

# Infant Mortality in Tennessee

## 2003-2012



Division of Policy, Planning and Assessment  
Surveillance, Epidemiology and Evaluation

**TENNESSEE DEPARTMENT OF HEALTH ORGANIZATION**

John J Dreyzehner, MD, MPH, FACOEM, Commissioner

Bruce Behringer, MPH, Deputy Commissioner for Continuous Improvement and Training

David Reagan, MD, PhD, Chief Medical Officer

Lori Ferranti, PhD, MBA, MSN, Assistant Commissioner, Division of Policy, Planning & Assessment

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**Report prepared by:**

Audrey M Bauer, DVM, MPH

Surveillance, Epidemiology and Evaluation  
Division of Policy, Planning and Assessment  
Tennessee Department of Health

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## Executive Summary

Infant mortality (the death of a child before one year of age) is an often used measure of population health as it is associated with a wide variety of factors such as maternal health, quality and access to medical care, socioeconomic conditions and public health practices.<sup>1</sup> Despite a dramatic decline during the 20th century, improvement in the infant mortality rate in the United States plateaued between 2000 and 2005, and has only slowly declined in more recent years.<sup>1,2,3</sup> Although Tennessee's infant mortality rate has also declined in the past decade, in 2010 the state ranked 48th among the 50 states (i.e. had the 3<sup>rd</sup> highest rate) and racial disparities persist, with black babies in Tennessee almost twice as likely as white babies to die during their first year of life.<sup>2</sup>

This report offers a comprehensive picture of infant mortality in Tennessee. It examines state trends in infant mortality rates and differences across regions and counties, by age at death and among racial/ethnic groups. Leading causes of infant deaths are also examined, both statewide and again by region, age at death and race/ethnicity. Important infant mortality risk factors are explored, including low birthweight, preterm birth, maternal smoking and others. Also included are focused discussions of sudden unexplained infant deaths, perinatal regionalization and its role in the delivery and care of very low birthweight infants, and early term deliveries.

### Key Findings:

#### Infant Mortality Rates

- The Tennessee infant mortality rate was 7.2 deaths per 1,000 live births in 2012 – a decrease of 22% compared to 2003.
- Average, annual infant mortality rates for TN regions ranged from 5.7/1,000 in the Mid-Cumberland region to 10.2/1,000 in the Shelby County region between 2010 and 2012; county-level rates ranged from 0.0/1,000 in Jackson, Moore and Perry counties to 24.2/1,000 in Van Buren County.
- 60% of infant deaths in 2012 occurred during the neonatal period (i.e. from birth to 27 days of age).
- Between 2003 and 2012, the infant mortality rate decreased for infants born to both black and to white non-Hispanics. Although the racial gap in infant mortality narrowed during this time, the black non-Hispanic rate remained almost double that of white non-Hispanics (12.1 vs. 6.2/1,000, respectively) in 2012.
- The infant mortality rate among Hispanics was 3.7/1,000, lower than both white and black non-Hispanics.

#### Tennessee's Infant Mortality Rate Continues to Improve

Since this report was prepared for publication, newly available data show that TN's infant mortality rate dropped to 6.8 deaths per 1,000 live births in 2013.

#### Leading Causes of Infant Deaths

- The leading causes of infant deaths in Tennessee in 2012 were birth defects, preterm birth and low birthweight and accidents. Together, these three causes accounted for 2 out of every 5 infant deaths in the state.
- The majority of accidental deaths were due to suffocation and strangulation, over one-half of which occurred in bed.
- Sudden infant death syndrome (SIDS) was the 5<sup>th</sup> leading cause of death.
- Infant mortality rates due to preterm birth and low birthweight and to SIDS decreased between 2003 and 2012.
- Preterm birth and low birthweight were the leading cause of neonatal deaths; accidents were the leading cause of postneonatal deaths.
- Preterm birth and low birthweight were the leading cause of infant deaths among black non-Hispanics. Birth defects were the leading cause among white non-Hispanics and Hispanics.

