INFANT MORTALITY TRENDS IN VIRGINIA 2014-2016

A report from the VIRGINIA STATE CHILD FATALITY REVIEW TEAM

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STATE CHILD FATALITY REVIEW TEAM MISSION STATEMENT

As an interdisciplinary team, we review and analyze sudden, violent, or unnatural deaths of children so that strategies can be recommended to reduce the number of preventable child deaths in Virginia.

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TECHNICAL NOTES

In 1994, the Virginia General Assembly enacted Virginia Code §32.1-283.1, which established the State Child Fatality Review Team. This statute directed the Team to develop and implement procedures to ensure the systematic analysis of child deaths in Virginia. Since its inception, the State Child Fatality Review Team has conducted in-depth reviews of child fatalities that fall within designated topics and timeframes chosen by the Team. In 2015, the Team implemented an Infant and Child Mortality Surveillance System to further its mission of better understanding the causes of child death in order to create data-informed prevention strategies to reduce infant mortality in Virginia. This project seeks to provide annual reports detailing the circumstances and characteristics of both infant and child deaths occurring in Virginia.

DATA SOURCES

The National Center for Health Statistics prepared the population data used to calculate all infant mortality rates presented in this report.

NON-NATURAL INFANT DEATHS

OCME JURISDICTION:
Pursuant to § 32.1-283 of the Code of Virginia, the following deaths fall under the jurisdiction of the OCME:

- Any death from trauma, injury, violence, poisoning, accident, suicide, or homicide;
- Any sudden death when person was in apparent good health or unattended by a physician;
- Any death to persons in jail, prison, other correctional institution or in police custody or receiving services in a state hospital or training center operated by the Department of Behavioral Health and Developmental Services;
- Any sudden death as an apparent result of fire;
- Any sudden death of an infant; and
- Any other suspicious, unusual or unnatural death.

Data collection for non-natural deaths consisted of data extraction from the Virginia Medical Examiner Data System (VMEDS) along with thorough review of all relevant records including but not limited to the decedent infant's medical records, the mother's prenatal and labor and delivery records, Child Protective Services records, and law enforcement records pertaining to the death investigation.

During its investigation, the OCME determines not only an individual's cause of death but also the manner in which he or she died. Manner of death consists of one of the following: accident, homicide, natural, suicide, or undetermined. Suicide is not applicable to infants, so this report makes no mention of suicide deaths. Deaths are deemed undetermined when two or more manners are plausible and a pathologist cannot designate with certainty one particular manner over another.

NATURAL INFANT DEATHS

The Virginia Department of Health's Division of Health Statistics (DHS) provided mortality data on the number of natural infant deaths that did not fall under OCME jurisdiction. DHS records contain information on the deaths of all children who resided in Virginia.

Although the OCME does investigate some natural deaths, the OCME does not assign ICD-10 codes when finalizing cause of death. To maintain uniformity of reporting, this report categorizes all natural infant deaths using the ICD-10 code assigned by DHS. This report classifies non-natural deaths investigated by the OCME using the cause and manner of death assigned by the OCME. For these reasons, data provided in this report may differ from official DHS publications and other agency reports using similar data.

INCLUSION AND EXCLUSION CRITERA

The Infant and Child Mortality Surveillance System includes infants who:

- were designated a live birth;[1]
- died between January 1, 2014 and December 31, 2016;
- were between the ages of 0 and 364 days;
- resided in Virginia; and
- died in Virginia.

DATA CLASSIFICATION

This report separates race into three categories: white, black, and other. "Other" includes decedents of Asian, American Indian or Alaskan Native descent as well as decedents who identified as more than one race. This report separates race from ethnicity as Hispanic individuals may identify as a member of any race.

Rates measure the frequency of an event in a defined population over a specified period. Rates account for population size allowing for comparison among different sized populations, in different locations, and at different times. This method of reporting illustrates the risk present in a given population. This report calculates infant mortality rates per 1,000 live births. Rates based on 20 or fewer cases are statistically unreliable and should be interpreted and used with caution.

To provide a picture of the location of infant fatalities in Virginia, this report offers three regional breakdowns: OCME district of death, Health Planning Region (HPR) of residence, and Health Planning Region of injury. Appendix B provides a table of Virginia localities by the four OCME districts and five HPRs. Since most natural deaths did not fall under OCME jurisdiction, natural deaths do not include OCME district data.

[1] "Live birth" is defined as the complete expulsion or extraction from the mother of a product of human conception, irrespective of the duration of pregnancy, which, after such expulsion or extraction, breathes or shows any other evidence of life such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached. (Section 32.1-249 (7) Code of Virginia)

EXECUTIVE SUMMARY

In 1994, the Virginia General Assembly established the Virginia State Child Fatality Review Team, an interdisciplinary team composed of representatives from various state and local agencies, advocates, and other stakeholders. As a public health exercise, the Team reviews and analyzes infant and child deaths to understand how and why children die, to strengthen the state's systematic response to child death, and to recommend intervention and prevention strategies to prevent future deaths. The Team implemented the Infant and Child Mortality Surveillance System in an effort to guide and better inform discussions, planning, and legislative action that affects the health and well-being of children and families in the Commonwealth.

Infant mortality encompasses all deaths to children during their first year of life. It is a critical indicator used to determine not only a population's maternal and infant health but also the overall health of a population.[2] In its first annual infant mortality report, the Team focused on this vital measure of societal health by examining both natural and non-natural infant fatalities in Virginia between 2014 and 2016.

KEY FINDINGS

The Team presents the following findings on the leading causes and associated risk factors of infant death in an effort to learn from the past and encourage the initiation of innovative prevention and intervention strategies to improve the health and well-being of Virginia's most vulnerable residents. Provided below are the key findings from the Team's analysis and an overview of trends in overall, natural and non-natural infant mortality rates in Virginia.

OVERALL

- Of the 1,652 infants who resided and died in Virginia from 2014 to 2016, 1,313 died of natural causes (79.5%) and 339 died of non-natural causes (20.5%).
- Males presented higher natural and non-natural infant mortality rates (4.76 and 1.30 per 1,000 live births) compared to females (3.76 and 0.90).
- Despite having a lower number of fatalities, black (6.93 and 1.75) and other race (4.89 and 1.19) infants died at a higher rate of both natural and non-natural causes than white infants (3.08 and 0.84).
- Hispanic infants were at higher risk of death due to natural causes (3.53) compared to non-natural causes (0.64).
- The Eastern and Central Health Planning Regions (HPR) reported the highest natural infant mortality rates (5.83 and 5.55, respectively), while Southwest and Eastern Virginia reported the highest non-natural rates (2.01 and 1.60, respectively).

NATURAL CAUSES

- The vast majority of infants who died of natural causes were under one month of age (80%); more specifically, over one-half of infants were one day old or younger at the time of their death (53.5%).

[2] Centers for Disease Control and Prevention (2018). *Reproductive Health: Infant Mortality.* Retrieved from: https://www.cdc.gov/reproductivehealth/maternalinfanthealth/infantmortality.htm.

- The leading cause of natural death for infants under one month of age was conditions originating in the perinatal period. After one month of age, congenital malformations, deformations, and chromosomal abnormalities became the leading cause of natural infant fatalities.
- From ages 1-6 months, a more broad range of diseases led to infant fatalities including infectious diseases (15.9%) and diseases of the circulatory (13.8%) and respiratory systems (9%).
- Sudden Infant Death Syndrome[3] caused six deaths from 2014-2016 (See Figure 8).

NON-NATURAL CAUSES

- Decedents 1-3 months of age accounted for over one-half of non-natural infant fatalities (53.7%).
- Medico-legal death investigations concluded nearly 9 in 10 non-natural infant deaths were sleep-related (87.3%), and the majority were undetermined in manner (74%). As a result, the leading cause of non-natural infant death was Sudden Unexplained Infant Death (SUID) representing 52.2% of fatalities.
- Over one-fourth of caregivers had a history of substance misuse (27.4%) and more than one-fifth have a mental health diagnosis. (21.5%).
- The top four risk factors for sleep-related deaths were sleeping with soft bedding (92.6%), sleeping on an inappropriate sleep surface (84.5%), co-sleeping/bed-sharing (52.1%), and secondhand smoke exposure (49.7%).
- Forensic pathologists identified 23 deaths due to homicide from 2014-2016 (6.8%). Of these deaths, the perpetrator was a biological parent in nearly two-thirds of instances (65.4%).
- Motor vehicle collisions caused three infant deaths over the three-year period.

TRENDS IN INFANT MORTALITY

In Virginia, the overall infant mortality rate decreased by 7.6% from 2013 to 2016.

The overall natural infant mortality rate decreased by 14.7% between 2013 and 2016.

- The rate of natural infant death fell for both white and black infants (27.1% and 25.5%) while the rate for other race infants increased by 99.6%. A 22.8% decline was seen in the rate among Hispanic infants.
- The largest reduction was seen in the Eastern HPR (16.5%) followed by the Southwest (9.8%), Northern (6.9%), and Central (6.7%) regions. In contrast, the Northwest HPR experienced an 11.5% increase.

Since 2013, the overall rate of non-natural infant death rose by 27.7%.

- Other race infants experienced a 120.7% rise, which was significantly higher than the 29.9% for black infants and 13.9% for white infants. Hispanic infants saw a 4.5% reduction in non-natural infant deaths since 2013.
- Non-natural infant deaths escalated by 130.5% in Southwest Virginia, which was the largest upswing among HPRs of residence. Central Virginia saw a 62.3% growth followed by the Northwest (18.7%), Northern (9.3%), and Eastern (2%) regions.
- Since 2013, the sleep-related infant death rate rose 37.7%.

[3] Sudden Infant Death Syndrome - No significant disease, anatomic defect, or risk factors after complete examination and investigation of circumstances surrounding the death.

THEMES FOR PREVENTION

EDUCATION AND AWARENESS OF CHILD DEVELOPMENT

Educating parents and caregivers on child development in an effort to better align caregivers' expectations with children's abilities as they grow and mature is imperative to reducing the state's infant mortality rate. Additionally, communities should encourage and support programs focused on fostering close relationships between parents and children.

SUBSTANCE MISUSE, SMOKING, AND MENTAL HEALTH

Improving access to quality mental health and substance misuse treatment programs is critical to lowering infant mortality as well as cultivating the health and well-being of children and families in the Commonwealth. Smoking cessation programs serve as another essential piece aiding in the reduction of not only preterm birth but also sleep-related and other causes of infant death.[4]

NUANCED SAFE SLEEP MESSAGING

In order to reduce the rate of sleep-related infant death, the state should develop a comprehensive and consistent statewide safe sleep message that provides a platform for a nuanced discussion targeting the underlying reasons why caregivers choose to place infants in unsafe sleep environments. For example, many families voiced concerns that the infant slept better, was more comfortable, and "preferred" sleeping in the prone position. Caregivers often propped the infant up on pillows to prevent choking due to reflux or placed pillows surrounding the infant so he/she would not roll over without fully realizing the risks associated with soft bedding in the sleep space. Caregivers also noted co-sleeping in an effort to bond with the infant, to appease fussiness or illness, to facilitate nighttime feedings, and to improve sleep. Safe sleep education should incorporate elements aimed at addressing these underlying attitudes and concerns.

HEALTH DISPARITIES AND SOCIAL DETERMINANTS OF HEALTH

Social and environmental factors influence an infant's overall health, along with his or her risk of death. Disparities exist in infant mortality, preterm birth, and infants born low birth weight based on a mother's race and socioeconomic status.[4] Natural and non-natural infant mortality rates were higher for black and other race infants compared to white infants. Infants born to families with lower income, regardless of race, also experienced a higher risk of adverse outcomes. This report noted poor living conditions, housing instability and overcrowding as additional factors that may be associated with higher rates of infant mortality. It is critical to acknowledge the significance of social determinants of health and to support programs and policies targeting the reduction of health disparities and inequities. This will allow Virginia to align with one of Healthy People 2020's overarching goals: *to achieve health equity, eliminate disparities, and improve the health of all groups*.[5]

[4] Centers for Disease Control and Prevention (2017). *Reproductive Health: Preterm Birth*. Retrieved from: https://www.cdc.gov/reproductivehealth/maternalinfanthealth/pretermbirth.htm
[5] Office of Disease Prevention and Health Promotion (2018). *Healthy People: Disparities.* Retrieved from: https://www.healthypeople.gov/2020/about/foundation-health-measures/Disparities

HOME VISITING

Home visiting services are a valuable tool communities can utilize in the pursuit of improving outcomes for children and their families in Virginia. Home visiting programs are an evidence-based and economical way to empower and support families ensuring they have the skills, resources, and services needed to create a stable home environment.[6] Research indicates infants whose families received home visiting were 2.5 times less likely to die in infancy compared to infants whose families did not receive the service.[7] The continued support of home visiting programs throughout the Commonwealth is integral to the reduction of preventable infant deaths.

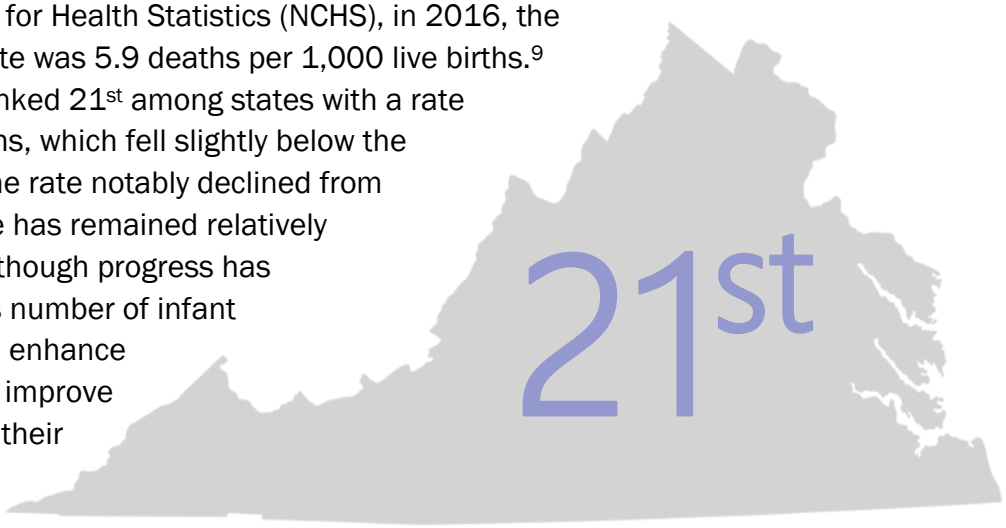
[6] Center for American Progress (2017). *Home Visiting Programs Are Vital for Maternal and Infant Health.* Retrieved from: https://www.americanprogress.org/issues/early-childhood/reports/2017/09/12/438414/home-visiting-programs-vital-maternal-infant-health/
[7] Donovan, Edward F., et al. "Intensive Home Visiting Is Associated With Decreased Risk of Infant Death." *Pediatrics*, American Academy of Pediatrics, 1 June 2007, http://pediatrics.aappublications.org/content/119/6/1145

INTRODUCTION

The Virginia State Child Fatality Review Team presents its first annual infant mortality report, which offers a portrait of both natural and non-natural infant fatalities in Virginia between 2014 and 2016. Infant mortality encompasses all deaths of children during their first year of life and is a critical indicator used to determine not only a population's maternal and infant health but also the overall health of a population.[8] The study and analysis of infant mortality reveals health disparities, the quality of healthcare, and other social issues within a society.

