

Pregnancy-Associated Deaths in Pennsylvania, 2013 – 2018

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pennsylvania
DEPARTMENT OF HEALTH

Dedication

With the utmost sympathy and respect, we dedicate this report
to the memory of those mothers who have died.

Table of Contents

Executive Summary	4
Definitions	6
Background	8
Methods	9
Findings	12
Limitations	24
Maternal Mortality Review Committee	26
Conclusions	27
Citations	28
Appendix A	32

Executive Summary

Maternal Mortality has been steadily increasing in the United States.¹ The Pennsylvania Maternal Mortality Review Committee (PA MMRC) was established by Act 24 of 2018 to review all pregnancy-associated deaths and provide recommendations to reduce preventable pregnancy-related deaths in Pennsylvania. In this report, the definition of pregnancy-associated death is the death of a woman while pregnant or up to 1 year from the end of a pregnancy regardless of the outcome, duration or site of the pregnancy, including all accidental or incidental causes of maternal death. While a pregnancy-related death is the death of a woman while pregnant or within one 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.²

This report examines maternal characteristics of pregnancy-associated deaths in Pennsylvania from 2013 to 2018, including racial/ethnic distribution, age, education attainment, marital status, urban and rural distribution, method of delivery, payment type, adequacy of prenatal care, and cause of death. While the PA MMRC is currently reviewing 2018 pregnancy-associated deaths, analysis of trends and demographics of previous years deaths will help Pennsylvania gain a better understanding of this complex public health issue. This report serves as a source of information for the PA MMRC, Pennsylvania Perinatal Quality Collaborative, public, state, and federal agencies, as well as health care providers and any other organizations and individuals involved in improving maternal health in Pennsylvania.

Vital records data, including birth, death, and fetal death data, were used to identify pregnancy-associated deaths in Pennsylvania. The following identification methods were used to identify deaths: 1) linking death certificates of women with birth and fetal death records within the previous 365 days, and 2) the pregnancy checkbox on death certificates.

Key Findings:

- There is an increasing trend in pregnancy-associated deaths in Pennsylvania, from 84 deaths in 2013 to 102 in 2018, with a 21.4% increase.
- Racial/ethnic disparities exist among pregnancy-associated deaths in Pennsylvania. Non-Hispanic Blacks accounted for 126 (23%) of pregnancy-associated deaths in Pennsylvania from 2013 to 2018, while only accounting for 14% of births in Pennsylvania during this time period.³
- Pregnancy-associated deaths were evenly distributed among both urban and rural counties in Pennsylvania during 2013 to 2018, with the more densely populated urban counties accounting for 408 (75%) of pregnancy-associated deaths, which is comparable to the percentage of births to urban county residents during this time (76%).³
- Of the pregnancy-associated deaths with payment information for the birth, 198 (53%) of the births were paid by Medicaid, while only 32% of all births in Pennsylvania during this period were paid for by Medicaid.³
- Nearly half of the women that experienced a pregnancy-associated death from 2013 – 2018 did not receive adequate prenatal care.
- Accidental poisoning, which includes drug related overdose deaths, accounted for 162 (30%) pregnancy-associated deaths from 2013 to 2018. It was also the leading cause of pregnancy-associated death among both Black and White women in Pennsylvania from 2013 to 2018. In 2013, 19% of all pregnancy-associated deaths were due to accidental poisonings, and 40% in 2018.

Definitions

Pregnancy-Associated Death

In this report the definition of pregnancy-associated deaths, as defined by The Centers for Disease Control and Prevention (CDC),² was used to examine maternal mortality in Pennsylvania. The CDC defines pregnancy-associated death as “the death of a woman while pregnant or up to one year from the end of a pregnancy regardless of the outcome, duration, or site of the pregnancy, including all accidental or incidental causes of maternal death.”² Pregnancy-associated deaths are reviewed by MMRCs and then subcategorized as either 1) pregnancy-related or 2) pregnancy-associated but not related. The deaths identified in this report have not been reviewed by the Pennsylvania MMRC, therefore, the analysis of the subcategory of pregnancy relatedness is not provided in this report.

- 1) **Pregnancy-related death:** CDC defines pregnancy-related death as “the death of a woman while pregnant or within one 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.” An example of pregnancy-related death would be a maternal death from a complication of eclampsia.²

- 2) **Pregnancy-associated but not related death:** CDC defines pregnancy-associated but not related death as “the death of a woman while pregnant or within one year of termination of pregnancy from any cause, which is not a cause of pregnancy or illness exacerbated by pregnancy.”² An example of pregnancy-associated but not related death is maternal death from a motor vehicle accident.

Urban and Rural County Definitions

Rural county: A county is considered rural when the number of persons per square mile within the county is less than 284.⁴

Urban county: A county is considered urban when the number of persons per square mile within the county is 284 persons or more.⁴

Cause of Death Definitions

The cause of death was identified using the underlying cause of death listed on the death certificate and grouped based on the following definition and ICD-10 codes (see Appendix A):

Natural: Natural cause of pregnancy-associated death is related to a medical condition. It includes direct and indirect obstetric (OB) causes of death, organ system related causes e.g. circulatory, respiratory, genitourinary, endocrine, digestive, musculoskeletal, nervous systems, congenital malformations, mental behavior, neoplasms, other pregnancy-related cause, pregnancy with abortive outcome, septicemia, and other system/sign/lab abnormality causes.

Non-natural: Non-natural cause of pregnancy-associated death is related to a non-medical or accidental condition resulting in death. This includes accidental poisoning, accidental drowning, assault, falls, intentional self-harm, smoke/fire/flames, and transportation accident.

Background

Maternal morbidity and mortality have psychological, social and economic consequences that affect women, their children, their families, and their communities.⁵ Global trend in Maternal Mortality Ratio (MMR), the number of maternal deaths per 100,000 live births, decreased about 35% from 342 in 2000 to 211 in 2017.¹ However, the United States has seen a 52% increase in MMR during this same time period, from 12 in 2000 to 18 in 2017.¹ Compared to other high Socio-demographic Index (SDI) countries, the US not only has higher MMR, but it is one of the few countries where MMR is increasing.^{1,6}

There are many factors that influence the increase of MMR in the United States. Chronic health conditions have increased in the US, which are linked to pregnancy complications, and may place a woman at higher risk of adverse pregnancy outcome.⁷ Studies have shown that an increasing number of pregnant women in the US are having chronic health conditions such as hypertension, diabetes, and chronic heart disease, which may put women at higher risk of complications during pregnancy and postpartum.² Another reason for the increase in MMR may be related to the US opioid crisis. According to CDC, opioid use has quadrupled among pregnant women in the US from 1999 to 2014, leading to an increase in opioid-related overdose deaths in pregnant women.⁸ The year after delivery is a vulnerable period for women with opioid use disorder, and the immediate postpartum period has the highest risk of opioid overdose death.⁹ The increase in MMR in the US may also be related to the improved identification of pregnancy-related deaths through the use of computerized data linkages by the states, changes in the way causes of death are coded, and the addition of a pregnancy checkbox to the death certificate. These changes could also be leading to an overestimation in the number of pregnancy-related deaths.^{2,10}

According to CDC, approximately 3 in 5 pregnancy-related deaths are preventable.^{2,11} A maternal death is considered preventable when there is a chance that death could have been avoided by one or more reasonable changes at the patient, family, provider, facility, system, and/or community level.^{2,11} MMRCs are essential to establishing a better understanding of the root causes of maternal deaths and recommending actions that can be taken to decrease

maternal mortality at a state or national level.¹² The PA MMRC, established in 2018, is responsible for reviewing all pregnancy-associated deaths in Pennsylvania. It categorizes pregnancy-associated death as pregnancy-related or pregnancy-associated but not related, determines cause of death and preventability, establishes critical factors contributing to death, recommends actions that can be taken to address the contributing factors, and measures the impact of those actions if implemented.^{12,13} The PA MMRC is currently reviewing pregnancy-associated deaths that occurred in 2018.