## **Executive Summary *cont.***

### **Infant Mortality Risk Factors**

- Between 2004 and 2012, there was a decreasing trend in the prevalence of the following infant mortality risk factors in Tennessee: low birthweight, preterm birth, births to teen moms, births to women with high school or lower levels of education and maternal cigarette smoking.
- The prevalence of the following risk factors increased during this time period: births to older women (over 35 years of age) and those to unmarried women.
- The strongest predictors of infant mortality were low birthweight and preterm birth. In 2012, low birthweight infants were 18 times more likely to die in their first year of life than those born at higher weights, while preterm infants were 15 times more likely to die than term infants.
- Among the infant mortality risk factors examined, the most common were unmarried mothers (44% of live births), mothers with high school or lower education (18%) and maternal cigarette smoking (16%). The least common was inadequate prenatal care (4%).
- Nine percent of infants were born low birthweight and 11% were born preterm.
- The following risk factors were more common among infants born to black non-Hispanics than among those born to white non-Hispanics and Hispanics: low birthweight, preterm birth, short birth interval, teen mom, unmarried mom and inadequate prenatal care.
- Infants born to Hispanic women had the highest prevalence of older maternal age and high school or lower educational level.
- Infants born to white non-Hispanic women had the highest prevalence of maternal smoking.

The above findings, along with other information contained in this report, offer a comprehensive picture of infant mortality and its risk factors in Tennessee. The purpose of the report is to inform public health professionals, policy makers and the general public on the factors that influence infant mortality, its importance and impact in the state, and avenues for prevention. It is hoped this information will help guide efforts to address this issue and improve maternal and child health in Tennessee.

### **Tennessee's Efforts to Address Infant Mortality**

Infant mortality has long been a public health priority in Tennessee. In 2013, a Public Health Advisory Committee on Infant Mortality developed the "Tennessee Public Health Strategic Plan to Improve Birth Outcomes and Reduce Infant Mortality." Strategies include:

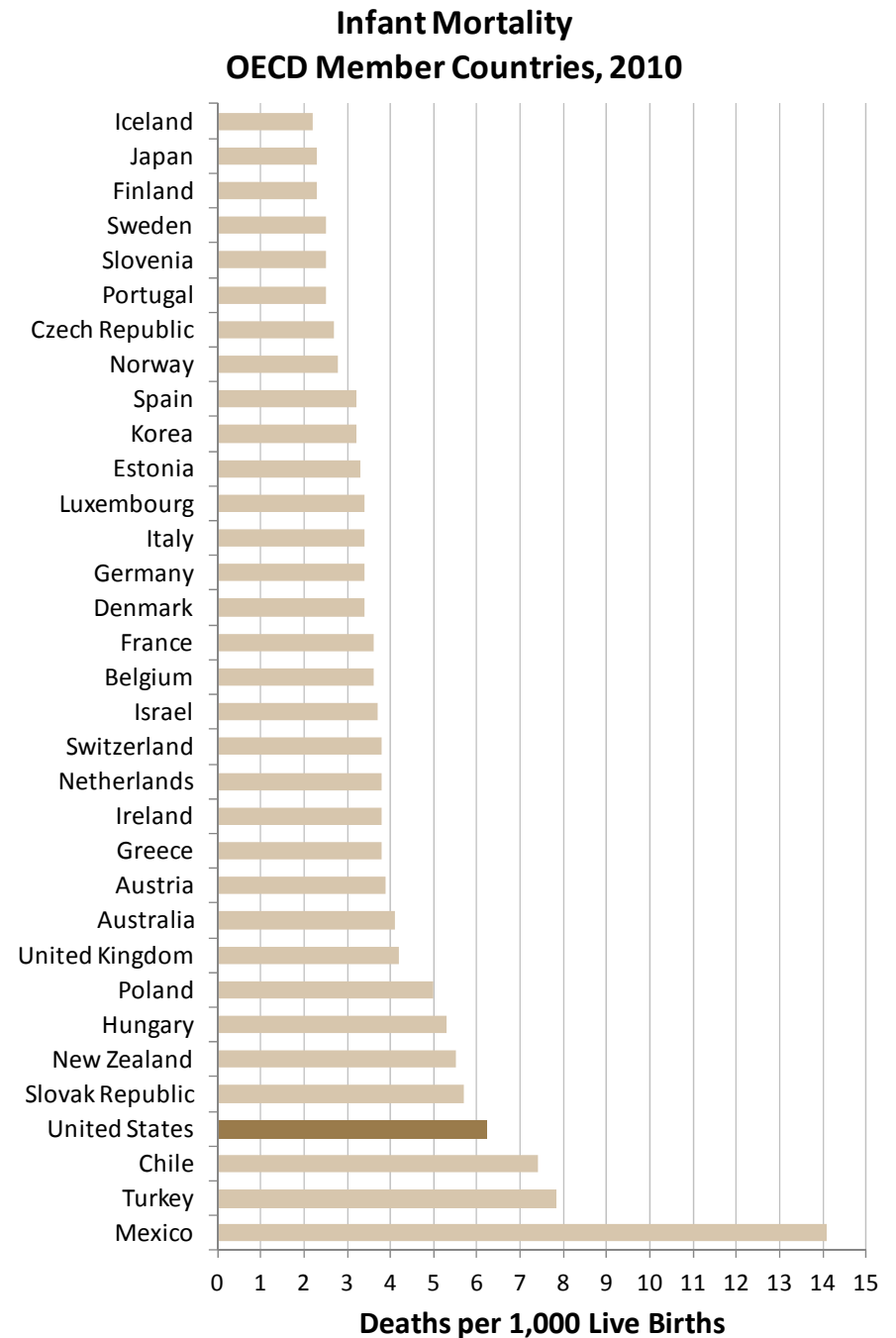
- Decrease unintended pregnancies
- Maintain a strong public health infrastructure
- Increase the proportion of very low birth weight infants born at level III hospitals or subspecialty perinatal centers
- Decrease the rate of sudden unexpected infant deaths (i.e. SIDS, accidental suffocation/strangulation in bed, and undetermined causes)
- Increase the proportion of women who begin prenatal care in the first trimester
- Decrease the rate of preterm births
- Increase the proportion of infants who were ever breastfed
- Decrease the percentage of women who smoke during pregnancy

Tennessee Department of Health staff members at all levels (Central Office, regional offices, and local health departments) are collaborating with diverse community partners to address the strategies outlined above.

# Infant Mortality Rates

## Infant Mortality Rates International Comparisons

- The United States' international ranking for infant mortality among Organization for Economic Co-operation and Development member countries fell from 12<sup>th</sup> in 1960 to 26<sup>th</sup> in 2000.<sup>4</sup>
- Its ranking continued to fall between 2000 and 2010, at which time the U.S. ranked 30<sup>th</sup>, behind most European nations, Australia, New Zealand, Israel, Japan and Korea.<sup>4</sup>
- A study by the National Center for Health Statistics determined that the primary reason for the United States' higher infant mortality rate when compared to European countries is the much higher percentage of preterm births in the U.S.<sup>5</sup>
- Although infant mortality rates for preterm infants are lower in the United States than in most European countries, the U.S.'s higher percentage of preterm births has a large effect on overall infant mortality rates.<sup>5</sup>