In an effort to guide and better inform discussions, planning, and legislation aimed at improving the health and well-being of children and families in the Commonwealth, the Team implemented the Infant and Child Mortality Surveillance System. This project serves as a public health exercise to examine the underlying causes, characteristics, and risk factors associated with child death in Virginia. Moving forward, this project will allow for the statistical analysis of trends over time, provide a better understanding of circumstances surrounding specific causes of death, as well as offer greater context for child fatalities overall.

According to the National Center for Health Statistics (NCHS), in 2016, the United States' infant mortality rate was 5.9 deaths per 1,000 live births.[9] Virginia's infant mortality rate ranked 21st among states with a rate of 5.8 deaths per 1,000 live births, which fell slightly below the national average.[10] In Virginia, the rate notably declined from 2005 to 2016; however, the rate has remained relatively stable over the last few years. Although progress has been made in reducing Virginia's number of infant fatalities, this initiative hopes to enhance this effort and ultimately improve outcomes for children and their families in the Commonwealth.



In its commitment to learn from the past in order to prevent future child deaths, the State Child Fatality Review Team presents the following findings, to encourage the initiation of innovative prevention and intervention strategies and to strengthen the state's systematic response to child death.

[8] Centers for Disease Control and Prevention (2018). *Reproductive Health: Infant Mortality.* Retrieved from: https://www.cdc.gov/reproductivehealth/maternalinfanthealth/infantmortality.htm.
[9] Centers for Disease Control and Prevention (2018). *National Center for Health Statistics: Infant Mortality Rates by State, 2016*. Retrieved from: https://www.cdc.gov/nchs/pressroom/sosmap/infant_mortality_rates/infant_mortality.htm.
[10] This report only includes deaths to infants who both resided and died in Virginia. For this reason, rates presented in this report will differ from rates calculated by the National Center for Health Statistics.

SECTION I: NON-NATURAL INFANT DEATHS

TABLE 1: CHARACTERISTICS OF NON-NATURAL INFANT DEATHS, VIRGINIA, 2014-2016 (N=339)

	N	%	RATE
YEAR OF DEATH			
2014	115	33.9	1.12
2015	102	30.1	0.99
2016	122	36.0	1.20
SEX			
Male	204	60.2	1.30
Female	135	39.8	0.90
AGE			
< 1 month	37	10.9	-
1-3 months	182	53.7	-
4-6 months	84	24.8	-
7-9 months	26	7.7	-
10-11 months	10	2.9	-
RACE			
White	172	50.7	0.84
Black	134	39.5	1.75
Other	33	9.7	1.19
HISPANIC ETHNICITY			
Yes	29	8.6	0.64
OCME DISTRICT			
Central	92	27.1	1.21
Tidewater	96	28.3	1.48
Western	93	27.4	1.87
Northern	58	17.1	0.50
MECHANISM OF FATAL INJURY [11]			
Sleep-Related[12]	295	87.0	0.96
Sudden Unexpected Infant Death	176	51.9	0.58
Asphyxia	62	18.3	0.20
Undetermined	59	17.4	0.19
Traumatic Brain Injury	25	7.4	0.08
Blunt Force Trauma to Body	9	2.7	0.03
Poisoning	4	1.2	0.01
Smoke Combustion Products Inhalation	4	1.2	0.01
Thermal Injuries	4	1.2	0.01
Other[13]	5	0.6	0.01
MANNER OF DEATH			
Undetermined[14]	249	73.5	0.81
Accident	67	19.8	0.22
Homicide	23	6.8	0.07
TOTAL	**339**	**100.0**	**1.10**

The OCME investigated 339 infant deaths resulting from unintentional injury, homicide, or of undetermined manner from 2014 to 2016.

KEY POINTS:

- Males accounted for the largest proportion and rate of deaths compared to females.
- More than three-fourths of deaths occurred to infants aged one to six months (78.5%).
- Decedents one to three months of age accounted for over one-half of fatalities (53.7%).
- The rate for black infants was more than two-fold the rate for white infants (1.75, 0.84).
- The majority of fatalities were undetermined in manner (74%).
- Medico-legal death investigations concluded nearly nine in ten deaths were sleep-related.
- The leading cause of non-natural infant death was Sudden Unexpected Infant Death (SUID), accounting for 51.9% of deaths.
- The Western district saw the highest rate of infant deaths.

[11] Percentages reported might not sum to 100% since a single death may fall within more than one mechanism of fatal injury.
[12] Sleep-related - possibly or directly related to an unsafe sleeping environment following of a medico-legal death investigation.
[13] "Other" includes premature birth due to maternal trauma, exposure (hyperthermia/hypothermia), exsanguination, intracranial hemorrhage
[14] Undetermined - When two or more manners are plausible and one manner cannot be designated over another.

REGIONAL VARIATIONS

OFFICE OF THE CHIEF MEDICAL EXAMINER (OCME) DISTRICTS

The Tidewater OCME district contained the largest proportion of non-natural infant deaths (28.3%) followed by Western (27.4%), Central (27.1%), and Northern (17.1%) districts. Although Tidewater constituted the largest proportion of infant deaths (29.8%), the Western district reported the highest infant death rate (1.87 per 1,000) compared to the Tidewater, Central and Northern districts (1.48, 1.21, and 0.50, respectively). The infant death rate in the Western district was nearly four times higher than the Northern district.

HEALTH PLANNING REGIONS (HPR)

Geographical differences were noted in both the frequency and rate of non-natural infant deaths based on the Health Planning Region (HPR) where the decedent infant lived (See Figure 1). Similar to OCME district, the Southwest HPR saw a considerably higher rate than any other region in the Commonwealth with a non-natural infant mortality rate double that of the Northern HPR, which had the lowest regional rate (2.01 and 0.41). The second highest rate was noted in the Eastern region (1.60) followed by Central and Northwest Virginia (1.31 and 0.91, respectively). In contrast, the non-natural infant mortality rate in the Northern HPR (0.41) was significantly lower than any other region in Virginia. As highlighted in Figure 2, the localities with rates over 6.0 deaths per 1,000 live births were Buchanan (6.13), Northampton (6.19), Lee (6.43), Botetourt (7.89), Danville (9.66), and Henry (9.96).

FIGURE 1: RATE OF NON-NATURAL INFANT DEATHS BY HEALTH PLANNING REGION OF RESIDENCE, VIRGINIA, 2014-2016 (N=339)

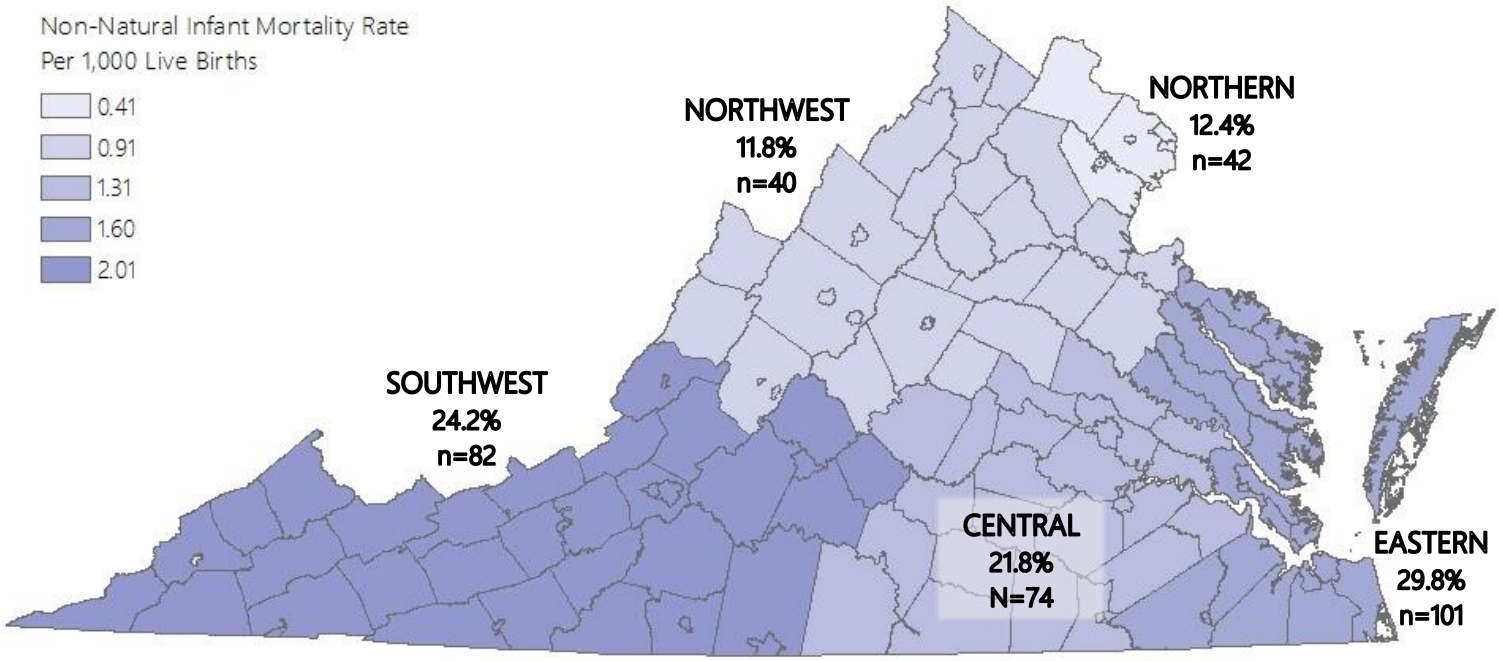
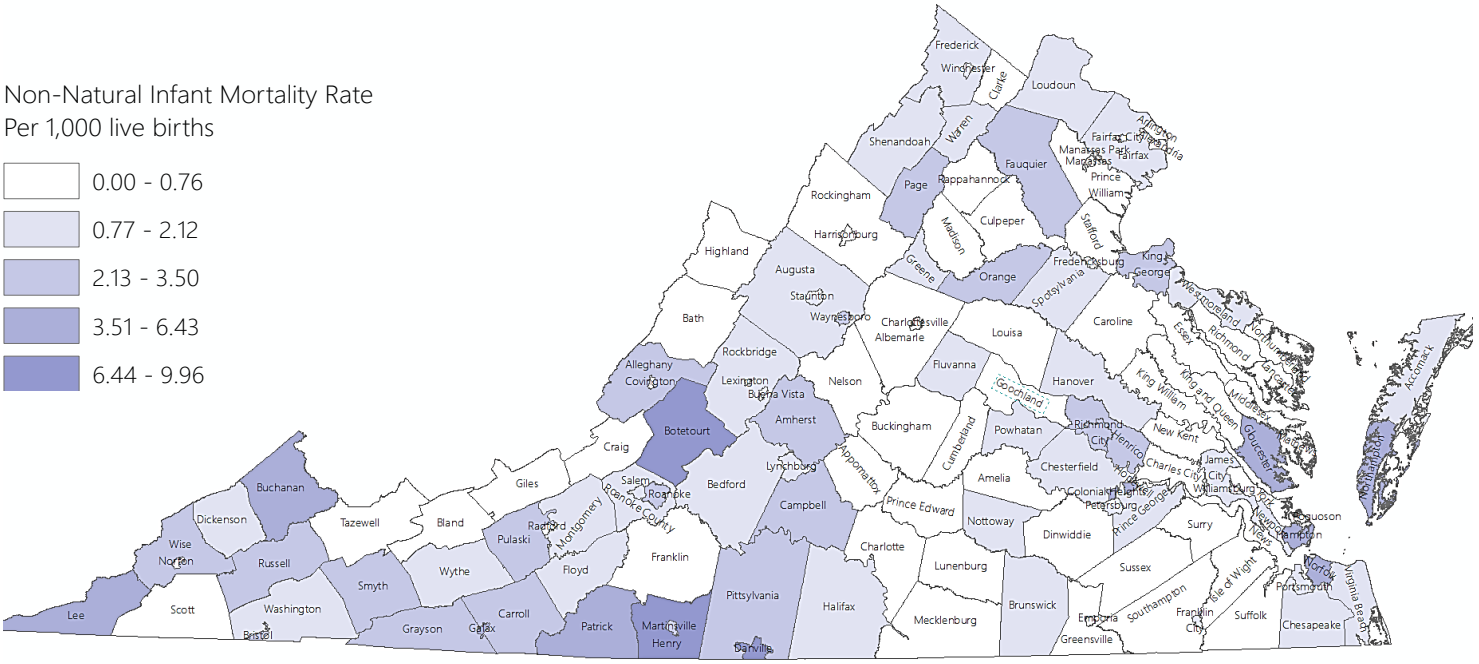
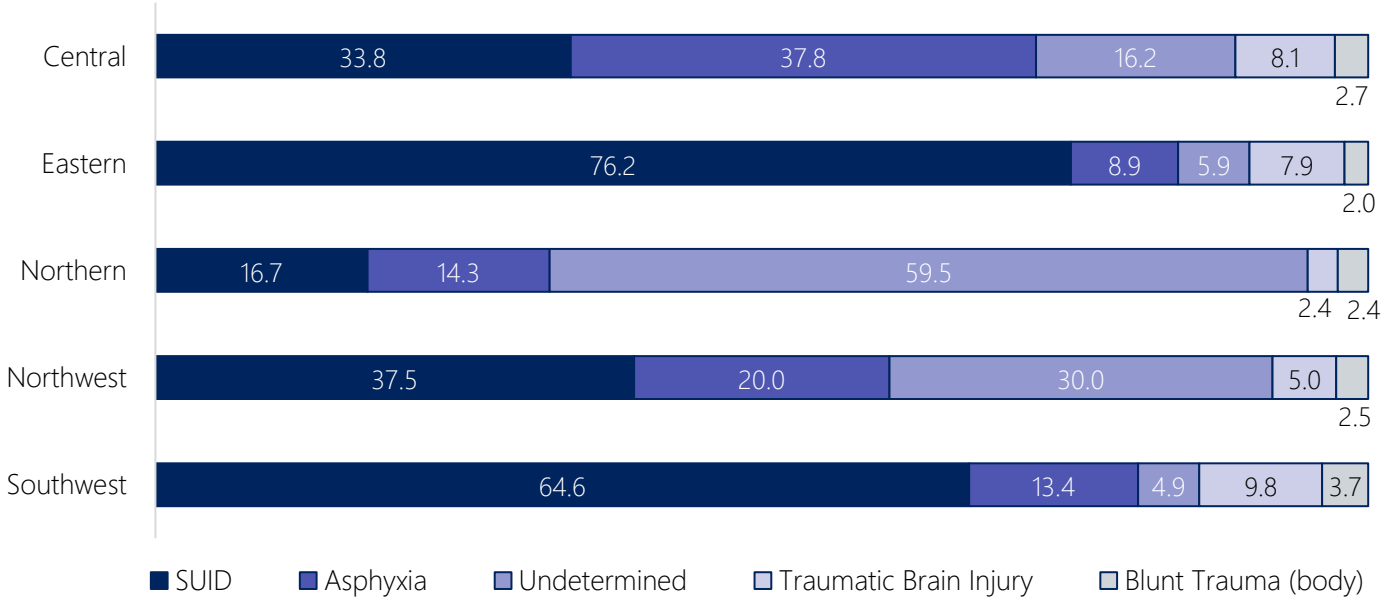