Methods

Data Sources:

Pennsylvania death certificates of women ages 10 to 60 years from 2013 to 2018 were used to extract potential pregnancy-associated deaths for the analysis. Birth certificates and fetal death certificates from 2012 to 2018 were then used to identify if those potential deaths are within a year after the end of the pregnancy. These data were supplied by the Bureau of Health Statistics & Registries, Pennsylvania Department of Health, Harrisburg, Pennsylvania. The Bureau of Health Statistics & Registries specifically disclaims responsibility for any analyses, interpretations, or conclusions.

Identification of Cases:

Pregnancy-associated deaths were identified through vital records data from the Pennsylvania Department of Health (DOH) Bureau of Health Statistics & Registries. These deaths were identified using logic provided by CDC. First, deaths of women of reproductive age (10-60 years) were identified using death certificate data to from years 2013 to 2018. Next, the deaths that were identified were linked to fetal death and birth certificate data from 2012 to 2018 to determine if the deaths were within 365 days after the end of pregnancy. Then the pregnancy checkboxes on the death certificates were analyzed to identify anyone who was pregnant at the time of death or pregnant within the 365 days preceding their death. The deaths identified through matching to fetal death/births and pregnancy checkbox were combined and de-duplicated.

Further analysis was done in cases where the checkbox was marked “Unknown if pregnant within the past year” to determine relation to pregnancy by searching for words that would indicate a relationship to pregnancy, such as “postpartum, ectopic, eclampsia, pregnancy, preeclampsia.” A search of the cause of death axis codes was also performed to find pregnancy-related ICD-10 codes. If no relation was identified, then those records with unknown checkboxes were removed from the “checkbox file.” The remaining records from the “checkbox file” were combined with the “linked file.” This combined data set includes all identified pregnancy-associated deaths from 2013 – 2018.

Analysis of Adequacy of Prenatal Care Utilization:

American College of Obstetricians and Gynecologists (ACOG) recommends that pregnant women with an uncomplicated first pregnancy have a prenatal care visit with their obstetric care provider every 4 weeks for the first 28 weeks of gestation, every 2 weeks until 36 weeks of gestation, and every week after that until delivery.¹⁴ Women with high risk pregnancy or who are having medical or obstetric problems during pregnancy require closer monitoring by obstetric providers.¹⁴

For this report, adequacy of prenatal care was assessed for pregnancy-associated deaths that were linked to a birth certificate (checkbox only cases and fetal death case were excluded). APNCU (Adequacy of Prenatal Care Utilization) Index or Kotelchuck Index was utilized for this report to assess adequacy of prenatal care adequacy.¹⁵ The APNCU is based on the month prenatal care began and the number of visits adjusted for gestational age at delivery.¹⁵

Analysis of Time Between Pregnancy and Death:

For this report, analysis of status of pregnancy at time of death was assessed using matching birth and fetal death certificates and the pregnancy checkbox. Since the death certificate has a date of death and the birth/fetal death certificate has a date of birth/fetal death, these dates were used to calculate a date difference. The date difference was then used to determine the woman’s pregnancy status at the time of death.

The following methods were used to determine status at time of death.

Pregnant at time of death was identified when the following existed:

- 1) The difference between the date of death on the death certificate and the date of birth on the matching birth certificate or date of death on the fetal death certificate was zero, and the pregnancy checkbox indicated “pregnant at time of death.”
- 2) The difference between the date of death on the death certificate and the date of birth on the matching birth certificate or date of death on the fetal death certificate was greater than 1 day and less than or equal to 365 days; however, the pregnancy checkbox indicated “pregnant at time of death”. This indicated that she gave birth within the last year but was currently pregnant again when she died.
- 3) There was no matching birth or fetal death certificate, and the pregnancy checkbox indicated “pregnant at time of death.”

End of Pregnancy to 42 days postpartum at time of death was identified when the following existed:

- 1) The difference between the date of death on the death certificate and the date of birth on the matching birth certificate or date of death on the fetal death certificate was zero, and the pregnancy checkbox indicated “not pregnant, but pregnant within 42 days of death.”
- 2) The difference between the date of death on the death certificate and the date of birth on the matching birth certificate or date of death on the fetal death certificate was 1 to 42 days.
- 3) There was no matching birth or fetal death certificate, and the pregnancy checkbox indicated “not pregnant, but pregnant within 42 days of death.”

43 to 365 days postpartum at time of death was identified when the following existed:

- 1) The difference between the date of death on the death certificate and the date of birth on the matching birth certificate or date of death on the fetal death certificate was 43 to 365 days and the pregnancy checkbox did not indicate “pregnant at time of death.”
- 2) There was no matching birth or fetal death certificate, and the pregnancy checkbox indicated “not pregnant, but pregnant 43 days to 1 year before death.”

Findings

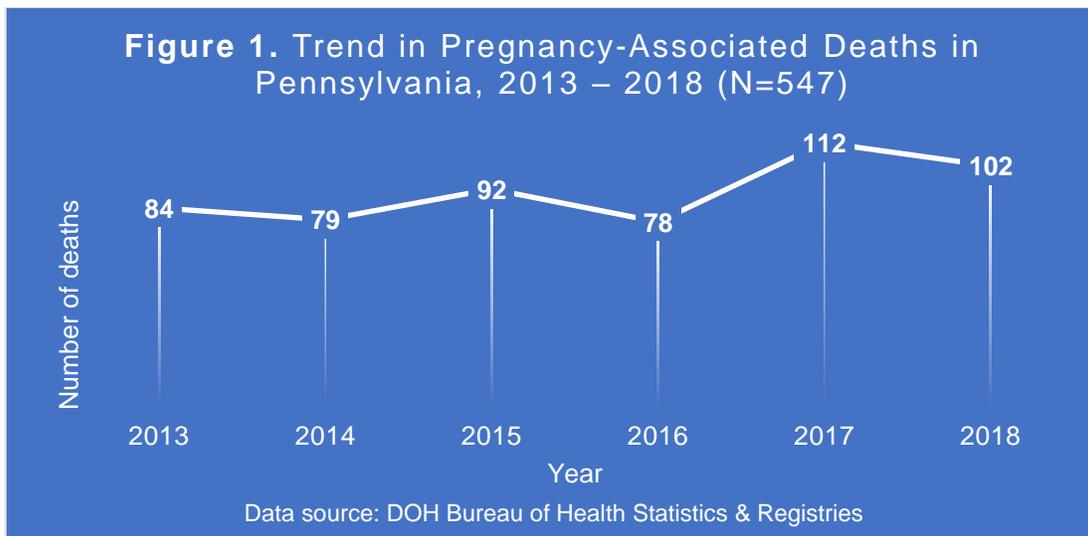
Identification of Pregnancy-Associated Deaths

Of the pregnancy-associated deaths from 2013 – 2018 (547 deaths), 375 (69%) of the deaths were identified by matching a birth or fetal death certificate with the death certificate. In addition, 161 (29%) additional people were identified as pregnant within 0 to 365 days of death by the pregnancy checkbox on the death certificate. The pregnancy checkbox was used to identify additional individuals that had been pregnant 0 to 365 days prior to their death but did not have a matching birth/fetal death certificate. To complete the pregnancy checkbox, the person certifying the death must choose either 1) not pregnant within the last year, 2) pregnant at time of death, 3) not pregnant, but pregnant within 42 days of death, 4) not pregnant, but pregnant 43 days to 1 year before death, or 5) unknown if pregnant within the last year. Therefore, any checkbox answer of 2, 3, or 4 was counted as a pregnancy 0 to 365 days before death and was included in the counts.

