Diploma or GED	<b>16.2†</b>	
Some College or Associate Degree	<b>13.0†</b>	
Bachelor's Degree or More	<b>24.2†</b>	

**% Preventable of Pregnancy-Related Deaths**

No High School Diploma	<b>**</b>	
High School Diploma or GED	<b>85.7%†</b>	
Some College or Associate Degree	<b>100.0%†</b>	
Bachelor's Degree or More	<b>80.0%†</b>	

\*\* suppressed rate based on value < 6; † rate based on value < 20, interpret with caution

Women with some college education or an Associate degree had the lowest Pregnancy-Related Mortality Ratio (PRMR) at 13.0 deaths per 100,000 live births (of which 100.0% were considered preventable), increasing to 16.2 among women with a high school diploma or GED (85.7% preventable), 23.8 among women with no high school diploma (percent preventable suppressed), and 24.2 among women with a Bachelor’s degree or more (80.0% preventable). All PRMR and preventability among Pregnancy-Related deaths are based on fewer than 20 cases and should be interpreted with caution. It is also useful to note that the distribution and ratios of deaths by maternal education level, like those for race and ethnicity or maternal age, are not adjusted for any possible confounding factors as no

statistical analysis was performed; as a result, the differences observed by maternal education may be also be capturing differences by maternal age, as women with more advanced degrees tend to be older than those with some college or less.

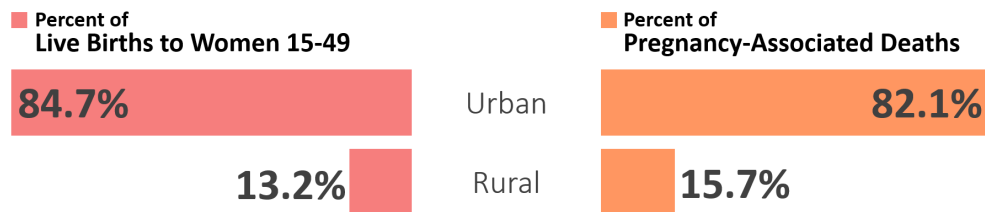
### MM by Maternal Residence

Reviewed deaths were also stratified by whether the woman resided in an urban or rural county, based on definitions by the [Bureau of Public Health Statistics](#). The distribution of live births and Pregnancy-Associated deaths by county type are fairly similar, as shown in **Figure 23**. Women living in urban counties (Maricopa, Pima, Pinal, and Yuma) made up 84.7% of live births to women 15-49 and 82.1% of Pregnancy-Associated deaths. Women living in rural counties (Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Mohave, Navajo, Santa Cruz, and Yavapai) had 13.2% of live births to women 15-49 and 15.7% of Pregnancy-Associated Deaths.

**Figure 23.**

Live Births and Pregnancy-Associated Deaths by County Type of Residence

*Among Live Births in Arizona to Women 15-49 Years Old and MMRC Reviewed Pregnancy-Associated Deaths in Arizona of Women 15-49 Years Old, 2016-2017 (n=134)*



*Rural counties are Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Mohave, Navajo, Santa Cruz, and Yavapai; Urban counties are Maricopa, Pima, Pinal, and Yuma; Based on definitions used by the [ADHS Bureau of Public Health Statistics](#).*

The PAMR and PRMR by county type of the woman’s residence is included in **Figure 24**. Women who lived in a rural county had a higher PAMR than women who lived in an urban county (PAMR 94.0 versus 76.6, respectively). Each county type had similar proportions of preventable Pregnancy-Associated deaths, with 81.0% of rural Pregnancy-Associated deaths and 83.6% of urban Pregnancy-Associated deaths deemed preventable.

**Figure 24.**

Mortality Ratios and Preventability of Deaths by County Type of Residence

Among Pregnancy-Associated Deaths (n=134) and Pregnancy-Related Deaths (n=31) in Arizona, 2016-2017

<b>Pregnancy-Associated Mortality Ratio (Pregnancy-Associated Deaths per 100,000 live births)</b>	
Rural	94.0
Urban	76.6
<b>% Preventable of all Pregnancy-Associated Deaths</b>	
Rural	81.0%†
Urban	83.6%
<b>Pregnancy-Related Mortality Ratio (Pregnancy-related deaths per 100,000 live births)</b>	
Rural	**
Urban	20.2
<b>% Preventable of Pregnancy-Related Deaths</b>	
Rural	**
Urban	82.8%

*Rural counties are Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Mohave, Navajo, Santa Cruz, and Yavapai  
Urban counties are Maricopa, Pima, Pinal, and Yuma*

*Based on definitions used by the ADHS Bureau of Public Health Statistics.*

*\*\* suppressed rate based on value < 6; † rate based on value < 20, interpret with caution*

Over a quarter of Pregnancy-Associated deaths of women living in urban counties were Pregnancy-Related (26.4%), with a Pregnancy-Related Mortality Ratio of 20.2; 82.8% of Pregnancy-Related deaths to women in urban counties were preventable. There were fewer than 6 Pregnancy-Related deaths to women in rural counties, and thus both the PRMR and proportion preventable are suppressed.

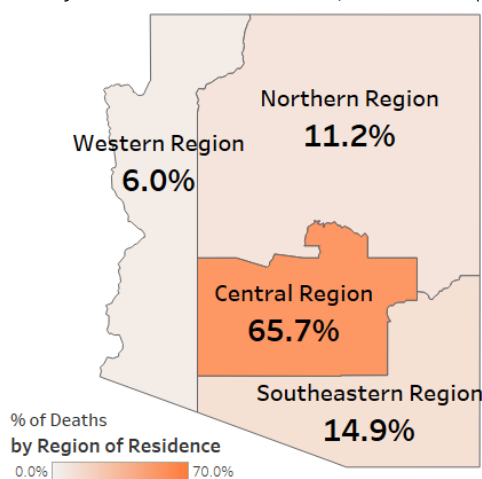
Figures 25-26 shows the distribution of all reviewed Pregnancy-Associated deaths by the region of each woman's last residence and where each death occurred. These regions are based on the boundaries used by the [ADHS Bureau of Emergency Medical Services and Trauma System](#). Similarly, Figure 27 shows the distribution of all reviewed Pregnancy-Associated deaths by region where the injury occurred for those deaths that resulted from accidents, suicides, or homicides, including motor vehicle accidents, drug overdoses, assaults, and other causes. As a comparison, Figure 28 shows the distribution of live births by region of residence to women ages 15-49 during the same time period (2016-2017).

For women living in the Central Region, there was a lower proportion of deaths based on residence (65.7%), where the death occurred (67.2%), and where the injury occurred (54.7%), compared to the proportion of live births to women living in the region (70.2%). Conversely, the Northern region had a higher proportion of deaths based on residence (11.2%), where the death occurred (10.4%), and where the injury occurred (15.6%), compared to the proportion of live births in that region (7.1%). While the proportion of live births and deaths by residence in the Western region were the same (6.0%), there was a lower proportion of deaths by where the death occurred (5.2%) and a higher proportion of deaths by where the injury occurred (10.9%). Lastly, the proportion of deaths by where the death occurred (17.2%) and where the injury occurred (18.8%) were both higher than the proportion of live births in the Southeastern region (16.8%), but the proportion of deaths by residence was lower in this region (14.9%).

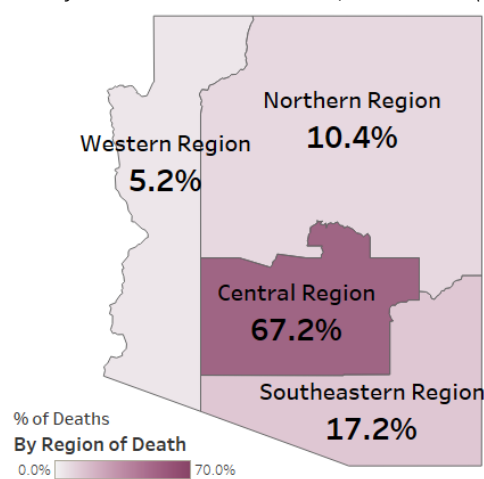
Overall this indicates that deaths may have disproportionately affected women living in the Northern region, although no statistical analysis was conducted to test this relationship. Similarly, deaths

disproportionately occurred in the Northern and Southeastern regions, and injuries resulting in death disproportionately occurred in the Northern, Southeastern, and Western regions. It is interesting to note that due to the availability of trauma centers and other high-risk medical care in the Central region, there could have been a higher proportion of deaths occurring in that region as a result of transfers from across the state compared to live births, which are limited to women living in the region rather than where the birth occurred; however, along with deaths by residence and where fatal injuries occurred, the Central region also had disproportionately fewer deaths by where the death occurred than live births by residence.

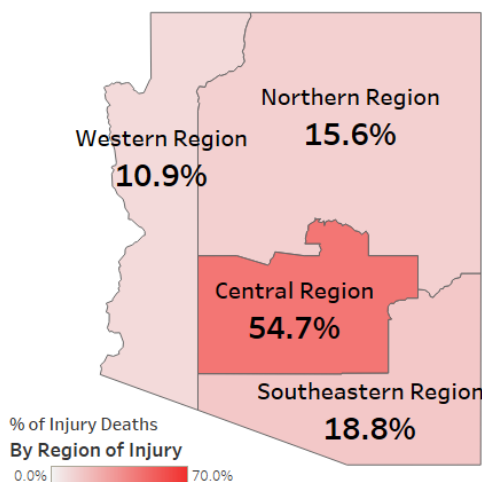
**Figure 25.**  
Deaths by Region of Residence  
Among All Pregnancy-Associated Deaths in  
Arizona of Women 15-49 Years Old, 2016-2017 (n=131)



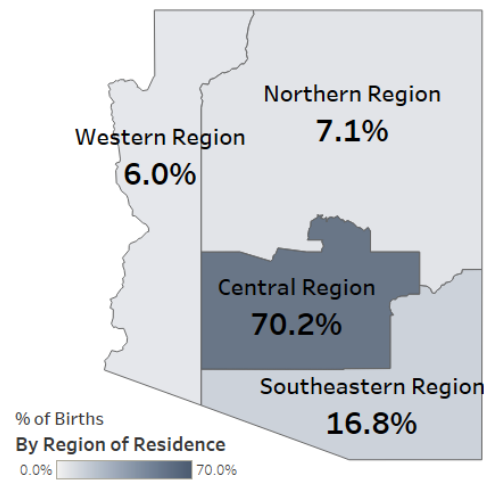
**Figure 26.**  
Deaths by Region of Death  
Among All Pregnancy-Associated Deaths in  
Arizona of Women 15-49 Years Old, 2016-2017 (n=134)



**Figure 27.**  
Deaths by Region of Injury  
Among Injury Pregnancy-Associated Deaths in  
Arizona of Women 15-49 Years Old, 2016-2017 (n=64)



**Figure 28.**  
Live Births by Region of Residence  
Among Live Births in Arizona to Women 15-49 Years  
Old, 2016-2017 (n=165,902)



## MM by Contributing Factor

As part of the maternal mortality reviews, the MMRC identifies factors that may have contributed to each death, along with recommendations to prevent similar deaths in the future. Page 2 of the MMRIA Committee Decisions Form (**Appendix E**) includes a list of 28 Contributing Factors that the MMRC can identify for each case. Upon additional analyses, each of the following Factors contributed to over half of all reviewed deaths between 2016-2017:

- ▮▮ **Continuity of Care:** Care providers did not have access to women’s complete records or did not communicate women’s status sufficiently. Lack of continuity can be between prenatal, labor and delivery, and postpartum providers.
- ▮▮ **Communication:** Care was fragmented (i.e. uncoordinated or not comprehensive) among or between healthcare facilities or units, (e.g. records not available between inpatient and outpatient or among units within the hospital, such as Emergency Department and Labor and Delivery).
- ▮▮ **Assessment:** The factors placing the woman at risk for a poor clinical outcome were not recognized, and/or the woman was not transferred/transported to a provider able to give a higher level of care.
- ▮▮ **Clinical Skill/Quality:** Personnel were not appropriately skilled for the situation or did not exercise clinical judgment consistent with current standards of care (e.g. error in the preparation or administration of medication or unavailability of translation services).

These top four Contributing Factors were the same for Pregnancy-Related and Pregnancy-Associated deaths and are central themes to the recommendations developed by the MMRC which are located in **Section 4**.



## Section 3: Severe Maternal Morbidity, 2016-2019

As indicated in **Section 1**, SMM is a critical measure used in understanding the causes and gaps leading to, but not always resulting in, pregnancy-related maternal deaths. There are long-standing implications of SMM on women and families, including extended hospital stays, major surgery, mental and physical distress, adverse outcomes for the fetus or infant, and sometimes death.<sup>72 73 74 75</sup> Because SMM is more prevalent than MM, these analyses offer a better understanding of how maternal health is impacted by various risk factors and demographics. To this end, studying SMM in Arizona is critical to identifying key areas for intervention and prevention of these conditions in the future.

As a central component of Arizona's initiatives to improve maternal health outcomes in the state, ADHS has embarked on a new effort to improve surveillance of SMM to inform quality improvement efforts to implement maternal safety protocols during labor and delivery as well as other prevention efforts for Arizona's women before, during, and after pregnancy.<sup>76</sup> Beginning in 2019, ADHS conducted a study to identify and review events of SMM utilizing the Hospital Discharge Database (HDD) and birth certificate data, based on an enhanced version of an algorithm developed by the American College of Gynecologists and Obstetrician's (ACOG) Alliance for Innovation in Maternal Health Initiative (AIM) and used by the New York City's Department of Health and Mental Hygiene.<sup>77 78</sup>

### Methodology for Analyzing Severe Maternal Morbidity

#### Data Sources

SMM analysis stems from two main data sources:

- ▮▮ **Hospital Discharge Data:** Hospital discharge data is a valuable source of information about the patterns of care, public health, and the burden of chronic disease and injury morbidity. ADHS collects hospital discharge records for inpatient and emergency department visits from all Arizona licensed hospitals, excluding Indian Health Service facilities. This collection is required by Arizona Revised Statute (A.R.S.) § 36125-05, and Arizona Administrative Code Title 9, Chapter 11, Articles 4 and 5. This data is released every 6 months.
- ▮▮ **Birth Certificate Data:** Information on live births is compiled from the original documents filed with the Arizona Department of Health Services' Office of Vital Records and from transcripts of original birth and death certificates filed in other states but affecting Arizona residents (does not include live births outside of the U.S.). It is made available annually following the completion of the previous calendar year.

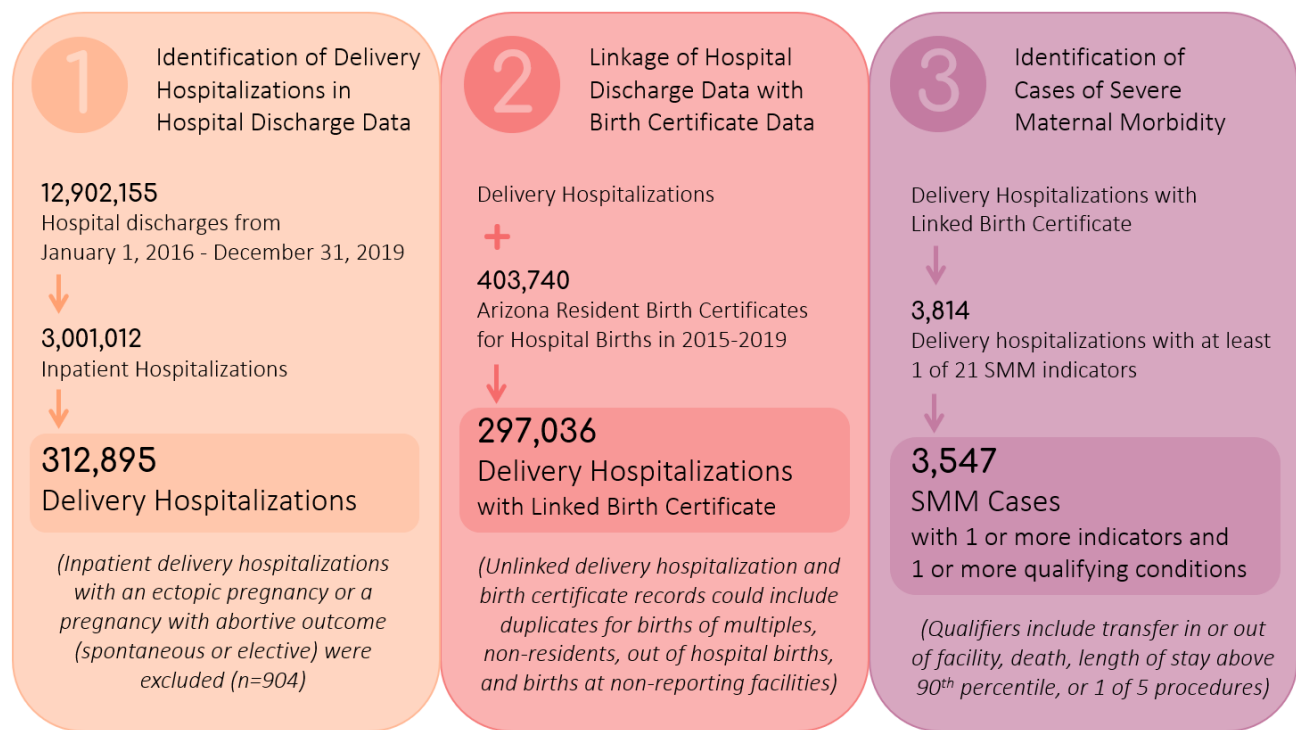
#### SMM Case Identification Procedure

All hospital records for inpatient hospitalizations with a discharge date between January 1, 2016, and December 31, 2019 (n=3,001,012) were analyzed to identify in-state delivery hospitalizations (n=312,895). Inpatient delivery hospitalizations with an ectopic pregnancy or a pregnancy with abortive outcome (spontaneous or elective) were excluded (n=904). The remaining hospital discharge records were then linked

to birth certificate data using a combination of the mother’s first, last, and prior last names, date of birth, and social security number. There were 82,927 birth certificates for Arizona resident hospital live births in 2016, 80,229 in 2017, 79,078 in 2018, and 77,788 in 2019; birth certificates for 2015 were included for delivery hospitalizations with discharges in early 2016. More information about birth certificate data and other vital statistics can be found in the [Arizona Health Status and Vital Statistics Annual Reports](#). The final number of linked birth certificate and delivery hospitalizations for Arizona residents in an Arizona facility that reports to the Arizona Hospital Discharge Database at the time of analysis was 297,036 (95.8% for inpatient delivery hospitalizations to Arizona residents). **Figure 29** depicts the process of identifying delivery hospitalizations and their linkage to birth certificate data.

**Figure 29.**

Identification Protocol for Delivery Hospitalizations and Linkage of the HDD and Birth Certificate Datasets



SMM events were identified among delivery hospitalizations using an algorithm developed by the Centers for Disease Control and Prevention and adopted by the AIM initiative.<sup>79</sup> This algorithm identifies 21 indicators of SMM that represent either serious complications of pregnancy or delivery such as cardiac arrests and acute renal failure or procedures used to manage serious conditions, such as blood transfusions and hysterectomies. All indicators were identified using ICD-10CM diagnosis and procedure codes. Due to the late 2015 to early 2016 transition from ICD-9CM to ICD-10CM diagnoses and procedure codes, the interpretation of 2016 rates and counts should be cautionary. The diagnosis and procedure-based indicators can be found in **Figure 30** and the definitions and ICD-10CM codes used to identify SMM events can be found in **Appendix G**.

**Figure 30.**

Diagnosis and Procedure-Based Indicators Used to Identify SMM Events

Diagnosis SMM Indicators	Procedure SMM Indicators
<ul style="list-style-type: none"><li>• Acute Myocardial Infarction</li><li>• Acute Renal Failure</li><li>• Adult Respiratory Distress Syndrome</li><li>• Amniotic Fluid Embolism</li><li>• Aneurysm</li><li>• Cardiac Arrest</li><li>• Disseminated Intravascular Coagulation</li><li>• Eclampsia</li><li>• Heart Failure</li><li>• Puerperal Cerebrovascular Disorders</li><li>• Pulmonary Edema</li><li>• Sepsis</li><li>• Severe Anesthesia Complications</li><li>• Shock</li><li>• Sickle Cell Anemia with Crisis</li><li>• Thrombotic Embolism</li></ul>	<ul style="list-style-type: none"><li>• Blood Transfusion</li><li>• Conversion of Cardiac Rhythm</li><li>• Hysterectomy</li><li>• Temporary Tracheostomy</li><li>• Ventilation</li></ul>

Out of all these delivery hospitalizations in Arizona, 3,814 had at least one indicator for Severe Maternal Morbidity (SMM). For inclusion in the final sample, events with an indicator of SMM must also have at least one qualifying factor: length of hospital stay in the 90th percentile or higher by the method of delivery (3 or more days for vaginal deliveries, four or more days for repeat cesarean deliveries, and five or more days for primary cesarean); the mother was transferred before or after delivery to a different facility; the mother died during the delivery hospitalization, or at least one of the five procedure indicators was present. This was adapted from the methods published in the New York City Department of Health and Mental Hygiene’s most recent report of SMM and the HRSA National Outcome Measure of SMM. There were 3,547 qualifying SMM events included in the final analysis.

## Definitions for Common Terminology in Severe Maternal Morbidity

The following are definitions for common terminology found in this section on severe maternal morbidity in Arizona. Additional definitions can be found in the glossary located in **Appendix B**.

- **Severe Maternal Morbidity (SMM):** Unexpected conditions or outcomes of pregnancy, delivery, or postpartum that aggravate or lead to significant negative effects on a woman's health and wellbeing.
- **Resident:** Arizona residency was determined by the county of residence as listed on the birth certificate at the time of delivery. This is not an indication of citizenship or legal residence in Arizona.
- **SMM Events:** Includes women with a delivery hospitalization and a diagnosis or a procedure code indicator for SMM, as well as a qualifying condition indicating severity, including transfer in or out of the birth facility, death, length of stay longer than expected, or one of the procedure codes.
- **Indicator of SMM:** A list of 21 diagnoses or procedures considered an indication of SMM during the delivery hospitalization, identified by a set of ICD-10 billing codes in the Hospital Discharge Data (HDD) record. See Appendix B for a complete list and definition of these indicators.
- **Qualifying Condition of SMM:** At least one of five conditions that must be met for the inclusion of an SMM case in this study – transfer into or out of the delivery hospitalization, death during the delivery hospitalization, one of the five SMM procedure indicators, or a length of stay of 4 or more days for vaginal or primary cesarean deliveries, or 5 or more days for repeat cesarean deliveries.
- **SMM Rate:** Number of delivery hospitalizations with an indication of an SMM diagnosis or procedure codes along with a qualifying condition over the total number of delivery hospitalizations calculated per 10,000 delivery hospitalizations.
- **Arizona Perinatal Trust Levels of Care:** Based on the Arizona Perinatal Trust Voluntary Certification Program (VCP) which is a peer review/quality assurance process to reduce morbidity and mortality and improve the care of patients. A full description of each level of care can be found in **Appendix G**.
- **Primary Care Areas:** A Primary Care Area (PCA) denotes the geographic area generally served by a common primary health provider. For example, it is used by the Health Resources and Services Administration to designate areas of workforce shortage.
- **Singleton Birth:** The live birth of only one child during a single delivery.
- **Term Deliveries:** Live births occurring between 37-41 weeks gestation (37w0d – 41w6d).

## Findings for Severe Maternal Morbidity in Arizona, 2016-2019

### Demographics of Delivery Hospitalizations and SMM Events

**Figure 31** shows the distribution of resident delivery hospitalizations during 2016-2019 with a linked hospital discharge and birth certificate used in this analysis. Additional information on delivery characteristics can be found in **Appendix F**.

**Figure 31**

Inpatient Delivery Hospitalizations of Arizona Residents, 2016-2019 (*n*=297,036)

Year	# of Deliveries	% of Deliveries	# of SMM Events	% of SMM Events
2016	77,644	26.1%	995	28.1%
2017	73,341	24.7%	840	23.7%
2018	73,618	24.8%	809	22.8%
2019	72,433	24.4%	903	25.5%
<b>Maternal Race and Ethnicity</b>				
American Indian or Alaska Native	11,518	3.9%	349	9.8%
Asian or Pacific Islander	12,319	4.1%	163	4.6%
Black or African American	17,641	5.9%	289	8.1%
Hispanic or Latina	124,144	41.8%	1,651	46.5%
White, non-Hispanic	131,414	44.2%	1,095	30.9%
<b>Rural vs Urban County of Residence*</b>				
Rural	33,355	11.2%	519	14.6%
Urban	263,681	88.8%	3,028	85.4%
<b>Maternal Age</b>				
19 Years and Younger	17,732	6.0%	282	8.0%
20-29 Years	157,815	53.1%	1,713	48.3%
30-39 Years	113,244	38.1%	1,389	39.2%
40 Years and Older	8,245	2.8%	163	4.6%
<b>Parity</b>				
No Previous Live Birth	107,930	36.3%	1,446	40.8%
1 Previous Live Birth	89,500	30.1%	800	22.6%
2 Previous Live Births	53,380	18.0%	522	14.7%
3 Previous Live Births	26,106	8.8%	368	10.4%
4 or More Previous Live Births	19,971	6.7%	406	11.4%
<b>Primary Payer of Birth</b>				
Private Insurance	125,997	42.4%	1,143	32.2%
AHCCCS	152,932	51.5%	2,114	59.6%
IHS	2,505	0.8%	85	2.4%
Self-pay	7,907	2.7%	96	2.7%
Other Government**	3,301	1.1%	35	1.0%
Other / Unknown**	4,394	1.5%	74	2.1%
<b>Method of Delivery</b>				
Primary Cesarean	45,792	15.4%	1,298	36.6%
Repeat Cesarean	35,475	11.9%	723	20.4%
Vaginal Birth After Cesarean (VBAC)	7,233	2.4%	84	2.4%
Vaginal Delivery	208,536	70.2%	1,442	40.7%

\* Rural counties are Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Mohave, Navajo, Santa Cruz, and Yavapai; Urban counties are Maricopa, Pima, Pinal, and Yuma.; Based on definitions used by the ADHS Bureau of Public Health Statistics.

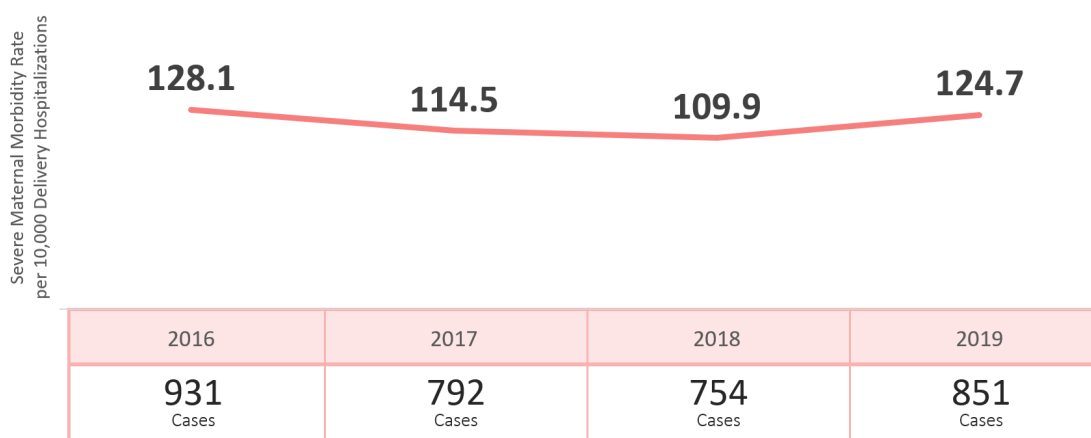
\*\* Other government payers include Department of Defense TRICARE, the Children's Health Insurance Program (CHIP), and the Veteran's Health Administration (VHA). Other/Unknown includes those with unlisted or missing payer information.

## Overall Rate of Severe Maternal Morbidity

Based on the SMM case identification protocol described earlier, Arizona’s 2016-2019 overall SMM rate was 119.4 per 10,000 delivery hospitalizations, with annual rates of SMM ranging from 109.9 to 128.1 (**Figure 32**).

**Figure 32.**

Rate and Number of Events of Severe Maternal Morbidity by Year  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



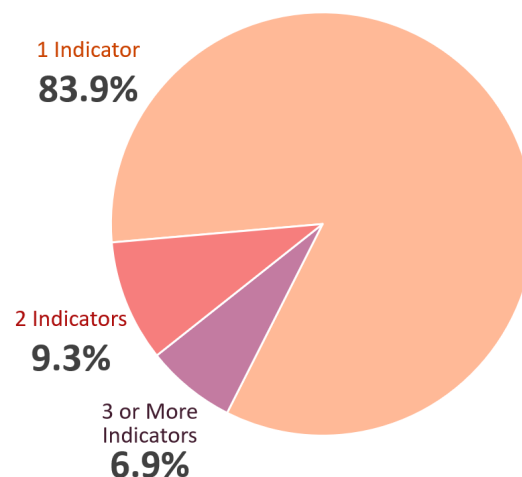
## Indicators of Severe Maternal Morbidity

The majority of SMM events (83.9%) had one indicator out of a total of 21 indicators; 9.3% of events had two indicators and a smaller proportion of events (6.9%) had three or more indicators. **Figure 33** shows the distribution of the number of SMM indicators per case.

Most of the SMM events (76.4%) had at least one of the 5 procedure indicators, with 65.5% having procedure indicators only and 10.9% having both procedure and diagnosis indicators (**Figure 34**). This is driven largely by transfusions, which were present in 67.6% of all SMM events (**Figure 35**). Meanwhile, 34.5% of SMM events had one of the 16 diagnosis indicators, with 23.6% having diagnosis indicators only.