FIGURE 2: RATE OF NON-NATURAL INFANT DEATHS BY LOCALITY OF RESIDENCE, VIRGINA, 2014-2016 (N=339)



In all regions across the Commonwealth, sleep-related deaths caused the majority of non-natural infant deaths. As highlighted in Figure 3, Sudden Unexplained Infant Death (SUID), asphyxia, and undetermined were the most common causes of death seen in Virginia, comprising over 80% of all deaths. Traumatic Brain Injury (TBI) accounted for approximately 10% of infant deaths in the Southwest region and approximately 8% of deaths in both Central and Eastern Virginia.

FIGURE 3: PROPORTION OF CAUSES OF DEATH BY HEALTH PLANNING REGION OF RESIDENCE, VIRGINIA, 2014-2016 (N=339)



INFANT CHARACTERISTICS

The majority of infants were singleton births (92%), while 6.8% of infant decedents were a twin. Infants born preterm and/or at low birth weights are at higher risk for serious health issues throughout their lives.[15] Seventy-four, or 22.9%, of infant decedents in Virginia were born at a lower birth weight and over one in four were preterm (26.1%). Among non-natural infant deaths in Virginia, 5% reportedly had a birth defect. Birth defects included cardiac anomalies/defects and physical malformations. Additionally, 51 infants, or 15%, spent time in the Neonatal Intensive Care Unit (NICU) after birth. The majority of infant decedents exhibited signs or symptoms of poor health in the 72 hours prior to their death (53.7%). Most infants visited a pediatrician after discharge from the hospital after birth and in the 30 days prior to the fatal incident. Approximately one-third of infants had had attended all scheduled medical appointments. Additionally, 10 infants received a "failure to thrive" diagnosis at some point in their lives.

INFANT SUBSTANCE EXPOSURE

Birth records noted substance exposure at birth for 45, or 13%, of infants. Among the 45 substance-exposed infants (SEI), 11, or 24%, received a diagnosis of Neonatal Abstinence Syndrome (NAS).

FIGURE 4: SUBSTANCE-EXPOSED INFANTS BY DRUG CLASS, VIRGINIA, 2014-2016 (n=45)

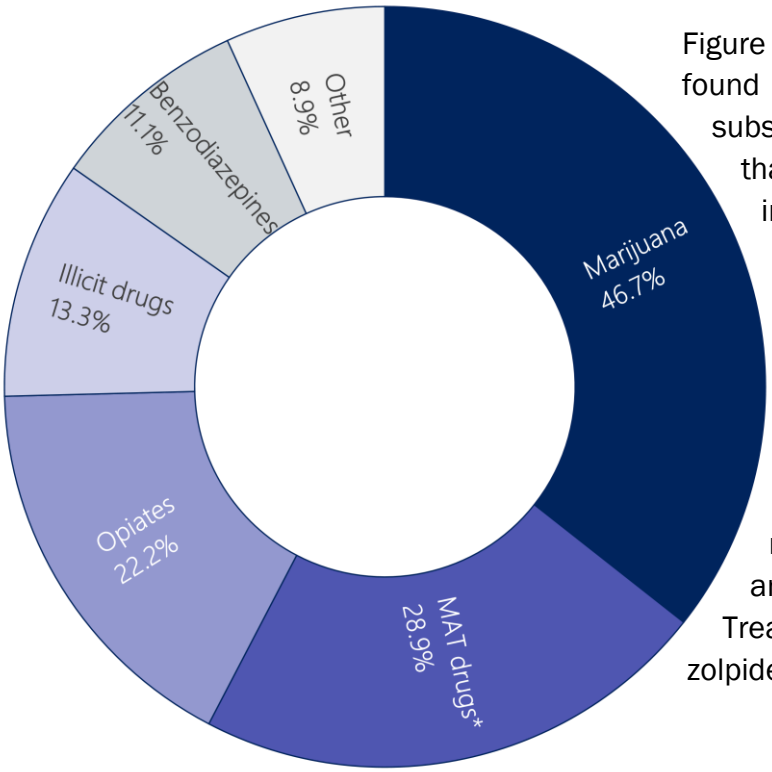


Figure 4 depicts the type of drugs and/or medications found in the decedent's system at birth. Three in four substance-exposed infants tested positive for more than one substance at birth (75.6%), while one in four infants tested positive for only one substance (24.4%).

Infants exposed to illicit drugs tested positive for heroin, cocaine, methamphetamines and/or phencyclidine (PCP). Opiates were commonly codeine, morphine, hydromorphone, oxymorphone, tramadol, and other unspecified narcotics. Buprenorphine, methadone, suboxone, and subutex constituted Medication Assisted Treatment (MAT) drugs. Other substances included zolpidem (Ambien), amphetamines, and nicotine.

*MAT drugs – Medication Assisted Treatment drugs.

[15] Eunice Kennedy Shriver National Institute of Child Health and Human Development (2016). *Are there ways to reduce the risk of infant mortality?* Retrieved from: https://www.nichd.nih.gov/health/topics/infant-mortality/topicinfo/reduce-risk

FAMILY AND CAREGIVER CHARACTERISTICS

Nearly one-half of mothers were between 20 and 25 years of age at the time of the decedent's birth (47.5%). The second most common age group was mothers aged 26 to 30 constituting 20.6% of cases. The average maternal age was 29 years old. Few infants were born to teenage mothers (6.8%) or mothers aged 36 and older (5.9%). Nearly one-quarter of decedents were their mother's first-born child (24.8%); however, the majority of mothers had at least one other child (75.2%). The number of siblings ranged from one to seven.

Nearly two-thirds of mother's received some form of prenatal care during pregnancy (64.3%). Medical records noted the month of initiation for nearly two-thirds of mothers who received prenatal care (62.8%), which allowed the Team to evaluate whether or not the mother was late to seek prenatal care. Of these mothers, 11.7% received late prenatal care, defined as beginning care during the third trimester (≥ 28 weeks) and another 6.5% received care described as "limited" or "inadequate".[16] Additionally, 7.3% of mothers did not receive any prenatal care during pregnancy.

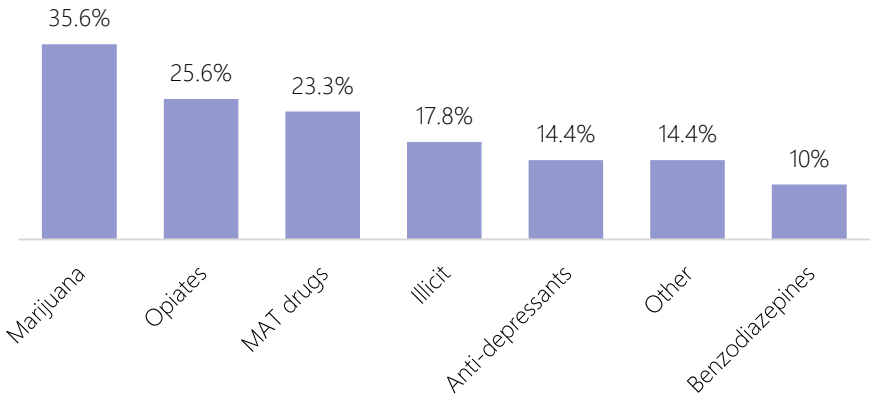
The American Academy of Pediatrics (AAP) recommends exclusive breastfeeding for the first six months due to the protections it provides against a variety of adverse health outcomes as well as the significant benefits to both the mother and infant.[17] The majority of mothers breastfed the infant decedent at birth (57.5%); however, the infant's last meal prior to the fatal incident contained breast milk in only 18.9% of cases. Most infants were formula fed during their last meal prior to death (51.9%). This suggests a short duration of breastfeeding.

15 CAREGIVERS WERE LINKED TO A PRIOR CHILD DEATH

Fifty-six families struggled with housing instability, overcrowding, and other poor living conditions (16.5%). Many families resided in homes described as uninhabitable. Additionally, Child Protective Services (CPS) had a history with 52 families prior to the fatal incident (15.3%), and records noted that 30 families had a history of intimate partner violence (8.9%).

PRENATAL SUBSTANCE MISUSE

FIGURE 5: MATERNAL PRENATAL SUBSTANCE USE BY DRUG CATEGORY, VA, 2014-2016 (n=90)



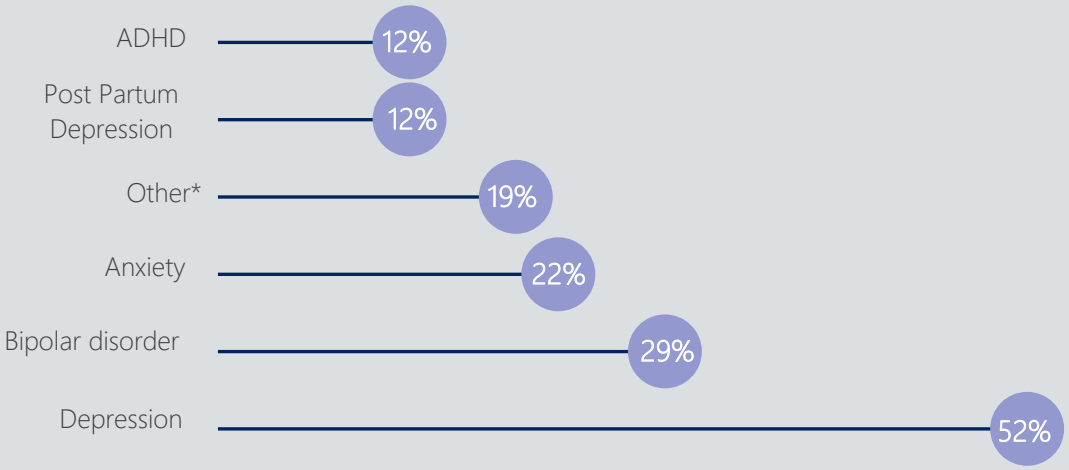
More than one in four mothers reported smoking cigarettes (28.9%) and using substances (26.5%) during pregnancy. As displayed in Figure 5, marijuana, opiates, and illicit drugs were the most common substances used. Among substance misusing mothers, the majority were polysubstance users.

[16] Child Trends Databank. (2015). *Late or no prenatal care*. Retrieved from: https://www.childtrends.org/?late-or-no-prenatal-care
[17] American Academy of Pediatrics (2018). *Breastfeeding: Benefits of Breastfeeding.* Retrieved from: https://www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/Breastfeeding/Pages/Benefits-of-Breastfeeding.aspx

FAMILIAL SUBSTANCE MISUSE AND MENTAL HEALTH

- Over one-fourth of caregivers currently misused or had a history of substance misuse (27.4%), while at least one of the decedent's primary caregivers had a history of alcohol abuse in 23.3% of cases.
- Among those with a reported substance use disorder, caregivers most often misused illicit drugs - cocaine, heroin, methamphetamines, and PCP - more than any other substance (37.6%).
- Opioids were the second most common misused substance accounting for 36.6% of caregiver substance misuse. Opiates included oxycodone, OxyContin, Percocet, and fentanyl.
- Seventeen of the 93 caregivers with a substance misuse history were currently or had previously been in a substance use treatment program (18.3%).
- Investigators suspected caregiver substance use around the time of the fatal event in 15% of incidents.
- More than one-fifth of caregivers were diagnosed with a mental illness (21.5%). The majority of caregivers with a known mental illness were mothers (93.2%) (See Figure 6).

FIGURE 6: CAREGIVER DURING THE FATAL INCIDENT BY MENTAL HEALTH DIAGNOSES, VIRGINIA, 2014-2016 (n=73)

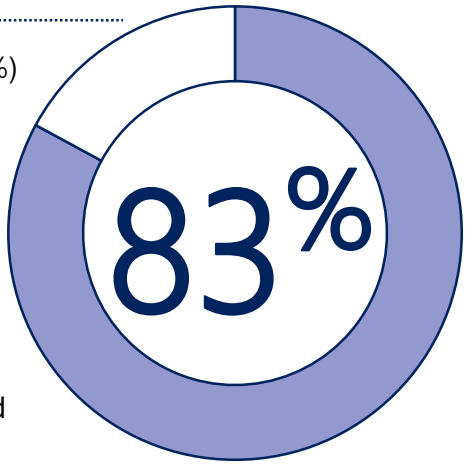


*Other diagnoses include Borderline Personality Disorder, Schizophrenia, Panic disorder, Post Traumatic Stress Disorder, Intermittent Explosive Disorder, Anger Management, and unspecified conditions.