Eleven (2%) additional people were identified as pregnancy-associated deaths by examining all death certificates that did not have a match to a birth/fetal death certificate and had a checkbox answer on the death certificate of “unknown if pregnant within the last year.” Those death certificates were then searched for terms related to pregnancy in the death certificate, as well as pregnancy related ICD-10 codes under cause of death. More information on this identification process can be found in the methods section.

Trend in Pregnancy-Associated Deaths

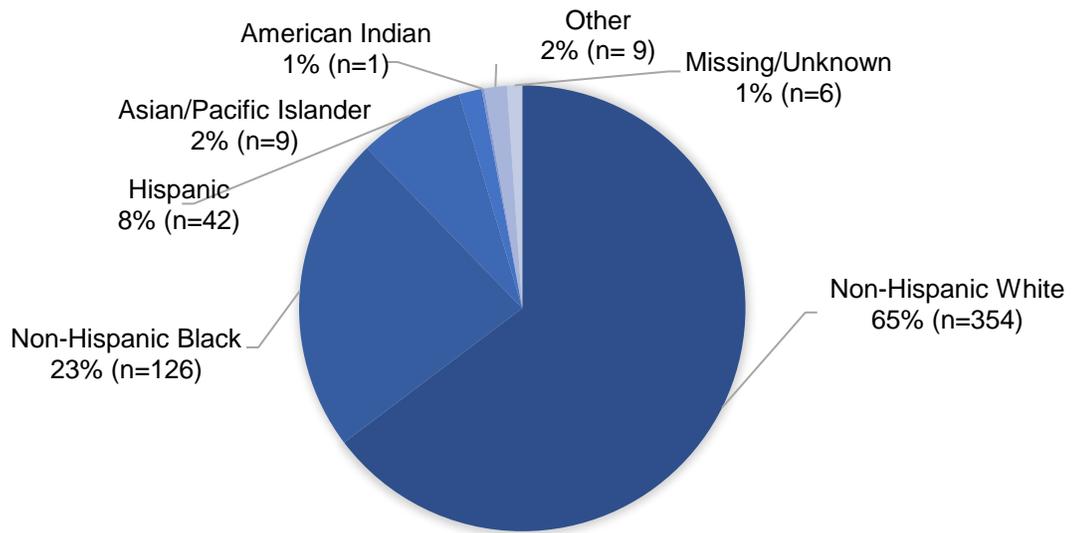
There was a total of 547 pregnancy-associated deaths in Pennsylvania from 2013 to 2018. There were 331 (61%) pregnancy-associated deaths identified by linkage to a birth certificate, 44 (8%) by linkage to a fetal death certificate, 161 (29%) identified only by checkboxes, and 11 (2%) by ICD-10 or literal match. Pregnancy-associated deaths increased in Pennsylvania from 84 deaths in 2013 to 102 in 2018, a 21.4% increase.



Race and Ethnicity

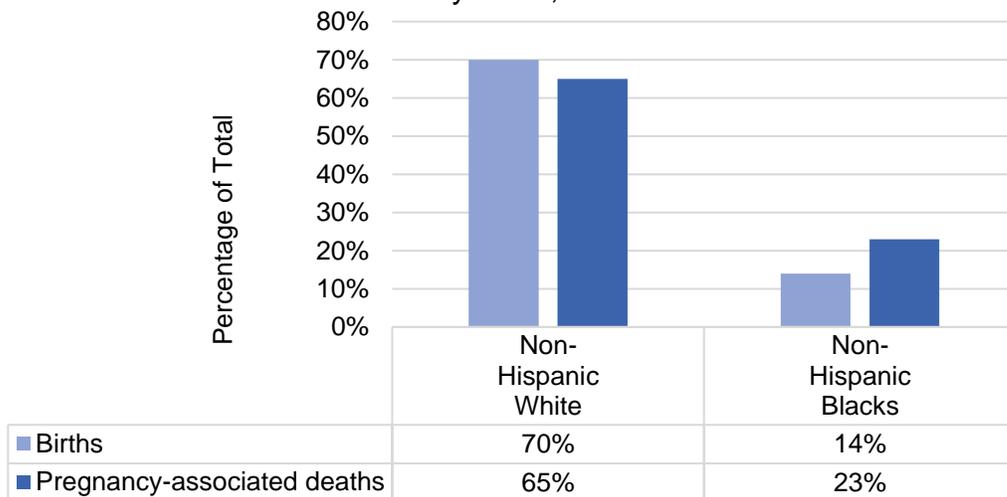
Racial and ethnic disparities exist among pregnancy-associated deaths in Pennsylvania. Non-Hispanic Whites accounted for 70% of the births in Pennsylvania between 2013 – 2018,³ and represented 354 (65%) of pregnancy-associated deaths during this time period. However, non-Hispanic Blacks accounted for only 14% of the births in Pennsylvania between 2013 – 2018,³ but represented 126 (23%) of the pregnancy-associated deaths during this time period. The racial/ethnic disparity identified in pregnancy-associated deaths in Pennsylvania mirrors the disparity seen in national maternal mortality data.¹⁶

Figure 2. Distribution of Pregnancy-Associated Deaths by Race/Ethnicity in Pennsylvania, 2013 – 2018 (N=547)



Note: Numbers rounded to the nearest whole
Data source: DOH Bureau of Health Statistics & Registries

Figure 3. Distribution of Pregnancy-Associated Deaths and Births Among Non-Hispanic Whites and Non-Hispanic Blacks in Pennsylvania, 2013 – 2018