**Figure 33.**

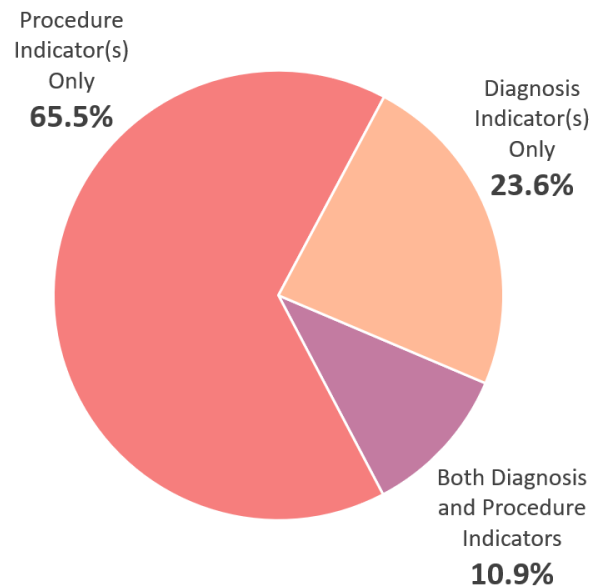
Distribution of Indicators Among Events of Severe Maternal Morbidities  
Among Arizona Resident Delivery Hospitalizations, 2016-2019





The most common SMM diagnosis indicators were adult respiratory distress syndrome (299, 8.4%), acute renal failure (272, 7.7%), and sepsis (270, 7.6%). The most common SMM procedure indicators were blood transfusion (2397, 67.6%), hysterectomy (275, 7.8%), and ventilation (161, 4.5%). The frequency of SMM indicators among the identified SMM events is depicted in **Figure 35**. An SMM case can have more than one indicator as described in **Figure 33**. See **Appendix G** for a complete list of and definition of SMM indicators.

**Figure 34.**  
Type of Indicators Among  
Events of Severe Maternal Morbidities  
Among Arizona Resident Delivery Hospitalizations,  
2016-2019



**Figure 35.**  
Indicators Among Severe Maternal Morbidities  
Among Arizona Resident Delivery Hospitalizations,  
2016-2019

Diagnoses Indicator	Count	Percent
Adult Respiratory Distress Syndrome	299	8.4
Acute Renal Failure	272	7.7
Sepsis	270	7.6
Disseminated Intravascular Coagulation (DIC)	231	6.5
Acute Heart Failure / Pulmonary Edema	211	6.0
Shock	199	5.6
Eclampsia	64	1.8
Puerperal Cerebrovascular Disorder	59	1.7
Air and Thrombotic Embolism	36	1.0
Cardiac Arrest / Ventricular Fibrillation	25	0.7
Amniotic Fluid Embolism	19	0.5
Sickle Cell Disease with Crisis	17	0.5
Acute Myocardial Infarction	8	0.2
Aneurysm	8	0.2
Severe Anesthesia Complications	*	
Heart Failure / Arrest during Procedure or Surgery	*	

Procedure Indicator	Count	Percent
Transfusion	2397	67.6
Hysterectomy	275	7.8
Ventilation	161	4.5
Conversion of Cardiac Rhythm	26	0.7
Temporary Tracheostomy	*	

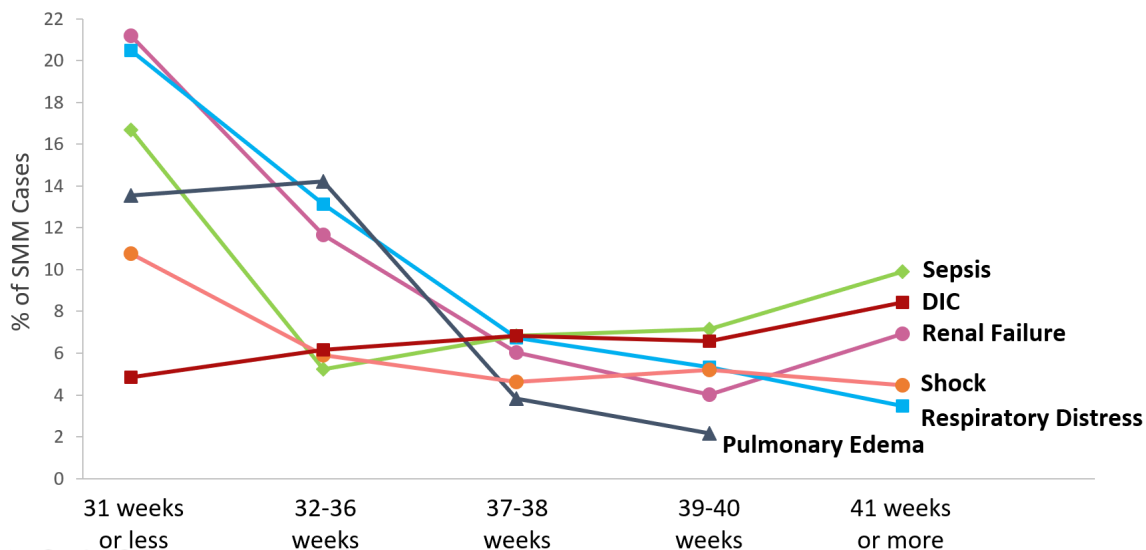
\* Suppressed value < 6

While the six most common diagnosis indicators were the same across gestational age, the proportion of SMM events with these indicators, as well as the relative ranking among these indicators, varied by gestational age (**Figure 36**). Almost all of these indicators were most prevalent among SMM events in early preterm deliveries (before 37 weeks gestation). Some, like renal failure and sepsis, were lowest between 37-40 weeks gestation, with higher proportions among both preterm and late or post-term SMM events, while a higher proportion of SMM events had DIC at later gestational ages. Among procedure indicators, hysterectomy and ventilation were most prevalent among SMM events delivered at earlier gestational ages, but transfusion was highest among SMM events in deliveries at later gestational ages (**Figure 37**).

**Figure 36.**

Top Diagnosis Indicators of Severe Maternal Morbidity by Gestational Age

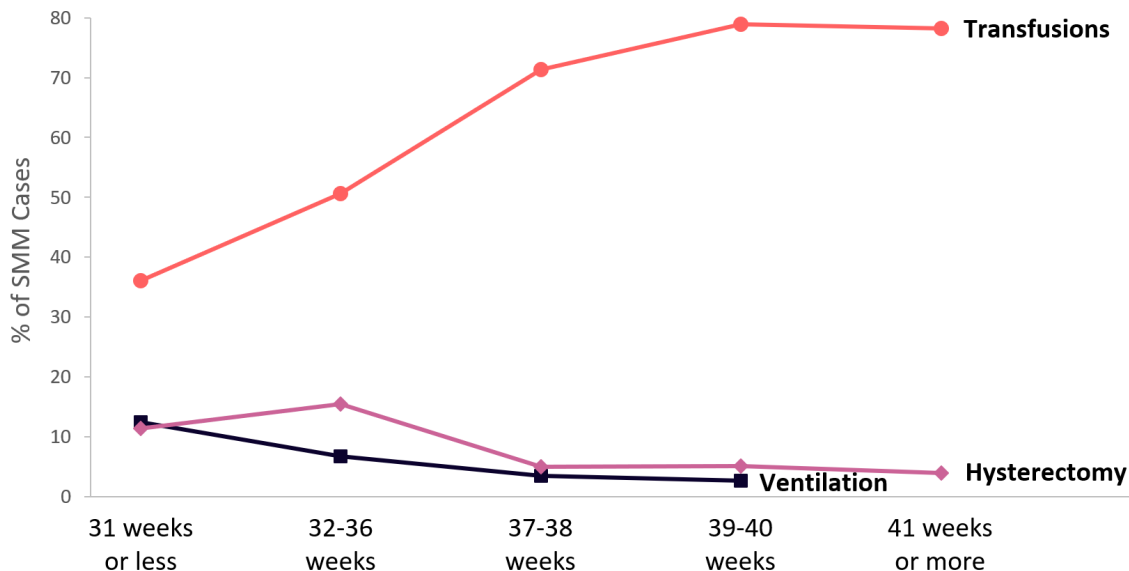
Among Arizona Resident Delivery Hospitalizations, 2016-2019



**Figure 37.**

Top Procedure Indicators of Severe Maternal Morbidity by Gestational Age

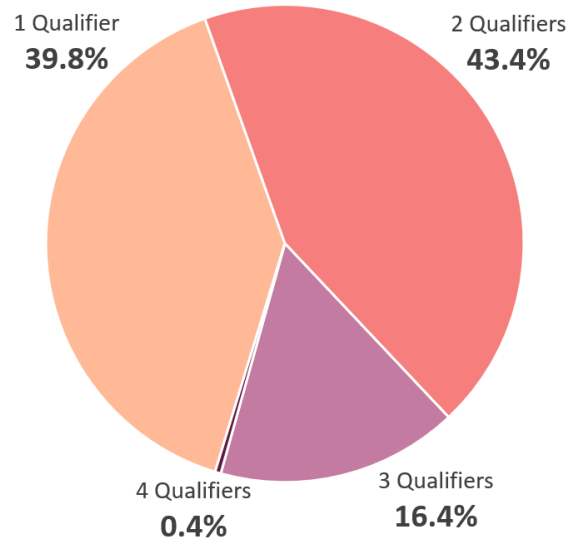
Among Arizona Resident Delivery Hospitalizations, 2016-2019



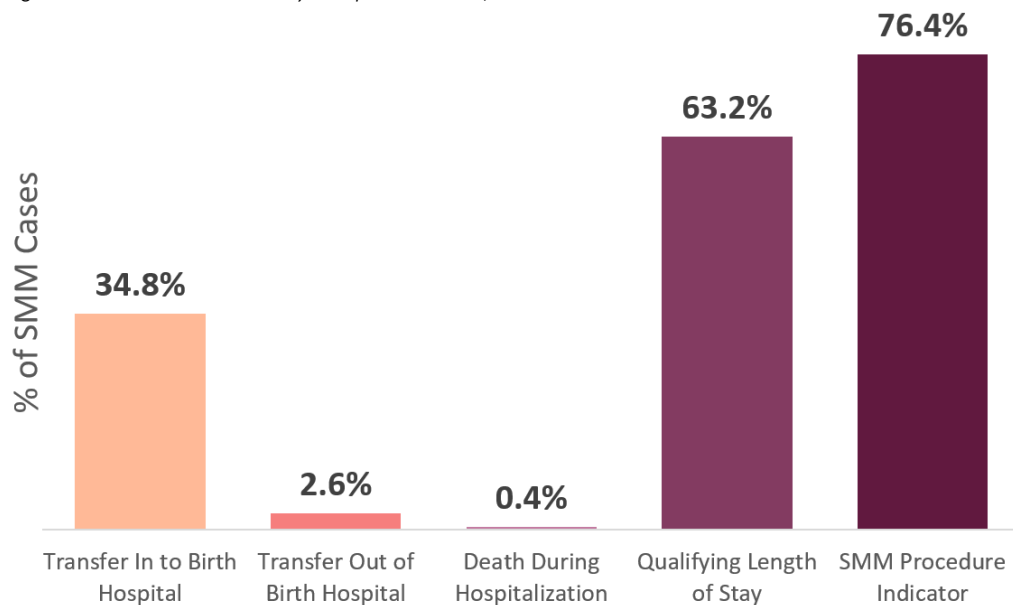
In addition to the presence of an SMM indicator, SMM events must also have met at least one qualifying condition for inclusion in this analysis. Over a third of SMM events had only one of the qualifying conditions (39.8%), as seen in **Figure 38**, while 43.4% of SMM events met two qualifying conditions, 16.4% had three qualifiers, and 0.4% had four qualifiers.

The most common qualifier was the presence of a procedure indicator (76.4% of SMM events, **Figure 39**), predominantly due to transfusions. Events with a qualifying length of stay (LOS) made up 63.2% of SMM events; qualifying events for LOS were in or above the 90<sup>th</sup> percentiles by method of delivery (five or more days for primary cesarean, four or more days for repeat cesarean, and three or more days for vaginal deliveries). Just over a third of SMM events were transferred into the delivery hospital (34.8%). Transfer from the delivery hospital and death during hospitalization were much less common, with 2.6% and 0.4% (or 4 per 1,000) SMM events, respectively. These qualifiers are not mutually exclusive, and as shown in **Figure 38**, some events had more than 1.

**Figure 38.**  
Number of Qualifying Conditions per Severe Maternal Morbidity Case  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



**Figure 39.**  
Distribution of Qualifying Conditions among Events of Severe Maternal Morbidity  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



*Qualifying conditions are not mutually exclusive; each condition is shown as percent of all SMM cases regardless number or type of other qualifiers*

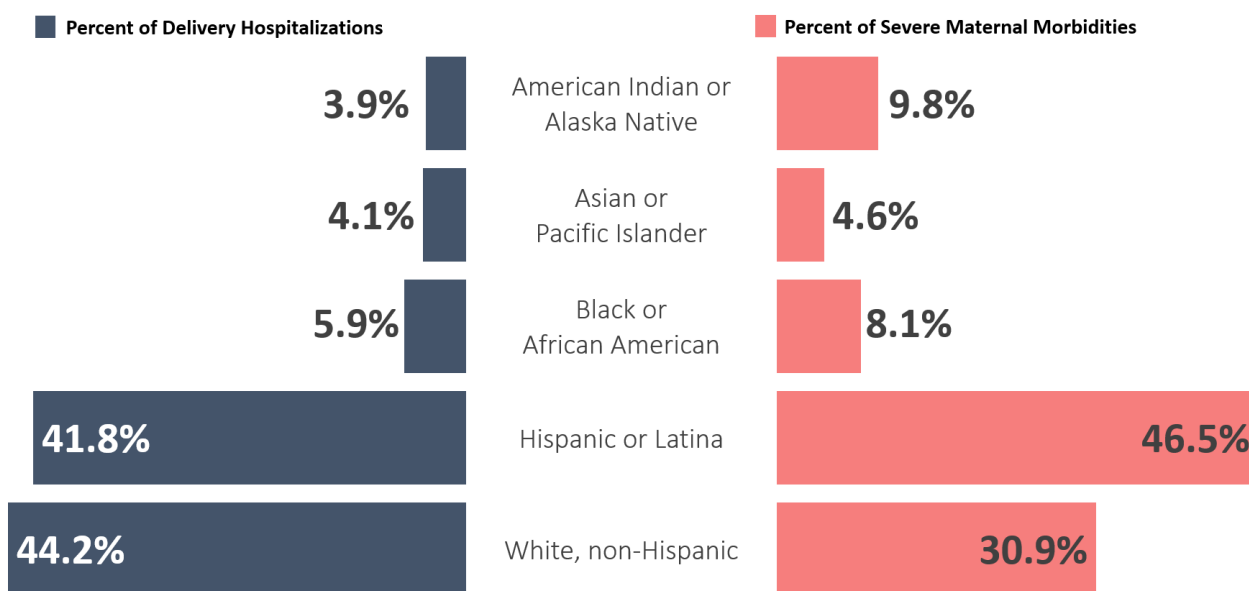
## SMM Rate by Maternal Race and Ethnicity

Severe maternal morbidity disproportionately affected women of color, as shown in **Figure 40**. Despite making up less than 4% of delivery hospitalizations, nearly 10% of SMM events were American Indian or Alaska Native women, and just over 8% of SMM events were Black or African American women, who had less than 6% of delivery hospitalizations. Similarly, 46.5% of SMM events were among Hispanic or Latina women, who represented roughly 42% of deliveries. Conversely, just under 31% of SMM events were among non-Hispanic White women, while non-Hispanic White women had 44% of deliveries.

**Figure 40.**

Delivery Hospitalizations and Severe Maternal Morbidities by Race and Ethnicity

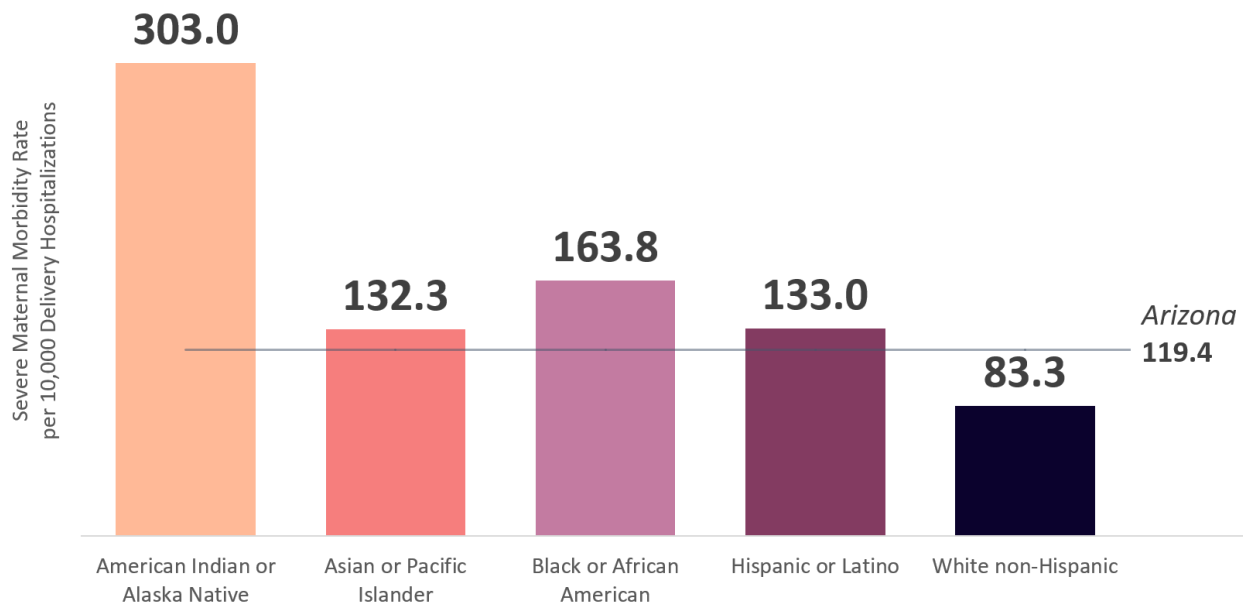
Among Arizona Resident Delivery Hospitalizations, 2016-2019



The SMM rate for American Indian or Alaska Native women was the highest at 303.0 SMM events per 10,000 delivery hospitalizations, or over 3.5 times the SMM rate for non-Hispanic White women (83.3). Black or African American women had an SMM rate of 163.8 (nearly 2 times the rate among non-Hispanic White women), followed by 133.0 among Hispanic or Latina women and 132.3 among Asian or Pacific Islander women (both over 1.5 times the rate among non-Hispanic White). A comparison of these SMM rates by maternal race and ethnicity can be seen in **Figure 41**.

**Figure 41.**

Rate of Severe Maternal Morbidity by Maternal Race and Ethnicity  
Among Arizona Resident Delivery Hospitalizations, 2016-2019

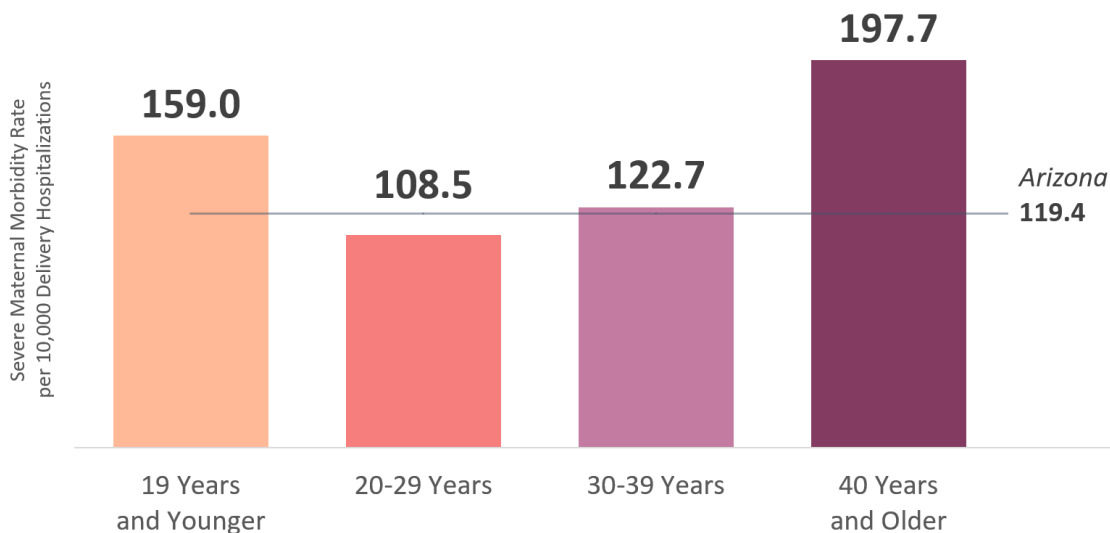


### SMM by Maternal Age

As can be seen in **Figure 42**, SMM was higher for women at the youngest and oldest ages. The highest rates of SMM were for women 40 and over (197.7) and women 19 and younger (159.0). Women between 20-29 years old (108.5) and 30-39 years old (122.7) had much lower rates.

**Figure 42.**

Rate of Severe Maternal Morbidity by Maternal Age  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



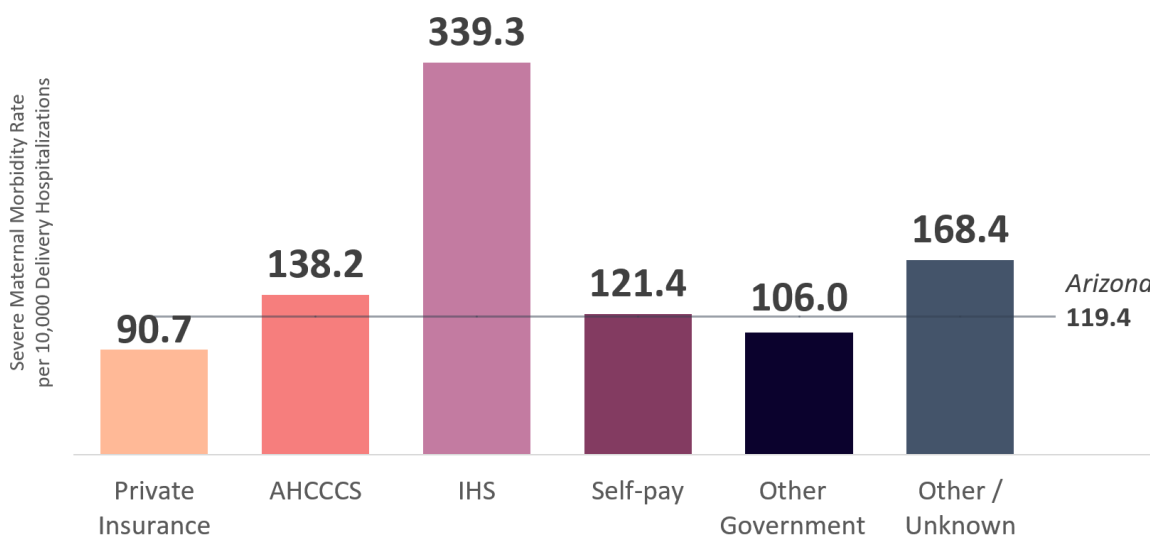
## SMM Rate by Other Socioeconomic and Demographic Indicators

The rate of SMM also varied by other socioeconomic and demographic variables, including primary payer type for delivery hospitalization, relative poverty to other areas, and income inequality of Primary Care Area (PCA) of maternal residence (see Glossary for definition), and highest level of maternal education.

Over 51% of delivery hospitalizations were paid primarily through Medicaid (the Arizona Health Care Cost Containment System (AHCCCS)), and had an SMM rate of 138.2 (**Figure 43**). Women with private insurance or who paid out of pocket for their deliveries had lower rates of SMM at 90.7 and 121.4, respectively. Despite representing a small portion of delivery hospitalizations (less than 1%), the SMM rate was highest among live births paid primary by the Indian Health Service (IHS) at 339.3 SMM events per 10,000 delivery hospitalizations. This data is based on the listed primary payer on the birth certificate, and no data was collected or used from IHS facilities.

**Figure 43.**

Rate of Severe Maternal Morbidity by Primary Payer Type  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



*Other Government payers include Department of Defense TRICARE, the Children's Health Insurance Program (CHIP), and the Veteran's Health Association (VHA). Other/Unknown includes those with unlisted or missing payer information.*

Three measures of socioeconomic status and other environmental factors were assessed by Primary Care Area (PCA) in order to see how relative poverty, insurance access, and income inequality might affect maternal health outcomes. The PCAs were ranked based on each of these measures and then grouped into quartiles; these include the percent of adults ages 18-64 years within the PCA who lived below 100% of the federal poverty level (FPL), percent of all women ages 19-64 years without health insurance (regardless of pregnancy status), and the Gini index of income inequality. These three measures are from the 2018 American Community Survey 5-year Estimates spanning 2014-2018, which is the most recent data available.

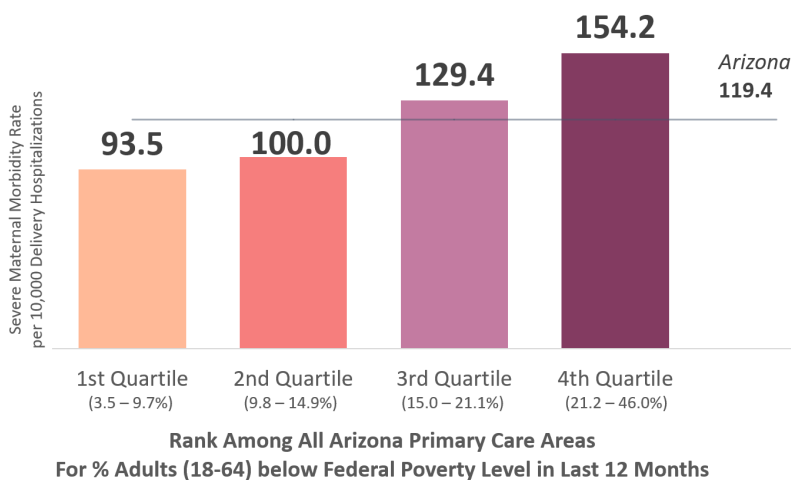
For adults below 100% FPL, the PCAs were divided so the 1<sup>st</sup> quartile of PCAs had 3.5-9.7% living below the FPL (most affluent), the 2<sup>nd</sup> quartile had 9.8-14.9% below the FPL, the 3<sup>rd</sup> quartile had 15.0-21.1% below the FPL,



**Figure 44.**

Rate of SMM by % Adults (18-64) in Primary Care Area Living Below Federal Poverty Level

Among Arizona Resident Delivery Hospitalizations, 2016-2019



Source: 2018 American Community Survey, 5-year Estimates (2014-2018)

and the 4<sup>th</sup> quartile had 21.2-46.0% below the FPL (highest proportion of adults below FPL). For reference, the overall proportion of adults below 100% FPL in the previous 12 months for Arizona during this time was 15.4%.

Women who lived in the quartile of PCAs with the highest proportion of adults living below the FPL had an SMM rate of 154.2, or 1.6 times the rate of women who lived in the most affluent quartile of PCAs (lowest proportion below the FPL), which was 93.5. As seen in **Figure 44**, rates of SMM increased as the relative poverty level increased. The distribution of poverty rates within each PCA and quartile is available in **Appendix F**.

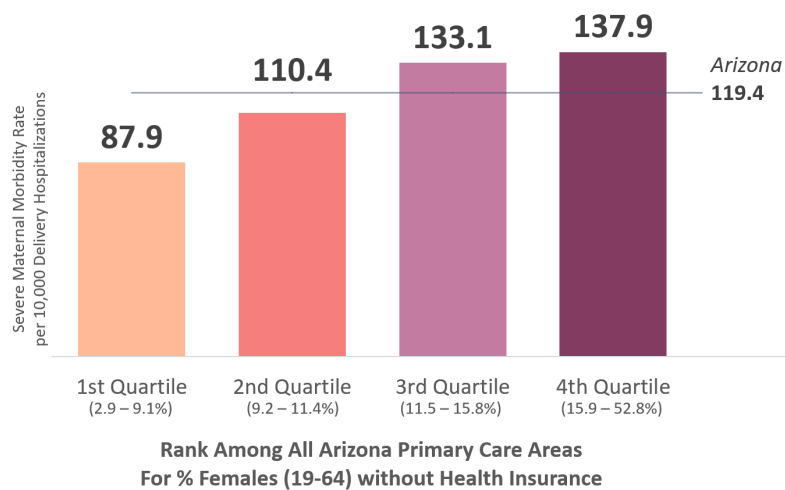
For women ages 19-64 without health insurance, in the 1<sup>st</sup> quartile 2.9-9.1% of women had no health insurance (least without insurance), in the 2<sup>nd</sup> quartile 9.2-11.4% of women had no health insurance, in the 3<sup>rd</sup> quartile 11.5-15.8% of women had no health insurance, and in the 4<sup>th</sup> quartile 15.9-52.8% of women had no health insurance (most without insurance). In Arizona overall, 13.1% of women ages 19-64 did not have health insurance.

Women who lived in the quartile of PCAs with the lowest levels of health insurance coverage (highest proportions of uninsured women) had the highest SMM rate of 137.9, or 1.6 times the rate of women living in the quartile of PCAs with the highest levels of health insurance coverage (87.9). As seen in **Figure 45**, rates of SMM increased along with the relative proportion of women without health insurance coverage. The proportion of women without health insurance for each PCA, as well as quartile distributions, are available in **Appendix F**.