Caregivers may have more than one mental health diagnosis, so percentages will not sum to 100.

CAREGIVER AT TIME OF FATAL INCIDENT

- The caregiver at the time of death was most often the mother (40.4%) followed by both parents (27.7%) and the father (14.7%).
- Other caregivers included grandparents (5.9%), unlicensed in-home childcare providers (5.9%), other family members (3.8%), family friends (3%), mother's paramour (1.5%), and daycare facilities (0.9%).
- Among caregivers who used substances at the time of the fatal incident, approximately one-half were under the influence of alcohol, one-third ingested multiple substances, one-fourth smoked marijuana, and one-fifth used illicit drugs.



OF INFANTS WERE WITH A BIOLOGICAL PARENT DURING FATAL INCIDENT.

MECHANISMS OF INJURY

SUDDEN UNEXPLAINED INFANT DEATH

- Over one-half of non-natural infant fatalities were due to SUID (51.9%).
- The SUID death rate (0.58) was nearly three times higher than asphyxia, the next most common cause of death (0.20).

ASPHYXIA

- Asphyxia was the second-leading cause of death (18.3%), encompassing suffocation (93.6%), strangulation (4.8%), and drowning (1.6%).
- An unsafe sleep environment caused 49 of the 62 asphyxia deaths.
- Three asphyxia deaths were homicides.

UNDETERMINED

- Undetermined deaths constituted 17.4% of fatalities, making it the third-leading cause of infant death in Virginia.
- Unsafe sleep environments played a role in the majority of undetermined deaths (91.5%).

TRAUMATIC BRAIN INJURY

- A Traumatic Brain Injury (TBI) caused 25 non-natural infant deaths in Virginia (7.4%). These deaths were due to abusive head trauma or blunt force/closed head trauma.
- Pathologists determined the manner of death to be homicide (88%), accident (8%), and undetermined (4%).
- Motor vehicle collisions caused two deaths.
- Nearly two-thirds of TBI deaths resulted from being beaten or kicked (64%).
- Perpetrators shook 64% of infants.

BLUNT FORCE TRAUMA (NOT HEAD)

- Blunt force trauma to the body led to nine deaths (2.7%).

BLUNT FORCE TRAUMA (NOT HEAD) cont'd

- Manner of death included homicide (55.6%), accident (33.3%), and undetermined (11.1%).
- Motor vehicle collisions caused three deaths.
- The perpetrator beat or kicked four decedents and shook three decedents.

POISONING

- Four non-natural infant fatalities were due to poisoning (1.2%).
- Prescription medications caused two and contributed to two deaths (oxycodone and oxymorphone). Illicit drugs contributed to two deaths. An over-the-counter medication, Diphenhydramine, or Benadryl, led to one death. Laundry detergent accounted for one death.
- The child ingested the substance in one death, while the parent/caregiver administered the substance in two deaths, and it was unknown how one decedent accessed the substance.

THERMAL INJURY & SMOKE INHALATION

- Thermal injuries and smoke/combustion product inhalation accounted for four deaths.
- House fires caused all four deaths.
- Two homes had smoke detectors that did not work, one home did not have smoke detectors, and one smoke detector access was unknown.
- The source of three of the four fires was a heating device like a space heater. One fire was cooking-related.

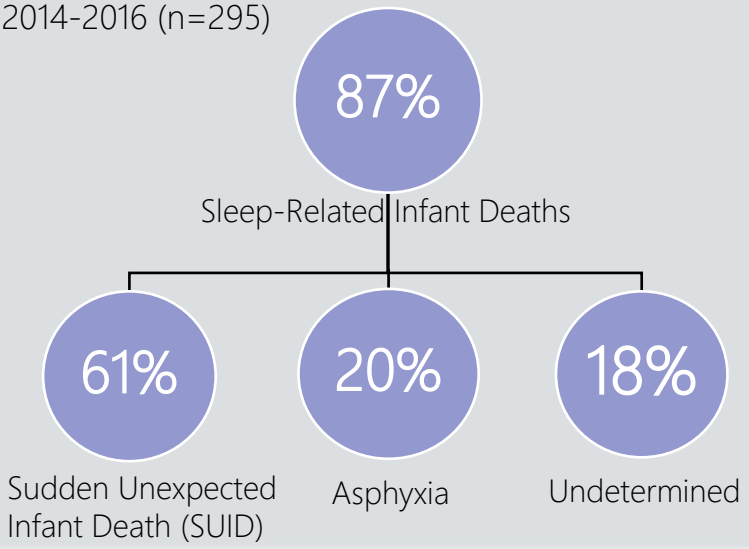
PREMATURE BIRTH DUE TO MATERNAL TRAUMA

- Two infant deaths resulted from premature birth due to maternal trauma.
- Motor vehicle collisions caused both deaths. The mother was the driver in one fatality and a pedestrian in the other.

SECTION II: SLEEP-RELATED INFANT DEATHS

Sleep-related death refers to fatalities that occur during sleep or in a sleep environment; these deaths cause approximately 3,500 deaths in the United States each year.[18] In Virginia, medico-legal death investigation determined 87% of non-natural infant deaths between 2014 and 2016 were sleep-related in nature. The sleep-related infant death rate increased by 36.4% over the three-year period (2014: 0.98; 2015: 0.85; 2016: 1.05). In this report, Sudden Unexpected Infant Death (SUID), asphyxia, and undetermined comprise sleep-related fatalities (Figure 7). The manner of death for most infant deaths related to unsafe sleep was undetermined (81.4%) followed by accident (18.6%). The underlying causes of sleep-related asphyxia deaths were suffocation/strangulation by bedding, overlay by caregiver, wedging, and intentional suffocation by caregiver.

FIGURE 7: SLEEP-RELATED CAUSES OF DEATH, VA, 2014-2016 (n=295)



DIAGNOSTIC SHIFT

Sudden Infant Death Syndrome (SIDS) is defined as "the sudden death of an infant younger than 1 year of age that cannot be explained even after a full investigation that includes a complete autopsy, examination of the death scene, and review of the clinical history."[19] SIDS deaths are considered natural deaths while other sleep-related causes are labeled accident, homicide, or undetermined in manner. Although sleep-related deaths are often referred to as SIDS, a diagnostic shift occurred among forensic pathologists as a result of improved death investigations, safe sleep research, and public health campaigns that indicated many SIDS deaths were associated with environmental factors that could be modified to reduce the risk of death. Recognizing the significance of the identified risk factors, pathologists created SUID as a new diagnosis. This diagnostic shift led to a dramatic decrease in SIDS since 2007 and a rise in SUID, asphyxia, and undetermined deaths (See Figure 8). For this reason, the six SIDS deaths that occurred from 2014 to 2016 are included in Section IV on natural infant deaths and are not included in this section.

INFANT DEMOGRAPHICS

Males accounted for the majority of sleep-related fatalities (60%) and presented a higher sleep-related mortality rate (1.13) than females (0.79). Black infants proved to have the highest rate (1.42 per 1,000) compared to white and other race infants (0.76 and 1.08, respectively). Additionally, the sleep-related mortality rate for Hispanic infants was 0.61 deaths per 1,000 live births. As highlighted in Figure 9, nearly three in five infants were aged one to three months at the time of the fatal incident (58.3%) and almost one

[18] US Department of Health and Human Services, Centers for Disease Control and Prevention. CDC WONDER. (2017). *Infant deaths; linked birth/infant death records.* Available at: http://wonder.cdc.gov/lbd.html.
[19] National Institute of Health: Eunice Kenney Shriver National Institute of Child Health and Human Development (2017). *Common SIDS and SUID Terms and Definitions.* Retrieved from: https://www1.nichd.nih.gov/sts/about/SIDS/Pages/common.aspx

in four infants were aged four to six months (23.1%). Less than 19% of sleep-related infant deaths occurred either prior to one month of age or after 6 months of age.

Autopsies found evidence of an illness like human rhinovirus, human adenovirus, upper/lower respiratory tract infection, parainfluenza virus, tracheobronchitis, bronchiopneumonia in approximately one-third of infant decedents (31%). Forty-nine infants, or 16.6%, spent time in the NICU prior to discharge after birth.

FIGURE 8: SHIFTS IN SLEEP-RELATED INFANT DEATH DIAGNOSES, VIRGINIA, 2003-2016

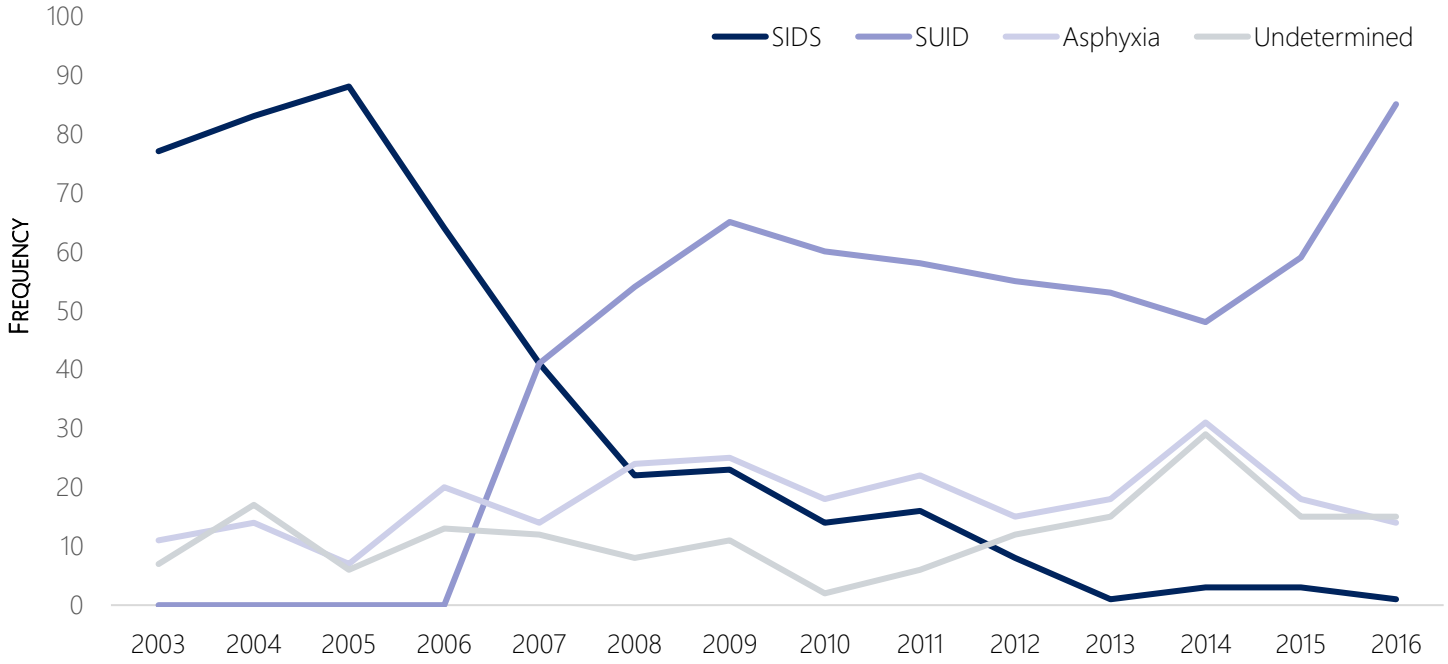
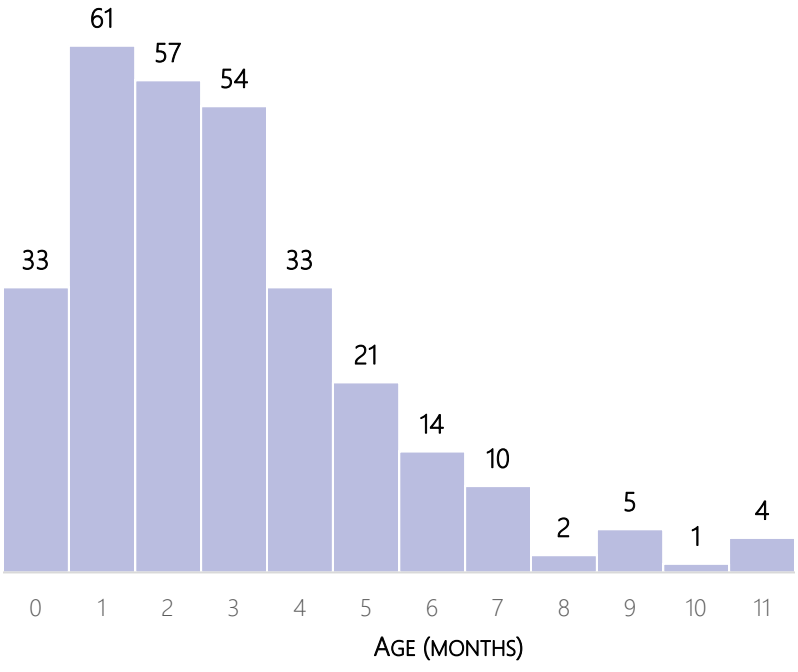


FIGURE 9: FREQUENCY OF SLEEP-RELATED INFANT DEATH BY AGE IN MONTHS, VIRGINIA, 2014-2016 (n=295)



RISK AND PROTECTIVE FACTORS

The American Academy of Pediatrics (AAP) provides recommendations to encourage safe sleep environments in order to reduce the risk of sleep-related deaths.[20] Figure 10 displays the AAP-identified risk and protective factors present in sleep-related infant deaths in Virginia.

SLEEP LOCATION

The fatality occurred in the infant's primary residence in 82.7% of incidents. The majority of sleep-related fatalities occurred when the infant was under the care of a biological parent (82.4%), while 6.4% of infants were under the

care of a grandparent's care. Three sleep-related deaths transpired at a childcare facility: two licensed facilities and one with an unknown licensing status. In addition, 19 fatalities occurred in unlicensed in-home childcare providers.

Placing an infant to sleep on an inappropriate sleep surface (84.4%) and with soft bedding (92.5%) constituted the two most common risk factors present at the time of the fatal incident. The AAP recommends that infants sleep in a crib, bassinet, or Pack 'n Play. Caregivers placed infants in one of these locations in about one-quarter of instances (26.8%), even though nearly two-thirds of caregivers owned an AAP-approved sleep surface at the time of the fatal incident (66.1%). Approximately one-half of caregivers placed the infant on an adult bed (49.2%) while 12.5% placed the decedent on a couch or sofa.