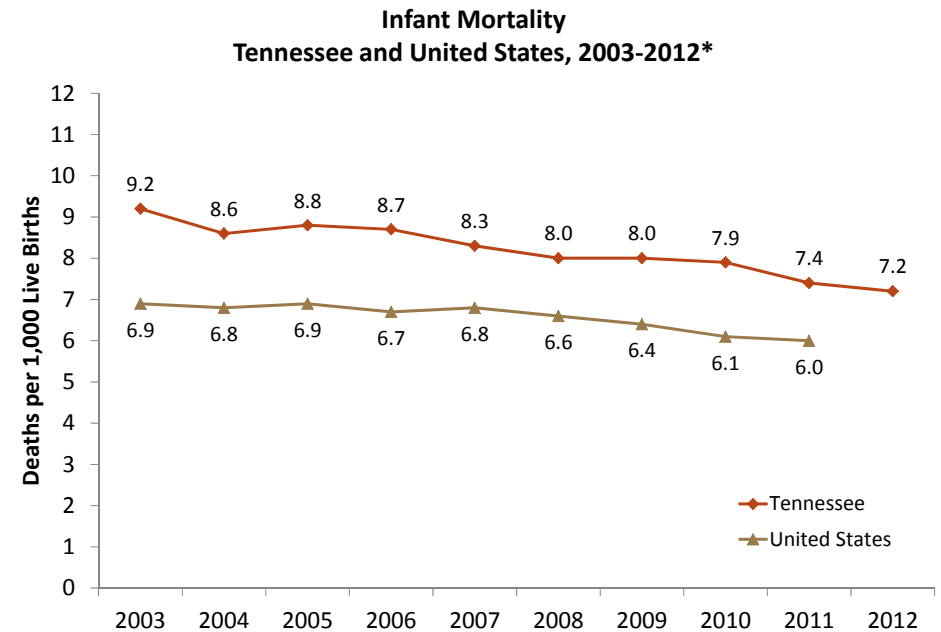
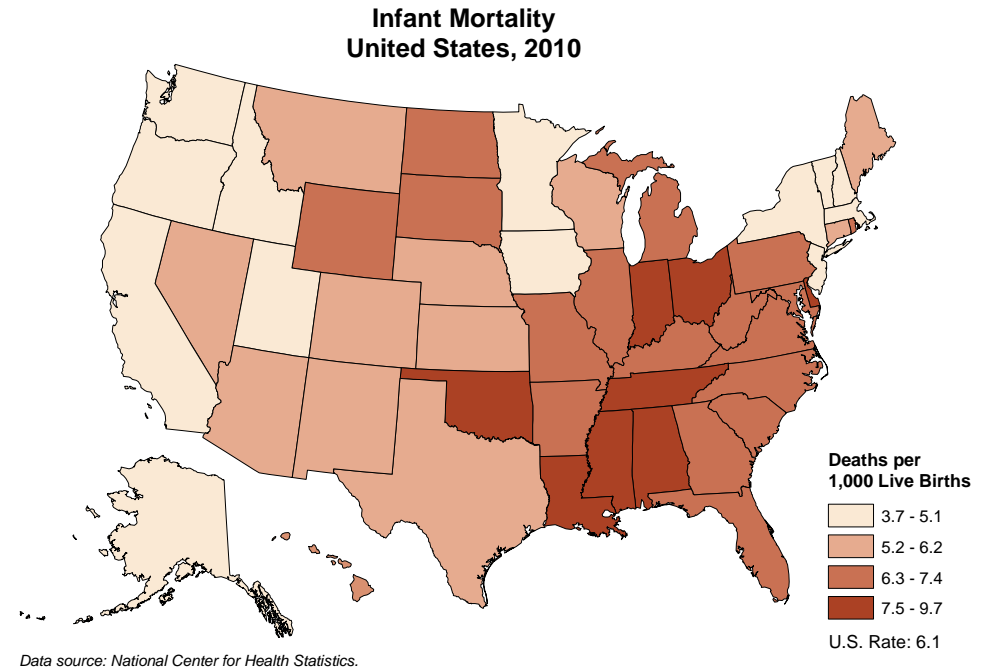


Data source: Organization for Economic Co-operation and Development (OECD).