Data source: DOH Bureau of Health Statistics & Registries

Maternal Age

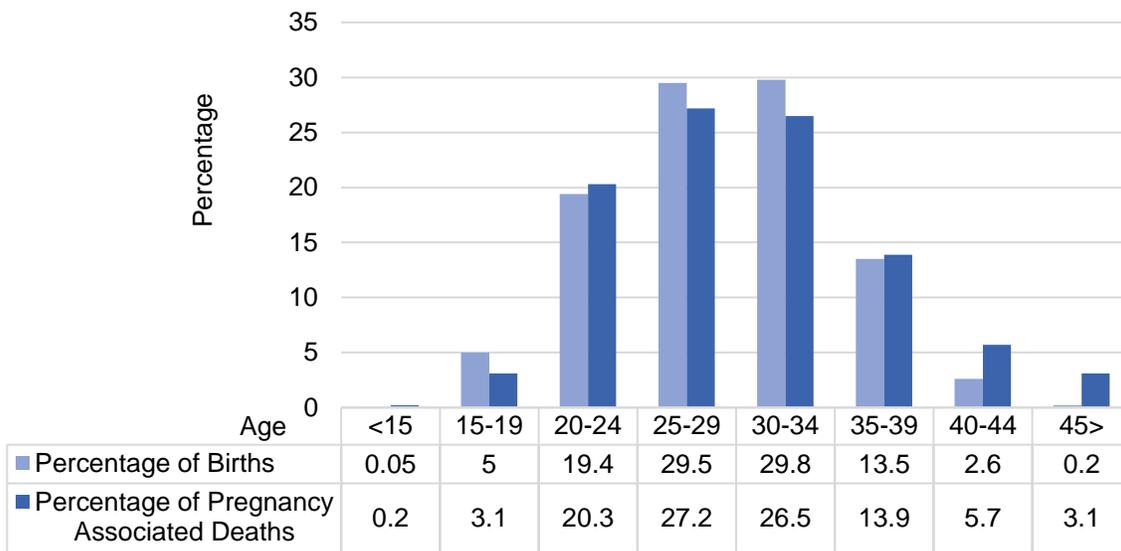
Maternal age at time of death was obtained from the death certificates. Women 20 – 34 years of age had the highest number of pregnancy-associated deaths in Pennsylvania from 2013 – 2018, with a cumulative total of 74%. Women 20 – 34 years of age were the largest group of women (79%) that gave birth in Pennsylvania from 2013 – 2018.³ Women 35 or older represented 17% of all women giving birth in Pennsylvania between 2013 – 2018 but were 23% of cases of pregnancy-associated deaths in the state from 2013 – 2018.³ Advanced maternal age (≥ 35 years) is associated with higher risk of pregnancy complications, including preeclampsia, eclampsia, and postpartum hemorrhage.^{17,18}

Table 1. Pregnancy-Associated Deaths by Maternal Age in Pennsylvania, 2013 – 2018 (N=547)

Maternal Age (years)	Pregnancy-Associated Deaths						Total (%)
	2013	2014	2015	2016	2017	2018	
10 – 14	0	0	0	1	0	0	1 (<1)
15 -19	3	2	4	3	2	3	17 (3.1)
20 – 24	14	19	18	13	24	23	111 (20.3)
25 – 29	21	16	28	26	31	27	149 (27.2)
30 – 34	23	18	26	18	30	30	145 (26.5)
35 – 39	15	12	10	11	15	13	76 (13.9)
40 – 44	4	8	5	3	6	5	31 (5.7)
45 – 49	2	1	0	1	3	1	8 (1.5)
50 – 54	2	3	0	1	1	0	7 (1.3)
55 – 60	0	0	1	1	0	0	2 (<1)

Data source: DOH Bureau of Health Statistics & Registries

Figure 4. Distribution of Pregnancy-Associated Deaths and Births by Maternal Age in Pennsylvania, 2013 – 2018 (N=547)

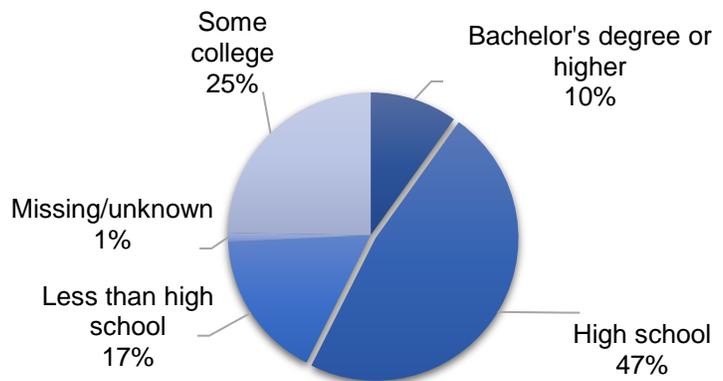


Data source: DOH Bureau of Health Statistics & Registries

Education

Of the 547 pregnancy-associated deaths identified in Pennsylvania from 2013 – 2018, 91 (17%) had less than high school education, 261 (48%) had high school education, 136 (25%) had some college education, and 53 (10%) had a bachelor's degree or higher education. Education status for 6 (1%) people was either missing or unknown. Women with less than high school and high school education accounted for almost two-thirds (64%)

Figure 5. Distribution of Pregnancy-Associated Deaths by Maternal Education in Pennsylvania, 2013 – 2018 (N=547)



Data source: DOH Bureau of Health Statistics & Registries

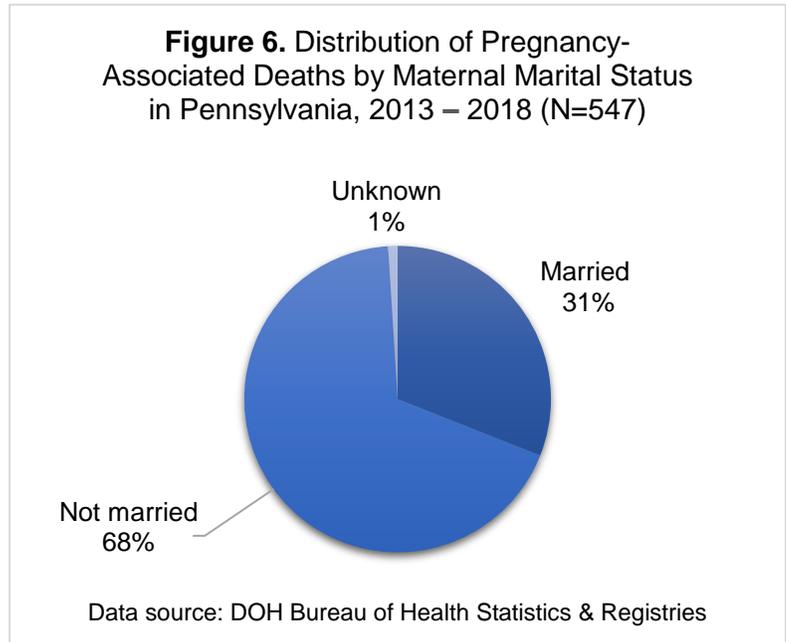
of the pregnancy-associated deaths in Pennsylvania. Education is an important social determinant of health.¹⁹ There is an inverse relationship between maternal education

attainment and maternal mortality, in which lower levels of maternal education, even with access to intrapartum care, is associated with higher maternal mortality.^{20,21}

Marital Status

Of the total 547 pregnancy-associated deaths in Pennsylvania from 2013 – 2018, 372 (68%) were not married at time of death, 167 (31%) were married, and only 8 (1%) of women did not have a listed marital status. Mothers that were not married accounted for 41% of births in Pennsylvania from 2013-2018³ but for 68% of pregnancy-associated deaths during the same time period.