**Figure 45.**

Rate of SMM by % Females (19-64) in Primary Care Area without Health Insurance

Among Arizona Resident Delivery Hospitalizations, 2016-2019

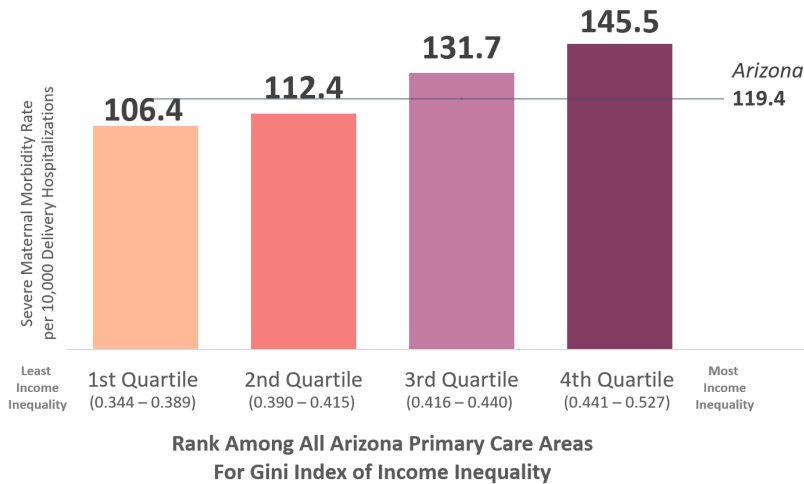


Source: 2018 American Community Survey, 5-year Estimates (2014-2018)

**Figure 46.**

Rate of Severe Maternal Morbidity by Gini Index of Income Inequality of Primary Care Area

Among Arizona Resident Delivery Hospitalizations, 2016-2019



Source: 2018 American Community Survey, 5-year Estimates (2014-2018)

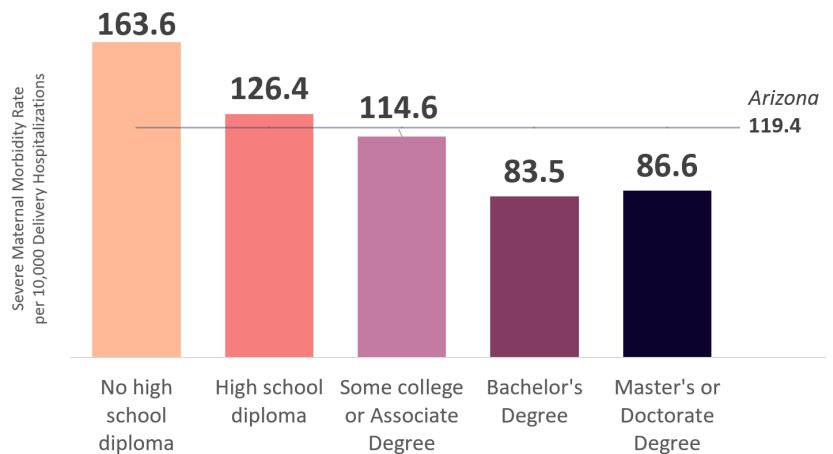
Gini indexes) had the highest rate of SMM at 145.5, 1.4 times the rate of women living in the quartile of PCAs with the least income inequality (lowest Gini indexes) whose SMM rate was 106.4. As relative income inequality increased (increases in Gini indexes), the SMM rate also increased in a nearly linear way, as seen in **Figure 46**. Individual Gini index scores for each PCA, along with quartile distribution, is available in **Appendix F**.

The rate of SMM decreased with increasing maternal education. Women who never received a high school diploma or GED had the highest SMM rate at 163.6, as seen in **Figure 47**. Women with a Bachelor's degree had the lowest SMM rates at 83.5 and women with a Master's or Doctorate degree had a similar SMM rate of 86.6. This indicates that maternal education might be preventative for SMM. Additionally, education often corresponds to other measures of socioeconomic status including income, geographic location, and access to care.

**Figure 47.**

Rate of Severe Maternal Morbidity by Highest Education Completed

Among Arizona Resident Delivery Hospitalizations, 2016-2019



The Gini Index indicates the relative level of income inequality that exists in a community or population, by comparing the observed distribution of income across a group to what a perfectly equal income distribution would be.<sup>80</sup> The PCAs were separated into quartiles based on their Gini index so that the 1<sup>st</sup> quartile had indexes ranging from 0.344-0.389 (closer to 0 or more equal), the 2<sup>nd</sup> quartile had indexes ranging from 0.390-0.415, the 3<sup>rd</sup> quartile had indexes ranging from 0.416-0.440, and the 4<sup>th</sup> quartile had indexes ranging from 0.441-0.527 (closer to 1 or more unequal). The Gini index for Arizona was 0.468.

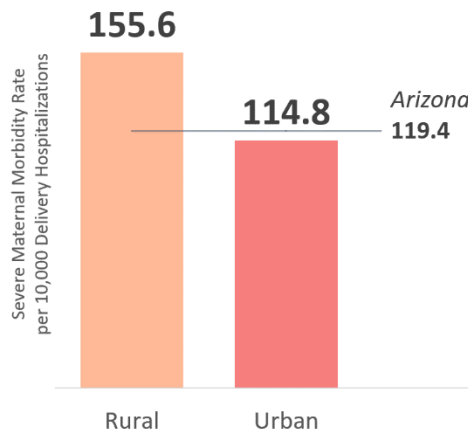
Women living in the quartile of PCAs with the most income inequity (highest

## SMM Distribution by Maternal Residence

The SMM rate by county of maternal residence at the time of delivery varied greatly, as shown by the map in **Figure 48**. Santa Cruz County and Maricopa County had the lowest rates of SMM in the state, with rates of 56.7 and 106.2, respectively, followed by Pinal County (108.8) and Yavapai County (108.8). The county with the highest rate of SMM was Apache County with a rate of 275.4, followed by Graham County (241.3), Navajo County (228.5), and Yuma County (184.1). It should be noted that for La Paz County and Santa Cruz County there were less than 20 SMM events for 2016-2019, and thus their rates should be interpreted with caution. Greenlee county had less than six events for 2016-2019 and thus the rate is suppressed.

Overall, the SMM rate was higher for women living in rural counties (as defined by the Bureau of Public Health Statistics: Apache, Coconino, Cochise, Gila, Graham, Greenlee, La Paz, Mohave, Navajo, Santa Cruz, and Yavapai) with a rate of 155.6, compared to women living in urban counties (Maricopa, Pima, Pinal, and Yuma) whose SMM rate was 114.8, shown in **Figure 49**.

**Figure 49.**  
Rate of Severe Maternal Morbidity by County Type of Residence  
Among Arizona Resident Delivery Hospitalizations, 2016-2019

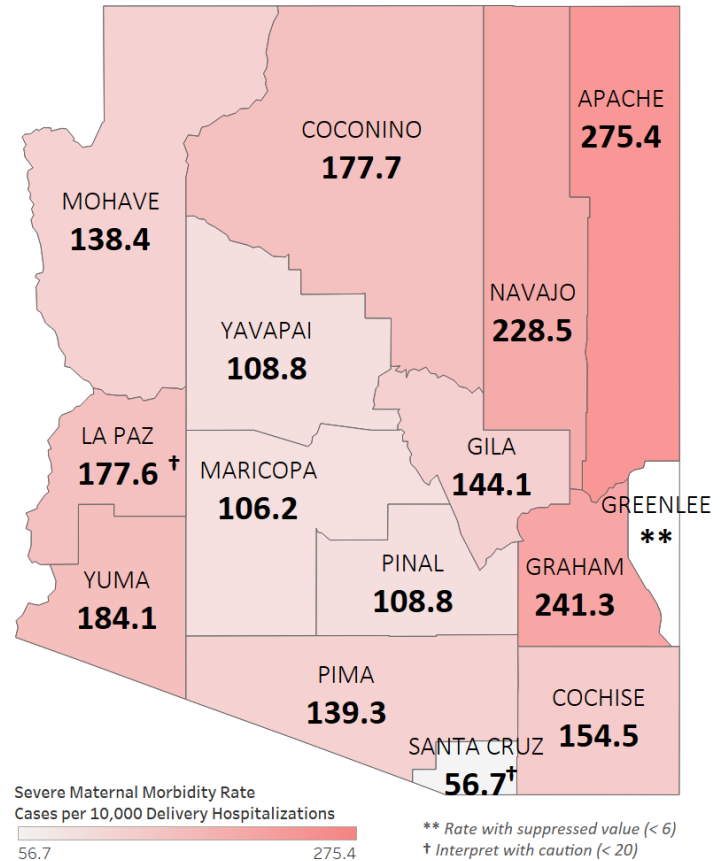


**Rural counties:** Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Mohave, Navajo, Santa Cruz, and Yavapai

**Urban counties:** Maricopa, Pima, Pinal, and Yuma

Based on definitions used by the ADHS Bureau of Public Health Statistics.

**Figure 48.**  
Rate of Severe Maternal Morbidity by County of Residence  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



## SMM Rate by Obstetric History and Maternal Health

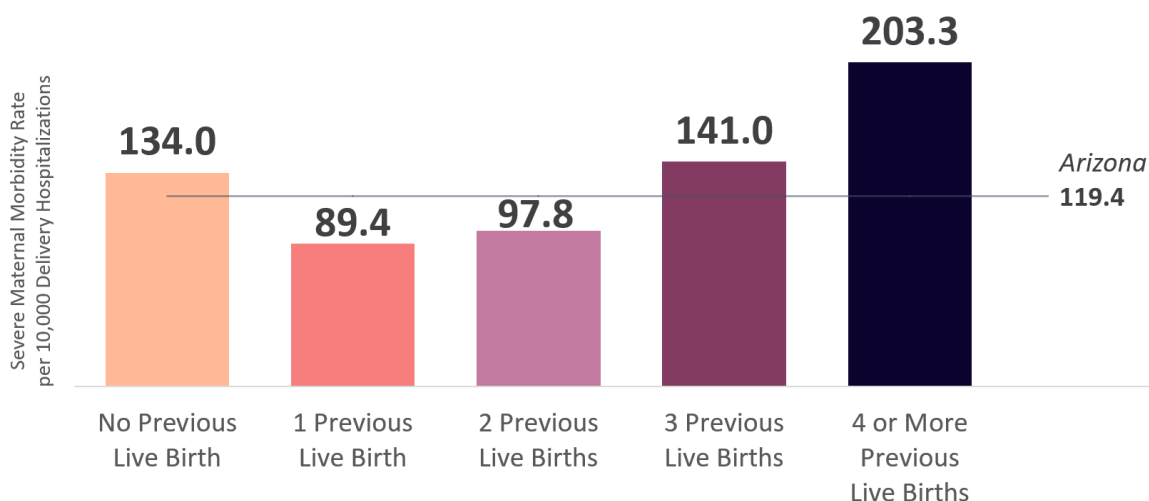
The rate of SMM varied based on the mother’s obstetric history, including number of previous live births and time between pregnancies, as well as the mother’s preconception health status.

Women with one previous live birth had the lowest rates of SMM at 89.4 SMM events per 10,000 delivery hospitalizations. This was lower than the SMM rate of women without a previous live birth (134.0); these findings are consistent with studies that have found women with at least one previous live birth tend to have lower adverse outcomes than women without a previous birth, in part because some high risk women elect not to have more than one child.<sup>81</sup> Women with only one previous live birth also had a lower SMM rate than women with two previous live births (97.8), three previous live births (141.0) and four or more previous live births (203.3). These differences are shown in **Figure 50**.

**Figure 50.**

Rate of Severe Maternal Morbidity by Parity

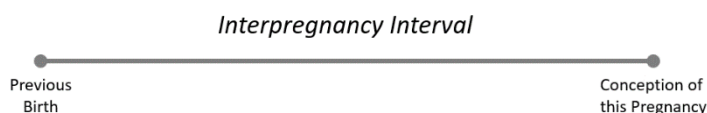
Among Arizona Resident Delivery Hospitalizations, 2016-2019



For women with at least one previous birth, SMM rates were increased among the shortest and longest interpregnancy intervals, or the time between the previous live birth and the conception of the subsequent most recent pregnancy (**Figure 51**). The intervals with the highest SMM rates were 60 months or longer (137.5), less than 6 months (135.9), and between six and 11 months (128.3). Women who got pregnant between 18 and 23 months and between 24 and 35 months after a previous live birth had the lowest rates of SMM (90.4 and 87.9, respectively).

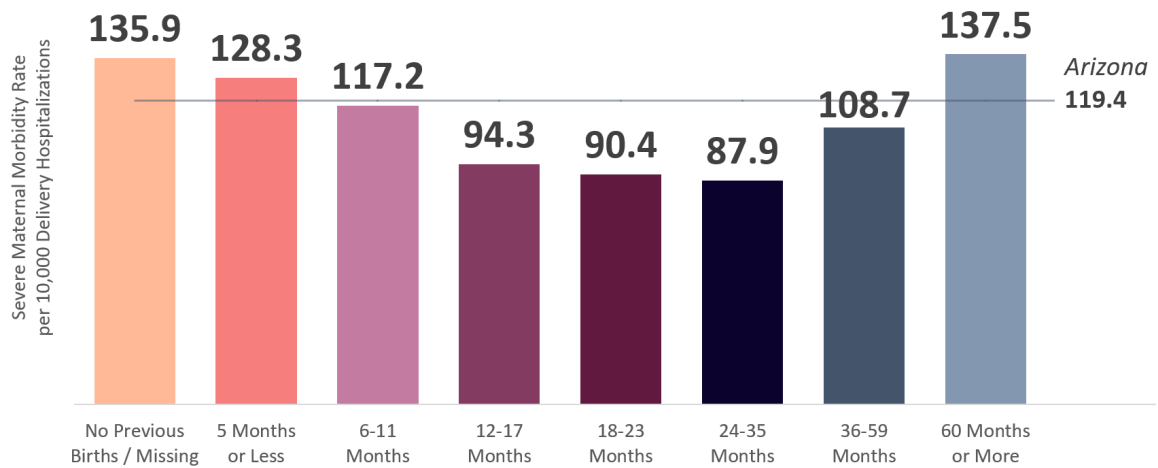
### Interpregnancy Interval:

Time between previous birth and conception of subsequent pregnancy



**Figure 51.**

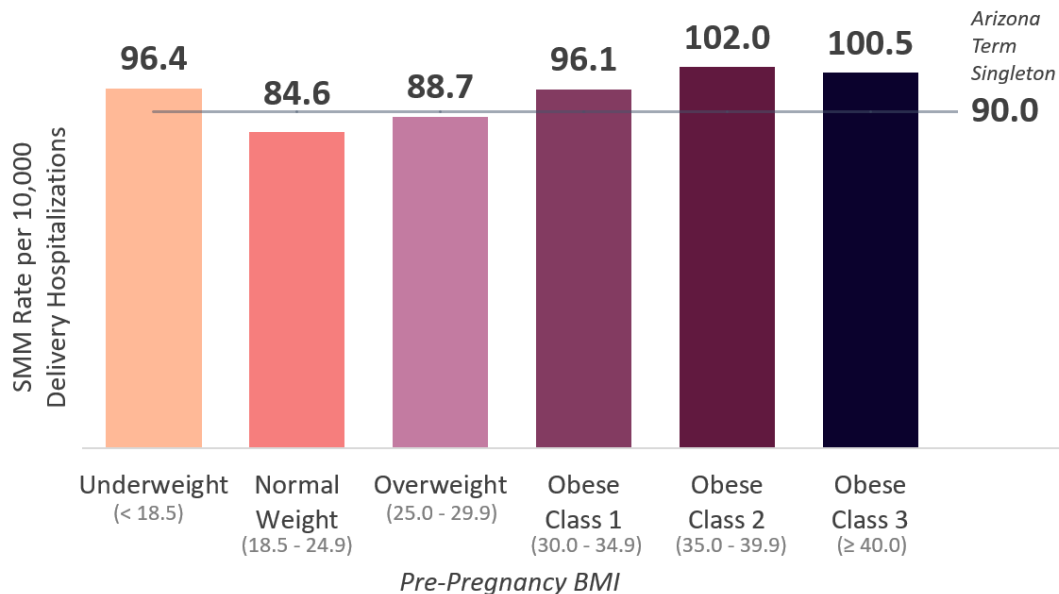
Rate of Severe Maternal Morbidity by Interpregnancy Interval  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



Among women with a singleton, term delivery, those with a pre-pregnancy Body Mass Index (BMI) in the normal weight range (18.5-24.9) had the lowest rate of SMM at 84.6 (**Figure 52**). Women who were overweight, but not obese, before pregnancy (BMI 25.0-29.9) had the second lowest rate of SMM (88.7), while women who were underweight prior to getting pregnant (BMI less than 18.5) had an SMM rate of 96.4. Women who had an obese pre-pregnancy BMI (30.0 or greater) had an SMM rate of 98.4 (not shown), which varied by class: 96.1 for women in obese class 1 (BMI 30.0-34.9), 102.0 for women in obese class 2 (BMI 35.0-39.9), and 100.5 in obese class 3 (BMI 40 or greater).

**Figure 52.**

Rate of Severe Maternal Morbidity by Pre-Pregnancy Body Mass Index (BMI)  
Among Term Singleton Arizona Resident Delivery Hospitalizations, 2016-2019



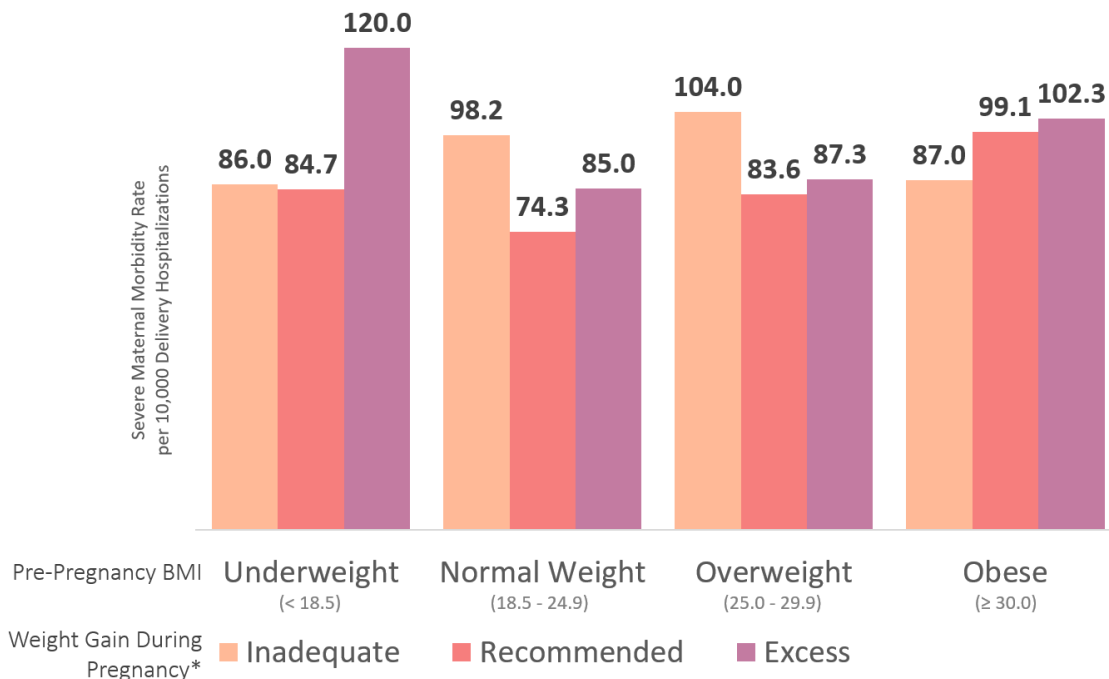
When SMM was assessed by weight gain during pregnancy across all BMI groups for term, singleton deliveries, the SMM rate was slightly elevated among women with both inadequate weight gain (95.6) and excess weight gain (92.0) compared to women achieving the recommended weight gain (82.2). The 2009 updated recommendations from the Institute of Medicine for weight gain during pregnancy is based on pre-pregnancy BMI and was adjusted for gestational age (in weeks) at birth (not shown).

As seen in **Figure 53**, there were more drastic differences between SMM rates for weight gain during pregnancy among term, singleton deliveries when separated by pre-pregnancy BMI. Of all weight gain and BMI combinations, underweight women with excess weight gain had the highest rate of SMM at 120.0, which is notably higher than other underweight women who gained either inadequate weight (86.0) or recommended weight (84.7). For women of normal weight and overweight BMI before pregnancy, gaining inadequate weight was higher than other weight gain groups: among women of normal weight BMI, those with inadequate weight gain had an SMM rate of 98.2 compared to 85.0 for those that had excess weight gain and 74.3 for those with recommended weight gain, and among women with an overweight BMI, those with inadequate weight gain had an SMM rate of 104.0 compared to 87.3 among excess weight gain and 83.6 for recommended weight gain. Among the group of women with an obese BMI (including all three classes of obesity) those who gained inadequate weight had the lowest SMM rate (87.0), with increased rates among obese women with both recommended weight gain (99.1) and excess weight gain (102.3). More information about the Institute of Medicine recommendations for weight gain during pregnancy and how this measure was used in this analysis can be found in **Appendix G**.

**Figure 53.**

Rate of Severe Maternal Morbidity by Pre-Pregnancy Body Mass Index (BMI) and Weight Gain During Pregnancy

*Among Term Singleton Arizona Resident Delivery Hospitalizations, 2016-2019*

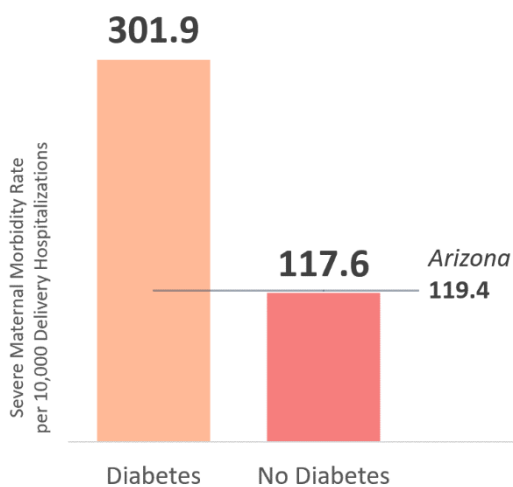


\* Based on recommendations for singleton pregnancies by pre-pregnancy BMI and number of weeks gestation, adapted from the Institute of Medicine and National Research Council's 2009 Weight Gain During Pregnancy: Reexamining the Guidelines.

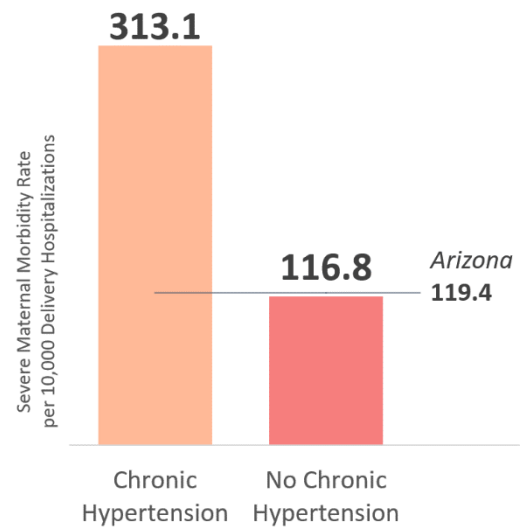


The presence of a chronic condition prior to pregnancy notably increased SMM rates during delivery, as shown in **Figures 54-55**. Women with pre-existing diabetes had an SMM rate 2.6 times that of women without pre-existing diabetes, with rates of 301.9 versus 117.6, respectively. Similarly, women with chronic hypertension had an SMM rate 2.7 times that of women without chronic hypertension; the SMM rate for chronic hypertension was 313.1 and the rate without chronic hypertension was 116.8.

**Figure 54.**  
Rate of Severe Maternal Morbidity  
by Pre-Existing Diabetes  
*Among Arizona Resident Delivery Hospitalizations,  
2016-2019*

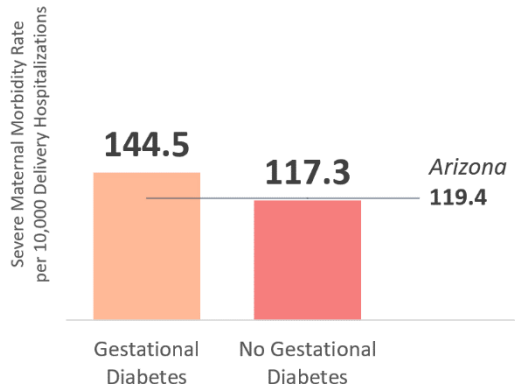


**Figure 55.**  
Rate of Severe Maternal Morbidity  
by Chronic Hypertension  
*Among Arizona Resident Delivery Hospitalizations,  
2016-2019*

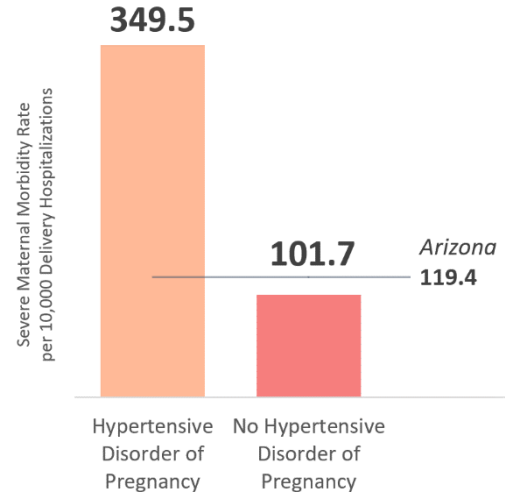


The presence of gestational diabetes or hypertension during pregnancy also increased SMM rates (**Figures 56-57**). Women with gestational diabetes had an increased SMM rate (144.5 with versus 117.3 without), while women with a hypertensive disorder of pregnancy (including pregnancy-induced hypertension, pre-eclampsia, and eclampsia) had 3.4 times the SMM rate of women without a hypertensive disorder of pregnancy (349.5 with versus 101.7 without). By definition, the women with these gestational conditions did not have either pre-existing diabetes or chronic hypertension, and these conditions arose only during and as a result of the pregnancy.

**Figure 56.**  
Rate of Severe Maternal Morbidity  
by Gestational Diabetes  
Among Arizona Resident Delivery Hospitalizations,  
2016-2019



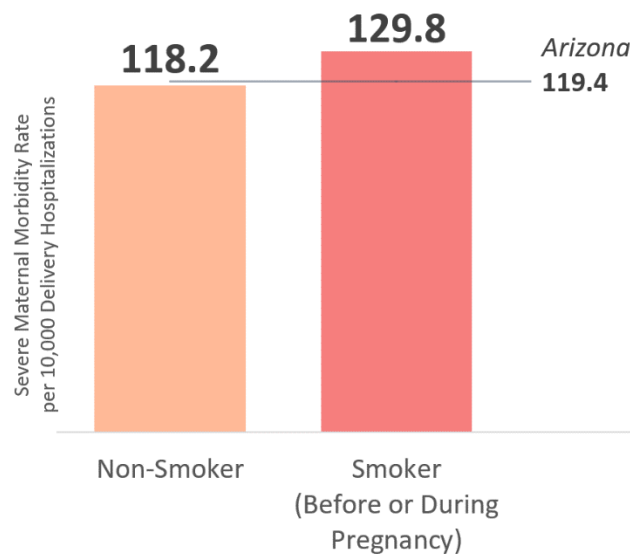
**Figure 57.**  
Rate of Severe Maternal Morbidity  
by Hypertensive Disorders of Pregnancy  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



*Hypertensive Disorders of Pregnancy includes Gestational Hypertension, Preeclampsia, and Eclampsia*

SMM rates were relatively unchanged by smoking tobacco any time before or during pregnancy, shown in **Figure 58**. Non-smokers had an SMM rate of 118.2, while mothers who smoked tobacco at all before or during pregnancy had an SMM rate of 129.8.

**Figure 58.**  
Rate of Severe Maternal Morbidity by Smoking Tobacco  
Among Arizona Resident Delivery Hospitalizations, 2016-2019

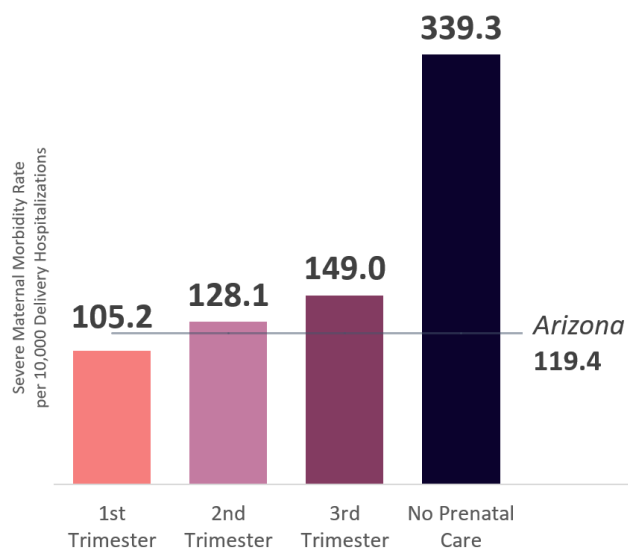


## SMM Rate by Prenatal Care and Method of Delivery

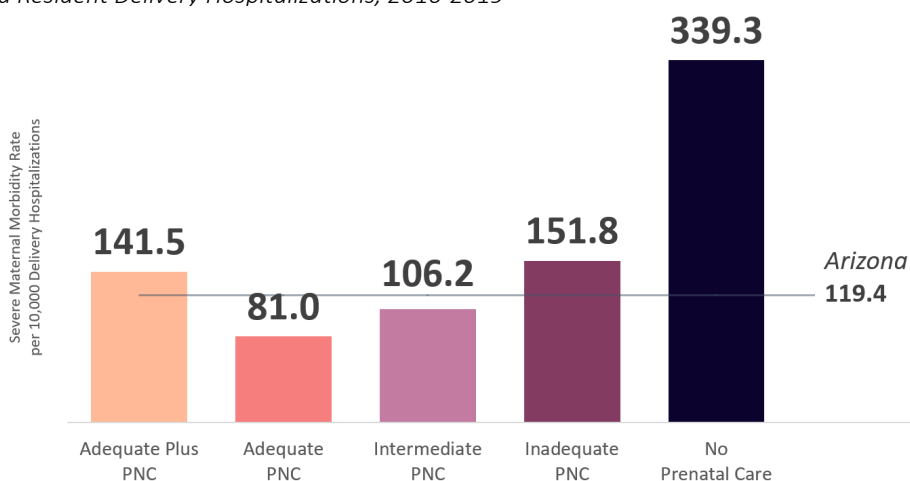
SMM increased with delayed initiation of prenatal care, with the highest rate among women without any prenatal care (339.3). Prenatal care begun in the second trimester had an SMM rate of 128.1, increasing to 149.0 among women who began prenatal care in their last trimester (Figure 59). In contrast, women who began prenatal care in their first trimester of pregnancy had the lowest rate of SMM (105.2).