## Infant Mortality Rates United States Comparisons

- In 2010, state-level infant mortality rates in the United States ranged from 3.7 deaths per 1,000 live births in Alaska to 9.7/1,000 in Mississippi.<sup>2</sup>
- Tennessee ranked 48<sup>th</sup> among the 50 states for infant mortality with a rate of 7.9/1,000. In other words, Tennessee had the 3<sup>rd</sup> highest infant mortality rate in 2010.<sup>2</sup>
- Infant mortality rates declined in both Tennessee and in the United States between 2003 and 2011.\* However, there was a greater decline in Tennessee (19% decrease) than in the U.S. (13% decrease). As a result, the infant mortality disparity between Tennessee and the nation as a whole narrowed slightly during this time period.<sup>2,3</sup>
- In 2011, the infant mortality rate in Tennessee was 7.4/1,000, compared to 6.0/1,000 in the U.S.<sup>3</sup>



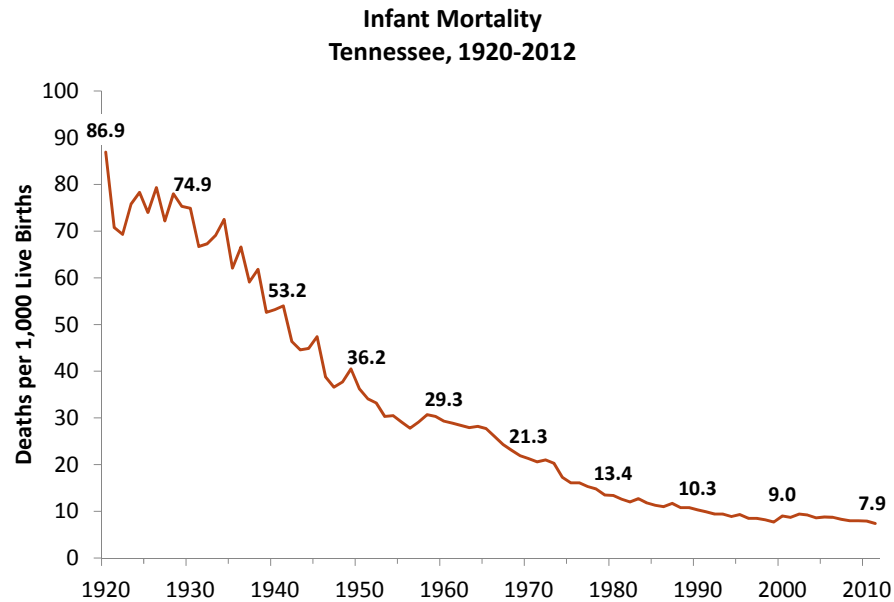
\*2011 U.S. data are preliminary.

Data sources: 1) Tennessee Department of Health; Division of Policy, Planning and Assessment. 2) National Center for Health Statistics.