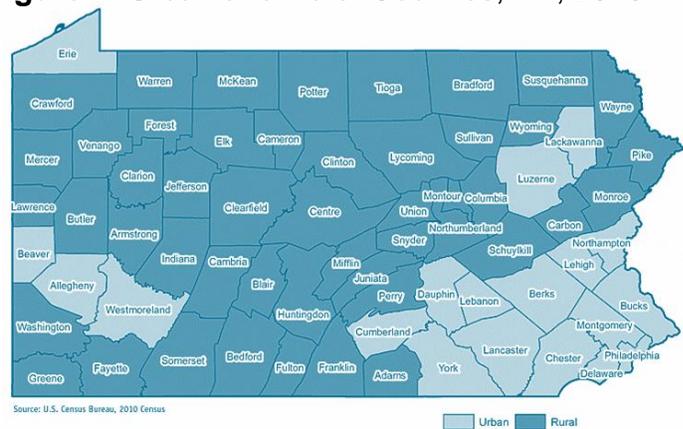
Unmarried childbearing women face financial, social, and health disadvantages. Unmarried mothers are more likely to die from pregnancy-related issues and are at higher risk for still birth and infant death.^{22,23}



Urban and Rural Location

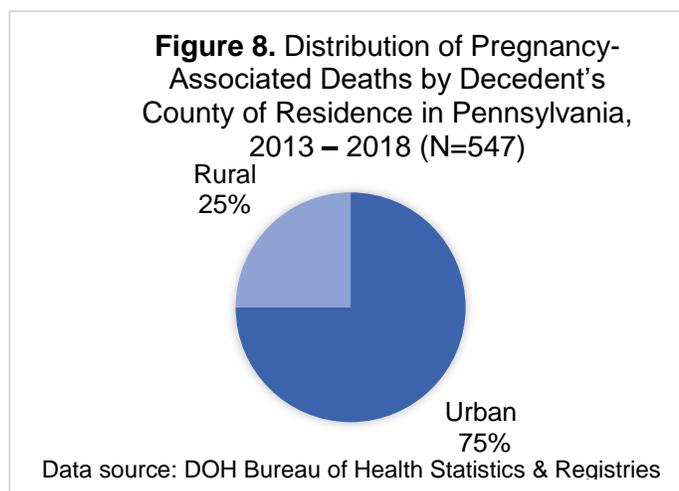
Urban and rural counties are determined based on population density. The Center for Rural Pennsylvania defines rural counties as those with less than 284 persons per square mile, and urban counties with 284 persons or more per square mile.⁴ Nineteen of the 67 counties in Pennsylvania are urban, and the remaining 48 are rural.⁴

Figure 7. Urban and Rural Counties, PA, 2010



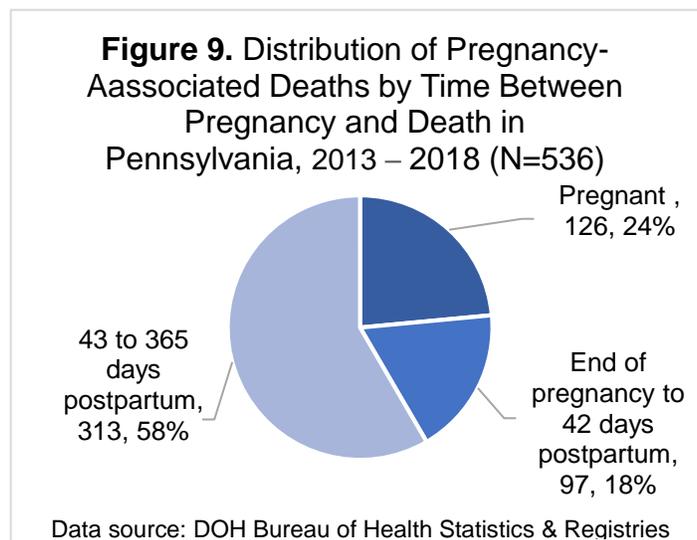
Source: The Center for Rural Pennsylvania

Between 2013 and 2018, 76% (635,664) of births were among residents of urban counties, and 24% (199,902) of births were among residents of rural counties.³ Pregnancy-associated deaths of rural and urban county residents are comparable to the live birth rates, with 408 (75%) deaths of urban county residents and 139 deaths (25%) of rural county residents.



Time Between Pregnancy and Death

Knowing at what point in pregnancy/postpartum a death occurred is helpful to understanding when interventions are needed. The needs of pregnant people and the challenges they face can change from prenatal to postpartum periods. Most of the pregnancy-associated deaths identified in Pennsylvania happened after the end of pregnancy, while 24% occurred while pregnant. This identifies delivery and postpartum periods as a critical time for interventions.



Of the 547 pregnancy-associated deaths identified, 11 deaths did not have a matching birth or fetal death certificate and “unknown” indicated on the pregnancy checkbox. These 11 deaths were excluded from the analysis of pregnancy status at time of death.

Method of Delivery

Method of delivery is categorized as vaginal or cesarean. For this report, method of delivery was only calculated for deaths with a linkage to a birth certificate. Method of delivery was not analyzed for fetal deaths and checkbox linkages because these deaths do not have any method of delivery information available. There were 334 pregnancy-associated deaths linked to birth certificates, 200 (60%) were born by vaginal delivery, 128 (39%) were born by cesarean section, and 3 (1%) had missing information. In Pennsylvania from 2013 – 2018, 30% of all births were by cesarean section delivery but 39% of pregnancy-associated deaths.³ ACOG recommends that “in the absence of maternal or fetal indications for cesarean delivery, a plan for vaginal delivery is safe and appropriate and should be recommended.”²⁴ Women delivering by cesarean section have a higher risk of maternal mortality as compared to those delivering by vaginal delivery.^{25,26}

Method of Payment

Method of payment data was only available for cases that were matched to a birth certificate or fetal death certification. Of the 375 identified cases of pregnancy-associated deaths in Pennsylvania from 2013 to 2018 with payment information, 98 (26%) were private insurance, 198 (53%) were Medicaid, and 19 (5%) were self-pay. Payment information was missing or unknown for 45 cases (12%), and 15 (4%) were listed as other method of payment. Medicaid was the method of payment for 32% of births in Pennsylvania from 2013 to 2018 but 53% of pregnancy-associated deaths during the same time period in Pennsylvania.³ This disparity in pregnancy-associated deaths in Pennsylvania indicates that women from lower socioeconomic groups exhibited a higher rate of deaths.