Rates of SMM also differed by adequacy of prenatal care utilization (Figure 60). Using the Kotelchuck Index, or the Adequacy of Prenatal Care Utilization Index (APNCU), the adequacy of prenatal care was determined by timing and number of prenatal care visits the woman received, following ACOG guidelines for prenatal care.<sup>82</sup> Women with adequate prenatal care had the lowest SMM rate at 81.0, followed by women with intermediate levels of prenatal care (106.2). Women who had more than adequate prenatal care, also known as intensive prenatal care utilization due to medical needs for additional monitoring, had an SMM rate of 141.5, which similarly might reflect increased medical risks during pregnancy. Women with inadequate levels of prenatal care had a higher SMM rate of 151.8. More information about this measure can be found in Appendix G.

**Figure 59.**  
Rate of Severe Maternal Morbidity by Initiation into Prenatal Care  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



**Figure 60.**  
Rate of Severe Maternal Morbidity by Utilization of Prenatal Care  
Among Arizona Resident Delivery Hospitalizations, 2016-2019

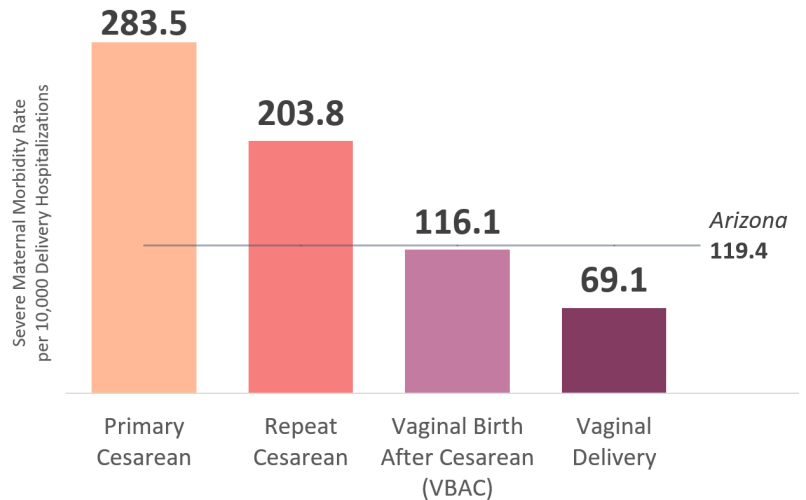


Prenatal care utilization was assessed using the Adequacy of Prenatal Care Utilization Index (APNCU), which creates a ratio of expected versus received care, using ACOG guidelines and prenatal care recommendations. More information on this measure can be found in Appendix G.

The method of delivery robustly affected SMM rates. Women with cesarean section deliveries had a higher overall SMM rate than women who delivered vaginally (248.7 for cesarean versus 70.7 for vaginal, not shown). High SMM among cesarean deliveries might be the combined effect of the medical risk indications for primary or repeat cesarean, as well as the expected or unexpected complications resulting from those delivery procedures. Women with a primary cesarean delivery had the highest rate of SMM at 283.5, even compared to women with a repeat cesarean delivery (203.8; **Figure 61**). Women with a vaginal delivery after cesarean (VBAC, SMM rate 116.1) had a similar SMM rate as the state overall SMM rate (119.4). Vaginal deliveries without previous cesareans had the lowest SMM rate at 69.1.

**Figure 61.**

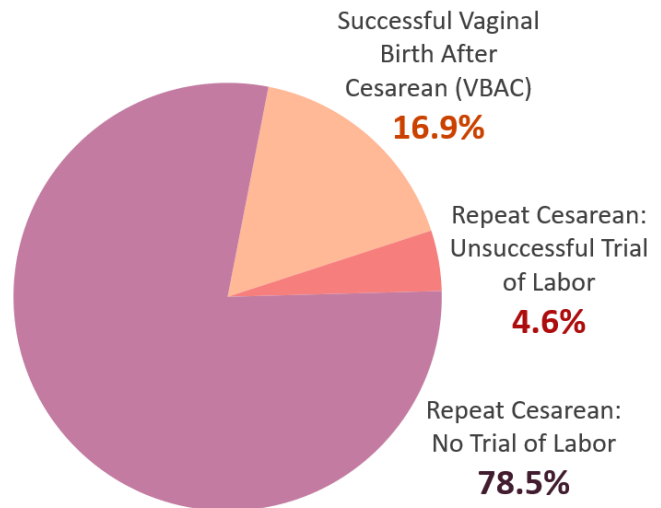
Rate of Severe Maternal Morbidity by Method of Delivery Among Arizona Resident Delivery Hospitalizations, 2016-2019



Overall, women with a history of a previous cesarean delivery had an SMM rate (189.0) higher than women without a previous cesarean (107.8; **Figure 63**). Among women with a previous cesarean, trial of labor was attempted in 21.5% of deliveries, with 78.7% of these attempts resulting in VBAC (16.9% of all previous cesareans) and repeat cesareans for the other 21.3% (4.6% of all previous cesareans) (**Figure 62**). Women with a VBAC delivery had an SMM rate of 116.1, while women with an unsuccessful trial of labor and resulting repeat cesarean had an SMM rate of 296.7. Over three quarters of women with a previous cesarean (78.5%) had a repeat cesarean delivery without a trial of labor, and an SMM rate of 198.4.

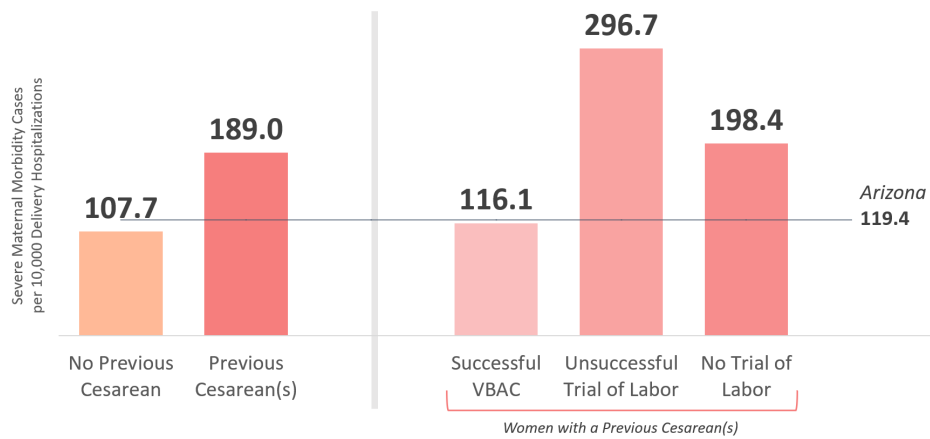
**Figure 62.**

Trial of Labor and Method of Delivery Among Arizona Resident Delivery Hospitalizations with a Previous Cesarean Delivery, 2016-2019



**Figure 63.**

Rate of Severe Maternal Morbidity by Previous Cesarean and Trial of Labor  
Among Arizona Resident Delivery Hospitalizations, 2016-2019

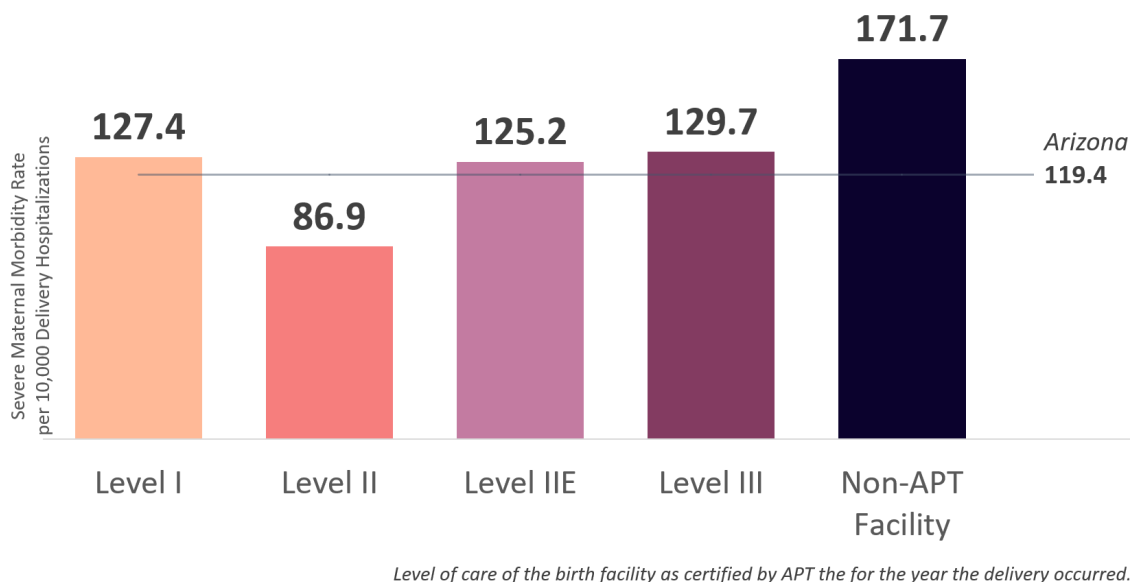


### SMM Rate by Level of Care

The Arizona Perinatal Trust (APT) facilitates the Voluntary Certification Program (VCP) which assigns a certification level to participating facilities based on the services and level of care they provide to mothers and infants during and after labor and delivery. As shown in **Figure 64**, women who delivered in a Level II facility had the lowest rate of SMM (86.9), followed by Level IIE facilities (125.2) and Level I facilities (127.4). Women who delivered at Level III facilities, usually indicative of high-risk pregnancies or deliveries needing the most intensive care services, had the highest rate of SMM among APT certified facilities at 129.7. Among those facilities not currently certified by the APT, women had an SMM rate of 171.7, which includes deliveries in non-birth facilities.

**Figure 64.**

Rate of Severe Maternal Morbidity by Arizona Perinatal Trust Level of Care  
Among Arizona Resident Delivery Hospitalizations, 2016-2019

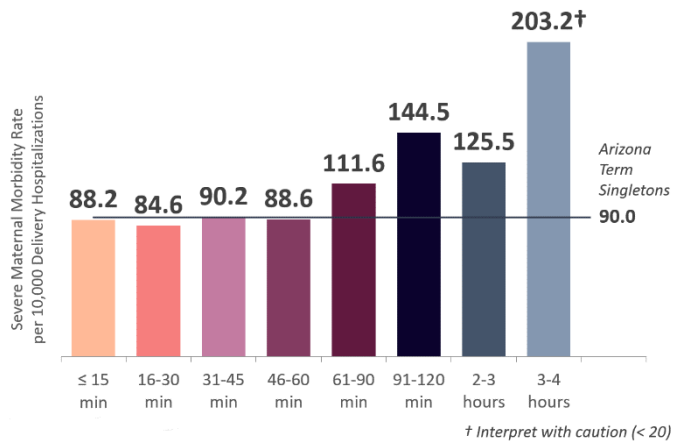


## SMM Rate by Distance to of Care

The rates of SMM varied by driving distance and driving time to care, with SMM rates highest among women who lived more than 60 minutes or 50 miles away from their birth facility (**Figures 65-68**). Among term, singleton deliveries, women living more than 60 minutes away had an SMM rate of 125.3 compared to 86.9 among women who lived closer to their facility, and women living more than 50 miles away had an SMM rate of 134.9 compared to 87.3 for women who lived closer (not shown). This remained true even when separated by whether a woman was transferred into the birth facility, as seen in **Figures 66 and 68**.

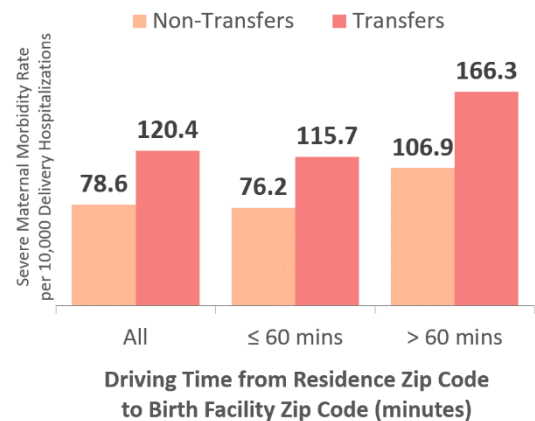
**Figure 65.**

Rate of Severe Maternal Morbidity by Driving Time to Birth Facility ZIP Code from Residence ZIP Code Among Term Singleton Arizona Resident Delivery Hospitalizations, 2016-2019



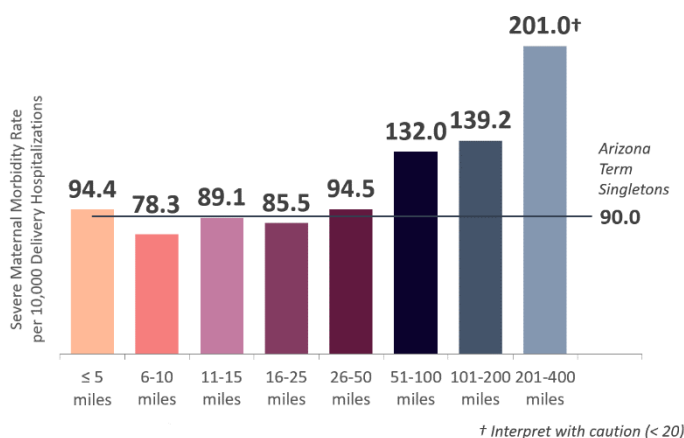
**Figure 66.**

Rate of SMM by Driving Time and Transfer to Birth Facility Among Term Singleton Arizona Resident Delivery Hospitalizations, 2016-2019



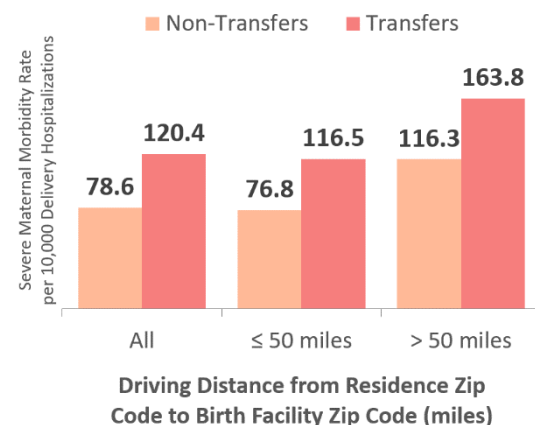
**Figure 67.**

Rate of Severe Maternal Morbidity by Driving Distance to Birth Facility ZIP Code from Residence ZIP Code Among Term Singleton Arizona Resident Delivery Hospitalizations, 2016-2019



**Figure 68.**

Rate of SMM by Driving Distance and Transfer to Birth Facility Among Term Singleton Arizona Resident Delivery Hospitalizations, 2016-2019

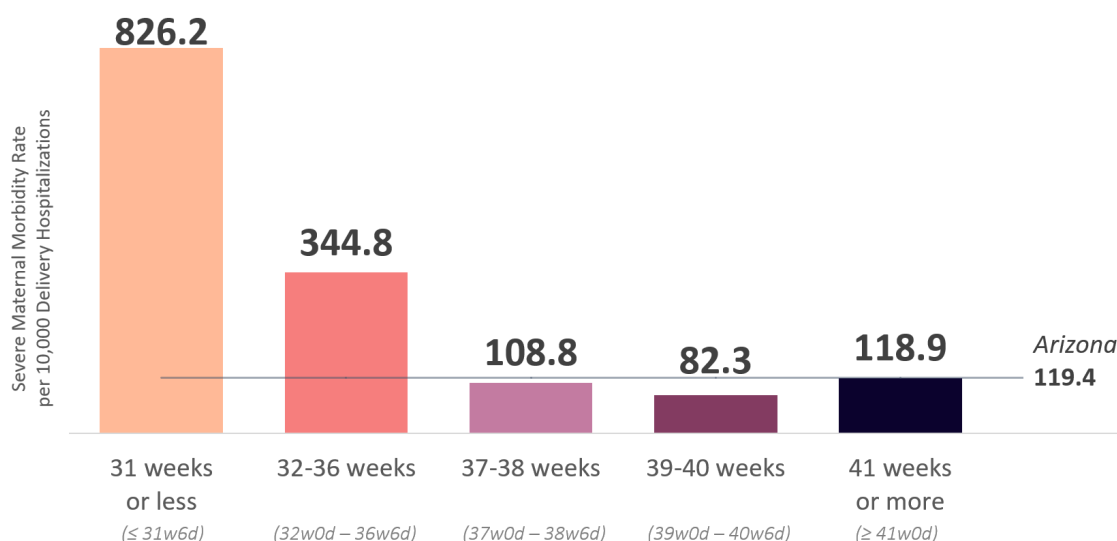




## SMM Rate by Infant Health Outcomes

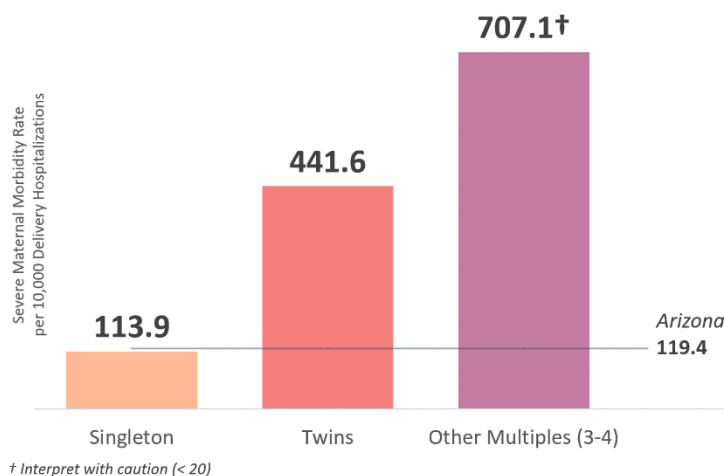
Women who had a preterm delivery (before 37 weeks gestation) had considerably higher rates of SMM than women who delivered at or after term; all preterm deliveries had an SMM rate of 411.6 versus 92.1 for term deliveries (37-41 weeks, not shown). **Figure 69** shows the rate of SMM by gestational age groups. Women delivering prior to 32 weeks gestation (extremely/very preterm) had the highest SMM rate of 826.2, followed by women delivering between 32-36 weeks (moderately/late preterm) with an SMM rate of 344.8. Full term deliveries (39-40 weeks) had an SMM rate of 82.3, which was lower than both early term (37-38 weeks) at 108.8 and late term or post-term (41 weeks or more) at 118.9.

**Figure 69.**  
Rate of Severe Maternal Morbidity by Gestational Age  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



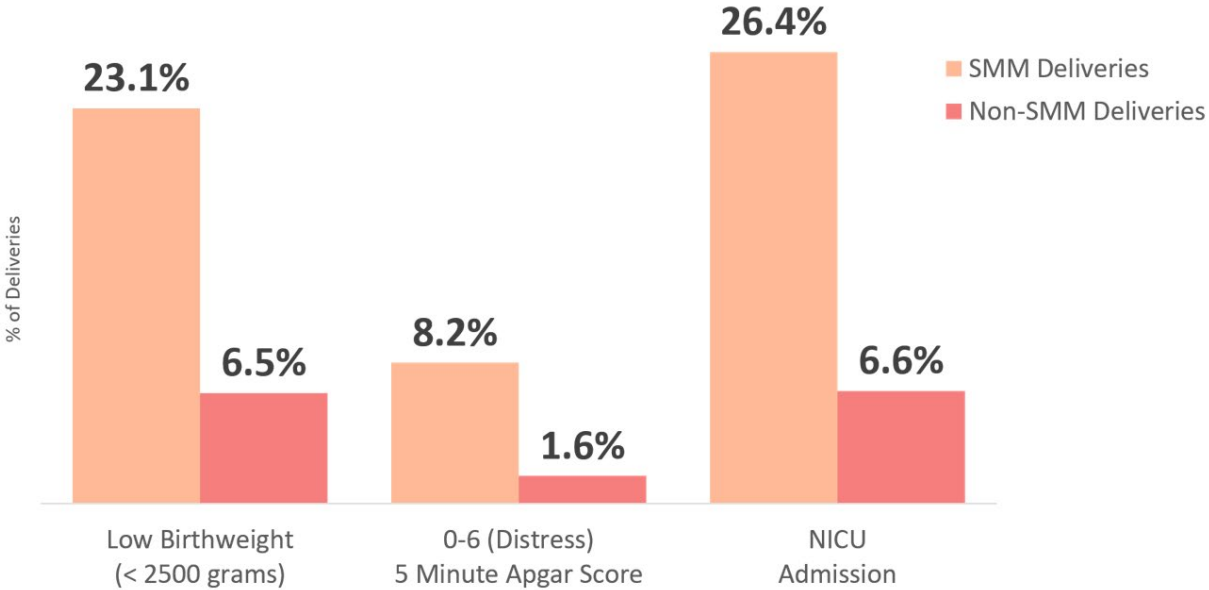
Deliveries of twins and other multiples accounted for only 1.65% (n=4,900) of all resident delivery hospitalizations, but 6.18% of SMM events (n=219). While the SMM rate for singleton deliveries was 113.9, the SMM rate among twins was 441.6 and for other higher order multiples was 707.1 (**Figure 70**).

**Figure 70.**  
Rate of Severe Maternal Morbidity by Plurality  
Among Arizona Resident Delivery Hospitalizations, 2016-2019



Women who had an SMM also had higher rates of adverse infant outcomes, both of which could be the result of a complication during pregnancy or delivery that affected both mother and baby. As seen in **Figure 71**, among deliveries with an SMM, 23.1% had a low birthweight or very low birthweight infant (less than 2500 grams), compared to 6.5% among all non-SMM hospital deliveries. At 5 minutes after delivery, 8.2% of SMM events had an Apgar score of 6 or less indicating distress, compared to 1.6% of non-SMM deliveries. Lastly, 26.4% of SMM events had a baby admitted to the NICU, compared to 6.6% of non-SMM deliveries.

**Figure 71.**  
Adverse Infant Outcomes among Hospital Deliveries by Severe Maternal Morbidity  
*Among Arizona Resident Delivery Hospitalizations, 2016-2019*





## Section 4: Recommendations for Preventing Maternal Mortality and Severe Maternal Morbidity in Arizona

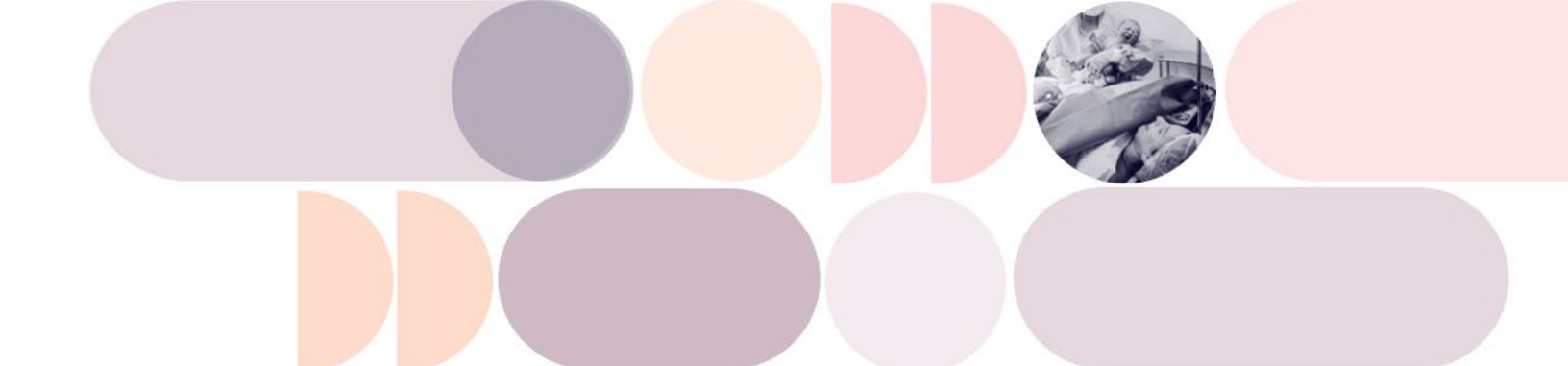
Given the MM and SMM outcomes presented in Sections 2 and 3, the Arizona MMRC identified the following recommendations to prevent these outcomes in the future. The recommendations are presented in four categories that align with the Levels included in the MMRIA Committee Decisions Form (**Appendix E**). These Levels indicate who might be responsible for enacting these recommendations, though some recommendations include more specificity than others.

These recommendations were initially derived from the recommendations made during MM case reviews. MMRP staff completed qualitative analysis on all recommendations made for 2016-2017 deaths and presented the initial synthesized recommendations to the MMRC. Following presentations of aggregate MM and SMM data, the MMRC added to and adjusted the list recommendations based on overarching findings and observations from these analyses. It is also important to note that while some data associated with these recommendations may be suppressed in Sections 2 and 3 due to numbers being less than six, the recommendations are not suppressed in this section.

The intent of these recommendations is that, through widespread dissemination, partners and key stakeholders across the state will consider them for implementation. In some cases, the recommendations may currently be in practice given that the timeframe for these reviews dates back to 2016. This is particularly true for some of the policy or practice recommendations geared towards payers, such as the AHCCCS, which has already implemented several of the models included in these recommendations.

### Patient/Family

- ▶▶ With the establishment of Patient and Family Advisory Councils among Arizona's healthcare facilities and other mechanisms (e.g., patient navigators, Community Health Workers) to support and educate patients and families, patients and families would strive to be **active participants in shared decision-making** for their healthcare needs and **communicate in a timely manner** to their healthcare providers any health concerns and/or symptoms of complications, disclose any pregnancy within the last year during all healthcare encounters, report barriers they may face in accessing care or adhering to provider recommendations, and disclose and/or seek support for patient risks or instabilities including financial, housing, or food insecurity, substance use disorders, or experience of domestic violence.

- 
- With the use of evidence-based patient tools and strategies to ensure patient/family comprehension and engagement, patients and families would adhere to recommendations and education to ensure timely care can be provided. This includes recommendations or education for **early prenatal care, postpartum warning signs, management of chronic conditions, treatment for perinatal mood disorders, and substance use disorders.**

## Provider/Facility

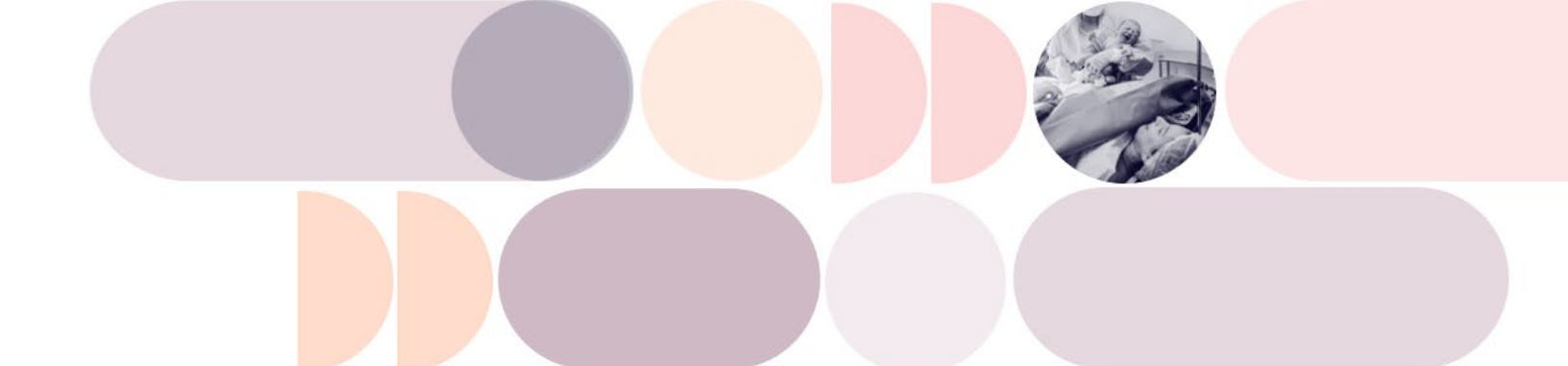
- Healthcare systems and providers should establish **continuity of care** through integrated or family levels of care models by 1) **assessing** all women to determine **special healthcare needs** of vulnerable populations using an **Individual Patient Risk Assessment** tool; 2) ensuring that proper **communication** occurs to convey these needs; 3) **referring** women to appropriate levels of care, services, and/or resources, including conducting a warm hand-off and confirmation of follow up; and 4) facilitating **continuity of care** as needed between the overlap of special healthcare needs for these populations using **case management** or **other navigation support** mechanisms (e.g., doulas, community health workers, home visitation). Specific vulnerable populations or circumstances that have been identified as frequently underserved in the perinatal period include:

### Most notably:

- ❖ Persons with mental health disorders or disabilities.
- ❖ Persons using substances, including tobacco, alcohol, illicit substances, prescription drugs, medical marijuana.
- ❖ Persons with high-risk pregnancies and/or multiple chronic medical conditions or comorbidities, including a focus on interpregnancy optimization of these conditions to prevent complications during pregnancy.
- ❖ Persons experiencing homelessness, financial instability, lack of consistent insurance, or other life instabilities.