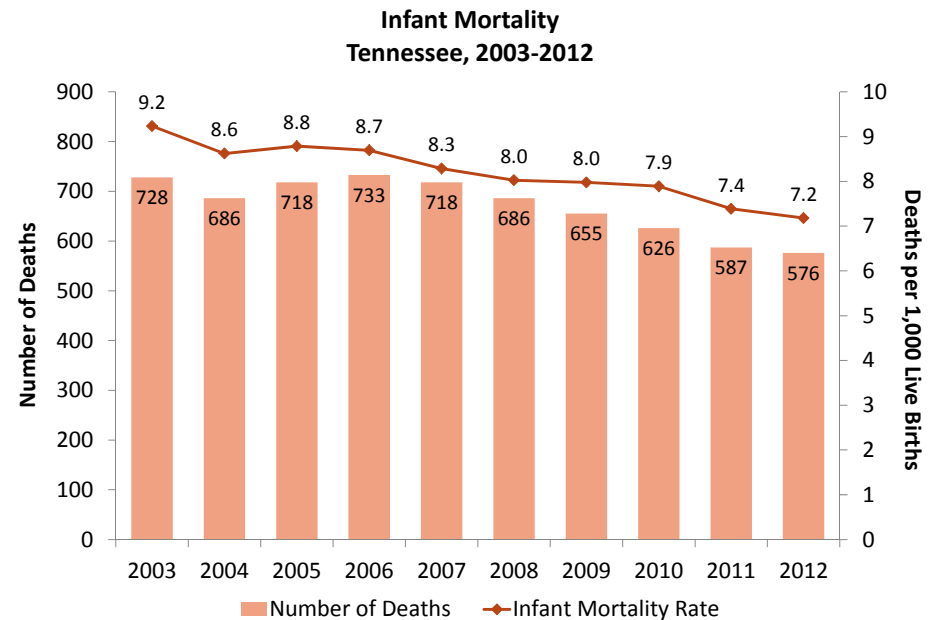
## Infant Mortality Rates

### Time Trends

- In 1920, approximately 87 out of every 1,000 infants born in Tennessee died before their first birthday. Ninety years later (i.e. 2010), this number had dropped to about 8 out of every 1,000.
- Although the pace of decline has slowed in recent years, the infant mortality rate in Tennessee continues to go down. Between 2003 and 2012, the rate went from 9.2 to 7.2 deaths per 1,000 live births – a 22% decrease. This change was statistically significant.
- In 2012, there were 576 infant deaths in Tennessee.



Data Sources: 1) Tennessee Department of Health; Division of Policy, Planning and Assessment. 2) Tennessee Vital Statistics Annual Bulletins.

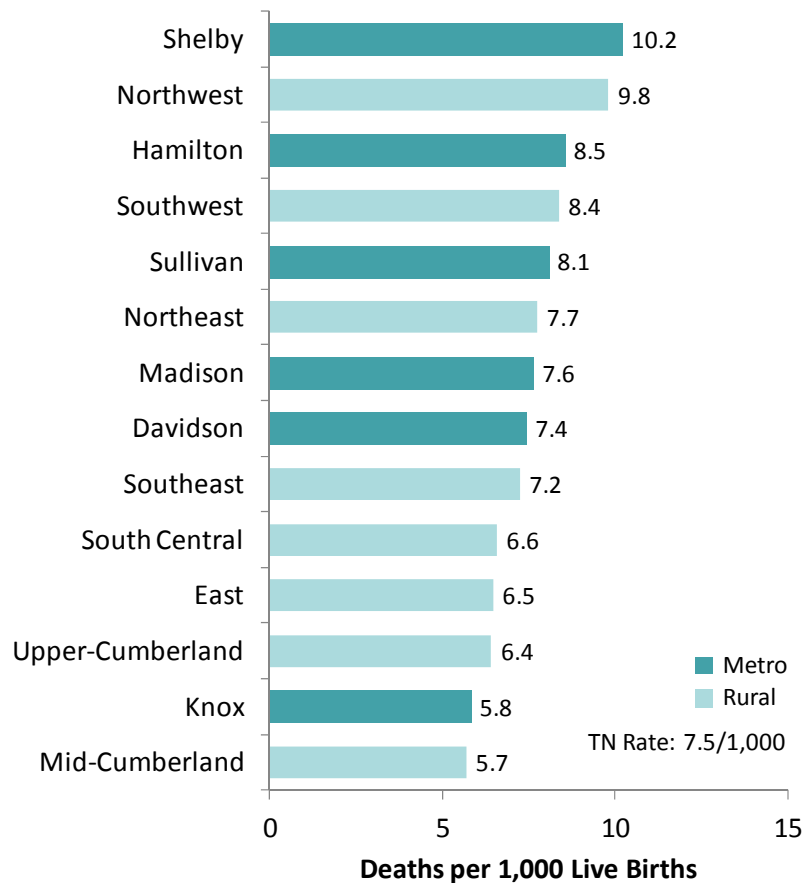


Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Infant Mortality Rates Regions