Prenatal Care Utilization

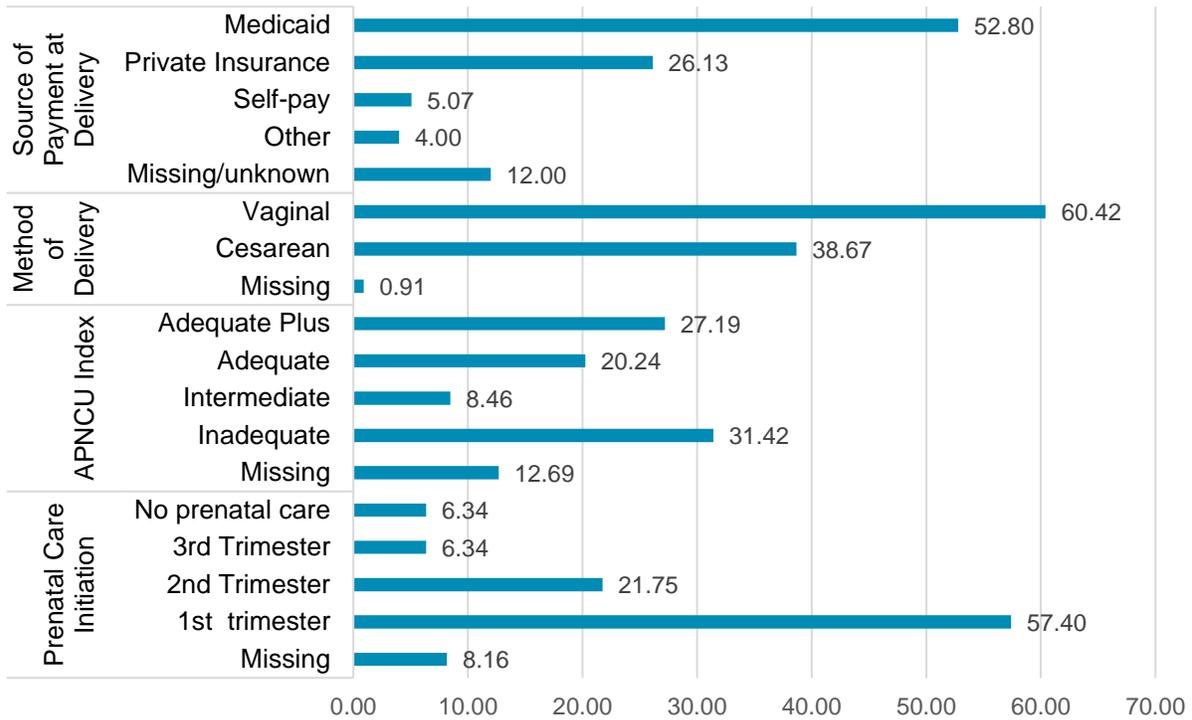
A prenatal care visit is a health care visit by a pregnant woman to her obstetric care provider that includes counseling about healthy diet, exercise, weight gain, avoiding specific risk factors, along with pregnancy and maternal health monitoring. It should include a discussion about maternal mental health and psychosocial stressors. Recommended pregnancy screening and

discussion of results of tests should also occur. The first prenatal care visit should be in the first trimester as soon as a woman finds out she is pregnant.¹⁴

Prenatal care initiation: A total of 331 cases of pregnancy-associated death with available prenatal care information was matched with birth certificate data: 27 (8%) were excluded due to incomplete information for this analysis. Of the 304 total cases, 190 (57 %) started prenatal care in the first trimester, 72 (22%) started prenatal care in the second trimester, 21 (6%) started prenatal care in the third trimester, and 21 (6%) received no prenatal care. Prenatal care starting in the first trimester with adequate prenatal visits ensures optimal monitoring of pregnancy for maternal and fetus health.¹⁴ Among all Pennsylvania births in 2013 – 2018, on average, 73% of women started prenatal care in the first trimester, but only 63% of women with pregnancy-associated deaths during the same period started prenatal care in the first trimester.³ No prenatal care places a mother and her fetus at increased health risk.¹⁴ Among all Pennsylvania births from 2013 – 2018, 1.6% of women received no prenatal care, but 6% of women with pregnancy-associated deaths received no prenatal care during that period.³

Adequacy of Prenatal Care: APNCU (Adequacy of Prenatal Care Utilization) Index, also known as the Kotelchuck Index, was used to assess adequacy of prenatal care.¹⁵ The APNCU is based on the month prenatal care began and the number of visits adjusted for gestational age at delivery.¹⁵ A total of 331 pregnancy-associated deaths with available prenatal care information were matched with birth certificate data; 42 (13%) were excluded due to incomplete information for this analysis. Of the 289 deaths, 90 (27%) received adequate plus prenatal care visits, 67 (20%) received adequate prenatal care visits, 28 (8%) received intermediate prenatal care visits, and 104 (31%) received inadequate prenatal care visits. In the United States, 76.4% of pregnant females received early and adequate prenatal care in 2018 (NVSS-N),²⁷ which is below the Healthy People 2030 target of 80%. Among women with pregnancy-associated death in Pennsylvania from 2013 to 2018, almost half 132 (40%) received inadequate or intermediate number of prenatal care visits.

Figure 10. Percent of Pregnancy-Associated Deaths by Characteristics in Pennsylvania, 2013 – 2018



Note: Only pregnancy-associated deaths with matching birth certificates are presented in the figure.
Data Source: DOH Bureau of Health Statistics & Registries

Cause of Death

Cause of death was analyzed using ICD-10 codes on the death certificate. Appendix A includes cause of death groupings and the corresponding ICD-10 codes. The leading causes of pregnancy-associated deaths in Pennsylvania from 2013 to 2018 were accidental poisoning 162 (30%), direct OB deaths 72 (13%), other pregnancy-related deaths 62 (11%), and transportation accident 55 (10%). These accounted for more than 60% of all pregnancy-associated deaths during this period.

Leading causes of medical or natural pregnancy-associated death include: direct OB death 72 (13%), other pregnancy-related 62 (11%), indirect OB deaths 27 (5%), circulatory system 24 (4.4%), other symptom/sign/lab abnormality 14 (3%), and neoplasm 13 (2.4%). Leading causes of non-natural pregnancy-associated death include:

accidental poisoning 162 (30%), transportation accident 55 (10%), assault 44 (8%), and intentional self-harm 41 (7.5%).

Table 2. Trend in Leading Causes of Pregnancy-Associated Deaths in Pennsylvania, 2013 – 2018 (N=547)

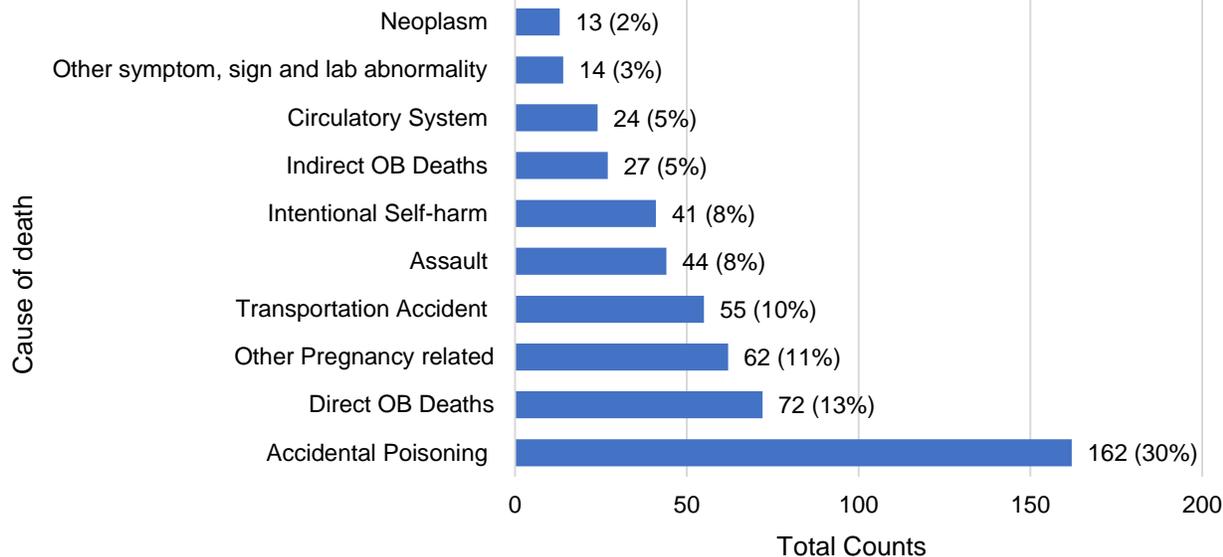
Cause of death	2013	2014	2015	2016	2017	2018	Total
	N (%)						
Accidental poisoning	16 (19.0)	14 (17.7)	29 (31.5)	21 (27.0)	41 (36.6)	41 (40.2)	162 (29.6)
Direct OB deaths	14 (16.7)	11 (14.0)	12 (13.0)	13 (16.7)	11 (9.8)	11 (10.8)	72 (13.2)
Other pregnancy-related	7 (8.3)	11 (14.0)	9 (9.8)	9 (11.5)	17 (15.2)	8 (8.8)	62 (11.3)
Transportation accident	14 (16.7)	9 (11.4)	7 (7.6)	6 (7.7)	11 (9.8)	8 (7.8)	55 (10.0)
Assault	6 (7.1)	10 (12.7)	3 (3.3)	4 (5.1)	10 (9.0)	11 (10.8)	44 (8.0)
Intentional self-harm	7 (8.3)	8 (10.0)	11 (12.0)	3 (3.9)	7 (6.3)	5 (5.0)	41 (7.5)
Indirect OB deaths	7 (8.3)	6 (7.6)	3 (3.3)	4 (5.1)	4 (3.6)	3 (2.9)	27 (4.9)
Circulatory system	5 (6.0)	1 (1.3)	6 (6.5)	5 (6.4)	3 (2.7)	4 (3.9)	24 (4.4)
Other system, sign, and lab abnormality	0 (0.0)	3 (3.8)	4 (4.4)	4 (5.1)	1 (1.0)	2 (2.0)	14 (2.6)
Neoplasm	1 (1.2)	3 (3.8)	1 (1.1)	3 (3.9)	3 (2.7)	2 (2.0)	13 (2.4)
Other *	7 (8.4)	3 (3.9)	7 (7.7)	6 (7.8)	4 (3.6)	6 (6.0)	33 (6.1)