**Other:** Persons experiencing domestic violence (e.g., shoe cards, implementing the red/black pen in bathrooms to mark on urine cup as a discrete mechanism to report domestic violence or human trafficking); persons who are incarcerated or recently incarcerated; populations experiencing historical trauma and/or systemic or structural barriers; persons who are experiencing other barriers to care (e.g. childcare, single-parent households, transportation, language barriers).

- All healthcare facilities/providers should develop and implement 1) standardized **policies/procedures** for assessing patient **knowledge** and education needs (including monitoring compliance with these policies) and 2) tools for properly and effectively **communicating** individualized pertinent health



information in an effective manner to the patient (including preferred language). Knowledge assessment and education needs of women before, during, and after pregnancy should include:

**Most notably:**

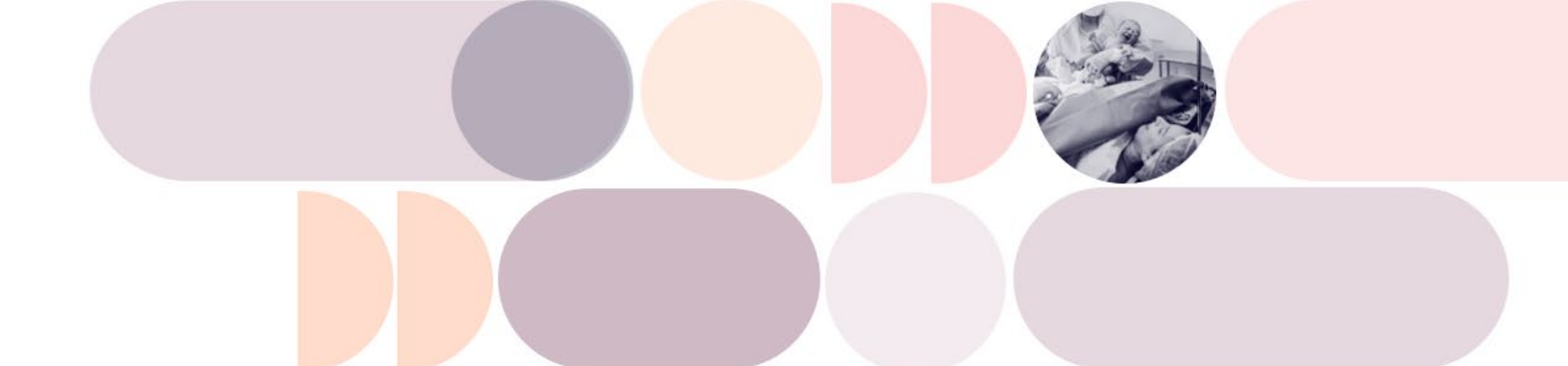
- ❖ Perinatal mood disorders.
- ❖ Family planning/contraception.
- ❖ Postpartum warning signs.
- ❖ Management of comorbidities before, during, and after pregnancy.
- ❖ Community resources and programs (e.g., hotlines, substance use treatment, mental or behavioral health support, domestic violence programs).
- ❖ Risks of substance use in pregnancy (tobacco, alcohol, illicit substances, prescription drugs, medical marijuana), including cessation strategies.

**Other:** Signs/Symptoms of common conditions of pregnancy; terminal illnesses and options for pregnancy management; general discharge instructions; newly diagnosed conditions/illnesses; preventive visits or other preventive measures (e.g., cancer screenings, HPV vaccine).

▮ In accordance with the recommendations and guidelines from the [Arizona Perinatal Trust](#) and [Alliance for Innovation on Maternal Health](#), all healthcare facilities/providers should develop, implement, and monitor compliance with evidence-based, **standard of care** bundles/policies for comorbidities before, during, and after pregnancy. Bundles/protocol suggestions include:

**Most notably:**

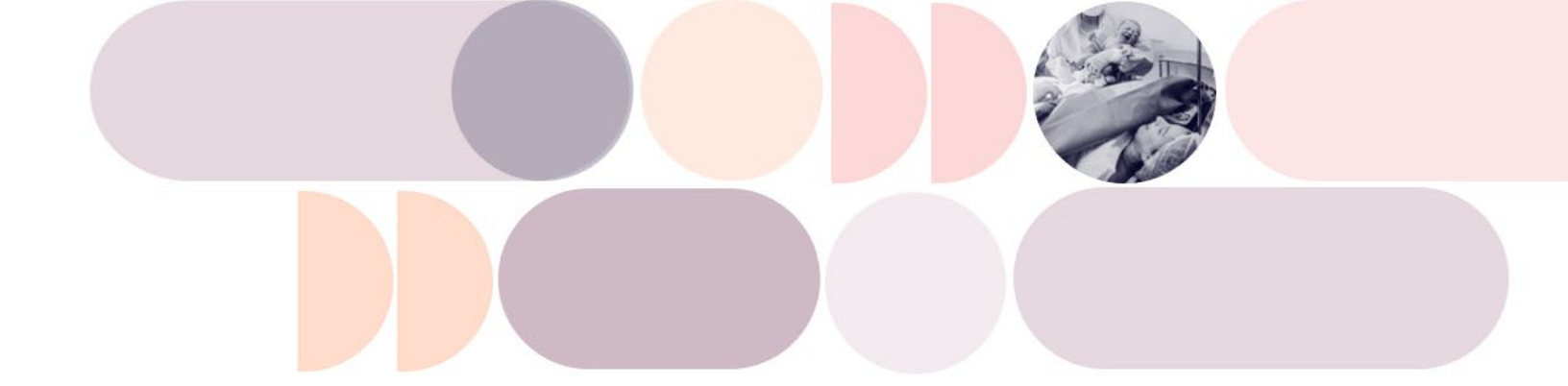
- ❖ Screening for perinatal mood disorders (*across all perinatal periods*).
- ❖ Screening for and reporting substance use (*across all perinatal periods*).
- ❖ Screening for/detecting domestic violence or human trafficking (*across all perinatal periods*).
- ❖ Sepsis bundle (*for all patients - not specific to perinatal patients*).
- ❖ Hypertensive disorders of pregnancy (e.g., preeclampsia, eclampsia, chronic hypertensive disease) (*across all perinatal periods*).
- ❖ Diabetes management in pregnancy (*across all perinatal periods for a patient with known diabetes [outside of pregnancy] or diagnosis of gestational diabetes*).
- ❖ Maternal-fetal medicine consults in high-risk patients (*at the time of first determination of high-risk pregnancy- also requires some sort of follow up*).
- ❖ Management of cardiac conditions in pregnancy (*across all perinatal periods - specific to patients with a known or newly diagnosed cardiac condition*). In cases of significant comorbid conditions (e.g., congenital heart disease) assure that providers of Ob-Gyn services are coordinating care with cardiac specialists.

- 
- ❖ Hemorrhage screening and treatment bundle (*at admission for labor and delivery but risk factors are often identified during the antenatal period*).
  - ❖ Optimization of postpartum care, such as the [ACOG Optimization of Postpartum Care Recommendations](#) (*postpartum period*).
  - ❖ Protocols related to eliminating bias in care, such as [the Reduction of Peripartum Racial/Ethnic Disparities](#) safety bundle (in accordance with recommendation C) (*across all perinatal periods*).

**Other:** Obstetric consultation for pregnant or postpartum patients presenting to the emergency department (e.g., Code 42), especially if experiencing housing instability (*across all perinatal periods*); unplanned cesarean section and induction of labor protocols (*during antenatal and intrapartum periods*); prescription drug monitoring/medication reconciliation (*across all perinatal periods*); management of medical marijuana use before, during, and after pregnancy (*across all perinatal periods*); fall prevention protocol (*during any hospital encounter and for all high fall risk patients during health encounters*).

- DD All Arizona hospitals with obstetrical services should participate in Arizona’s state-wide implementation of the **Alliance for Innovation on Maternal Health (AIM) Severe Hypertension in Pregnancy Patient Safety Bundle** and future implementation of other AIM Patient Safety Bundles.
- DD All facilities should adopt **perinatal consultation, transport guidelines** (required for [Arizona Perinatal Trust](#) and the [ADHS High-Risk Perinatal Program](#) facilities), and **Levels of Care** guidelines to ensure women are cared for at facilities with the appropriate level of care.
- DD To support women who live in [Maternity Care Deserts](#), or counties with no hospitals offering obstetric care and no OB/GYN or certified nurse-midwife providers, providers and facilities should explore opportunities to **expand telemedicine services** to ensure women and their care providers have access to timely and risk-appropriate care before, during, and after pregnancy.
- DD Enhance **state-wide workforce development opportunities** to **advance provider skills and awareness** of conditions across perinatal periods. This includes bolstering existing provider consultation or collaboration initiatives between Maternal Fetal Medicine specialists and other providers (including emergency department and urgent care providers), educating providers (e.g., pediatricians, Emergency Department, primary care) of conditions requiring immediate/emergent stabilization and perinatal transport for obstetric emergencies, and training maternity care providers in suboxone treatment.
- DD In accordance with the [Arizona Health Improvement Plan](#), all hospital/healthcare systems should adopt a **health equity framework** (e.g., [Institute for Healthcare Improvement Health Equity](#)





[Framework](#)) that prioritizes health equity as a strategic priority. This includes conducting organizational assessments, providing equity and inclusion trainings for providers, adopting equitable hiring and retention practices, promoting healthy behaviors and opportunities to address SDOH of patients and workers, and establishing an equitable physical environment.

## System

### Regulatory or State Policy

- ▶▶ In accordance with the [Helping MOMS Act \(H.R. 4996\)](#), **expand Medicaid coverage** of women to one year postpartum while reducing overall barriers to enrollment upon initial positive pregnancy test.
- ▶▶ In accordance with the [Arizona State Loan Repayment Program](#) and other national and state workforce development programs, create more opportunities to expand and diversify **Arizona's healthcare workforce** for providers of all levels caring for women before, during, and after pregnancy. This includes a particular focus on diversification of race and ethnicity, and provider types (e.g., OB/GYN, midwifery, mental or behavioral health providers, Community Health Workers, doulas, certified peer support specialists) that serve Arizona's Maternity Care Deserts or areas with limited access to maternity care.
- ▶▶ Collaborate with the Arizona Medical Board or other licensing agencies to establish **continuing education requirements** to ensure providers (especially emergency department providers) caring for women during and after pregnancy are educated about **perinatal conditions requiring immediate/emergent stabilization** and perinatal transport for obstetric emergencies.
- ▶▶ Identify opportunities to better leverage [Health Current](#) (the Arizona Health Information Exchange) to achieve a statewide, **universal medical record** and **prescription drug monitoring/medication reconciliation platform** to ensure timely communication and sharing of patient health information, particularly for sharing of records between mental health providers and other providers caring for women before, during, and after pregnancy.

### Payers

- ▶▶ **Integrated care, patient-centered medical homes, and/or family levels of care models** need to be adopted or strengthened to foster trust in patient/provider relationships, enhance **communication**, improve **quality of care**, and maintain **continuity of care**. This includes a need for sustainable reimbursement for all levels of providers that address the diverse needs of patients, including midwifery, doulas, Community Health Workers, and others. Suggestions for various areas of integrated care include:



**Most notably:**

- ❖ Integration of mental health care into primary care and inpatient services.
- ❖ Substance use treatment services, including medication assisted treatment and inpatient services.
- ❖ Transportation support, case management, community health workers, and home visitation services.
- ❖ Multidisciplinary teams for complex care-needs of patients with multiple comorbidities.
- ❖ Group prenatal care models that integrate wrap around services for pregnant women.
- ❖ Telehealth services, including remote monitoring, for primary and OB care.

**Other:** Allopathic medicine and alternative/complementary therapies (i.e. naturopathic medicine, homeopathic medicine, traditional healing medicine); practices for managing the use of medical marijuana with allopathic care models, including prescribing and reporting practices; other quality improvement efforts or patient safety bundle implementation.

- ▶▶ In accordance with the [American College of Obstetricians and Gynecologists](#), [National Institute for Children’s Health Quality](#), and [National Academy for State Health Policy](#), payers should adopt **maternity care incentive plans** to **optimize** both **family planning** and **postpartum care**. This includes postpartum visits via telemedicine, postpartum home visiting, and screenings for mothers during Early and Periodic Screening, Diagnostic and Treatment (EPSDT) visits for infants, as recommended by the [American Academy of Pediatrics Bright Futures Guidelines](#).
- ▶▶ Similar to the [AHCCCS American Indian Medical Home](#) model, payers should adopt an **American Indian Medical Home concept** for care coordination before, during, and after pregnancy, including intensive postpartum follow-up and peer support programs for Arizona’s American Indian or Alaska Native populations.
- ▶▶ Ensure **reproductive resources**, including preconception counseling, family planning, contraception, preventative screenings, HPV vaccination, prenatal care, postpartum care, and interpregnancy co-morbidity care are available to all women. This includes ensuring reimbursement eligibility for all OB/GYN providers placing long acting reversible contraception (LARC) during inpatient postpartum visits. Special populations to consider further facilitating access to these resources include women and adolescents who are experiencing:

**Most notably:**

- ❖ Substance use disorders.
- ❖ Homelessness.
- ❖ Terminal illness.

- 
- ❖ Chronic diseases.

**Other:** Domestic violence; mental or behavioral health disorders; barriers to accessing care, including inconsistent or lack of adequate insurance.

- ▮▮ Ensure patients who are uninsured or underinsured have access to **affordable** and **appropriate services or supplies**, including supplies to manage their conditions (e.g., glucose monitors, insulin), access to dental services, healthy food (particularly to support appropriate weight gain during pregnancy), housing assistance programs, and mental health or substance use services.
- ▮▮ All health plans should improve **transparency of their prescription drug formularies and pricing** to facilitate appropriate prescribing by providers and to eliminate patient barriers in obtaining medications.
- ▮▮ Establish community models of **peer support** across the perinatal period that are reimbursed by health care payers or other funding sources. These support services should include voluntary access and referral to appropriate resources for women experiencing:

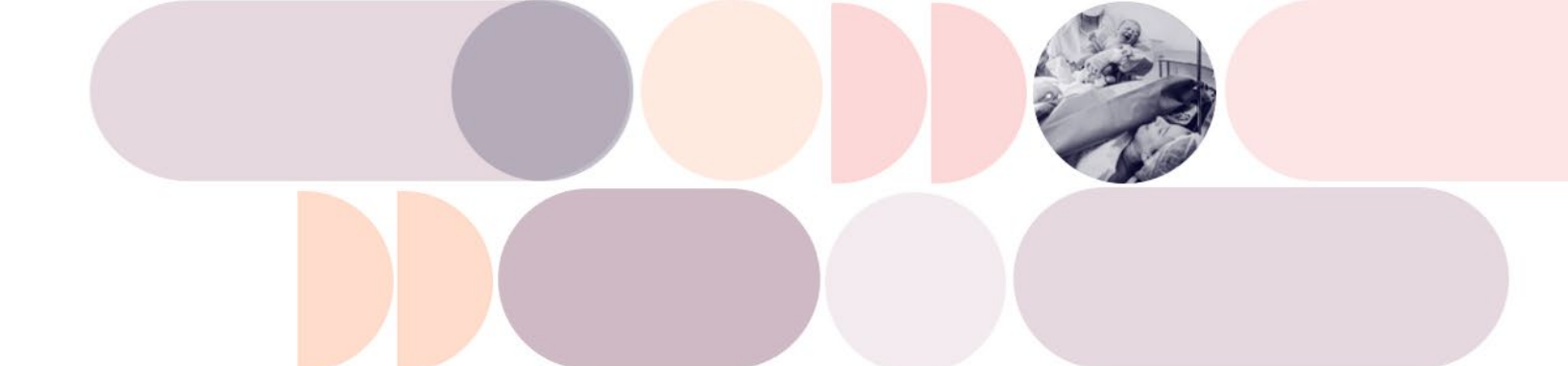
**Most notably:**

- ❖ Perinatal mood disorders, including support systems for families of individuals with perinatal mood disorders.
- ❖ Substance use disorders, including harm reduction environments.
- ❖ Domestic or intimate partner violence (including safety planning).
- ❖ Loss of a child or miscarriage; group prenatal care.

**Other:** Chronic conditions (e.g., diabetes); separation from a child or family (e.g., Department of Child Safety involvement); challenges with parenting, including solo-parenting and/or parenting children with disabilities or behavioral concerns.

## Law Enforcement

- ▮▮ In accordance with the [Arizona Opioid Action Plan](#), establish a supportive **harm reduction environment** for individuals experiencing **substance use disorders** by ensuring law enforcement officers and court systems coordinate with substance use prevention or diversion programs, including teen diversion programs, step down programs for those recently incarcerated (e.g., AHCCCS Justice in Reach Program), mentorship/peer support programs, and resources geared towards families aiming to support those with substance use disorder or people in recovery.
- ▮▮ In accordance with the [American College of Obstetricians and Gynecologists Statement on Gun Violence and Safety](#), establish supportive environments for women experiencing **domestic violence** by



identifying funding options for law enforcement to dispatch a social worker or mental health professional on domestic violence calls and enacting stricter enforcement of laws and/or punishments for individuals with multiple offenses of domestic violence or other violent crimes, including offering therapy or diversion programs for domestic violence offenders and providing periodic injury prevention evaluations and counseling regarding weapons.

### Other Systems or Policies

- ▶▶ Support **medical examiners** to collaborate with health systems and facilities to confirm qualifying conditions or situations requiring an autopsy and automatic qualifications for toxicology testing, including identifying and addressing facility-level (e.g., training, protocols) or patient/family-level (e.g., financial, cultural) barriers to conducting them.
- ▶▶ In accordance with the [Arizona Department of Transportation FY2020 Strategic Plan](#), ensure **roadways and highways** where pedestrians may be located are well lit and have sidewalks and crosswalks.
- ▶▶ In accordance with the [Arizona Adverse Childhood Experience Consortium](#), Arizona should become a **trauma-informed state** to recognize and respond to toxic stress and trauma experienced by women and families, and support women and families in overcoming them.
- ▶▶ In accordance with ADHS's current practices, continue to regularly prepare and **disseminate maternal morbidity and mortality data** that ensures health systems, facilities, and providers have feedback mechanisms about health outcomes for Arizona women before, during, and after pregnancy. In turn, communities should conduct periodic **community needs assessments** (e.g., every 5 years) to understand how maternal morbidity and mortality impact women and families in their area, and leverage resources such as the Arizona Health Improvement Plan to implement recommendations to prevent these in the future.
- ▶▶ In accordance with the strategies identified by Governor Ducey's [Executive Order](#) to expand telemedicine to Arizonans and [Tribal Connect Act of 2020 \(H.R.7973\)](#), support Arizona residents and providers in **expanding access to telehealth services**, particularly through expansion of low-cost broadband and telephone services on tribal lands and remote areas of the state.
- ▶▶ Identify systems or **other funding opportunities to support community-based recommendations** included below.



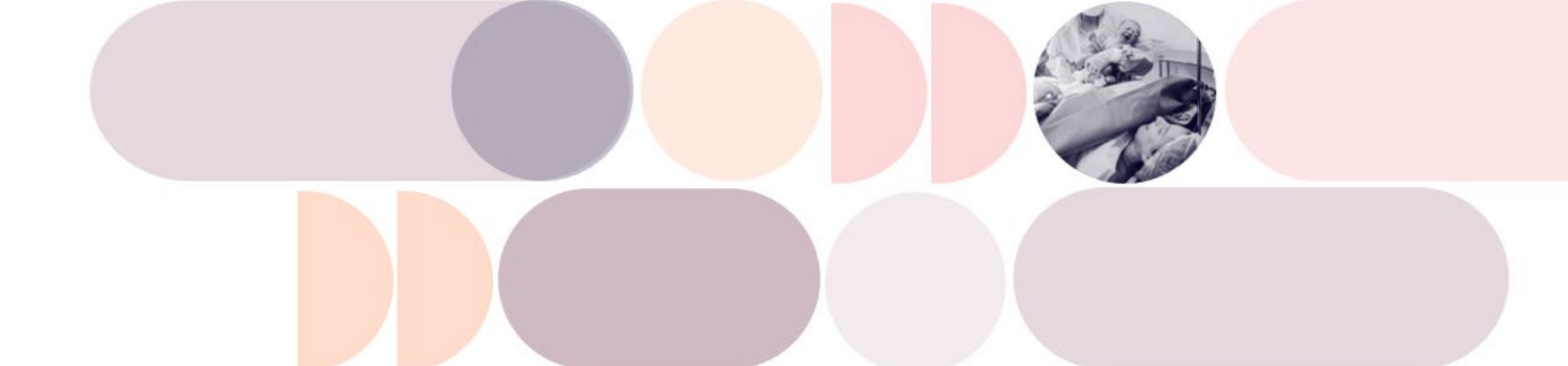
## Community

- ▶▶ Develop and provide community-based **outreach** and **education** via text or other communications to enhance awareness of the following topics to support women and families before, during, and after pregnancy:

### Most notably:

- ❖ Availability of comprehensive perinatal helplines, such as the [Birth to Five Helpline](#) (877-705-KIDS (5437)), [ADHS Pregnancy and Breastfeeding Helpline](#) (1-800-833-4642), and the [Women and Children's Health Information Center](#) (1-800-232-1676) to increase utilization of existing and low-cost services for women and families.
- ❖ In accordance with the [Arizona Suicide Prevention Action Plan](#), strategies for families to support individuals with a history of depression and/or suicide threats/attempts, including strategies for supporting people while they are in crisis, such as the [Applied Suicide Intervention Skills Training \(ASIST\)](#) suicide prevention training program.
- ❖ In accordance with the [Arizona Opioid Action Plan](#) and the [Arizona Neonatal Abstinence Syndrome Action Plan](#), availability of local resources for substance use treatment, mental health services, domestic violence, legal services, vocational training, etc., in a manner that is destigmatizing and encouraging to women before, during, and after pregnancy.
- ❖ In accordance with the [Arizona Opioid Action Plan](#), life saving strategies such as CPR or use of opioid antagonists such as Narcan (including information on where to obtain them).
- ❖ In accordance with the [AHCCCS Office of Individual and Family Affairs](#), enact efforts to reduce stigma of mental health.
- ❖ Elements of healthy relationships, strategies/resources to overcome instances of abuse, and education recognizing domestic violence as a crime – education should be provided in all high schools and/or middle schools.
- ❖ Opportunities to access free or low-cost health care at federally qualified health centers and other safety-net providers to support early entry into prenatal care.

**Other:** Parental strategies to educate children/youth about sexual predators, alcohol/tobacco/substance use, healthy relationships, and dangerous social environments; family planning resources, including where to access no cost or low-cost contraceptive services; local consequences of driving under the influence or driving with a suspended license (e.g., local fines, mandatory jail time), importance of wearing a seatbelt, and safe driving



protocols (e.g., no texting and driving, securing loads); dangers of vaping and safe use of medical marijuana before, during, and after pregnancy.

- ▶▶ Support schools in enhancing **behavioral health services** for students experiencing depression or other mental health concerns.
- ▶▶ Ensure women in all regions of the state have access to **faith-based services** (e.g., Catholic Social Services) or **other services** (e.g., public health services) to support women in completing their education, issues of life instability, lack of resources for child care, and/or access to healthy foods, etc.
- ▶▶ Establish community models of **peer support** across the perinatal period that includes voluntary access and referral to appropriate resources for women experiencing:
  - ❖ Perinatal mood disorders, including support systems for families of individuals with perinatal mood disorders.
  - ❖ Substance use disorders, including harm reduction environments.
  - ❖ Domestic or intimate partner violence (including safety planning).
  - ❖ Loss of a child or miscarriage.

**Other:** Chronic conditions (e.g., diabetes); separation from a child or family (e.g., DCS involvement); challenges with parenting, including solo-parenting and/or parenting children with disabilities or behavioral concerns.



## Section 5: Discussion

Arizona's PRMR for 2016-2017 was 18.3, while the national PRMR was 16.9 in 2016 and 17.3 in 2017. Though comparing Arizona's PRMR to national or other state ratios is not appropriate given slight differences in samples and inclusion criteria between states, this may further indicate a need to implement the recommendations included in **Section 4** and in this discussion.

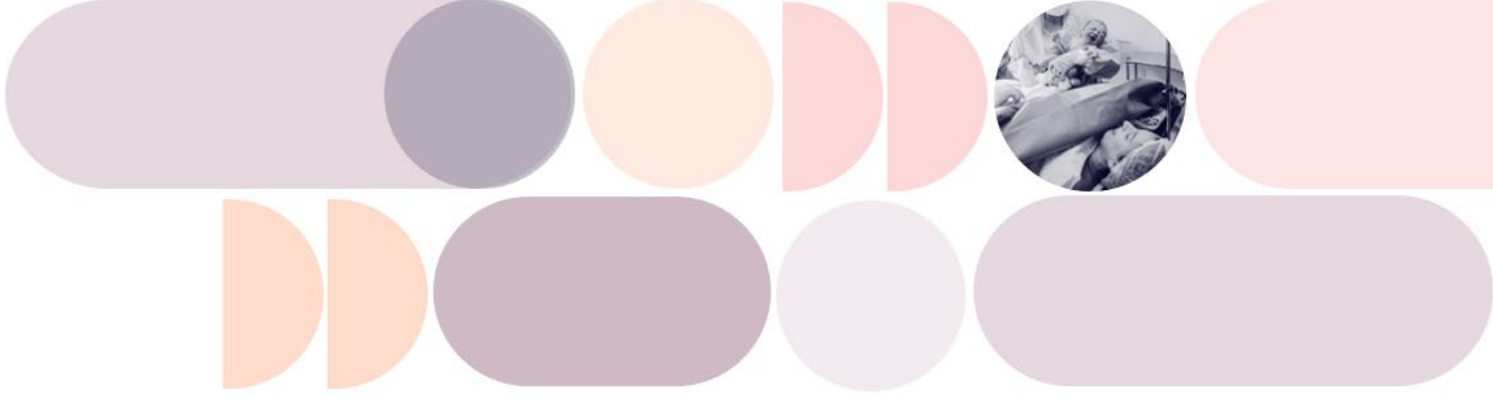
Common themes from these analyses revealed areas of opportunity in preventing MM and SMM, including a need for continuity of care throughout all perinatal periods (preconception, prenatal, labor and delivery, and postpartum), integration of mental and behavioral healthcare, addressing implicit and explicit biases in care, and supporting patient needs across all social determinants of health.

During the preconception health period, access to care to manage chronic conditions and improve overall health status prior to pregnancy would reduce the risk of Pregnancy-Related mortality and SMM, as women with pre-existing diabetes or chronic hypertension, as well as women with underweight or obese pre-pregnancy BMIs, all had increased rates of MM and SMM than their counterparts. Additionally, access to family planning services and effective contraceptives would empower women and their families to appropriately time pregnancies, as well as prevent unintended high-risk pregnancies.

Care during pregnancy was another area that shows promise in improving MM and SMM. Women with late or inadequate prenatal care, including those with no prenatal care at all, had much higher rates of SMM than women with early and adequate prenatal care. Access to prenatal care would allow for management of risk factors that exist before or arise during pregnancy, including chronic or gestational conditions such as diabetes and hypertension, as well as promote behaviors that improve maternal and neonatal outcomes like healthy weight gain and smoking cessation. Additionally, the prenatal period should be considered a key opportunity to assess patients for other risks, such as perinatal mood disorders, substance use, domestic violence, and SDOH such as housing, food, and financial security -- and ultimately, provide appropriate care or linkage to services that may support them in overcoming these risks.

There are also opportunities to improve care during labor and delivery, such as ensuring women have access to timely and risk-appropriate level of care and implementing quality improvement efforts. Non-APT certified facilities, including non-birthing hospitals, and Level I facilities both had higher rates of SMM compared to Level II facilities, which could be the result of limited high-risk maternal care specialists and resources. Conversely, Level III facilities also had higher SMM rates than Level II or Level IIE facilities, possibly indicating the successful transfer of high-risk pregnancies and delivery emergencies to these facilities capable of providing increased care. Quality improvement efforts, including AIM Patient Safety Bundles, should be adopted and implemented across the state to focus on Arizona's most prevalent and preventable risk factors





in a clinical setting through evidence-based practices. While Arizona is initially focusing on the AIM Severe Hypertension in Pregnancy bundle as a state-wide effort, health systems and facilities should identify and implement other quality improvements based on local needs and/or outcomes.

In addition to these areas for improved access and quality of care, several disparities in MM and SMM were identified by race and ethnicity, socioeconomic status, geography, and other maternal demographics. These disparities point to the need for improved health equity and targeted interventions to effectively reduce MM and SMM among the most vulnerable and high-risk populations in the state. Many of the recommendations developed by the MMRC reflect the tenets of [New York City's Standards for Respectful Care at Birth](#). These standards are centered on the principle that all women have a human right to respectful, safe, and quality care during their birthing experience through education, shared decision-making, support across perinatal periods, informed consent, quality of care, and dignity and nondiscrimination. These standards, paired with the [Institute for Healthcare Improvement Health Equity Framework](#) and other health equity initiatives, can support healthcare systems in achieving safe and equitable care for all women in Arizona.