SLEEP POSITION AND CO-SLEEPING

Forty-five percent of decedents were found in a prone position, 31.2% were supine, and 11.5% were on his/her side. Infants were found face down (30.5%), to the side (26.1%), and face up (21.7%). Records noted full or partial obstruction of the infant's face and/or nose in approximately one-half of instances (45.7%). Additionally, 16.9% of caregivers placed infants to sleep propped up on a pillow or with pillows surrounding the infant to serve as a barricade. Caregivers placed the decedent prone or propped up on pillows for reasons such as the infant did not like to sleep supine, the infant prefers sleeping prone, pillows comforted the infant, and many caregivers believed this would alleviate the risk of choking from reflux.

Bed-sharing is defined as caregiver(s) and infant sleeping together on any surface (bed, couch, chair, etc.).[20] Evidence suggests room-sharing, sleeping in the same room but on separate surfaces, decreases the risk of sleep-related deaths by as much as 50%.[20] More than one-half of adult caregivers noted co-sleeping/bed-sharing with the infant at the time of the fatal incident (51.9 %), and 14.2% of infants were sleeping with another child, making bed-sharing the third most common risk factor. Most fatal incidents involving bed-sharing occurred on an adult bed or a couch (89.4%). Environmental factors like soft bedding and bed-sharing may play a larger role with amplified risk when an infant is born premature or low birth weight.[20] About 17.6% of caregivers either fell asleep while feeding the decedent or co-slept with the decedent following a nightly feeding. Caregivers choosing to bed-share stated they did so to console the infant, to promote family bonding, to assuage fussiness or illness, or the infant only co-slept during naps.

CAREGIVER SMOKING AND SUBSTANCE USE

Co-sleeping while under the influence of drugs or alcohol further augments the associated risks. Investigators suspected the use of drugs or alcohol among 46 caregivers at the time of the fatal incident (15.6%). Over one-quarter of caregivers had a history of substance misuse (27.1%) and over two-fifths had a history of mental illness (22.7%). Research indicates infants exposed to cigarette smoke prenatally and/or in the home have a higher risk of sleep-related death compared to those who are not exposed.[20] In Virginia, one-half of infant decedents were exposed to secondhand smoke (49.8%) and nearly one-third experienced prenatal smoke exposure (32.5%).

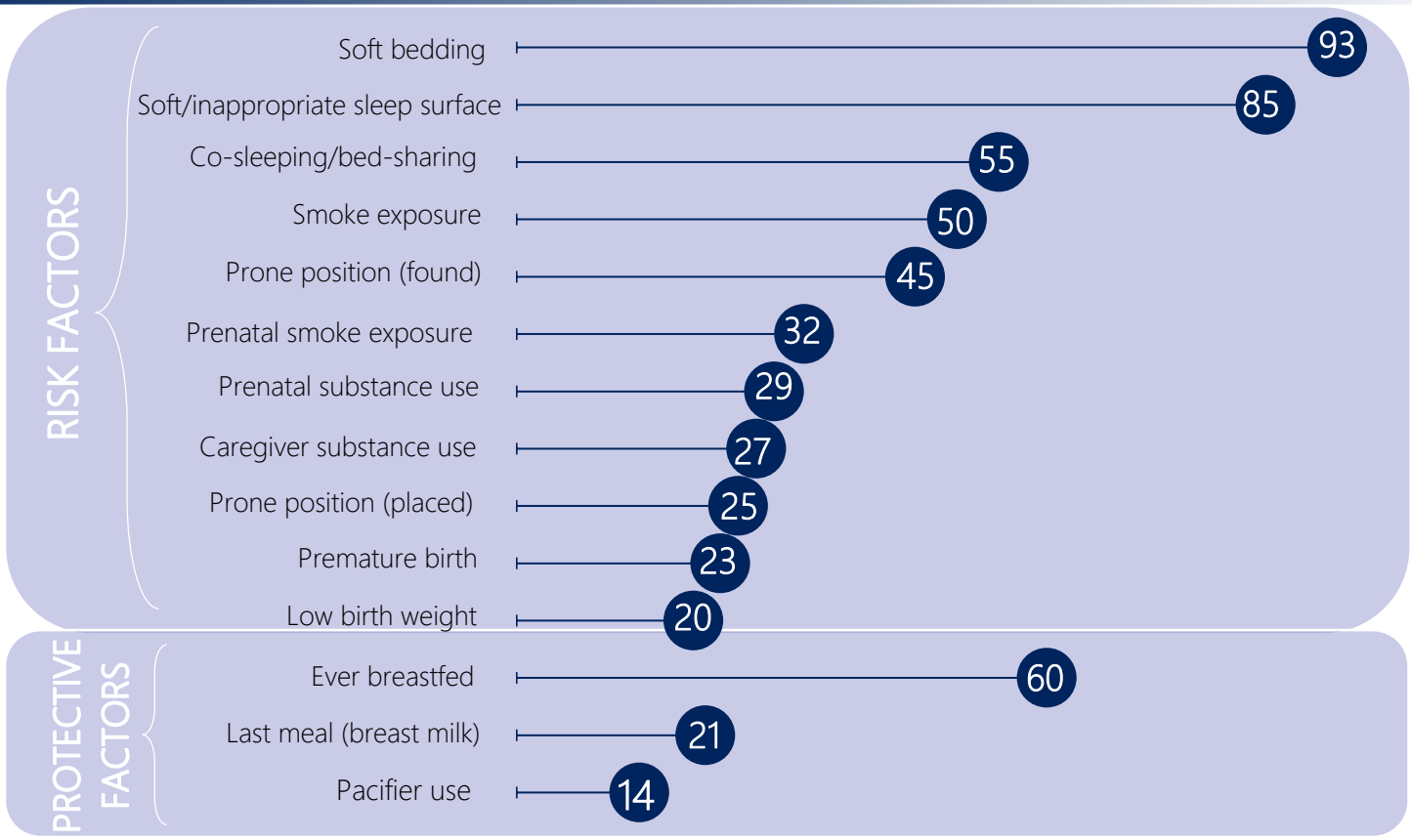
9 families had at least one prior sleep-related child death.

[20] Moon RY and AAP Task Force on Sudden Infant Death Syndrome. SIDS and Other Sleep-Related Infant Deaths: Evidence Base for 2016 Updated Recommendations for a Safe Infant Sleeping Environment. *Pediatrics.* 2016;138 (5):e20162940.

PROTECTIVE FACTORS

Research indicates breastfeeding decreases the risk of sleep-related death in infants by one-half; this reduction remained even when the infant was not exclusively breastfed.[21] However, in order to confer significant protective effects, findings suggest it is necessary to breastfeed for a minimum of two months with the benefits increasing with longer duration. As shown in Figure 10, 60% of infant decedents were ever breastfed, yet only 21.4% of infants received breast milk during their last meal. This suggests that although the majority of infants were breastfed at birth, few were breastfed long enough to obtain the noted benefits. It is important to note that mothers fell asleep while breastfeeding in 15 instances, while bottle-feeding in seven instances, and in many cases, mothers chose to bed-share following a nightly feeding. For these reasons, mothers should take precautions to ensure the least number of environmental risks are in place in case they fall asleep during feedings.

FIGURE 10: PERCENT OF RISK AND PROTECTIVE FACTORS[14] PRESENT AMONG SLEEP-RELATED INFANT DEATHS, VIRGINIA, 2014-2016 (n=295)



GEOGRAPHIC VARIATIONS

- As shown in Figure 11, the Northern Health Planning Region (HPR) presented a sleep-related mortality rate more than three times lower than the other regions in Virginia (0.38).

[21] Thompson J.M.D., Tanabe K, Moon RY, et al. Duration of Breastfeeding and Risk of SIDS: An Individual Participant Data Meta-analysis. *Pediatrics.* 2017;140(5):e20171324

- Southwestern Virginia accounted for about one-fourth of sleep-related infant deaths and had the highest sleep-related mortality rate in the state (1.67).
- Despite possessing the highest percentage of sleep-related death (29.2%), the Eastern HPR held the second highest rate (1.36) followed by the Central and Northwest regions (1.13, 0.86, respectively).
- Figure 12 illustrates the five localities with the highest sleep-related mortality rate: Buchanan (6.13), Lee (6.43), Northampton (6.19), Henry (7.97), and Danville (8.45).

FIGURE 11: RATE OF SLEEP-RELATED INFANT DEATHS BY HEALTH PLANNING REGION OF INJURY, VIRGINIA, 2014-2016 (n=295)

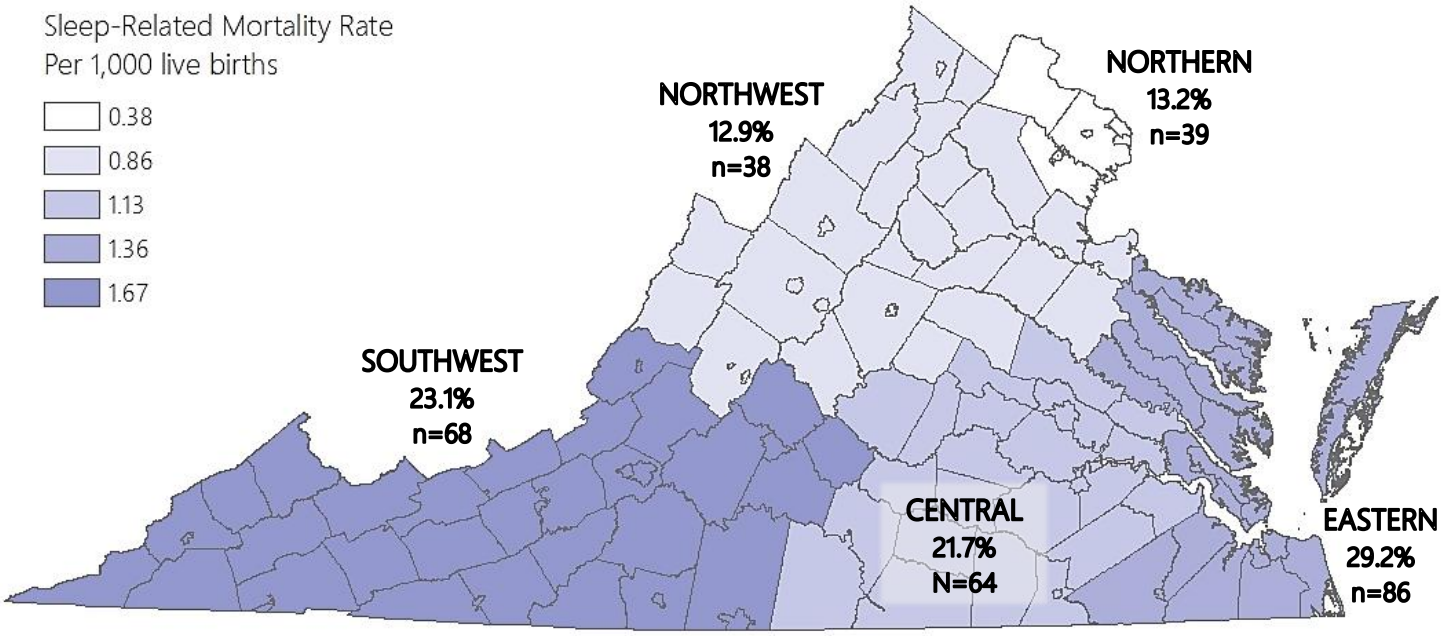
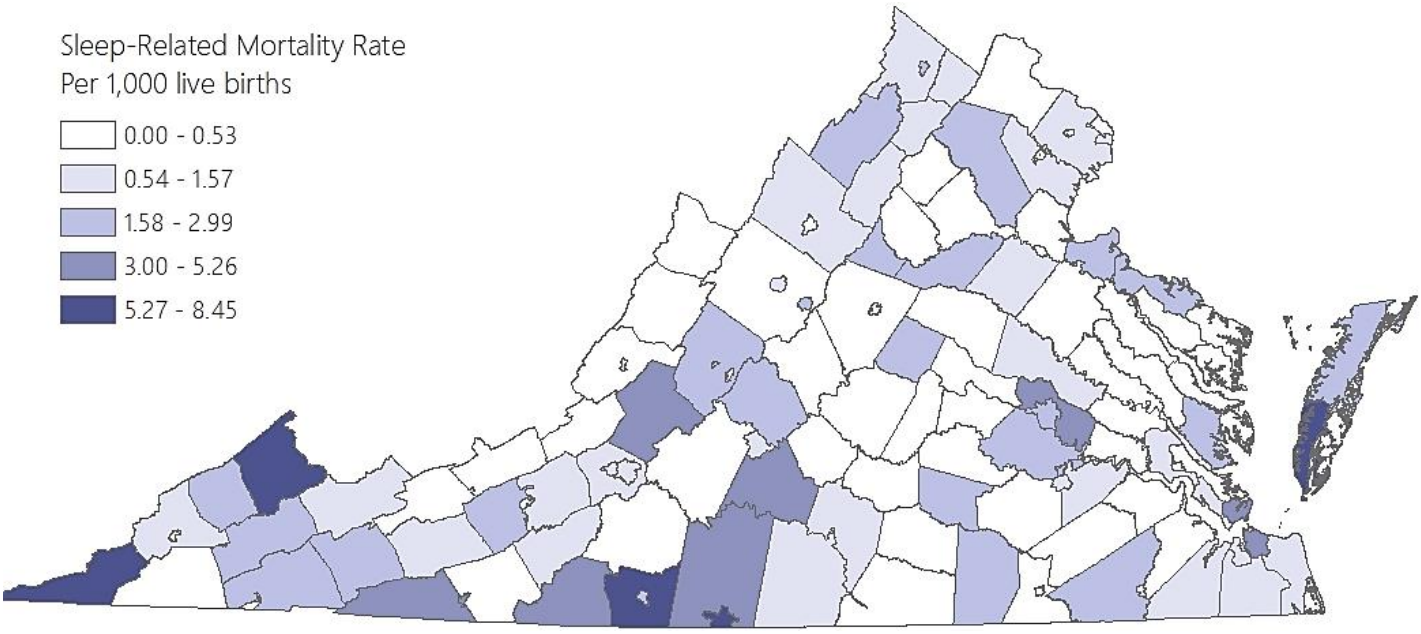


FIGURE 12: RATE OF SLEEP-RELATED INFANT DEATHS BY LOCALITY OF INJURY, VIRGINIA, 2014-2016 (n=295)



SECTION III: TRAUMATIC BRAIN INJURY AND BLUNT FORCE TRAUMA DEATHS

Of the 339 non-natural infant deaths in Virginia between 2014 and 2016, traumatic brain injury and/or blunt force trauma to the body caused 26 fatalities. Traumatic brain injury encompasses deaths due to blunt force or closed head trauma and abusive head trauma. The majority of infants who died from TBI or blunt force trauma were black (61.5%) males (61.5%) aged 4 to 6 months (50%). Black infants died at a rate five times higher compared to white or other race infants (0.21, 0.04, and 0.04, respectively). No Hispanic infants died resulting from a TBI or blunt force trauma.