Data source: DOH Bureau of Health Statistics & Registries

Note: Cause of death identified using ICD-10 codes provided in Appendix A

* Other represents: Accidental drowning, congenital malformations, digestive system, endocrine/nutrition/metabolic, falls, genitourinary, mental behavior, musculoskeletal, nervous system,

Figure 11. Leading Causes of Pregnancy-Associated Deaths in Pennsylvania, 2013 – 2018 (N=547)



Note: Numbers rounded to the nearest whole.
Data Source: DOH Bureau of Health Statistics & Registries

Accidental poisoning was the leading cause of pregnancy-associated death in Pennsylvania from 2013 to 2018. Accidental poisoning included unintentional prescription drug-related deaths (Appendix A). The number of accidental poisoning, pregnancy-associated deaths was nearly 3 times higher in 2018 (41) than in 2013 (16). This increasing trend corresponds with the significant increase in rates of drug- and opioid-related overdose deaths during this time period. In Pennsylvania, drug-related overdose deaths from 2013 (2,238) to 2017 (5,396) more than doubled.²⁹ In 2017, the rate of drug-related overdose deaths in Pennsylvania was 44.3 deaths per 100,000, which far exceeded the national average of 22 deaths per 100,000.²⁹ Although the drug overdose death rate was lower in 2018 (36.1) than in 2017 (44.3), Pennsylvania continues to have one of the highest age-adjusted drug overdose death rates in the US.²⁹ In 2018, 30% of the drug overdose deaths in Pennsylvania were among women.³⁰ Pennsylvania data on maternal hospital stays involving substance use and opioids showed that opioid use disorder was present in 14.6 per 1,000 deliveries in 2000-2001 and increased to 39.8 per 1,000 deliveries during 2016-2017.³¹ Maternal hospital stays with opioid use had

higher rates of co-occurring conditions when compared to maternal stays without opioid use, with the most common being tobacco use (67%) and mental health disorder (40%).³¹

The leading causes of pregnancy-associated death in Pennsylvania from 2013 to 2018 among Black women (including non-Hispanic Black and Hispanic Black) were accidental poisoning (28), assault (21), direct OB death (20), other pregnancy-related (15) and transportation accident (9). The leading causes of pregnancy-associated death among White women (includes non-Hispanic White and Hispanic White) during the same time period were accidental poisoning (130), transportation accident (41), other pregnancy-related (40), direct OB deaths (39), and intentional self-harm (29).

Limitations

This report identified pregnancy-associated deaths using the standard US death certificate pregnancy checkboxes and vital records data linkage from DOH. There are various limitations to using this approach.^{32,33,34} Errors can arise when the pregnancy checkbox is answered incorrectly by the certifier, either indicating that the mother was pregnant within a year or was not pregnant. This can result in over- or under-reporting of maternal deaths.^{32,33,34} For this report, 10% of the cases identified had a pregnancy checkbox marked that indicated they were not pregnant in the last 365 days but had a true linkage to a birth or fetal death record and were therefore true cases. However, it is possible that other cases were missed that had a pregnancy checkbox that indicated no pregnancy but were true pregnancy-associated deaths. These could have been missed by the linkage for several reasons: 1) the mother's name on the death certificate did not match the mother's name on the birth certificate (adoption), 2) miscarriage occurred early on in pregnancy, and there was no fetal death certificate created. For this report, 29% of the cases were identified by checkbox identification only. This means that there were no birth or fetal death records linked to the death certificate of the mother, but the pregnancy checkbox answer indicated they were pregnant within 365 days of their death. This could happen for several reasons: 1) the mother's name on the death certificate did not match the name on the birth certificate (adoption), 2) miscarriage occurred early on in pregnancy, and there was no fetal death certificate created, 3) the checkbox was answered, indicating a

pregnancy in error. At this time, it is unclear exactly how often the pregnancy checkbox is answered incorrectly; however, by conducting review of all pregnancy-associated deaths found through the pregnancy checkbox or linkage methods, the Pennsylvania MMRC will know more about the extent of this issue in the future. Another limitation of the pregnancy checkbox is the use of the unknown option. Of the 547 pregnancy-associated deaths identified for this report, 23% of them had the unknown answer choice marked for the pregnancy question. Only pregnancies with a documented outcome, such as a live birth or fetal death, can be linked; therefore, identification of cases without a documented live birth or fetal death relies on accurate pregnancy checkboxes information. Pregnancies resulting in an undocumented outcome such as an early miscarriage may have been missed if the pregnancy checkbox was inaccurate.^{31,32,33} Another known problem with vital record linkage is that it is difficult to link a deceased mother's records with vital records data from out of state.^{33,34,35}

In Pennsylvania, when an adoption is finalized, the name of the mother on the birth certificate is changed to the adoptive mother's name and the original file is sealed. This makes linking a death certificate to a birth certificate of a child that was placed for adoption impossible after the adoption has occurred. To reduce the number of linkages missed due to adoption, in the future, the data linkages will be run on a quarterly basis. This will allow deaths to be identified closer to real time and reduce the number of adoptions that would have been finalized by the time that the linkage is conducted. In the future, the Division of Vital Records will work on a process to conduct case matching on the original birth certificates, not the amended versions, to address this limitation. Deaths of women ages 10 to 60 were also matched to hospital discharge data to help alleviate this limitation. For this report, cases that had a checkbox that indicated pregnancy but did not link to a death certificate were included in the case counts. However, there is a chance that the checkbox was answered incorrectly. When deaths are reviewed by the MMRC, coroner and medical records are requested. After receiving these records, additional information becomes available, and, in some cases, it may be found that the person had not been pregnant, and the checkbox was marked incorrectly. For cases reviewed by MMRC, all checkbox cases are checked before being added to the state's case count for that year.