The mechanisms in which healthcare is reimbursed should reflect each of the discussion topics as a priority. At least one third of pregnancy-associated deaths in Arizona occur in the postpartum period indicating the need to expand AHCCCS coverage to one year postpartum. Similarly, care provided by midwives, doulas, community health workers, case managers and social workers have shown to improve maternal health outcomes, yet this is often not reflected in the way payers reimburse for maternal healthcare. Though there is a national focus on improving the quality of maternal health care to reduce MM and SMM, these efforts require extensive provider time and resources, which are also not often funded by payers. To this end, health outcomes for all mothers and babies in Arizona depend on how and if maternal healthcare is covered or reimbursed.



## Section 6: Limitations

Several limitations should be kept in mind when reviewing data included in this report. The following sections describe limitations in reporting MM and SMM in Arizona.

### Limitations in Reporting Maternal Mortality

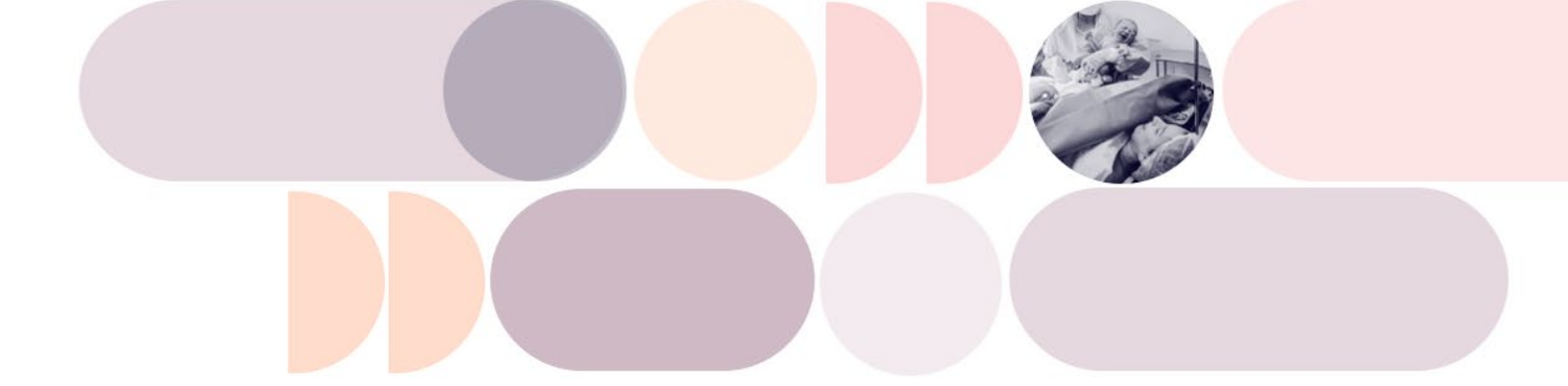
One of the most significant limitations in reviewing maternal mortalities is consistency in available records across all decedents. Though MMRP staff work diligently to identify and request records from relevant sources, delays in receiving these records and inconsistencies in details included in records creates gaps in our understanding of the factors contributing to each decedent's death. For example, the MMRC determined that only 65% of maternal mortality case narratives had complete or mostly complete records. Records that are often the most difficult to obtain include primary care records if the provider is unknown, case management or social work notes, and mental health or behavioral health records. The MMRP also respects the sovereignty of data and healthcare records originating from Arizona's tribal nations. To this end, healthcare, police, EMS, and other records from incidents or encounters occurring on a reservation are often unavailable.

While the MMRP does have a standard outline used to develop all case narratives, content included in the narratives is identified and abstracted by clinical nurse abstractors using their best judgment of the information available to them. Social factors that may or may not have contributed to a decedent's death are difficult to interpret from records, particularly in the absence of detailed case management notes or interviews with family members or friends (most often found in police records or medical examiner Preliminary Investigative Reports). Additionally, MMRC membership has shifted over time and attendance for reviews varies slightly from meeting to meeting. To this end, there is often a risk of bias or inconsistency during the abstraction and review process based on the available context narratives or the mix of professionals who are reviewing the narrative in any given meeting.

Though ADHS adopted the Review to Action Guidelines in 2018, the MMRC had already begun reviewing 2016 deaths at that time. Additionally, the Review to Action Guidelines have evolved over time, resulting in slight gaps or inconsistencies in committee decisions made for each death. The MMRP staff kept these inconsistencies in mind when analyzing and reporting data that may be affected.

### Limitations in Reporting Severe Maternal Morbidity

The hospital discharge data used in this report provide a unique opportunity to examine the clinical characteristics of delivery, such as diagnoses and procedures that occur in the hospital. Despite best efforts to identify and describe SMM events across clinical characteristics, several limitations should be noted. In



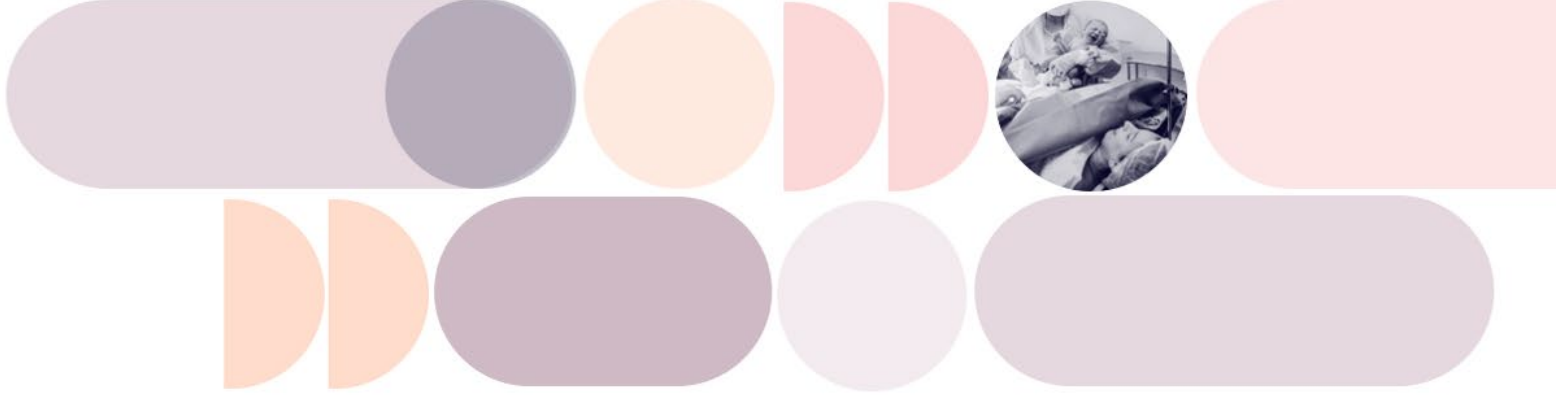
administrative data such as hospital discharge records, events based on ICD codes may be over- or underreported, or the severity of certain events may not be accurately captured. This is especially true with coding blood transfusions procedures in perinatal patients. While most facilities nationally were using ICD- 9-CM transfusion codes to report blood transfusion procedures before 2016, the transition to ICD-10-CM the reporting became more complex and some facilities were electing not to report.<sup>83</sup> Additionally, transfusion codes do not account for the number of units transfused. Together, the changes to ICD-10-CM and possible underreporting make it questionable to conclude that there was a real decrease in SMM rates from 2016-2017. Conversely, without the ability to control for the number of units of blood products given, transfusion may be overreported as a measure of SMM in events that might have received fewer than 4 units, which had previously been the defining benchmark of SMM. Further, as the Hospital Discharge Database is collected from billing and claims data, the codes present may be influenced by practices to maximize reimbursement, and may differ across facilities or patients with different payer types.<sup>84</sup>

This analysis only captures resident live births that occurred in a reporting facility, and these facilities do not include any of the IHS facilities in Arizona. Some reporting facilities may have data excluded based on data quality issues that would otherwise be available; this impacted this study by the exclusion of 2017 data among two birth facilities.

This analysis is also limited to delivery hospitalizations, thus pregnancies not resulting in a live birth, including ectopic and molar pregnancies, spontaneous abortions, and stillbirths, were excluded, as were deliveries outside of a hospital, such as home births or deliveries at birth centers. Prenatal encounters or postpartum hospitalizations that could have been related to unexpected outcomes of the delivery were also not included in this analysis.

The use of birth certificate data linked to hospital discharge data introduced additional limitations to this study, especially since births without a matching birth certificate and delivery hospitalization were not included. While this represents less than 5% of deliveries among Arizona residents in 2016-2019, it is still meaningful to note. Birth certificate data quality may also influence our analysis of SMM, especially with potential differences in how variables are captured across facilities, such as prenatal care or chronic health conditions. As this analysis used HDD data linked to birth certificate data, comparison to rates with samples using only unlinked HDD data may not be valid.

This report is a retrospective cross-sectional analysis of the distribution of SMM events and rates within a sample of resident delivery hospitalizations for 2016-2019, with no additional statistical testing to quantify the significance of relationships between various factors and outcomes. As such data should be interpreted with caution in identifying potential associations, and without conclusions about cause and effect.



Lastly, the analysis cannot consider social determinants of health of a particular woman such as economic stability, access to health providers, and environmental health that may impact SMM. These can be important contributors of SMM that often are overlooked.

## Section 7: Appendices

### Appendix A: Arizona Maternal Mortality Review Committee Membership

**Teresa Anzar, RNC-OB, MSN**

RN Consultant  
United Healthcare  
Arizona Perinatal Trust

**Autumn Argent, MSN, RNC-OB, CCE**

System Educator – Perinatal  
Norther Arizona Healthcare

**Melony Baty**

Healthy Start Project Director  
Maricopa County Department of Public Health

**Jennie Bever, PhD, IBCLC**

Founder  
4<sup>th</sup> Trimester

**Deb Christian**

Executive Director  
Arizona Perinatal Trust

**Mike Clement, MD**

Retired Pediatrician  
Arizona Perinatal Trust

**Dean Coonrod, MD**

Chair Department of Obstetrics and Gynecology  
Maricopa Integrated Health System / District Medical Group  
Professor Department of Obstetrics and Gynecology  
University of Arizona College of Medicine-Phoenix

**Kimberly Couch, RN, CNM, FNP, DPN (Capt.)**

Director of Women and Infant Services  
Phoenix Indian Medical Center  
Indian Health Services  
United States Public Health Service Corp

**Cortney Eakin, MD**

Global Women's Health Fellow  
Creighton University School of Medicine – Phoenix

**Nora Espino**

Intimate Partner Homicide Project Coordinator  
Arizona Coalition to End Sexual and Domestic Violence

**Timothy Flood, MD**

Bureau Medical Director  
Arizona Department of Health Services

**Katherine Glaser, MD, MPH**

General Obstetrics and Gynecology  
Tuba City Regional Health Care Corporation

**Kendra Gray, DO**

Maternal Fetal Medicine  
Phoenix Perinatal and Associates

**Craig (Will) Heise, MD**

Toxicologist  
University of Arizona, College of Medicine  
Phoenix, Dept of Medical Toxicology  
Banner University Medical Center – Phoenix

**Guadalupe Herrera-Garcia, DO**

Maternal Fetal Medicine  
Genesis Maternal Fetal Medicine

**Cindy Herrick**

2020 Mom  
National Maternal Mental Health Awareness  
Campaign Lead  
National Maternal Suicide Awareness  
Campaign Lead

**Kevin Huls, MD, MFM**

Medical Director  
Phoenix Perinatal Associates  
Banner University Medical Center

**Robert (BJ) Johnson, MD**

*MMRC Chairman*  
Maternal Fetal Medicine  
Arizona Perinatal Trust

**Diana Jolles, PhD, CNM, FACNM**

DNP Clinical Faculty  
Frontier Nursing University  
American Association of Birth Centers

**Kim Kriesel, LAC, PMH-C**

Perinatal Therapist  
Well Mamas Counseling

**Amy Lebbon, CNM**

Certified Nurse-Midwife  
Phoenix Indian Medical Center  
Indian Health Services

**Monique Lin, MD, MSPH**

Maternal Fetal Medicine  
Mountain Park Health Center, Inc.

**Sheri Lopez, CD-DONA, CLC, NCS, CPDD, CCBE, CPBET, RN**

Founder  
You Can't Groom Me  
Birth and Baby Services (BABS)

**Paula Mandel, RN**

Deputy Director  
Pima County Health Department

**Linda Meiner, MSN, RNC-NIC, NE-BC**

Clinical Transport Manager – Perinatal Transport  
PHI AirMedical / Air Evac Services

**Monica Miller, RN, BS**

Registered Nurse  
Valleywise Health

**Kimberly Moore-Salas**

Lactation Consultant  
Valleywise Health

**Tandie Myles, LCSW**

Licensed Clinical Social Worker  
Mountain Park Health Center, Maryvale Clinic

**Vicki Rainy**

Recovery Educator  
RI International

**Andrew Rubenstein, MD, FACOG**

Academic Chairman  
Dignity Health Medical Group, Department of Obstetrics and  
Gynecology  
Associate Professor  
Creighton University Medical Campus Phoenix

**Nick Stepp**

Detective  
Glendale Police Department

**Patricia Tarango, MS**

*MMRP Principle Investigator*  
Bureau Chief, Bureau of Women's and  
Children's Health  
Arizona Department of Health Services

**Roberta Ward, CNM, FNP, DNP**

Nurse-Midwife  
Salt River Pima-Maricopa Indian Care

**Breann Westmore**

Director, Maternal Child Health and  
Government Affairs  
March of Dimes, Arizona Chapter

**Elizabeth Wood**

Co-Founder, Educator  
Matrescence: 4<sup>th</sup> Trimester

## Appendix B: Glossary

- **Arizona Perinatal Trust Levels of Care:** Based on the Arizona Perinatal Trust Voluntary Certification Program (VCP) which is a peer review/quality assurance process to reduce maternal morbidity and mortality and to improve the care of patients. A full description of each level of care can be found in **Appendix G**.
- **Indicator of SMM:** a list of 21 diagnoses or procedures considered an indication of SMM during the delivery hospitalization, identified by a set of ICD-10 billing codes in the Hospital Discharge Data (HDD) record. See Appendix B for a complete list and definition of these indicators.
- **Maternal Mortality:** the death of a woman while pregnant or within 1 year of the end of a pregnancy – regardless of the outcome, duration, or site of the pregnancy – from any cause related to or aggravated by the pregnancy or its management. Though the CDC definition excludes accidental and incidental causes from maternal mortality reporting, the Arizona MMRP reviews and reports on all maternal mortalities occurring in Arizona regardless of the manner of death.
- **Pregnancy-Associated:** The death of a woman during pregnancy or within one year of the end of pregnancy, regardless of the cause. All deaths that have a temporal relationship to pregnancy are included.
- **Pregnancy-Associated Mortality Ratio:** An estimate of the number of pregnancy-associated deaths for every 100,000 live births.
- **Pregnancy-Related:** The death of a woman during pregnancy or within one year of the end 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. In addition to having a temporal relationship to pregnancy, these deaths are causally related to pregnancy or its management.
- **Pregnancy-Related Mortality Ratio:** An estimate of the number of pregnancy-related deaths for every 100,000 live births. This ratio is often used as an indicator to measure the nation’s health.
- **Preventability:** A death is considered preventable if the committee determines that there was at least some chance of the death being averted by one or more reasonable changes to patient, community, provider, facility, and/or systems factors. MMRIA allows MMRCs to document preventability decisions in two ways: 1) determining preventability as a “yes” or “no”, and/or 2) determining the chance to alter the outcome using a scale that indicates “no chance”, “some chance”, or “good chance”. Any death with a “yes” response or a response that there was “some chance” or a “good chance” to alter the outcome was considered “preventable”; deaths with a “no” response or “no chance” were considered “not preventable”.
- **Primary Care Areas:** A Primary Care Area (PCA) denotes the geographic area generally served by a common primary health provider. For example, it is used by the Health Resources and Services Administration to designate areas of workforce shortage.
- **Qualifying Condition of SMM:** at least one of five conditions that must be met for the inclusion of an SMM case in this study – transfer into or out of the delivery hospitalization, death during the delivery hospitalization, one of the five SMM procedure indicators, or a length of stay of 4 or more days for vaginal or primary cesarean deliveries, or 5 or more days for repeat cesarean deliveries.



- **Resident:** Arizona residency was determined by the county of residence as listed on the death certificate (MMRC reviewed deaths) or birth certificate at the time of delivery (analysis of Severe Maternal Morbidities). This is not an indication of citizenship or legal residence in Arizona.
- **Severe Maternal Morbidity (SMM):** unexpected conditions or outcomes of pregnancy, delivery, or postpartum that aggravate or lead to significant negative effects on a woman's health and wellbeing.
- **Severe Maternal Morbidity Events:** includes women with a delivery hospitalization and a diagnosis or a procedure code indicator for SMM, as well as a qualifying condition indicating severity, including transfer in or out of the birth facility, death, length of stay longer than expected, or one of the procedure codes.
- **Severe Maternal Morbidity Rate:** Number of delivery hospitalizations with an indication of an SMM diagnosis or procedure codes along with a qualifying condition over the total number of delivery hospitalizations calculated per 10,000 delivery hospitalizations.
- **Singleton Birth:** the birth of only one child during a single delivery.
- **Underlying Cause of Death:** The disease or injury that initiated the chain of events leading to death or the circumstances of the accident or violence which produced the fatal injury. In addition to the listed causes of death from the death certificate, the MMRC assigns an underlying cause of death code for Pregnancy-Related cases.

## Appendix C: AZ Statute Language



DOUGLAS A. DUCEY  
GOVERNOR

STATE OF ARIZONA  
OFFICE OF THE GOVERNOR

EXECUTIVE OFFICE

April 29, 2019

The Honorable Katie Hobbs  
Secretary of State  
1700 W. Washington, 7<sup>th</sup> Floor  
Phoenix, AZ 85007

Dear Secretary Hobbs:

I am transmitting to you the following bills from the Fifty-fourth Legislature, 1st Regular Session, which I signed on April 29th, 2019:

H.B. 2063 vehicle insurance cards; assigned numbers (Biasiucci)  
H.B. 2181 licensing; exemption; registrar of contractors (Grantham)  
H.B. 2452 vehicle emissions program; remote inspections (Griffin)  
S.B. 1024 medical marijuana; sales data; enforcement (Borrelli)  
S.B. 1040 maternal morbidity; mortality; report (Brophy-McGee)  
S.B. 1311 material witnesses; contempt; detention; bond (E. Farsworth)  
S.B. 1397 registrar of contractors omnibus (Mesnard)  
S.B. 1443 bullhead city; state land transfer (Borrelli)  
S.B. 1498 egg promotion program (Kerr)

Sincerely,

A handwritten signature in black ink that reads "Douglas A. Ducey".

Douglas A. Ducey  
Governor  
State of Arizona

cc: Senate Secretary  
Chief Clerk of the House of Representatives  
Arizona News Service

1700 WEST WASHINGTON STREET, PHOENIX, ARIZONA 85007  
602-542-4331 • [www.azgovernor.gov](http://www.azgovernor.gov)

House Engrossed Senate Bill

**FILED**  
**KATIE HOBBS**  
**SECRETARY OF STATE**

State of Arizona  
Senate  
Fifty-fourth Legislature  
First Regular Session  
2019

**CHAPTER 143**  
**SENATE BILL 1040**

AN ACT

ESTABLISHING THE ADVISORY COMMITTEE ON MATERNAL FATALITIES AND MORBIDITY.

(TEXT OF BILL BEGINS ON NEXT PAGE)

- 1 -

1 Be it enacted by the Legislature of the State of Arizona:

2 Section 1. Advisory committee on maternal fatalities and  
3 morbidity; membership; report; delayed repeal

4 A. The advisory committee on maternal fatalities and morbidity is  
5 established to recommend improvements to information collection concerning  
6 the incidence and causes of maternal fatalities and severe maternal  
7 morbidity. The director of the department of health services shall  
8 appoint the members of the advisory committee. One of the members of the  
9 advisory committee shall be from a county with a population of less than  
10 five hundred thousand. The director or the director's designee shall  
11 serve as chairperson of the committee. The chairperson may not be  
12 affiliated with an organization that is otherwise represented on the  
13 committee.

14 B. The advisory committee consists of the following members:

15 1. A representative of a contractor from each geographic service  
16 area designated by the Arizona health care cost containment system.

17 2. A representative of the Arizona health care cost containment  
18 system.

19 3. A representative of Indian health services.

20 4. Three obstetricians, of which at least two are maternal fetal  
21 medicine specialists, who are licensed pursuant to title 32, chapter 13 or  
22 17, Arizona Revised Statutes.

23 5. A certified nurse midwife who is certified pursuant to title 32,  
24 chapter 15, Arizona Revised Statutes.

25 6. Two representatives of nonprofit organizations that provide  
26 education, services or research related to maternal fatalities and  
27 morbidity.

28 7. A representative of this state's health information  
29 organization.

30 8. A representative of a public health organization.

31 9. Two representatives of organizations that represent hospitals in  
32 this state.

33 C. The department of health services, in conjunction with the  
34 advisory committee, shall hold a public hearing to receive public input  
35 regarding the recommended improvements to information collection  
36 concerning the incidence and causes of maternal fatalities and severe  
37 maternal morbidity.

38 D. On or before December 31, 2019, the advisory committee shall  
39 submit to the chairpersons of the health and human services committees of  
40 the house of representatives and the senate, or their successor  
41 committees, a report with recommendations concerning improving information  
42 collection on the incidence and causes of maternal fatalities and severe  
43 maternal morbidity.

1 E. This section is repealed on July 1, 2020.

2 Sec. 2. Department of health services; report; delayed repeal

3 A. On or before December 31, 2020, the department of health  
4 services shall submit a report to the governor, the speaker of the house  
5 of representatives and the president of the senate, and shall provide a  
6 copy to the secretary of state, on the incidence and causes of maternal  
7 fatalities and morbidity that includes all readily available data through  
8 the end of 2019.

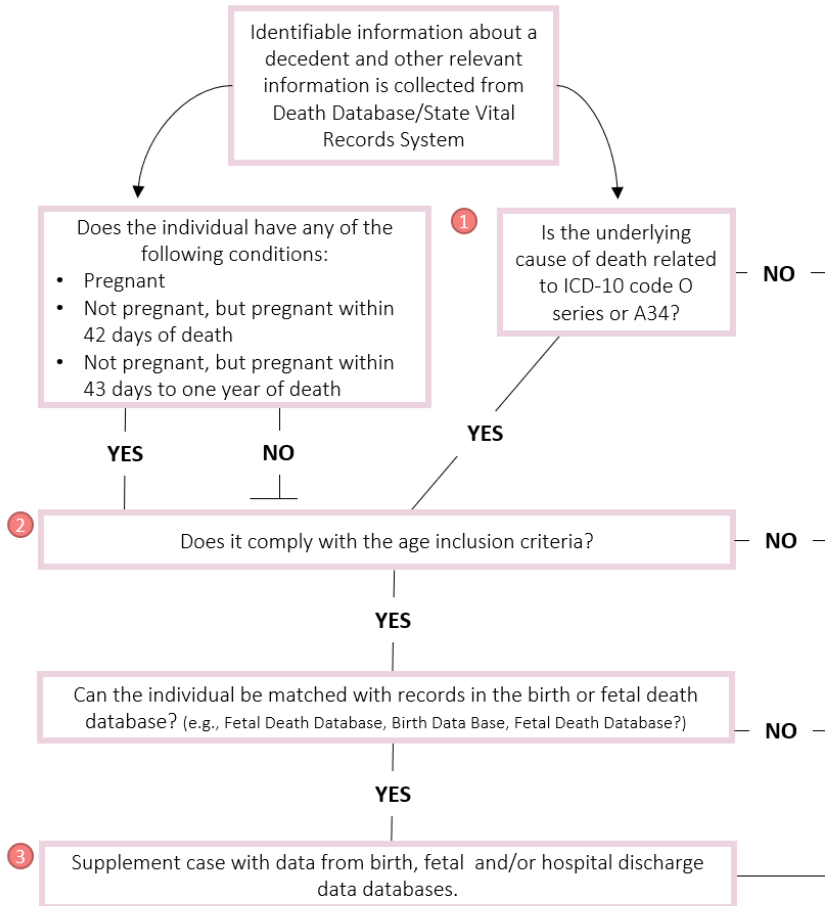
9 B. This section is repealed on July 1, 2021.

10 Sec. 3. Emergency

11 This act is an emergency measure that is necessary to preserve the  
12 public peace, health or safety and is operative immediately as provided by  
13 law.

## Appendix D: Review to Action Flow Chart

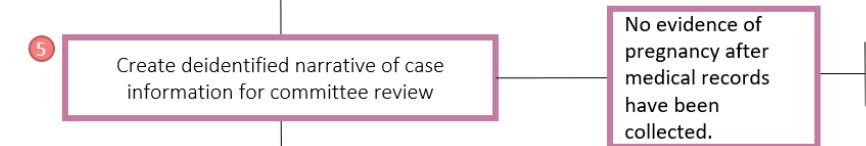
### Identification



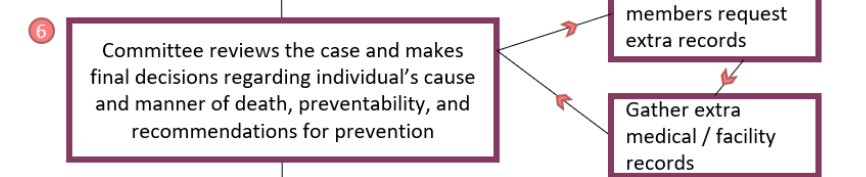
### Records Requests



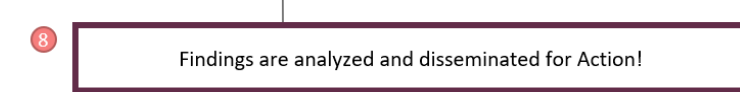
### Abstraction



### Review



### Action!



## Appendix E: MMRIA Committee Decisions Form

The Committee Decisions Form displayed here is Version 19 of the form. CDC updates this form periodically, and therefore, several version of this form were used to review the 134 maternal mortality cases included in this report.

MMRIA		MATERNAL MORTALITY REVIEW COMMITTEE DECISIONS FORM v19		1
<b>REVIEW DATE</b> <input type="text"/> / <input type="text"/> / <input type="text"/> <small>Month Day Year</small>		<b>RECORD ID #</b> <input type="text"/>		
<b>COMMITTEE DETERMINATION OF CAUSE(S) OF DEATH</b>				
<b>IF PREGNANCY-RELATED, COMMITTEE DETERMINATION OF UNDERLYING* CAUSE OF DEATH</b> Refer to page 3 for PMSS-MM cause of death list.				
<b>PREGNANCY-RELATEDNESS: SELECT ONE</b>				
<input type="checkbox"/> <b>PREGNANCY-RELATED</b> <small>The death of a woman during pregnancy or within one year of the end 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</small>		<b>TYPE</b>		
<input type="checkbox"/> <b>PREGNANCY-ASSOCIATED, BUT NOT -RELATED</b> <small>The death of a woman during pregnancy or within one year of the end of pregnancy from a cause that is not related to pregnancy</small>		<b>OPTIONAL: CAUSE (DESCRIPTIVE)</b>		
<input type="checkbox"/> <b>PREGNANCY-ASSOCIATED BUT UNABLE TO DETERMINE PREGNANCY-RELATEDNESS</b>		<b>UNDERLYING*</b>		
<input type="checkbox"/> <b>NOT PREGNANCY-RELATED OR -ASSOCIATED</b> <small>(i.e. false positive, woman was not pregnant within one year of her death)</small>		<b>CONTRIBUTING</b>		
		<b>IMMEDIATE</b>		
		<b>OTHER SIGNIFICANT</b>		
<b>COMMITTEE DETERMINATIONS ON CIRCUMSTANCES SURROUNDING DEATH</b>				
<b>DID OBESITY CONTRIBUTE TO THE DEATH?</b> <input type="checkbox"/> YES <input type="checkbox"/> PROBABLY <input type="checkbox"/> NO <input type="checkbox"/> UNKNOWN				
<b>DID DISCRIMINATION CONTRIBUTE TO THE DEATH?</b> <input type="checkbox"/> YES <input type="checkbox"/> PROBABLY <input type="checkbox"/> NO <input type="checkbox"/> UNKNOWN				
<b>DID MENTAL HEALTH CONDITIONS OTHER THAN SUBSTANCE USE DISORDER CONTRIBUTE TO THE DEATH?</b> <input type="checkbox"/> YES <input type="checkbox"/> PROBABLY <input type="checkbox"/> NO <input type="checkbox"/> UNKNOWN				
<b>DID SUBSTANCE USE DISORDER CONTRIBUTE TO THE DEATH?</b> <input type="checkbox"/> YES <input type="checkbox"/> PROBABLY <input type="checkbox"/> NO <input type="checkbox"/> UNKNOWN				
<b>MANNER OF DEATH</b>				
<b>WAS THIS DEATH A SUICIDE?</b> <input type="checkbox"/> YES <input type="checkbox"/> PROBABLY <input type="checkbox"/> NO <input type="checkbox"/> UNKNOWN				
<b>WAS THIS DEATH A HOMICIDE?</b> <input type="checkbox"/> YES <input type="checkbox"/> PROBABLY <input type="checkbox"/> NO <input type="checkbox"/> UNKNOWN				
<b>ESTIMATE THE DEGREE OF RELEVANT INFORMATION (RECORDS) AVAILABLE FOR THIS CASE:</b>		<b>IF ACCIDENTAL DEATH, HOMICIDE, OR SUICIDE, LIST THE MEANS OF FATAL INJURY</b>		
<input type="checkbox"/> <b>COMPLETE</b> <small>All records necessary for adequate review of the case were available</small>		<input type="checkbox"/> <b>FIREARM</b> <input type="checkbox"/> <b>FALL</b> <input type="checkbox"/> <b>INTENTIONAL NEGLIGENCE</b>		
<input type="checkbox"/> <b>SOMEWHAT COMPLETE</b> <small>Major gaps (i.e. information that would have been crucial to the review of the case)</small>		<input type="checkbox"/> <b>SHARP INSTRUMENT</b> <input type="checkbox"/> <b>PUNCHING/ KICKING/BEATING</b> <input type="checkbox"/> <b>OTHER, SPECIFY:</b>		
<input type="checkbox"/> <b>MOSTLY COMPLETE</b> <small>Minor gaps (i.e. information that would have been beneficial but was not essential to the review of the case)</small>		<input type="checkbox"/> <b>BLUNT INSTRUMENT</b> <input type="checkbox"/> <b>EXPLOSIVE</b>		
<input type="checkbox"/> <b>NOT COMPLETE</b> <small>Minimal records available for review (i.e. death certificate and no additional records)</small>		<input type="checkbox"/> <b>POISONING/ OVERDOSE</b> <input type="checkbox"/> <b>DROWNING</b>		
<input type="checkbox"/> <b>N/A</b>		<input type="checkbox"/> <b>HANGING/ STRANGULATION/ SUFFOCATION</b> <input type="checkbox"/> <b>FIRE OR BURNS</b> <input type="checkbox"/> <b>MOTOR VEHICLE</b> <input type="checkbox"/> <b>UNKNOWN</b> <input type="checkbox"/> <b>NOT APPLICABLE</b>		
<b>DOES THE COMMITTEE AGREE WITH THE UNDERLYING* CAUSE OF DEATH LISTED ON DEATH CERTIFICATE?</b> <input type="checkbox"/> YES <input type="checkbox"/> NO		<b>IF HOMICIDE, WHAT WAS THE RELATIONSHIP OF THE PERPETRATOR TO THE DECEDENT?</b>		
		<input type="checkbox"/> <b>NO RELATIONSHIP</b> <input type="checkbox"/> <b>OTHER ACQUAINTANCE</b> <input type="checkbox"/> <b>UNKNOWN</b>		
		<input type="checkbox"/> <b>PARTNER</b> <input type="checkbox"/> <b>OTHER, SPECIFY:</b> <input type="checkbox"/> <b>NOT APPLICABLE</b>		
		<input type="checkbox"/> <b>EX-PARTNER</b>		
		<input type="checkbox"/> <b>OTHER RELATIVE</b>		

\*Underlying cause refers to the disease or injury that initiated the chain of events leading to death or the circumstances of the accident or violence which produced the fatal injury



**COMMITTEE DETERMINATION OF PREVENTABILITY**

A death is considered preventable if the committee determines that there was at least some chance of the death being averted by one or more reasonable changes to patient, family, provider, facility, system and/or community factors.