FIGURE 13: FREQUENCY OF DEATHS DUE TO TRAUMA BY CAUSE OF DEATH, MANNER OF DEATH, AND SEX (n=26)

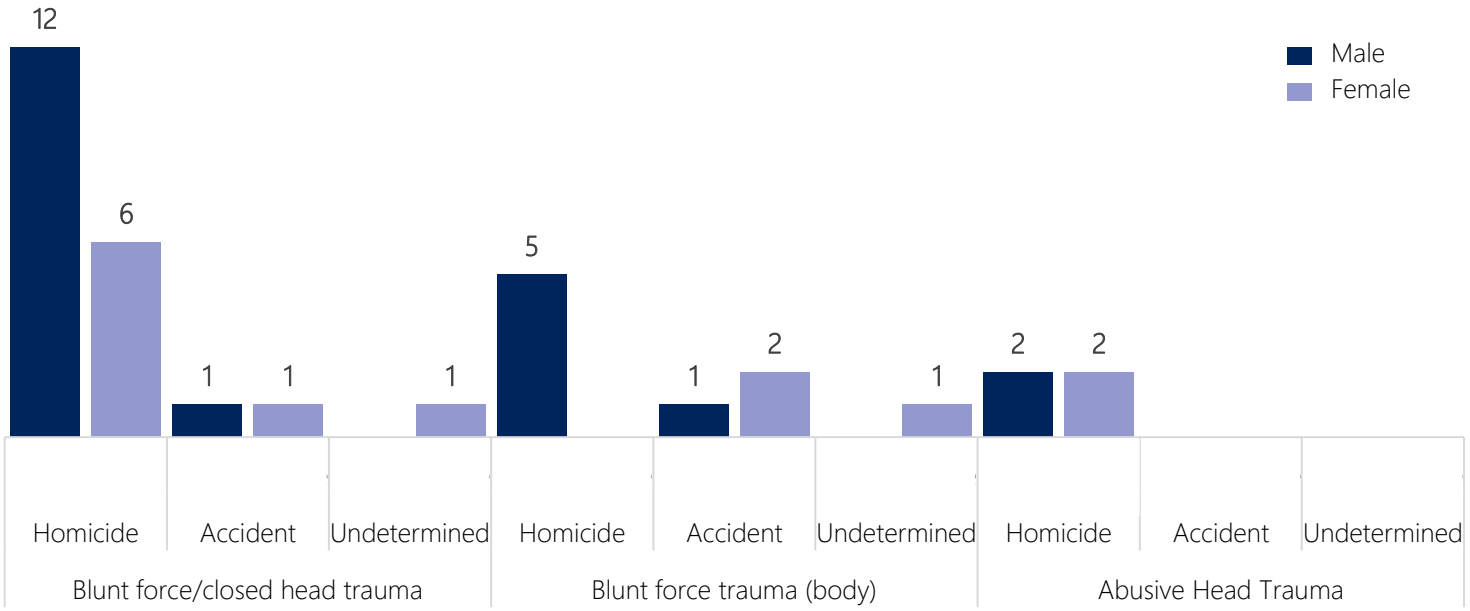
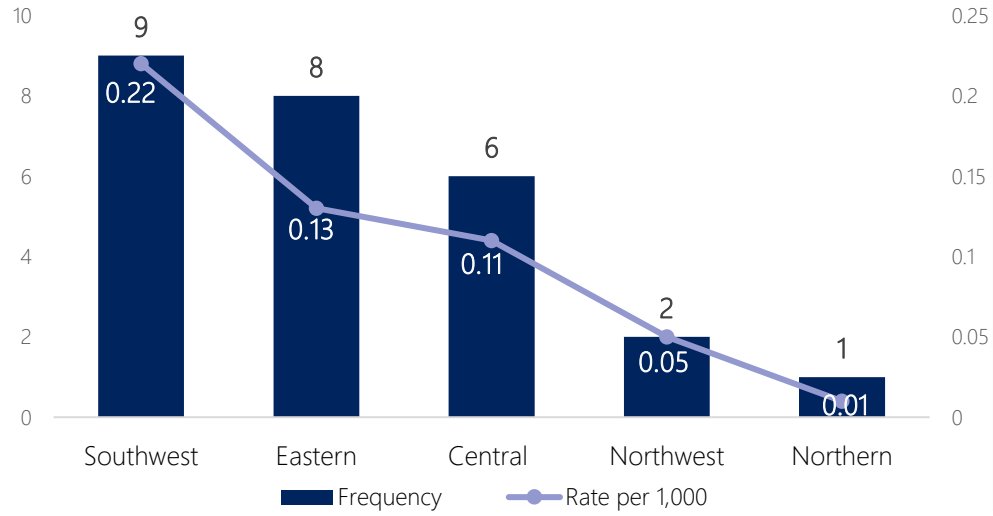


FIGURE 14: FREQUENCY AND RATE OF INFANT DEATHS DUE TO TRAUMATIC BRAIN INJURY AND BLUNT FORCE TRAUMA, VIRGINIA, 2014-2016 (n=26)

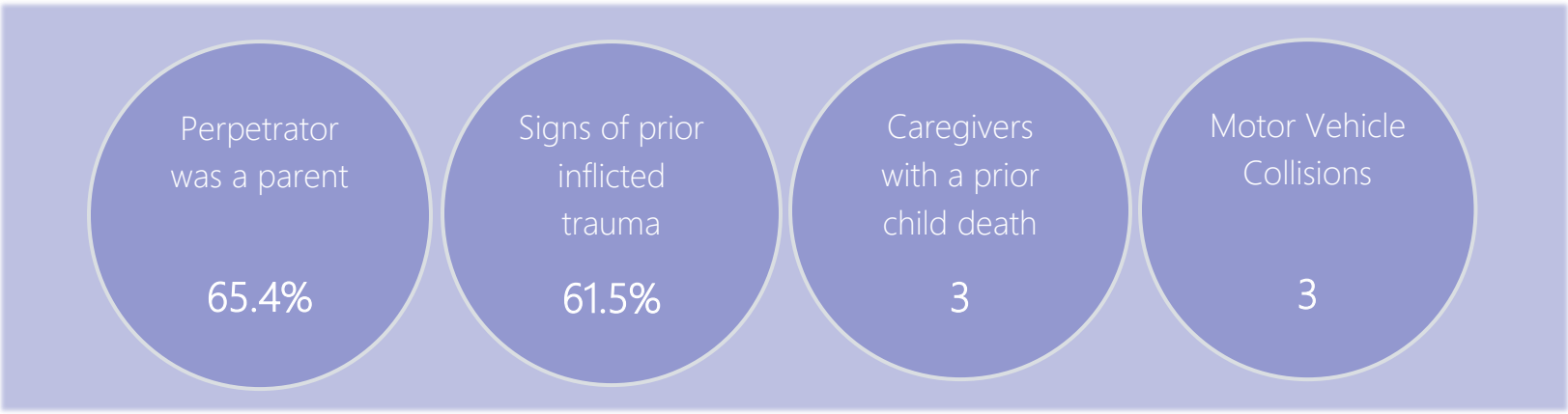


The largest frequency and rate of infant deaths caused by TBI and blunt force trauma occurred in the Southwest HPR with a rate nearly twice that of the Eastern HPR which had the second-highest rate. Northern and Northwest Virginia had mortality rates more than four times lower than Southwest Virginia.

INFANT AND CAREGIVER CHARACTERISTICS

Two in five infants were born at lower birth weights (19.2%) and over one in four were born premature (26.9%). Many infant decedents exhibited symptoms associated with poor health in the 72 hours prior to death (42.3%) suggesting infants acted fussier and may have been more difficult to console in the days prior to death.

One-half of infants were born to mothers aged 20 to 25 with mothers aged 26 to 30 and above 36 were the second most common age groups, each accounting for 11.5% of deaths. The average maternal age was 27 years old. One-quarter of caregivers reported a substance misuse history (26.9%), which included opioids, cocaine, methamphetamine, and marijuana.



A biological parent perpetrated nearly two-thirds of infant deaths due to TBI or blunt force trauma to the body (65.4%); in more than two in three incidents, the father was the perpetrator (69.2%) followed by the mother (11.5%). The mother's paramour served as the perpetrator in two instances, while a family friend or other family member inflicted the injuries in two other incidents. Injuries included shaking (61.5%) and/or being beaten, kicked, or punched (61.5%). An autopsy showed evidence of prior inflicted trauma for more than three in five infants (61.5%). A forensic pathologist identified bilateral retinal hemorrhages in 12 of the 26 cases (46.5%) and documented retinal detachment in one case. Three infants weighed less than the 5th percentile and were over the 50th percentile for height, which is a classic sign for chronic child abuse.[22] Three caregivers disclosed having at least one prior child death, one family disclosed this was their third child death, and one decedent's twin experienced similar injuries that required hospitalization.

MOTOR VEHICLE COLLISIONS

Of the three deaths caused by a motor vehicle collision, two infants were passengers in a vehicle and one was a pedestrian being pushed in a stroller. Two of the three incidents included reckless driving with cell phone use contributing. Two of three drivers were under the influence at the time of the fatal incident; one driver consumed alcohol while the other was under the influence of marijuana laced with cocaine. Of the infants who were passengers in the vehicle, one infant was in a car seat and one infant was not at the time of the collision.

[22] Cole, S.Z. and Lanham, J.S. (April 2011). "Failure to Thrive: An Update." *American Family Physician 83(7): 829-834.*

SECTION IV: NATURAL INFANT DEATHS

Table 2: Number, Percent and Rate of Natural Infant Deaths - Virginia, 2014-2016 (N=1,313)

	No	%	Rate
YEAR OF DEATH			
2014	470	35.8	4.56
2015	437	33.3	4.25
2016	406	30.9	4.00
SEX			
Male	749	57.0	4.76
Female	564	43.0	3.76
AGE			
< 1 month	1050	80.0	-
1-3 months	144	11.0	-
4-6 months	62	4.7	-
7-9 months	34	2.6	-
10-11 months	23	1.8	-
RACE			
White	630	48.0	3.08
Black	531	40.4	6.93
Other	136	10.4	4.89
HISPANIC ETHNICITY			
Yes	161	12.3	3.53
HEALTH PLANNING REGION OF RESIDENCE			
Eastern	369	28.1	5.83
Central	313	23.8	5.55
Northern	303	23.1	2.95
Southwest	169	12.9	4.15
Northwest	159	12.1	3.60
MECHANISM OF INJURY			
Conditions originating in the perinatal period	810	61.7	2.63
Congenital malformations, deformations, and chromosomal abnormalities	287	21.9	0.93
Diseases of the circulatory system	45	3.4	0.15
Infectious/parasitic diseases	43	3.3	0.14
Diseases of the respiratory system	28	2.1	0.09
Symptoms, signs, and abnormal clinical/laboratory findings not elsewhere classified	22	1.7	0.07
Diseases of the nervous system	18	1.4	0.06
Other natural deaths	18	1.1	0.05
Endocrine, nutritional, or metabolic diseases	12	0.9	0.04
Diseases of the genitourinary system	9	0.7	0.03
Diseases of the digestive system	8	0.6	0.03
Diseases of the blood/blood-forming organs and the immune mechanism	7	0.5	0.02
Neoplasms	6	0.5	0.02
TOTAL	**1313**	**100.0**	**4.27**

INFANT CHARACTERISTICS

Of the 1,652 infants who resided and died in Virginia between 2014 and 2016, 1,313 infants died of natural causes (79.5%). Most infants who died due to natural causes were white (48%), non-Hispanic (87.7%) males (57%) residing in Eastern Virginia (28.1%). Nearly all natural infant deaths occurred to infants three months of age and younger (91%) with the majority of infants aged one day and younger (53.5%). As shown in Figure 15, prior to seven months of age, male infants died at a higher rate and frequency than females, but from seven to eleven months of age, females began to die at a slightly higher frequency than males. Despite black infants having a lower number of deaths than white infants, Figure 16 depicts that black infants died of natural causes at a rate more than double that of white infants (6.93 and 3.08, respectively).