Maternal Mortality Review Committee

The CDC recommends that maternal deaths be investigated through a state-based maternal mortality review committee (MMRC) in order to institute the systemic changes needed to decrease maternal mortality.² The Maternal Mortality Review Act, Act 24 of 2018, was signed into law by Governor Wolf on May 9, 2018, and established the Pennsylvania Maternal Mortality Review Committee (PA MMRC). The PA MMRC was created for the purpose of confidential identification, review, and dissemination of findings regarding maternal deaths in the commonwealth. The committee members of the PA MMRC are multidisciplinary professionals and partners who serve pregnant and postpartum women. In September 2019, the Pennsylvania Department of Health secured funding from the CDC to support these efforts.

The mission of the PA MMRC is to systematically review all maternal deaths, identify root causes of these deaths, and develop strategies to reduce preventable morbidity, mortality, and racial disparities related to pregnancy in Pennsylvania.³⁶ The PA MMRC staff at the DOH identify pregnancy-associated deaths, gather records to better understand the circumstances of the person's life and death, and create deidentified case summaries for review by the members of the committee.³⁶ The MMRC determines if the death is "pregnancy-related" or "pregnancy-associated but not related," if the death is preventable, what factors contributed to the death, and actions that can be taken to prevent future deaths.^{2,36} Based on the committee's determinations, the PA MMRC makes recommendations to formulate policy and program changes in Pennsylvania to improve pregnancy outcomes and improve maternal health during and after pregnancy. The PA MMRC is currently reviewing 2018 pregnancy-associated deaths. The findings from the committee's review will inform policy decisions and interventions in the commonwealth.

The PA MMRC works in coordination with the Philadelphia MMRC, which was established in 2010.³⁶ The Philadelphia MMRC reviews maternal deaths among Philadelphia residents. The PA MMRC collaborates with the Pennsylvania Perinatal Quality Collaborative (PA PQC), which serves as the implementation arm of the PA MMRC for dissemination and implementation of recommendations at the provider and facility level. Reducing maternal mortality and improving care for pregnant and postpartum women and newborns is a major aim of the PA PQC.³⁷ Sixty

birth sites in Pennsylvania and 14 commercial and Medicaid health plans across the commonwealth participate in the PA PQC, representing 80% of births in Pennsylvania.³⁷ By engaging birth sites and providers in quality improvement projects, sharing of best practices and collaborative work, the PA PQC aspires to improve the care of mothers and infants throughout the commonwealth.

Conclusions

This report identified pregnancy-associated deaths in Pennsylvania from 2013 to 2018, and an increasing trend in pregnancy-associated deaths was observed during this period. Of these deaths, a majority occurred after the end of pregnancy. An analysis of sociodemographic factors found that non-Hispanic Blacks and those utilizing Medicaid as source of payment at delivery are disproportionately impacted. When compared to all births, those who experienced a pregnancy-associated death initiated prenatal care in the first trimester at a lower rate and were less likely to have an adequate number of prenatal care visits. A notable increase in pregnancy-associated deaths due to accidental poisonings was observed.

Pennsylvania Department of Health recommends a concerted effort at all levels (federal, state, and local governments; communities; health care systems; providers; and families) to jointly address the needs of pregnant people in Pennsylvania to prevent pregnancy-associated deaths. To address this public health issue, all birthing facilities in Pennsylvania are encouraged join the PA PQC to learn best practices and implement quality improvement initiatives to advance maternal health care in Pennsylvania. Across Pennsylvania support should be provided for policies and programs that 1) address racial and ethnic inequities that contribute to disparities in pregnancy outcomes, 2) increase early and adequate prenatal care, 3) address the needs of women in the postpartum period, and 4) address substance use and substance use disorders (SUD) in reproductive aged women.

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Appendix A: ICD-10 Codes for Causes of Death

Natural Causes of Pregnancy-associated Deaths:

- **Pregnancy with abortive outcome** - (ICD-10 CM Diagnosis Code O00 - O07): Pregnancy with abortive outcome
- **Direct OB Cause** - (ICD-10 CM Diagnosis Code O10 – O92): Pregnancy, childbirth and the puerperium
- **Other pregnancy-related cause** - (ICD-10 CM Diagnosis Code O95 - O97): Other obstetric conditions, not elsewhere classified
- **Indirect OB cause** – (ICD-10 CM Diagnosis Code O98 – O99): Maternal infectious and parasitic diseases complicating pregnancy, childbirth and the puerperium
- **Circulatory** – (ICD-10 CM Diagnosis Code I00 - I99): Diseases of the circulatory system
- **Respiratory** - (ICD-10 CM Diagnosis Code J00 - J98): Diseases of the respiratory system
- **Genitourinary** – (ICD-10 CM Diagnosis Code N00 - N98): Diseases of the genitourinary system
- **Endocrine/nutrition/metabolic** – (ICD-10 CM Diagnosis Code E00 - E88): Endocrine, nutritional and metabolic diseases
- **Digestive** – (ICD-10 CM Diagnosis Code K00 - K92): Diseases of the digestive system
- **Musculoskeletal** – (ICD-10 CM Diagnosis Code M00 - M99): Diseases of the musculoskeletal system and connective tissue
- **Nervous** – (ICD-10 CM Diagnosis Code G00 – G98): Diseases of the nervous system
- **Congenital malformations** – (ICD-10 CM Diagnosis Code Q00 – Q99): Congenital malformations, deformations and chromosomal abnormalities

- **Mental behavior** – (ICD-10 CM Diagnosis Code F01 – F99): Mental, Behavioral and Neurodevelopmental disorders
- **Neoplasms** - (ICD-10 CM Diagnosis Code C00 – D48): Neoplasms
- **Septicemia** - (ICD-10 CM Diagnosis Code A41): Other sepsis
- **Other system/sign/lab abnormality causes** - (ICD-10 CM Diagnosis Code R00 - R99): Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified

Non-natural Causes of Pregnancy-associated Deaths

- **Accidental poisoning** - (ICD-10 CM Diagnosis Code X40 - X49): Accidental poisoning by and exposure to noxious substances
- **Accidental drowning** - (ICD-10 CM Diagnosis Code W65 – W74): Accidental non-transport drowning and submersion
- **Assault** – (ICD-10 CM Diagnosis Code X85 – Y09, W20 - W64, W75 - W99, X10 - X39, X50 - X59, Y10 - Y89): External causes of morbidity
- **Falls** - (ICD-10 CM Diagnosis Code W00 – W19): Slipping, tripping, stumbling and falls
- **Intentional self-harm** - (ICD-10 CM Diagnosis Code X60 - X84): Suicide and Attempted suicide
- **Smoke/fire/flames** - (ICD-10 CM Diagnosis Code X00 - X09): Exposure to smoke, fire and flames
- **Transportation accident** - (ICD-10 CM Diagnosis Code V01 - V99): Any accident involving a device designed primarily for, or being used at the time primarily for, conveying persons or goods from one place to another