WAS THIS DEATH PREVENTABLE?  YES  NO

CHANCE TO ALTER OUTCOME  GOOD CHANCE  SOME CHANCE  
 NO CHANCE  UNABLE TO DETERMINE

**CONTRIBUTING FACTORS AND RECOMMENDATIONS FOR ACTION** (Entries may continue to grid on page 5)

**CONTRIBUTING FACTORS WORKSHEET**

What were the factors that contributed to this death?  
 Multiple contributing factors may be present at each level.

**RECOMMENDATIONS OF THE COMMITTEE**

If there was at least some chance that the death could have been averted, what were the specific and feasible actions that, if implemented or altered, might have changed the course of events?

LEVEL	CONTRIBUTING FACTORS (choose as many as needed below)	DESCRIPTION OF ISSUE (enter a description for EACH contributing factor listed)	COMMITTEE RECOMMENDATIONS [Who?] should [do what?] [when?] Map recommendations to contributing factors.	PREVENTION LEVEL (choose below)	EXPECTED IMPACT (choose below)
PATIENT/FAMILY	▼			▼	▼
PROVIDER	▼			▼	▼
FACILITY	▼			▼	▼
SYSTEM	▼			▼	▼
COMMUNITY	▼			▼	▼

**CONTRIBUTING FACTOR KEY (DESCRIPTIONS ON PAGE 4)**

- Access/financial
- Adherence
- Assessment
- Childhood abuse/trauma
- Chronic disease
- Clinical skill/quality of care
- Communication
- Continuity of care/care coordination
- Cultural/religious
- Delay
- Discrimination
- Environmental
- Equipment/technology
- Interpersonal racism
- Knowledge
- Law Enforcement
- Legal
- Mental health conditions
- Outreach
- Policies/procedures
- Referral
- Social support/isolation
- Structural racism
- Substance use disorder - alcohol, illicit/prescription drugs
- Tobacco use
- Unstable housing
- Violence
- Other

**PREVENTION LEVEL**

- **PRIMARY:** Prevents the contributing factor before it ever occurs
- **SECONDARY:** Reduces the impact of the contributing factor once it has occurred (i.e. treatment)
- **TERTIARY:** Reduces the impact or progression of what has become an ongoing contributing factor (i.e. management of complications)

**EXPECTED IMPACT**

- **SMALL:** Education/counseling (community- and/or provider-based health promotion and education activities)
- **MEDIUM:** Clinical intervention and coordination of care across continuum of well-woman visits (protocols, prescriptions)
- **LARGE:** Long-lasting protective intervention (improve readiness, recognition and response to obstetric emergencies/LARC)
- **EXTRA LARGE:** Change in context (promote environments that support healthy living/ensure available and accessible services)
- **GIANT:** Address social determinants of health (poverty, inequality, etc.)

### IF PREGNANCY-RELATED, COMMITTEE DETERMINATION OF UNDERLYING CAUSE OF DEATH\* PMSS-MM

If more than one is selected, please list them in order of importance beginning with the most compelling (1-2; no more than 2 may be selected in the system).

\*PREGNANCY-RELATED DEATH: THE DEATH OF A WOMAN DURING PREGNANCY OR WITHIN ONE YEAR OF THE END 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.

- |   |   |  |
|---|---|--|
| <input type="checkbox"/> 10 Hemorrhage (excludes aneurysms or CVA)  | <input type="checkbox"/> 83 Collagen vascular/autoimmune diseases   | <input type="checkbox"/> 92.1 Epilepsy/seizure disorder  |
| <input type="checkbox"/> 10.1 Hemorrhage - rupture/laceration/<br>intra-abdominal bleeding                            | <input type="checkbox"/> 83.1 Systemic lupus erythematosus (SLE)  | <input type="checkbox"/> 92.9 Other neurologic diseases/NOS  |
| <input type="checkbox"/> 10.2 Placental abruption   | <input type="checkbox"/> 83.9 Other collagen vascular diseases/NOS  | <input type="checkbox"/> 93 Renal disease  |
| <input type="checkbox"/> 10.3 Placenta previa   | <input type="checkbox"/> 85 Conditions unique to pregnancy (e.g.<br>gestational diabetes, hyperemesis, liver<br>disease of pregnancy)                           | <input type="checkbox"/> 93.1 Chronic renal failure/End-stage renal<br>disease (ESRD)  |
| <input type="checkbox"/> 10.4 Ruptured ectopic pregnancy  | <input type="checkbox"/> 88 Injury  | <input type="checkbox"/> 93.9 Other renal disease/NOS  |
| <input type="checkbox"/> 10.5 Hemorrhage - uterine atony/postpartum<br>hemorrhage                                     | <input type="checkbox"/> 88.1 Intentional (homicide)  | <input type="checkbox"/> 95 Cerebrovascular accident (hemorrhage/<br>thrombosis/aneurysm/ malformation)<br>not secondary to hypertensive disease |
| <input type="checkbox"/> 10.6 Placenta accreta/increta/percreta   | <input type="checkbox"/> 88.2 Unintentional   | <input type="checkbox"/> 96 Metabolic/endocrine  |
| <input type="checkbox"/> 10.7 Hemorrhage due to retained placenta   | <input type="checkbox"/> 88.9 Unknown/NOS   | <input type="checkbox"/> 96.1 Obesity  |
| <input type="checkbox"/> 10.8 Hemorrhage due to primary DIC   | <input type="checkbox"/> 89 Cancer  | <input type="checkbox"/> 96.2 Diabetes mellitus  |
| <input type="checkbox"/> 10.9 Other hemorrhage/NOS  | <input type="checkbox"/> 89.1 Gestational trophoblastic disease (GTD)   | <input type="checkbox"/> 96.9 Other metabolic/endocrine disorders  |
| <input type="checkbox"/> 20 Infection   | <input type="checkbox"/> 89.3 Malignant melanoma  | <input type="checkbox"/> 97 Gastrointestinal disorders   |
| <input type="checkbox"/> 20.1 Postpartum genital tract (e.g. of the uterus/<br>pelvis/perineum/necrotizing fasciitis) | <input type="checkbox"/> 89.9 Other malignancies/NOS  | <input type="checkbox"/> 97.1 Crohn's disease/ulcerative colitis   |
| <input type="checkbox"/> 20.2 Sepsis/septic shock   | <input type="checkbox"/> 90 Cardiovascular conditions   | <input type="checkbox"/> 97.2 Liver disease/failure/transplant   |
| <input type="checkbox"/> 20.4 Chorioamnionitis/antepartum infection   | <input type="checkbox"/> 90.1 Coronary artery disease/myocardial<br>infarction (MI)/atherosclerotic<br>cardiovascular disease                                   | <input type="checkbox"/> 97.9 Other gastrointestinal diseases/NOS  |
| <input type="checkbox"/> 20.5 Non-pelvic infections (e.g. pneumonia, TB,<br>meningitis, HIV)                          | <input type="checkbox"/> 90.2 Pulmonary hypertension  | <input type="checkbox"/> 100 Mental health conditions  |
| <input type="checkbox"/> 20.6 Urinary tract infection   | <input type="checkbox"/> 90.3 Valvular heart disease congenital and<br>acquired   | <input type="checkbox"/> 100.1 Depression  |
| <input type="checkbox"/> 20.9 Other infections/NOS  | <input type="checkbox"/> 90.4 Vascular aneurysm/dissection (non-cerebral)   | <input type="checkbox"/> 100.9 Other psychiatric conditions/NOS  |
| <input type="checkbox"/> 30 Embolism - thrombotic (non-cerebral)  | <input type="checkbox"/> 90.5 Hypertensive cardiovascular disease   | <input type="checkbox"/> 999 Unknown COD   |
| <input type="checkbox"/> 30.9 Other embolism/NOS  | <input type="checkbox"/> 90.6 Marfan Syndrome   |  |
| <input type="checkbox"/> 31 Embolism - amniotic fluid   | <input type="checkbox"/> 90.7 Conduction defects/arrhythmias  |  |
| <input type="checkbox"/> 40 Preeclampsia  | <input type="checkbox"/> 90.8 Vascular malformations outside head and<br>coronary arteries  |  |
| <input type="checkbox"/> 50 Eclampsia   | <input type="checkbox"/> 90.9 Other cardiovascular disease, including CHF,<br>cardiomegaly, cardiac hypertrophy, cardiac<br>fibrosis, non-acute myocarditis/NOS |  |
| <input type="checkbox"/> 60 Chronic hypertension with superimposed<br>preeclampsia                                    | <input type="checkbox"/> 91 Pulmonary conditions (excludes ARDS-Adult<br>respiratory distress syndrome)   |  |
| <input type="checkbox"/> 70 Anesthesia complications  | <input type="checkbox"/> 91.1 Chronic lung disease  |  |
| <input type="checkbox"/> 80 Cardiomyopathy  | <input type="checkbox"/> 91.2 Cystic fibrosis   |  |
| <input type="checkbox"/> 80.1 Postpartum/peripartum cardiomyopathy  | <input type="checkbox"/> 91.3 Asthma  |  |
| <input type="checkbox"/> 80.2 Hypertrophic cardiomyopathy   | <input type="checkbox"/> 91.9 Other pulmonary disease/NOS   |  |
| <input type="checkbox"/> 80.9 Other cardiomyopathy/NOS  | <input type="checkbox"/> 92 Neurologic/neurovascular conditions<br>(excluding CVAs)   |  |
| <input type="checkbox"/> 82 Hematologic   |   |  |
| <input type="checkbox"/> 82.1 Sickle cell anemia  |   |  |
| <input type="checkbox"/> 82.9 Other hematologic conditions including<br>thrombophilias/TTP/HUS/NOS                    |   |  |

## CONTRIBUTING FACTOR DESCRIPTIONS

### LACK OF ACCESS/FINANCIAL RESOURCES

System issues, e.g. lack or loss of healthcare insurance or other financial duress, as opposed to woman's noncompliance, impacted woman's ability to care for herself (e.g. did not seek services because unable to miss work or afford postpartum visits after insurance expired). Other barriers to accessing care: insurance non-eligibility, provider shortage in woman's geographical area, and lack of public transportation.

### ADHERENCE TO MEDICAL RECOMMENDATIONS

The provider or patient did not follow protocol or failed to comply with standard procedures (i.e. non adherence to prescribed medications).

### FAILURE TO SCREEN/INADEQUATE ASSESSMENT OF RISK

Factors placing the woman at risk for a poor clinical outcome recognized, and the woman was not transferred/transported to a provider able to give a higher level of care.

### CHILDHOOD SEXUAL ABUSE/TRAUMA

The patient experienced rape, molestation, or one or more of the following: sexual exploitation during childhood plus persuasion, inducement, or coercion of a child to engage in sexually explicit conduct; physical or emotional abuse or violence other than that related to sexual abuse during childhood.

### CHRONIC DISEASE

Occurrence of one or more significant pre-existing medical conditions (e.g. obesity, cardiovascular disease, or diabetes).

### CLINICAL SKILL/QUALITY OF CARE (PROVIDER OR FACILITY PERSPECTIVE)

Personnel were not appropriately skilled for the situation or did not exercise clinical judgment consistent with current standards of care (e.g. error in the preparation or administration of medication or unavailability of translation services).

### POOR COMMUNICATION/LACK OF CASE COORDINATION OR MANAGEMENT/ LACK OF CONTINUITY OF CARE (SYSTEM PERSPECTIVE)

Care was fragmented (i.e. uncoordinated or not comprehensive) among or between healthcare facilities or units, (e.g. records not available between inpatient and outpatient or among units within the hospital, such as Emergency Department and Labor and Delivery).

### LACK OF CONTINUITY OF CARE (PROVIDER OR FACILITY PERSPECTIVE)

Care providers did not have access to woman's complete records or did not communicate woman's status sufficiently. Lack of continuity can be between prenatal, labor and delivery, and postpartum providers.

**CULTURAL/RELIGIOUS, OR LANGUAGE FACTORS** Demonstration that any of these factors was either a barrier to care due to lack of understanding or led to refusal of therapy due to beliefs (or belief systems).

### DELAY

The provider or patient was delayed in referring or accessing care, treatment, or follow-up care/action.

### DISCRIMINATION

Treating someone less or more favorably based on the group, class or category they belong to resulting from biases, prejudices, and stereotyping. It can manifest as differences in care, clinical communication and shared decision-making. (Smedley et al, 2003 and Dr. Rachel Hardeman)

### ENVIRONMENTAL FACTORS

Factors related to weather or social environment.

### INADEQUATE OR UNAVAILABLE EQUIPMENT/TECHNOLOGY

Equipment was missing, unavailable, or not functional, (e.g. absence of blood tubing connector).

### INTERPERSONAL RACISM

Discriminatory interactions between individuals based on differential assumptions about the abilities, motives, and intentions of others and resulting in differential actions toward others based on their race. It can be conscious as well as unconscious, and it includes acts of commission and acts of omission. It manifests as lack of respect, suspicion, devaluation, scapegoating, and dehumanization. (Jones, CP, 2000 and Dr. Cornelia Graves).

### KNOWLEDGE - LACK OF KNOWLEDGE REGARDING

**IMPORTANCE OF EVENT OR OF TREATMENT OR FOLLOW-UP**  
The provider or patient did not receive adequate education or lacked knowledge or understanding regarding the significance of a health event (e.g. shortness of breath as a trigger to seek immediate care) or lacked understanding about the need for treatment/follow-up after evaluation for a health event (e.g. needed to keep appointment for psychiatric referral after an ED visit for exacerbation of depression).

### INADEQUATE LAW ENFORCEMENT RESPONSE

Law enforcement response was not in a timely manner or was not appropriate or thorough in scope.

### LEGAL

Legal considerations that impacted outcome.

### MENTAL HEALTH CONDITIONS

The patient carried a diagnosis of a psychiatric disorder. This includes postpartum depression.

### INADEQUATE COMMUNITY OUTREACH/RESOURCES

Lack of coordination between healthcare system and other outside agencies/organizations in the geographic/cultural area that work with maternal health issues.

### LACK OF STANDARDIZED POLICIES/PROCEDURES

The facility lacked basic policies or infrastructure germane to the woman's needs (e.g. response to high blood pressure, or a lack of or outdated policy or protocol).

### LACK OF REFERRAL OR CONSULTATION

Specialists were not consulted or did not provide care; referrals to specialists were not made.

### STRUCTURAL RACISM

The systems of power based on historical injustices and contemporary social factors that systematically disadvantage people of color and advantage white people through inequities in housing, education, employment, earnings, benefits, credit, media, health care, criminal justice, etc. - (Adapted from Bailey ZD. Lancet. 2017 and Dr. Carla Ortigue)

### SOCIAL SUPPORT/ISOLATION - LACK OF FAMILY/ FRIEND OR SUPPORT SYSTEM

Social support from family, partner, or friends was lacking, inadequate, and/or dysfunctional.

### SUBSTANCE USE DISORDER - ALCOHOL, ILLICIT/ PRESCRIPTION DRUGS

Substance use disorder is characterized by recurrent use of alcohol and/or drugs causing clinically and functionally significant impairment, such as health problems or disability. The committee may determine that substance use disorder contributed to the death when the disorder directly compromised a woman's health status (e.g. acute methamphetamine intoxication exacerbated pregnancy-induced hypertension, or woman was more vulnerable to infections or medical conditions).

### TOBACCO USE

The patient's use of tobacco directly compromised the patient's health status (e.g. long-term smoking led to underlying chronic lung disease).

### UNSTABLE HOUSING

Woman lived "on the street," in a homeless shelter, or in transitional or temporary circumstances with family or friends.

### VIOLENCE AND INTIMATE PARTNER VIOLENCE (IPV)

Physical or emotional abuse perpetrated by current or former intimate partner, family member, or stranger.

### OTHER

Contributing factor not otherwise mentioned. Please provide description.

**CONTRIBUTING FACTORS AND RECOMMENDATIONS FOR ACTION** (Continued from page 2)

**CONTRIBUTING FACTORS WORKSHEET**

What were the factors that contributed to this death?  
Multiple contributing factors may be present at each level.

**RECOMMENDATIONS OF THE COMMITTEE**

If there was at least some chance that the death could have been averted, what were the specific and feasible actions that, if implemented or altered, might have changed the course of events?

LEVEL	CONTRIBUTING FACTORS (choose as many as needed below)	DESCRIPTION OF ISSUE (enter a description for EACH contributing factor listed)	COMMITTEE RECOMMENDATIONS [Who?] should [do what?] [when?] Map recommendations to contributing factors.	PREVENTION LEVEL (choose below)	EXPECTED IMPACT (choose below)
▼	▼			▼	▼
▼	▼			▼	▼
▼	▼			▼	▼
▼	▼			▼	▼
▼	▼			▼	▼
▼	▼			▼	▼
▼	▼			▼	▼
▼	▼			▼	▼
▼	▼			▼	▼



## Appendix F: Supplemental Data Tables for Severe Maternal Morbidity

### Severe Maternal Morbidity among Resident Hospital Deliveries, Arizona, 2016-2019

	# of Deliveries	% of Deliveries	# of SMM Events	% of SMM Events	SMM Rate
Overall	297,036	-	3,547	-	119.4
<b>Year</b>					
2016	77,644	26.1%	995	28.1%	128.1
2017	73,341	24.7%	840	23.7%	114.5
2018	73,618	24.8%	809	22.8%	109.9
2019	72,433	24.4%	903	25.5%	124.7
<b>Maternal Race and Ethnicity</b>					
American Indian or Alaska Native	11,518	3.9%	349	9.8%	303
Asian or Pacific Islander	12,319	4.1%	163	4.6%	132.3
Black or African American	17,641	5.9%	289	8.1%	163.8
Hispanic or Latina	124,144	41.8%	1,651	46.5%	133
White, non-Hispanic	131,414	44.2%	1,095	30.9%	83.3
<b>Maternal Age</b>					
19 Years and Younger	17,732	6.0%	282	8.0%	159
20-29 Years	157,815	53.1%	1,713	48.3%	108.5
30-39 Years	113,244	38.1%	1,389	39.2%	122.7
40 Years and Older	8,245	2.8%	163	4.6%	197.7
<b>Primary Payer of Birth (per the birth certificate)</b>					
Private Insurance	125,997	42.4%	1,143	32.2%	90.7
AHCCCS	152,932	51.5%	2,114	59.6%	138.2
IHS	2,505	0.8%	85	2.4%	339.3
Self-pay	7,907	2.7%	96	2.7%	121.4
Other Government (e.g. TRICARE, CHIP, VHA)	3,301	1.1%	35	1.0%	106
Other / Unknown	4,394	1.5%	74	2.1%	168.4
<b>Highest Education Level</b>					
No high school diploma	49,212	16.6%	805	22.7%	163.6
High school diploma	78,253	26.3%	989	27.9%	126.4
Some college or Associate Degree	94,622	31.9%	1,084	30.6%	114.6
Bachelor's Degree	49,200	16.6%	411	11.6%	83.5
Master's or Doctorate Degree	24,375	8.2%	211	5.9%	86.6
<b>Rural vs Urban County of Residence<sup>#</sup></b>					
Rural	33,355	11.2%	519	14.6%	155.6
Urban	263,681	88.8%	3,028	85.4%	114.8

<sup>#</sup> Based on Bureau of Public Health Statistic definitions

(continued)

County of Residence	# of Deliveries	% of Deliveries	# of SMM Events	% of SMM Events	SMM Rate
Apache	835	0.3%	23	0.6%	275.4
Cochise	5,244	1.8%	81	2.3%	154.5
Coconino	3,546	1.2%	63	1.8%	177.7
Gila	2,013	0.7%	29	0.8%	144.1
Graham	1,989	0.7%	48	1.4%	241.3
Greenlee	500	0.2%	*	**	100
La Paz	732	0.2%	13	0.4%†	177.6
Maricopa	194,392	65.4%	2,064	58.2%	106.2
Mohave	6,071	2.0%	84	2.4%	138.4
Navajo	4,157	1.4%	95	2.7%	228.5
Pima	40,984	13.8%	571	16.1%	139.3
Pinal	17,008	5.7%	185	5.2%	108.8
Santa Cruz	2,294	0.8%	13	0.4%†	56.7
Yavapai	5,974	2.0%	65	1.8%	108.8
Yuma	11,297	3.8%	208	5.9%	184.1
<b>Parity</b>					
No Previous Live Birth	107,930	36.3%	1,446	40.8%	134
1 Previous Live Birth	89,500	30.1%	800	22.6%	89.4
2 Previous Live Births	53,380	18.0%	522	14.7%	97.8
3 Previous Live Births	26,106	8.8%	368	10.4%	141
4 or More Previous Live Births	19,971	6.7%	406	11.4%	203.3
<b>Interpregnancy Interval</b>					
No Previous Live Births / Missing	109,324	36.8%	1,486	41.9%	135.9
5 Months or Less	10,130	3.4%	130	3.7%	128.3
6-11 Months	20,990	7.1%	246	6.9%	117.2
12-17 Months	25,445	8.6%	240	6.8%	94.3
18-23 Months	21,671	7.3%	196	5.5%	90.4
24-35 Months	31,058	10.5%	273	7.7%	87.9
36-59 Months	35,512	12.0%	386	10.9%	108.7
60 Months or More	42,906	14.4%	590	16.6%	137.5
<b>Pre-Existing Diabetes</b>					
Diabetes	2,948	1.0%	89	2.5%	301.9
No Diabetes	294,088	99.0%	3,458	97.5%	117.6
<b>Chronic Hypertension</b>					
Chronic Hypertension	3,897	1.3%	122	3.4%	313.1
No Chronic Hypertension	293,139	98.7%	3,425	96.6%	116.8

\* Cell suppressed due to value < 6

\*\* Not calculated due to suppressed cell value

† Rate using value less than 20; interpret with caution

(continued)

	# of Deliveries	% of Deliveries	# of SMM Events	% of SMM Events	SMM Rate
<b>Gestational Diabetes</b>					
Gestational Diabetes	23,525	7.9%	340	9.6%	144.5
No Gestational Diabetes	273,511	92.1%	3,207	90.4%	117.3
<b>Hypertensive Disorders of Pregnancy<sup>§</sup></b>					
Hypertensive Disorder of Pregnancy	21,203	7.1%	741	20.9%	349.5
No Hypertensive Disorder of Pregnancy	275,833	92.9%	2,806	79.1%	101.7
<b>Any Tobacco Smoking Before or During Pregnancy</b>					
Tobacco Smoker Before or During Pregnancy	21,261	7.2%	276	7.8%	129.8
Non-Smoker	275,340	92.7%	3,254	91.7%	118.2
<b>Any Smoking During Pregnancy</b>					
Tobacco Smoker During Pregnancy	13,931	4.7%	190	5.4%	136.4
Non-Smoker	282,671	95.2%	3,340	94.2%	118.2
<b>Prenatal Care Initiation</b>					
1st Trimester	211,883	71.3%	2,229	62.8%	105.2
2nd Trimester	52,546	17.7%	673	19.0%	128.1
3rd Trimester	17,780	6.0%	265	7.5%	149
No Prenatal Care	7,486	2.5%	254	7.2%	339.3
<b>Adequacy of Prenatal Care Utilization</b>					
Adequate Plus Prenatal Care	79,004	26.6%	1,118	31.5%	141.5
Adequate Prenatal Care	124,519	41.9%	1,009	28.4%	81
Intermediate Prenatal Care	33,440	11.3%	355	10.0%	106.2
Inadequate Prenatal Care	43,344	14.6%	658	18.6%	151.8
No Prenatal Care	7,486	2.5%	254	7.2%	339.3
<b>Method of Delivery</b>					
Primary Cesarean	45,792	15.4%	1,298	36.6%	283.5
Repeat Cesarean	35,475	11.9%	723	20.4%	203.8
Vaginal Birth After Cesarean (VBAC)	7,233	2.4%	84	2.4%	116.1
Vaginal Delivery	208,536	70.2%	1,442	40.7%	69.1
Any Cesarean Delivery	81,267	27.4%	2,021	57.0%	248.7
Any Vaginal Delivery	215,769	72.6%	1,526	43.0%	70.7
<b>History of a Previous Cesarean Delivery</b>					
Previous Cesarean(s)	42,708	14.4%	807	22.8%	189
No Previous Cesarean	254,328	85.6%	2,740	77.2%	107.7
<b>Trial of Labor among Women with a Previous Cesarean Delivery</b>					
Successful VBAC	7,233	2.4%	84	2.4%	116.1
Unsuccessful Trial of Labor	1,955	0.7%	58	1.6%	296.7
No Trial of Labor	33,520	11.3%	665	18.7%	198.4

<sup>§</sup> Hypertensive disorders of pregnancy include gestational hypertension, preeclampsia, and eclampsia



(continued)

<b>Level of Care by Arizona Perinatal Trust Certification</b>	<b># of Deliveries</b>	<b>% of Deliveries</b>	<b># of SMM Events</b>	<b>% of SMM Events</b>	<b>SMM Rate</b>
Level I	13,579	4.6%	173	4.9%	127.4
Level II	70,044	23.6%	609	17.2%	86.9
Level IIE	78,296	26.4%	980	27.6%	125.2
Level III	127,721	43.0%	1,657	46.7%	129.7
Non-APT Facility	7,395	2.5%	127	3.6%	171.7
<b>Gestational Age at Delivery</b>					
31 weeks or less	3,486	1.2%	288	8.1%	826.2
32-36 weeks	21,637	7.3%	746	21.0%	344.8
37-38 weeks	79,223	26.7%	862	24.3%	108.8
39-40 weeks	175,325	59.0%	1,443	40.7%	82.3
41 weeks or more	16,984	5.7%	202	5.7%	118.9
<b>Plurality</b>					
Singleton	292,136	98.4%	3,328	93.8%	113.9
Twins	4,801	1.6%	212	6.0%	441.6
Triplets or Quadruplets	99	0.0%	7	0.2%†	707.1
<b>Primary Care Area (PCA) Quartile: Percent Adults (18-64 years) Living below Federal Poverty Level*</b>					
1st Quartile (3.5-9.7%)	76,653	25.8%	717	20.2%	93.5
2nd Quartile (9.8-14.9%)	65,525	22.1%	655	18.5%	100
3rd Quartile (15.0-21.1%)	84,698	28.5%	1,096	30.9%	129.4
4th Quartile (21.2-46.0%)	69,790	23.5%	1,076	30.3%	154.2
<b>Primary Care Area (PCA) Quartile: Percent Females (19-64 years) without Health Insurance*</b>					
1st Quartile (2.9-9.1%)	56,539	19.0%	497	14.0%	87.9
2nd Quartile (9.2-11.4%)	87,507	29.5%	966	27.2%	110.4
3rd Quartile (11.5-15.8%)	49,958	16.8%	665	18.7%	133.1
4th Quartile (15.9-52.8%)	102,662	34.6%	1,416	39.9%	137.9
<b>Primary Care Area (PCA) Quartile: Gini Index of Income Inequality*</b>					
1st Quartile (0.344-0.389)	114,832	38.7%	1,222	34.5%	106.4
2nd Quartile (0.390-0.415)	74,210	25.0%	834	23.5%	112.4
3rd Quartile (0.416-0.440)	56,642	19.1%	746	21.0%	131.7
4th Quartile (0.441-0.527)	50,982	17.2%	742	20.9%	145.5

† Rate using value less than 20; interpret with caution

\* Based on 2018 American Community Survey 5-year Estimates (2014-2018).