FIGURE 15: FREQUENCY OF NATURAL INFANT DEATHS BY AGE AND SEX, VIRGINIA, 2014-2016 (N=1,313)

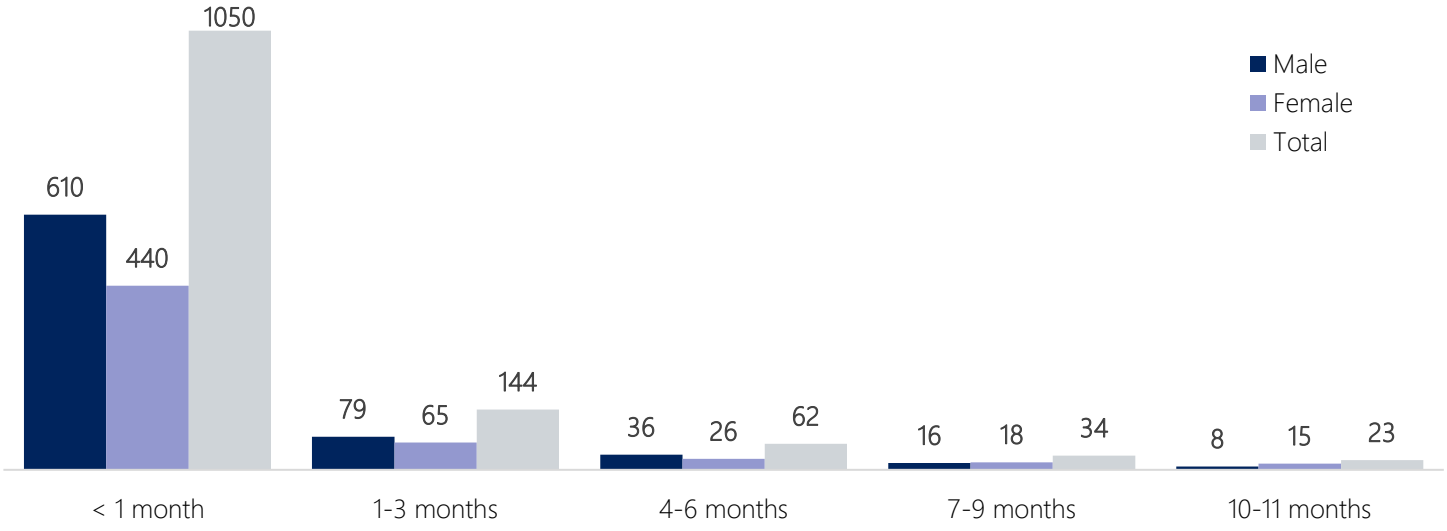
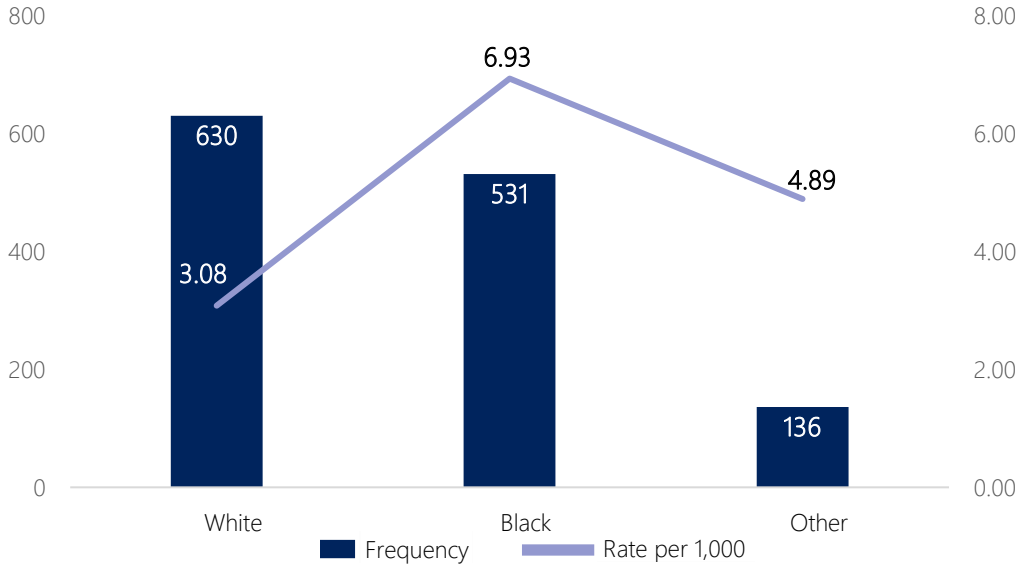


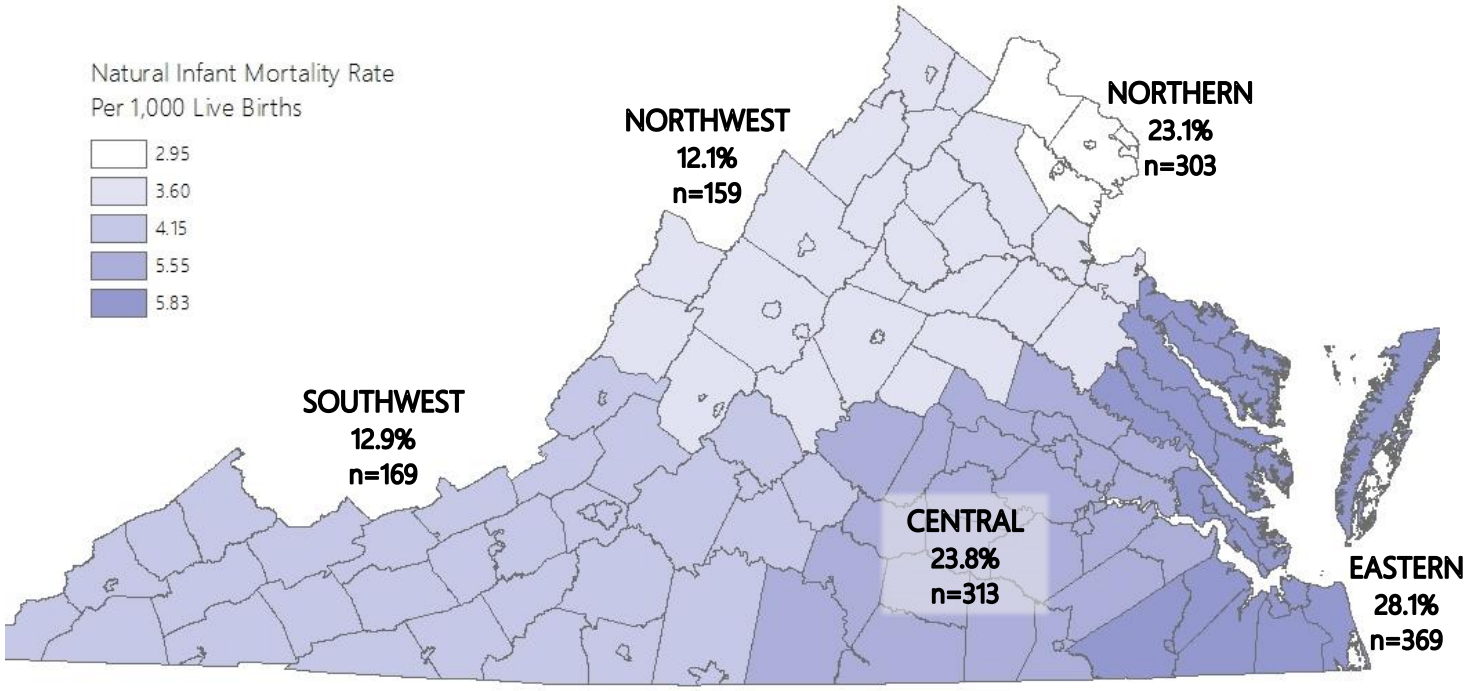
FIGURE 16: FREQUENCY AND RATE OF NATURAL INFANT DEATHS BY RACE, VIRGINIA, 2014-2016 (N=1,313)



REGIONAL VARIATIONS

The Eastern Health Planning Region (HPR) presented the largest number and rate of natural infant deaths in the Commonwealth (n=369 and 5.83) while the Central HPR displayed the second highest rate (n=313 and 5.55). Additionally, the Northern HPR exhibited the lowest rate of natural infant death with 2.95 deaths per 1,000 infants.

FIGURE 17: NATURAL INFANT MORTALITY RATE BY HEALTH PLANNING REGION, VIRGINIA, 2014-2016 (N=1,313)

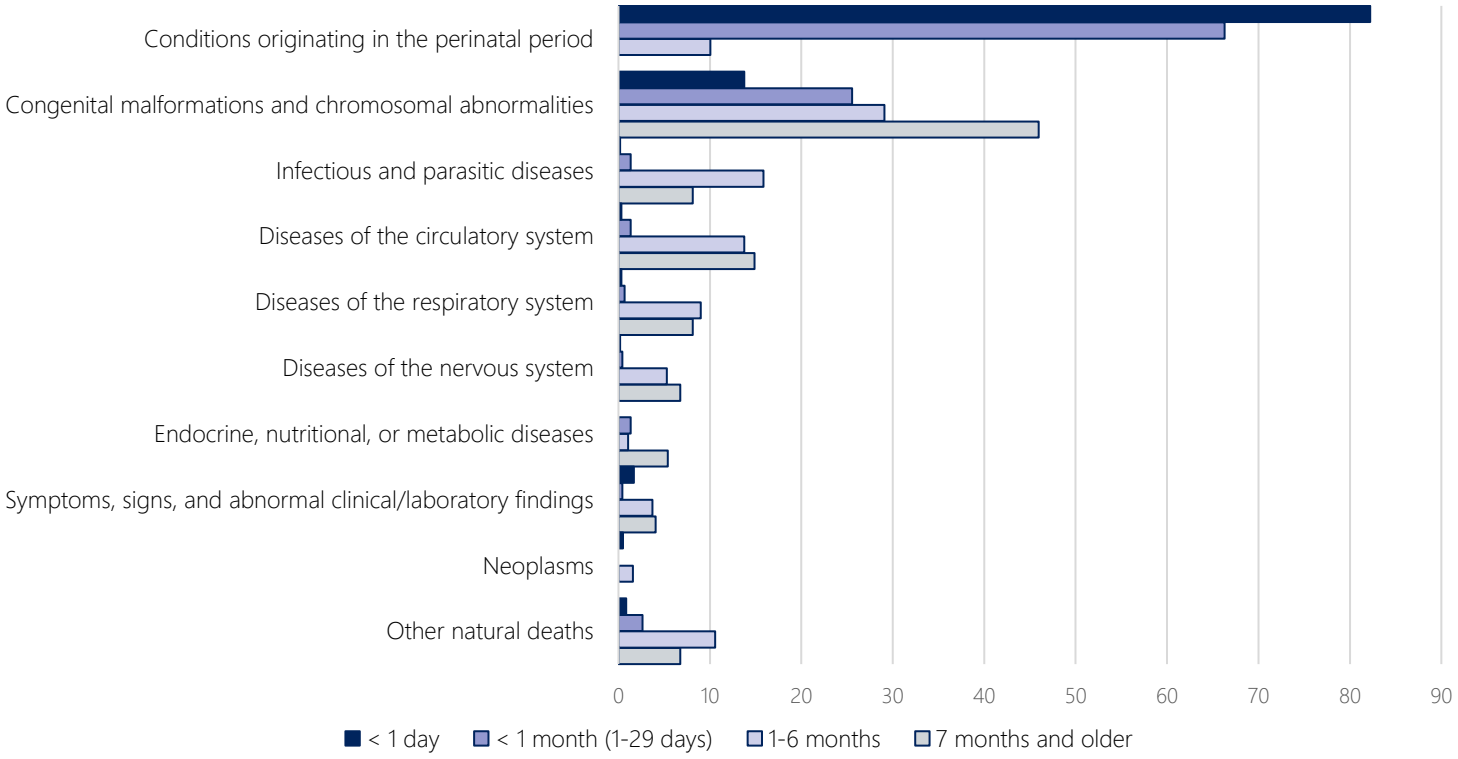


CAUSES OF NATURAL INFANT DEATH

- Conditions originating in the perinatal period caused the majority of natural infant deaths (61.7%) accounting for 2.63 deaths per 1,000 live births.
- The second leading cause of natural infant death in Virginia consisted of congenital malformations, deformations, and chromosomal abnormalities (21.9% and 0.93 per 1,000 live births).
- Figure 18 highlights that over 95% of infants under one day of age died due to conditions originating in the perinatal period (82.2%) and congenital malformations, deformations, and chromosomal abnormalities (13.8%). These were also the leading conditions for infants under one month of age.
- After infants reached one month of age, congenital malformations, deformations, and chromosomal abnormalities became the leading cause of death while deaths resulting from conditions originating in the perinatal period became less common.
- A more broad range of conditions led to the deaths of infants aged one to six months like infectious diseases (15.9%), circulatory diseases (13.8%), perinatal conditions (10.1%), and respiratory diseases (9%).

- Nearly one-half of deaths to infants aged seven months and older stemmed from congenital malformations, deformations, and chromosomal abnormalities (45.9%) followed by diseases of the circulatory system (14.9%).
- Perinatal conditions caused no fatalities to infants over six months old.
- Other natural causes of death encompassed diseases of the digestive system, musculoskeletal system, connective tissue, genitourinary system along with endocrine, nutritional, or metabolic diseases, mental and behavioral disorders, diseases of the blood/blood-forming organs, disorders involving the immune mechanism, complications of medical and surgical care, and SIDS.

FIGURE 18: PERCENTAGE OF MECHANISM OF INJURY BY AGE AMONG NATURAL INFANT DEATHS, VIRGINIA, 2014-2016 (N=1,313)



SUDDEN INFANT DEATH SYNDROME (SIDS)

As discussed in Section II, SIDS is defined as "the sudden death of an infant younger than 1 year of age that cannot be explained even after a full investigation that includes a complete autopsy, examination of the death scene, and review of the clinical history." The OCME has jurisdiction over the sudden death of any infant and is the only entity in the Commonwealth that can legally assign SIDS as an official cause of death. Therefore, this report uses the OCME classification when reporting SIDS deaths, though it may conflict with official DHS publications or other agency publications using similar data.

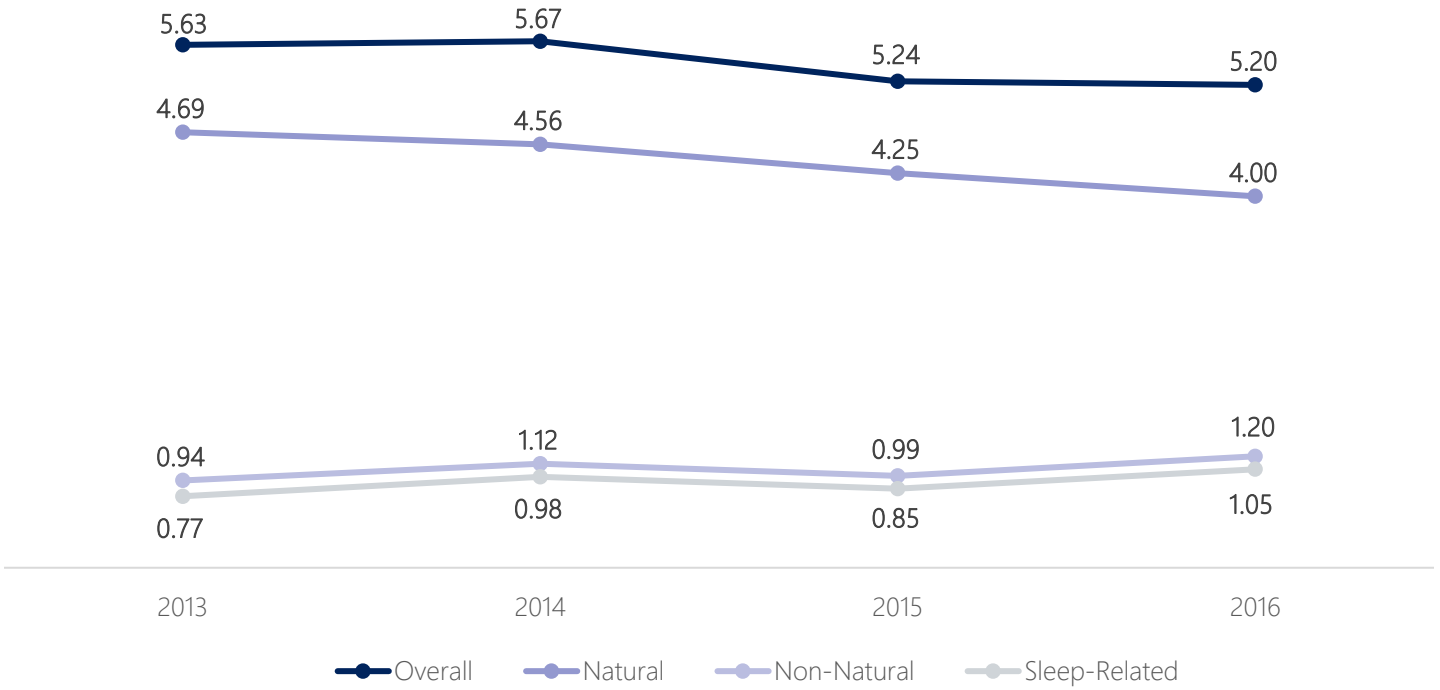
Sudden Infant Death Syndrome (SIDS) caused six infant deaths from 2014 to 2016. This number highlights a significant change in the classification of sudden and unexpected infant deaths as forensic pathologists continue to recognize the significance of risk factors in the infant's sleep environment in these types of deaths. This has led to an overall decrease in the number of infant deaths classified as natural SIDS deaths and the increase in Sudden Unexplained Infant Death (SUID), asphyxia, and undetermined classifications (See Figure 8).

SECTION V: INFANT DEATH TRENDS IN VIRGINIA

In Virginia, the overall infant mortality rate has continued to slowly decline since 2013, dropping from 5.63 to 5.20 deaths per 1,000 live births. The same holds true for the natural infant mortality rate, which declined from 4.69 in 2013 to 4.00 in 2016. Despite the steady decline in natural infant death, the non-natural infant mortality rate rose from 0.94 in 2013 to 1.20 in 2016. The frequency and rate of sleep-related infant deaths also increased over the four-year period (See Figures 19 and 20).

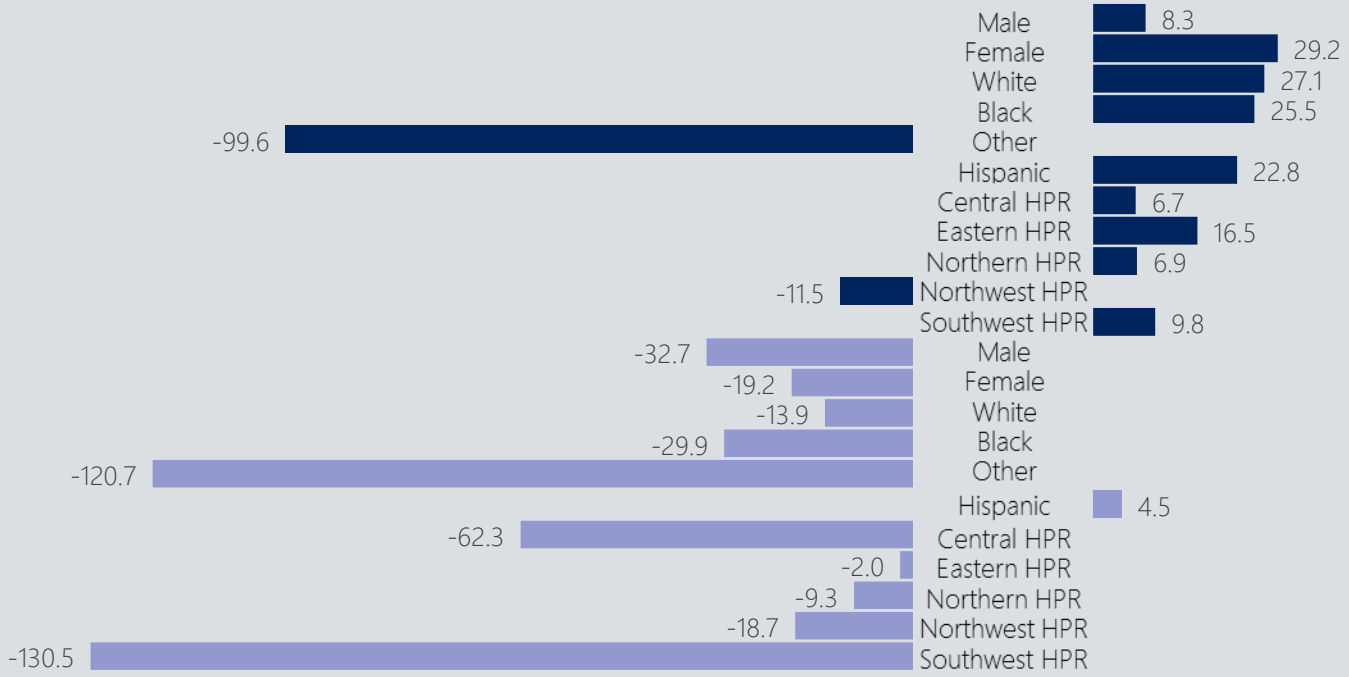
FIGURE 19: FREQUENCY AND RATE OF INFANT DEATH BY TYPE, VIRGINIA, 2013-2016 (N=2,251)

FIGURE 20: TRENDSIN INFANT MORTALITY RATES BY YEAR AND TYPE, VIRGINIA, 2013-2016 (N=2,251)



PERCENT CHANGES OVER TIME

FIGURE 21: PERCENT CHANGE IN NATURAL AND NON-NATURAL INFANT MORTALITY RATES BY SEX, RACE, AND HEALTH PLANNING REGION OF RESIDENCE, VIRGINIA, 2013-2016 (N=2,515)



OVERALL INFANT MORTALITY

- In Virginia, the overall infant mortality rate decreased by 7.6% from 2013 to 2016.

NATURAL INFANT DEATHS

- The natural infant mortality rate declined by 14.7% between 2013 and 2016.
- Both male and female infants showed a percent change decrease in the rate of natural infant deaths (8.3% and 29.2%, respectively).
- The rate of natural infant death fell for both white and black infants (27.1% and 25.5%) while the rate for other race infants increased by 99.6%.
- A 22.8% decline was seen in the natural infant mortality rate among Hispanic infants.
- All Health Planning Regions (HPR) experienced a reduction in the natural infant mortality rate except for the Northwest HPR that experienced an 11.5% increase.
- The largest decline since 2013 was seen in the Eastern HPR (16.5%) followed by the Southwest (9.8%), Northern (6.9%), and Central (6.7%) regions.

NON-NATURAL INFANT DEATHS

- Since 2013, the rate of non-natural infant death rate rose by 27.7%.
- The rate for males increased by 32.7% compared to a 19.2% increase for females.
- Other race infants experienced a 120.7% rise, which was significantly higher compared to 29.9% for black infants and 13.9% for white infants.
- Hispanic infants saw a 4.5% reduction in non-natural infant deaths since 2013.
- Each Health Planning Region (HPR) in the Commonwealth experienced a percent change increase in the non-natural infant mortality rate from 2013 to 2016. Non-natural infant deaths escalated by 130.5% in Southwest Virginia, which was the largest upswing among HPRs of residence. Central Virginia saw a 62.3% growth followed by Northwest (18.7%), Northern (9.3%), and Eastern (2%) Virginia.
- Since 2013, the sleep-related infant death rate rose 36.4%.

APPENDIX A: GLOSSARY

- **CAREGIVER:** the adult who was responsible for the care and supervision of the infant. In this report, caregivers included parents, step-parents, grandparents, paramours, babysitters, and others.
- **CO-SLEEPING/BED-SHARING:** the sharing of a sleep surface between the infant and at least one adult or child.
- **HEALTH PLANNING REGION (HPR):** geographical areas created for the purposes of regional health planning. Virginia's five HPRs are Eastern, Northern, Northwest, and Southwest.
- **INFANT:** child under one year of age (0-364 days).
- **LATE PRENATAL CARE:** initiating care during the third trimester (≥ 28 weeks) of pregnancy.[23]
- **LIVE BIRTH:** the complete expulsion or extraction from the mother of a product of human conception, irrespective of the duration of pregnancy, which, after such expulsion or extraction, breathes or shows any other evidence of life such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached. (Section 32.1-249 (7) Code of Virginia).
- **LOW BIRTH WEIGHT:** birth weight of less than 5.5 pounds, or 2500 grams.[24]
- **PRETERM BIRTH:** infants born alive before 37 weeks of pregnancy are completed. The three sub-categories of preterm birth are extremely preterm (less than 28 weeks), very preterm (28 to 32 weeks), and moderate to late preterm (32 to 37 weeks).[25]
- **RATE:** measure of the frequency with which an event occurs in a defined population over a specified period of time.[26]
- **SLEEP-RELATED DEATH:** fatalities that occur during sleep or in a sleep environment.
- **SUDDEN INFANT DEATH SYNDROME (SIDS):** the sudden death of an infant younger than one year of age that cannot be explained even after a full investigation that includes a complete autopsy, examination of the death scene, and review of the clinical history. SIDS deaths are natural in manner.[27]
- **SUDDEN UNEXPLAINED/UNEXPECTED INFANT DEATH (SUID):** like SIDS, SUID is a diagnosis of exclusion, made when there is an absence of pathological findings revealing injury, violence, disease, or other fatal medical condition. Unlike a SIDS diagnosis, a SUID diagnosis recognizes a host of confounding factors like the presence of unsafe sleep factors and/or medical problems such as pneumonia, prematurity, or congestion.[28, 29] SUID deaths are labeled homicide, accident, or undetermined in manner.
- **TRAUMATIC BRAIN INJURY:** encompasses deaths due to blunt force or closed head trauma and abusive head trauma.
- **UNDETERMINED:** When two or more manners of death are plausible and the forensic pathologist cannot designate one manner over another.

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[27] National Institute of Health: Eunice Kenney Shriver National Institute of Child Health and Human Development (2017). *Common SIDS and SUID Terms and Definitions.* Retrieved from: https://www1.nichd.nih.gov/sts/about/SIDS/Pages/common.aspx
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[29] Malloy, Michael H. and MacDorman, Marian. (May, 2005). "Changes in the classification of sudden unexpected infant deaths: United States, 1992-2001." *Pediatrics 115(5):* 1247-1253.

APPENDIX B: VIRGINIA LOCALITIES BY REGION

HEALTH PLANNING REGION (HPR)

CENTRAL:

Counties of: Amelia, Brunswick, Buckingham, Charles City, Charlotte, Chesterfield, Cumberland, Dinwiddie, Goochland, Greensville, Halifax, Hanover, Henrico, Lunenburg, Mecklenburg, New Kent, Nottoway, Powhatan, Prince Edward, Prince George, Surry, Sussex.

Cities of: Colonial Heights, Emporia, Hopewell, Petersburg, and Richmond.

NORTHERN:

Counties of: Arlington, Fairfax, Loudoun, and Prince William.

Cities of: Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park.

EASTERN:

Counties of: Accomack, Essex, Gloucester, Isle of Wight, James City, King and Queen, King William, Lancaster, Mathews, Middlesex, Northampton, Northumberland, Richmond, Southampton, Westmoreland, and York.

Cities of: Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg.

NORTHWEST:

Counties of: Albemarle, Augusta, Bath, Caroline, Clarke, Culpeper, Fauquier, Fluvanna, Frederick, Greene, Highland, King George, Louisa, Madison, Nelson, Orange, Page, Rappahannock, Rockbridge, Rockingham, Shenandoah, Spotsylvania, Stafford, and Warren.

Cities of: Buena Vista, Charlottesville, Fredericksburg, Harrisonburg, Staunton, Waynesboro, and Winchester.

SOUTHWEST:

Counties of: Alleghany, Amherst, Appomattox, Bedford, Bland Botetourt, Buchanan, Campbell, Carroll, Craig, Dickenson, Floyd, Franklin, Giles, Grayson, Henry, Lee, Montgomery, Patrick, Pittsylvania, Pulaski, Roanoke, Russell, Scott, Smyth, Tazewell, Washington, Wise, and Wythe.

Cities of: Bristol, Covington, Danville, Galax, Lynchburg, Martinsville, Norton, Radford, Roanoke, and Salem.

OFFICE OF THE CHIEF MEDICAL EXAMINER (OCME) DISTRICT

CENTRAL:

Counties of: Albemarle, Amelia, Brunswick, Buckingham, Caroline, Charles City, Charlotte, Chesterfield, Cumberland, Dinwiddie, Essex, Fluvanna, Gloucester, Goochland, Greene, Greensville, Halifax, Hanover, Henrico, James City, King and Queen, King George, King William, Lancaster, Louisa, Lunenburg, Mathews, Mecklenburg, Middlesex, Nelson, New Kent, Northumberland, Nottoway, Powhatan, Prince Edward, Prince George, Spotsylvania, Stafford, Surry, Sussex, Richmond, and Westmoreland.

Cities of: Charlottesville, Colonial Heights, Emporia, Fredericksburg, Hopewell, Petersburg, Richmond, and Williamsburg.

NORTHERN:

Counties of: Arlington, Clarke, Culpeper, Fairfax, Fauquier, Frederick, Loudoun, Madison, Manassas, Orange, Page, Prince William, Rappahannock, Shenandoah, and Warren.

Cities of: Alexandria, Arlington, Fairfax, Falls Church, Manassas Park City and Winchester.

TIDEWATER:

Counties of: Accomack, Isle of Wight, Northampton, Southampton, and York.

Cities of: Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, and Virginia Beach.

WESTERN:

Counties of: Alleghany, Amherst, Appomattox, Augusta, Bath, Bedford, Bland, Botetourt, Buchanan, Campbell, Carroll, Craig, Dickenson, Floyd, Franklin, Giles, Grayson, Henry, Highland, Lee, Montgomery, Patrick, Pittsylvania, Pulaski, Roanoke, Rockbridge, Rockingham, Russell, Scott, Smyth, Tazewell, Washington, Wise, and Wythe.

Cities of: Bristol, Buena Vista, Covington, Danville, Galax, Harrisonburg, Lexington, Lynchburg, Martinsville, Norton, Radford, Roanoke, Salem, Staunton, and Waynesboro.