## Severe Maternal Morbidity among Singleton Term Resident Hospital Deliveries, Arizona, 2016-2019

	# of Deliveries	% of Deliveries	# of SMM Events	% of SMM Events	SMM Rate
Overall	268,898	-	2,421	-	90.0
<b>Pre-Pregnancy Body Mass Index (BMI)</b>					
Underweight ( $\leq 18.5$ )	9,339	3.5%	90	3.7%	96.4
Normal Weight (18.5 – 24.9)	111,899	41.6%	947	39.1%	84.6
Overweight (25.0 – 29.9)	72,131	26.8%	640	26.4%	88.7
Obese - Class 1 (30.0 – 34.9)	41,957	15.6%	403	16.6%	96.1
Obese - Class 2 (35.0 – 39.9)	19,895	7.4%	203	8.4%	102
Obese - Class 3 ( $\geq 40.0$ )	12,938	4.8%	130	5.4%	100.5
<b>Weight Gain During Pregnancy</b>					
Inadequate	56,287	20.9%	538	22.2%	95.6
Recommended	75,543	28.1%	621	25.7%	82.2
Excess	136,329	50.7%	1,254	51.8%	92
<b>Weight Gain During Pregnancy by Pre-Pregnancy BMI</b>					
Underweight Inadequate	2,559	1.0%	22	0.9%	86
Underweight Recommended	3,780	1.4%	32	1.3%	84.7
Underweight Excess	3,000	1.1%	36	1.5%	120
Normal Weight Inadequate	28,119	10.5%	276	11.4%	98.2
Normal Weight Recommended	38,246	14.2%	284	11.7%	74.3
Normal Weight Excess	45,534	16.9%	387	16.0%	85
Overweight Inadequate	10,096	3.8%	105	4.3%	104
Overweight Recommended	17,467	6.5%	146	6.0%	83.6
Overweight Excess	44,568	16.6%	389	16.1%	87.3
Obese Inadequate	15,513	5.8%	135	5.6%	87
Obese Recommended	16,050	6.0%	159	6.6%	99.1
Obese Excess	43,227	16.1%	442	18.3%	102.3
<b>By Transfer into Birth Facility</b>					
Transfers	73,593	27.4%	886	36.6%	120.4
Non-Transfers	195,306	72.6%	1,535	63.4%	78.6
<b>Driving Time from ZIP Code of Residence to ZIP Code of Birth Facility</b>					
$\leq 15$ min	102,514	38.1%	904	37.3%	88.2
16-30 min	107,223	39.9%	907	37.5%	84.6
31-45 min	27,828	10.3%	251	10.4%	90.2
46-60 min	8,574	3.2%	76	3.1%	88.6
61-90 min	13,349	5.0%	149	6.2%	111.6
91-120 min	5,814	2.2%	84	3.5%	144.5
2-3 hours	1,832	0.7%	23	1.0%	125.5
3-4 hours	886	0.3%	18	0.7%†	203.2

† Rate using value less than 20; interpret with caution

Note: Driving Time calculated from ZIP Code of residence to ZIP Code of delivery facility using SAS analytical software and Google Maps; mean of 10 runs used to control for multiple routes; deliveries in the same ZIP Code as residence have time value of 0; deliveries at facilities with less than 6 live births or deliveries with missing ZIP Codes excluded

(continued)

<b>Driving Time from ZIP Code of Residence to ZIP Code of Birth Facility</b>	<b># of Deliveries</b>	<b>% of Deliveries</b>	<b># of SMM Events</b>	<b>% of SMM Events</b>	<b>SMM Rate</b>
≤ 60 mins	246,139	91.5%	2,138	88.3%	86.9
> 60 mins	22,109	8.2%	277	11.4%	125.3
<b>By Transfer into Birth Facility and Driving Time</b>					
Transfer ≤ 60 mins	66,317	24.7%	767	31.7%	115.7
Transfer > 60 mins	6,855	2.5%	114	4.7%	166.3
Non-Transfer ≤ 60 mins	179,822	66.9%	1,371	56.6%	76.2
Non-Transfer > 60 mins	15,254	5.7%	163	6.7%	106.9
<b>Driving Distance from ZIP Code of Residence to Zip Code of Birth Facility</b>					
≤ 5 miles	57,313	21.3%	541	22.3%	94.4
6-10 miles	67,694	25.2%	530	21.9%	78.3
11-15 miles	51,743	19.2%	461	19.0%	89.1
16-25 miles	48,070	17.9%	411	17.0%	85.5
26-50 miles	28,162	10.5%	266	11.0%	94.5
51-100 miles	12,352	4.6%	163	6.7%	132
101-200 miles	2,514	0.9%	35	1.4%	139.2
201-400 miles	398	0.1%	8	0.3%†	201
≤ 50 miles	252,982	94.1%	2,209	91.2%	87.3
> 50 miles	15,268	5.7%	206	8.5%	134.9
<b>By Transfer into Birth Facility and Driving Distance</b>					
Transfer ≤ 50 miles	67,188	25.0%	783	32.3%	116.5
Transfer > 50 miles	5,984	2.2%	98	4.0%	163.8
Non-Transfer ≤ 50 miles	185,794	69.1%	1,426	58.9%	76.8
Non-Transfer > 50 miles	9,284	3.5%	108	4.5%	116.3

† Rate using value less than 20; interpret with caution

Note: Driving Time and Driving Distance calculated from ZIP Code of residence to ZIP Code of delivery facility using SAS analytical software and Google Maps; mean of 10 runs used to control for multiple routes; deliveries in the same ZIP Code as residence have time and distance values of 0; deliveries at facilities with less than 6 live births or deliveries with missing ZIP Codes excluded

## Appendix G: Notes on Severe Maternal Morbidity Methods

### List of Facilities included in SMM Analyses

List does not include facilities with less than 20 live births for 2016-2019.

ABRAZO ARROWHEAD CAMPUS	DIGNITY HEALTH MERCY GILBERT MEDICAL CENTER
ABRAZO CENTRAL CAMPUS	DIGNITY HEALTH ST. JOSEPH'S HOSPITAL AND MEDICAL CENTER
ABRAZO SCOTTSDALE CAMPUS	FLAGSTAFF MEDICAL CENTER
ABRAZO WEST CAMPUS	HONORHEALTH SCOTTSDALE OSBORN MEDICAL CENTER
BANNER BAYWOOD MEDICAL CENTER	HONORHEALTH SCOTTSDALE SHEA MEDICAL CENTER
BANNER CASA GRANDE MEDICAL CENTER	HAVASU REGIONAL MEDICAL CENTER
BANNER DEL E WEBB MEDICAL CENTER	KINGMAN REGIONAL MEDICAL CENTER
BANNER DESERT MEDICAL CENTER	LITTLE COLORADO MEDICAL CENTER
BANNER ESTRELLA MEDICAL CENTER	MOUNTAIN VISTA MEDICAL CENTER
BANNER GATEWAY MEDICAL CENTER	MT. GRAHAM REGIONAL MED CENTER
BANNER IRONWOOD MEDICAL CENTER	NORTHWEST MEDICAL CENTER
BANNER PAGE HOSPITAL	SUMMIT HEALTHCARE REGIONAL MEDICAL CENTER
BANNER PAYSON MEDICAL CENTER	TEMPE ST. LUKE'S HOSPITAL
BANNER THUNDERBIRD MEDICAL CENTER	TUCSON MEDICAL CENTER
BANNER UNIVERSITY MEDICAL CENTER - PHOENIX	VALLEY VIEW MEDICAL CENTER
BANNER UNIVERSITY MEDICAL CENTER - TUCSON	VALLEYWISE HEALTH <i>(Maricopa Integrated Health System)</i>
CANYON VISTA MEDICAL CENTER	VERDE VALLEY MEDICAL CENTER
CARONDELET HOLY CROSS HOSPITAL	WESTERN AZ REGIONAL MEDICAL CENTER
CARONDELET ST JOSEPHS HOSPITAL	YAVAPAI REGIONAL MEDICAL CENTER-EAST
COBRE VALLEY REGIONAL MEDICAL CENTER	YUMA REGIONAL MEDICAL CENTER
DIGNITY HEALTH CHANDLER REGIONAL MEDICAL CENTER	

## Institute of Medicine Recommendations on Weight Gain during Pregnancy

Pre-Pregnancy BMI Group	Total weight gain (lb) *	Rate of weight gain in the 2 <sup>nd</sup> and 3 <sup>rd</sup> trimesters (lb/wk) *	Recommended total weight gain by gestational age (in weeks) at delivery (lb) **				
			37 weeks	38 weeks	39 weeks	40 weeks	41 weeks
Underweight (< 18.5)	28–40	1.0 (1.0–1.3)	25.0 - 36.1	26.0 - 37.4	27.0 - 38.7	28.0 - 40.0	29.0 - 41.3
Normal Weight (18.5–24.9)	25–35	1.0 (0.8–1.0)	22.6 - 32.0	23.4 - 33.0	24.2 - 34.0	25.0 - 35.0	25.8 - 36.0
Overweight (25.0–29.9)	15–25	0.6 (0.5–0.7)	13.5 - 22.9	14.0 - 23.6	14.5 - 24.3	15.0 - 25.0	15.5 - 25.7
Obese (≥ 30.0)	11–20	0.5 (0.4–0.6)	9.8 - 18.2	10.2 - 18.8	10.6 - 19.4	11.0 - 20.0	11.4 - 20.6

*Adapted from:*  
 \* National Research Council 2009. *Weight Gain During Pregnancy: Reexamining the Guidelines*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/12584>.  
 \*\* Utah Department of Health charts and tables of recommended weight gain during pregnancy by pre-pregnancy BMI group, available at [babyourbaby.org](http://babyourbaby.org) (based on recommendations from Institute of Medicine)

## Adequacy of Prenatal Care Utilization Index (APNCU)

The following information was taken from the March of Dimes Peristats [website](#):

Adequacy of prenatal care calculations are based on the Adequacy of Prenatal Care Utilization Index (APNCU), which measures the utilization of prenatal care on two dimensions. The first dimension, adequacy of initiation of prenatal care, measures the timing of initiation using the month prenatal care began reported on the birth certificate. The second dimension, adequacy of received services, is measured by taking the ratio of the actual number of visits reported on the birth certificate to the expected number of visits. The expected number of visits is based on the American College of Obstetrics and Gynecology prenatal care visitations standards for uncomplicated pregnancies (1), and is adjusted for the gestational age at initiation of care and for the gestational age at delivery. The two dimensions are combined into a single summary index, and grouped into four categories: Adequate Plus, Adequate, Intermediate, and Inadequate. On PeriStats, the percent of infants whose mothers received Adequate and Adequate Plus prenatal care are combined into one category, Adequate/Adeq+ prenatal care. Definitions for these categories include:

- **Adequate Plus:** Prenatal care begun by the 4th month of pregnancy and 110% or more of recommended visits received.
- **Adequate:** Prenatal care begun by the 4th month of pregnancy and 80-109% of recommended visits received.
- **Intermediate:** Prenatal care begun by the 4th month of pregnancy and 50-79% of recommended visits received.

- **Inadequate:** Prenatal care begun after the 4th month of pregnancy or less than 50% of recommended visits received.

## Arizona Perinatal Trust Facility Levels

### PERINATAL CARE CENTERS – LEVEL I

Provide hospital services for low-risk obstetrical patients, including cesarean delivery and basic and transitional newborn care; such centers should not electively deliver infants less than 36 weeks gestation.

### PERINATAL CARE CENTERS – LEVEL II

Provides hospital services for selected high risk obstetrical patients and newborns requiring selective continuing care; such centers should not electively deliver infants less than 32 weeks gestation.

### PERINATAL CARE CENTERS – LEVEL IIE

Provide hospital services for high-risk obstetrical patients and newborns requiring selective continuing care; such centers should not electively deliver infants less than 28 weeks gestation.

### PERINATAL CARE CENTERS – LEVEL III

Provide hospital services for all obstetrical and newborn patients including those patients requiring subspecialty and intensive care at all gestational ages.

## Driving Distance and Time to Care

Driving distance and time was calculated from the ZIP Code of maternal residence to the ZIP Code of the delivery facility using SAS analytical software and Google Maps; this [method](#) calculates driving distance rather than straight-line distances between zip codes. A mean distance of 10 runs for each zip code combination was used for analysis to control for variations in traffic and re-routes. Women delivering in the same zip code as their residence had a distance of 0. Delivery hospitalizations missing zip code data or live births at facilities with fewer than 6 deliveries were excluded (n=649).

## Indicators of SMM and Associated ICD-10 Codes

Indicator	Description	ICD-10-CM (Diagnosis) Codes
Acute myocardial infarction	Heart attack	I21.01, I21.02, I21.09, I21.11, I21.19, I21.21, I21.29, I21.3, I21.4, I21.9, I21.A1, I21.A9, I22.0, I22.1, I22.2, I22.8, I22.9
Acute renal failure	Kidney failure	N17.0, N17.1, N17.2, N17.8, N17.9, O90.4
Adult respiratory distress syndrome	Respiratory failure	J80, J95.1, J95.2, J95.3, J95.821, J95.822, J96.00, J96.01, J96.02, J96.20, J96.21, J96.22, R09.2
Amniotic fluid embolism	Condition where amniotic fluid or fetal material enters the mother's bloodstream causing systemic collapse of organ functions	O88.111, O88.112, O88.113, O88.119, O88.12, O88.13
Aneurysm	Abnormal widening of a blood vessel which may cause rupture and acute blood loss	I71.00, I71.01, I71.02, I71.03, I71.1, I71.2, I71.3, I71.4, I71.5, I71.6, I71.8, I71.9, I79.0
Cardiac arrest or ventricular fibrillation	Failure of the heart to pump blood	I49.01, I49.02, I46.2, I46.8, I46.9
Disseminated intravascular coagulation (DIC)	Interruption of blood clotting mechanism leading to bleeding	D65, D68.8, D68.9, O72.3
Eclampsia	Onset of seizures during pregnancy	O15.00, O15.02, O15.03, O15.1, O15.2, O15.9
Puerperal cerebrovascular disorders	Stroke	I60.00, I60.01, I60.02, I60.10, I60.11, I60.12, I60.2, I60.20, I60.21, I60.22, I60.30, I60.31, I60.32, I60.4, I60.50, I60.51, I60.52, I60.6, I60.7, I60.8, I60.9, I61.0, I61.1, I61.2, I61.3, I61.4, I61.5, I61.6, I61.8, I61.9, I62.00, I62.01, I62.02, I62.03, I62.1, I62.9, I63.00, I63.011, I63.012, I63.013, I63.019, I63.02, I63.031, I63.032, I63.033, I63.039, I63.09, I63.10, I63.111, I63.112, I63.113, I63.119, I63.12, I63.131, I63.132, I63.133, I63.139, I63.19, I63.20, I63.211, I63.212, I63.213, I63.219, I63.22,, I63.231, I63.232, I63.233, I63.239, I63.29, I63.30, I63.311, I63.312, I63.313, I63.319, I63.321, I63.322, I63.323, I63.329, I63.331, I63.332, I63.333, I63.339I63.341, I63.342, I63.343, I63.349I63.39, I63.40, I63.411, I63.412I63.413, I63.419, I63.421, I63.422I63.423, I63.429, I63.431, I63.432I63.433, I63.439, I63.441, I63.442I63.443, I63.449, I63.49, I63.50, I63.511, I63.512, I63.513, I63.519, I63.521,



		I63.522I63.523, I63.529, I63.531, I63.532, I63.533, I63.539I63.541, I63.542, I63.543, I63.549, I63.59, I63.6, I63.8, I63.9, I65.01, I65.02, I65.03, I65.09, I65.1, I65.21, I65.22, I65.23, I65.29, I65.8, I65.9, I66.01, I66.02, I66.03, I66.09, I66.11, I66.12, I66.13, I66.19, I66.21, I66.22, I66.23, I66.29, I66.3, I66.8, I66.9, I67.0, I67.1, I67.2, I67.3, I67.4, I67.5, I67.6, I67.7, I67.81, I67.82, I67.83, I67.841, I67.848, I67.89, I67.9, I68.0, I68.2, I68.8, O22.51, O22.52, O22.53, O87.3, I97.810, I97.811, I97.820, I97.821
Pulmonary edema	Excessive fluid in the lungs not allowing for oxygenation of tissues	J81.0, I50.1, I50.20, I50.21, I50.23, I50.30, I50.31, I50.33, I50.40, I50.41, I50.43, I50.9
Sepsis	Whole body response to an infection causing collapse and lack of organ function	O85, T80.211A, T81.4XXA, R65.20, A40.0, A40.1, A40.3, A40.8, A40.9, A41.01, A41.02, A41.1, A41.2, A41.3, A41.4, A41.50, A41.51, A41.52, A41.53, A41.59, A41.81, A41.89, A41.9, A32.7
Severe anesthesia complications	Complications resulting from pain control procedures	O74.0, O74.1, O74.2, O74.3, O89.01, O89.09, O89.1, O89.2
Shock	Condition where organs are not getting enough blood flow	O75.1, R57.0, R57.1, R57.8, R57.9, R65.21, T78.2XXA, T88.2XXA, T88.6XXA, T81.10XA, T81.11XA, T81.19XA
Sickle cell anemia with crisis	Episodes of acute pain in a person with sickle cell anemia	D57.00, D57.01, D57.02, D57.211, D57.212, D57.219, D57.411, D57.412, D57.419, D57.811, D57.812, D57.819
Thrombotic embolism	Blood clot	I26.01, I26.02, I26.09, I26.90, I26.92, I26.99, O88.011, O88.012, O88.013, O88.019, O88.02, O88.03, O88.211, O88.212, O88.213, O88.219, O88.22, O88.23, O88.311, O88.312, O88.313, O88.319, O88.32, O88.33, O88.811, O88.812, O88.813, O88.819, O88.82, O88.83

Indicator	Description	ICD-10-PCS (Procedure) Codes
Blood transfusion	Transfusion of whole blood and other blood products	30233H1, 30233K1, 30233L1, 30233M1, 30233N1, 30233P1, 30233R1, 30233T1, 30240H1, 30240K1,30240L1, 30240M1, 30240N1, 30240P1, 30240R1, 30240T1, 30243H1, 30243K1, 30243L1, 30243M1, 30243N1, 30243P1, 30243R1, 30243T1, 30233N0, 30233P0, 30240N0, 30240P0, 30243N0, 30243P0

Conversion of cardiac rhythm	Procedure that restores an irregular heartbeat to normal rhythm	5A2204Z, 5A12012
Hysterectomy	Removal of the uterus	OUT90ZZ, OUT94ZZ, OUT97ZZ, OUT98ZZ, OUT9FZZ
Temporary tracheostomy	Procedure where an alternate breathing route is provided through the trachea (windpipe)	OB110Z4, OB110F4, OB113Z4, OB113F4, OB114Z4, OB114F4
Ventilation	Assisted breathing	5A1935Z, 5A1945Z, 5A1955Z

Additional information about ICD-10 codes for SMM, as well as codes to identify delivery hospitalizations, can be found on both [CDC](#) or [AIM](#) websites.

## Primary Care Area Measures of Community Socioeconomic Status and Relative Quartiles

Primary Care Area	Adults (18-64) Living Below 100% Federal Poverty Level		Females (19-64) without Health Insurance		Gini Index of Income Inequality	
	%	Quartile	%	Quartile	Index	Quartile
Ahwatukee Foothills Village	4.4	1	5.3	1	0.3958	2
Ajo	31.5	4	27.5	4	0.4143	2
Alhambra Village	25.2	4	20.4	4	0.4452	4
Anthem	5.3	1	4.8	1	0.4223	3
Apache Junction	17.3	3	14.2	3	0.4283	3
Avondale	12.3	2	12.8	3	0.3665	1
Benson	24.4	4	7.4	1	0.4385	3
Bisbee	14.2	2	11.5	3	0.4385	3
Black Canyon City	17.1	3	9.5	2	0.4096	2
Buckeye	11	2	11.3	2	0.3691	1
Bullhead City	19.6	3	13.5	3	0.4322	3
Camelback East Village	15.4	3	15.9	4	0.4569	4
Casa Grande	17.6	3	11.3	2	0.4199	3
Casas Adobes	9.9	2	10	2	0.3942	2
Catalina Foothills	6.4	1	6.9	1	0.4899	4
Central City Village	34.9	4	25.1	4	0.4687	4
Chandler Central	9.7	1	10.2	2	0.3827	1
Chandler North	6.9	1	6.5	1	0.3749	1
Chandler South	5.3	1	4.1	1	0.3911	2
Chino Valley	13.4	2	15.7	3	0.436	3
Colorado City	25	4	24.5	4	0.4184	3
Colorado River Indian Tribe	33.2	4	22.3	4	0.4394	3
Coolidge	19.9	3	13	3	0.4062	2
Cottonwood\Sedona	17.9	3	17.5	4	0.4484	4
Deer Valley Village	10.7	2	10.3	2	0.368	1
Desert View Village	3.5	1	2.9	1	0.3948	2
Douglas & Pirtleville	26.6	4	15.2	3	0.44	3
Drexel Heights	17.7	3	13.7	3	0.4157	3

(continued)

Primary Care Area	Adults (18-64) Living Below 100% Federal Poverty Level		Females (19-64) without Health Insurance		Gini Index of Income Inequality	
	%	Quartile	%	Quartile	Index	Quartile
El Mirage & Youngtown	14.1	2	13.3	3	0.3533	1
Eloy	16.9	3	11.1	2	0.4267	3
Encanto Village	21.1	3	16.5	4	0.4592	4
Estrella Village & Tolleson	18.3	3	22.5	4	0.388	1
Flagstaff	19.1	3	12	3	0.4316	3
Florence	13.4	2	11	2	0.4156	3
Flowing Wells	22.2	4	24.9	4	0.5044	4
Fort McDowell Yavapai Nation	28.4	4	52.8	4	0.3805	1
Fortuna Foothills	13.6	2	12.2	3	0.3842	1
Fountain Hills / Rio Verde	4.9	1	4.2	1	0.4544	4
Gila River Indian Community	45	4	30.5	4	0.4984	4
Gilbert Central	5.5	1	7.1	1	0.3462	1
Gilbert North	6.6	1	7.9	1	0.3889	1
Gilbert South	5.1	1	4.9	1	0.3612	1
Glendale Central	23.8	4	21.6	4	0.4351	3
Glendale North	12.1	2	9.4	2	0.4022	2
Glendale West	7.9	1	10	2	0.3472	1
Globe	21.2	4	12.7	3	0.4106	2
Gold Canyon	10.8	2	9.3	2	0.4492	4
Golden Valley	29	4	11.2	2	0.4254	3
Goodyear & Litchfield Park	7.6	1	8.8	1	0.3693	1
Grand Canyon Village	14.8	2	15.6	3	0.3935	2
Green Valley	11.3	2	15.6	3	0.4216	3
Hopi Tribe	34.5	4	13.1	3	0.4889	4
Hualapai Tribe	31.4	4	26.4	4	0.4098	2
Kingman	23.5	4	11.5	3	0.4375	3
Lake Havasu City	13.7	2	15.1	3	0.4332	3
Laveen Village	13.1	2	10.8	2	0.3706	1
Marana	7.7	1	6.2	1	0.3558	1

(continued)

Primary Care Area	Adults (18-64) Living Below 100% Federal Poverty Level		Females (19-64) without Health Insurance		Gini Index of Income Inequality	
	%	Quartile	%	Quartile	Index	Quartile
Maricopa	10.8	2	10.2	2	0.3757	1
Maryvale Village	23.6	4	26.4	4	0.3903	1
Mesa Central	17.2	3	18.5	4	0.3998	2
Mesa East	12.8	2	12.7	3	0.4246	3
Mesa Gateway	9.2	1	11.3	2	0.385	1
Mesa North	9.9	2	10.1	2	0.4058	2
Mesa West	20.1	3	20.3	4	0.3998	2
Morenci	10.4	2	10	2	0.3809	1
Navajo Nation	37.4	4	26.2	4	0.5098	4
New River / Cave Creek	5.8	1	7.3	1	0.442	4
Nogales	30.2	4	15.3	3	0.5089	4
North Gateway / Rio Vista Village	3.9	1	9.6	2	0.3848	1
North Mountain Village	18.6	3	16.5	4	0.4154	2
Oro Valley	6.9	1	3.4	1	0.4221	3
Page	13.8	2	14.1	3	0.4047	2
Paradise Valley	5.7	1	3.4	1	0.5268	4
Paradise Valley Village	10.5	2	10.5	2	0.4091	2
Parker	13.4	2	11.2	2	0.4588	4
Pascua Yaqui Tribe	36.8	4	29.5	4	0.4635	4
Payson	16.9	3	17.2	4	0.4287	3
Peoria North	4.7	1	5.1	1	0.3603	1
Peoria South	9.3	1	11.1	2	0.3699	1
Picture Rocks	10.7	2	13.5	3	0.4567	4
Prescott	15.9	3	9.1	1	0.448	4
Prescott Valley	15.4	3	16.1	4	0.4049	2
Quartzsite	21.7	4	27.1	4	0.441	4
Queen Creek	6.1	1	6.8	1	0.3833	1
Rio Rico	13.9	2	14.8	3	0.4423	4
Saddlebrooke	17.3	3	10	2	0.3615	1

(continued)

Primary Care Area	Adults (18-64) Living Below 100% Federal Poverty Level		Females (19-64) without Health Insurance		Gini Index of Income Inequality	
	%	Quartile	%	Quartile	Index	Quartile
Safford	14.1	2	5.9	1	0.3764	1
Sahuarita	5.7	1	5.4	1	0.3437	1
Salt River Pima-Maricopa Indian Community	25	4	31	4	0.4919	4
San Carlos Apache Tribe	42.8	4	13.7	3	0.5074	4
San Luis	23.5	4	21.9	4	0.4337	3
San Tan Valley	8.2	1	10.7	2	0.3629	1
San Xavier	27.1	4	20	4	0.407	2
Scottsdale Central	6.5	1	8.3	1	0.4624	4
Scottsdale North	5.5	1	4.3	1	0.4669	4
Scottsdale South	12.7	2	12.1	3	0.4516	4
Show Low	17.9	3	17	4	0.4398	3
Sierra Vista	14	2	9.3	2	0.3921	2
Snowflake / Heber	19.1	3	14.9	3	0.4113	2
Somerton	21.2	4	19.3	4	0.4257	3
South Mountain Village & Guadalupe	20	3	21.6	4	0.4182	3
Springerville / Eager	16.5	3	11.2	2	0.3962	2
Sun City	10.8	2	8	1	0.4014	2
Sun City West	12.3	2	6.1	1	0.413	2
Sun Lakes	4	1	4.4	1	0.3995	2
Surprise North & Wickenburg	11.9	2	9.6	2	0.4416	4
Surprise South	8.7	1	8.6	1	0.3625	1
Tanque Verde	5.8	1	5	1	0.4049	2
Tempe North	29.9	4	10.8	2	0.4519	4
Tempe South	8.5	1	7	1	0.3826	1
Thatcher	17.7	3	8.5	1	0.3956	2
Tohono O'odham Nation	46	4	9.7	2	0.5123	4
Tucson Central	34.9	4	12.6	3	0.4827	4
Tucson East	15.3	3	11.1	2	0.4081	2

(continued)

Primary Care Area	Adults (18-64) Living Below 100% Federal Poverty Level		Females (19-64) without Health Insurance		Gini Index of Income Inequality	
	%	Quartile	%	Quartile	Index	Quartile
Tucson Estates	15.7	3	15.2	3	0.4227	3
Tucson Foothills	20.4	3	11.3	2	0.4349	3
Tucson South	23.7	4	22	4	0.4037	2
Tucson South East	5.7	1	5.4	1	0.3472	1
Tucson West	22	4	12.1	3	0.4127	2
Vail	4.7	1	6.6	1	0.3856	1
Valencia West	15.2	3	11.5	3	0.3906	2
White Mountain Apache Tribe	40.2	4	17.5	4	0.4772	4
Willcox & Bowie	15.9	3	18.2	4	0.4206	3
Williamson	12.9	2	14.8	3	0.4344	3
Winslow	22.8	4	11.9	3	0.4487	4
Yuma	17.4	3	15.3	3	0.4309	3

Source: 2018 American Community Survey, 5-year Estimates (2014-2018)

**Primary Care Areas:** A Primary Care Area (PCA) denotes the geographic area generally served by a common primary health provider. For example, it is used by the Health Resources and Services Administration to designate areas of workforce shortage.

**Federal Poverty Level:** Federal poverty levels are measures of income released by the Department of Health and Human Services (HHS) every year to determine eligibility for programs and benefits, such as Medicaid. It is based on the modified adjusted gross income as well as the number of individuals in a family who are reliant on that income.

**Gini Index of Income Inequality:** Taken from [census.gov](https://www.census.gov): The Gini Index is a summary measure of income inequality. The Gini coefficient incorporates the detailed shares data into a single statistic, which summarizes the dispersion of income across the entire income distribution. The Gini coefficient ranges from 0, indicating perfect equality (where everyone receives an equal share), to 1, perfect inequality (where only one recipient or group of recipients receives all the income). The Gini is based on the difference between the Lorenz curve (the observed cumulative income distribution) and the notion of a perfectly equal income distribution.



## Section 8: References

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