- Between 2010 and 2012, the average, annual infant mortality rate in Tennessee Health Department (TDH) regions ranged from 5.7 deaths per 1,000 live births in the Mid-Cumberland region to 10.2/1,000 in the Shelby County metropolitan region.
- Although the Mid-Cumberland region accounted for 18.4% of live births, just 14.0% of infant deaths occurred in this region.
- On the other hand, Shelby accounted for just 17.4% of live births, but 23.7% of infant deaths.

**Infant Mortality by Region  
Tennessee, 2010-2012**



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

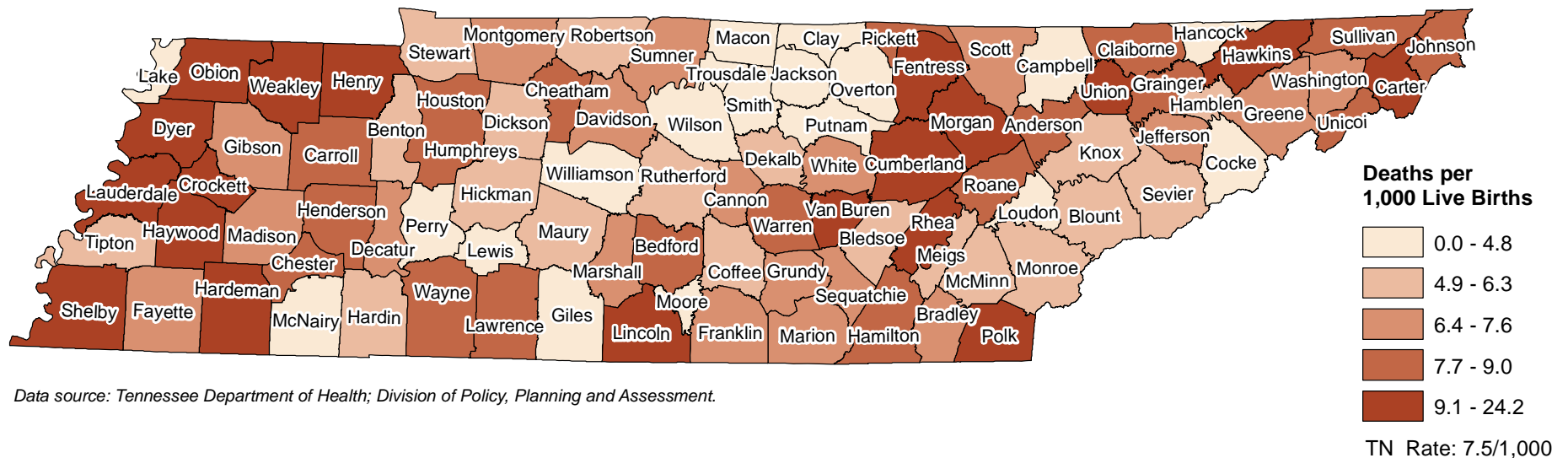
Distribution of Births and Infant Deaths by Region Tennessee, 2010-2012				
Region	Births		Infant Deaths	
	Total Number of Births	Percent of Births	Total Number of Deaths	Percent of Deaths
<b>Shelby</b>	41,672	17.4	424	23.7
<b>Northwest</b>	8,668	3.6	85	4.8
<b>Hamilton</b>	12,325	5.2	105	5.9
<b>Southwest</b>	9,562	4.0	80	4.5
<b>Sullivan</b>	4,720	2.0	38	2.1
<b>Northeast</b>	10,328	4.3	80	4.5
<b>Madison</b>	3,808	1.6	29	1.6
<b>Davidson</b>	28,879	12.1	214	12.0
<b>Southeast</b>	10,368	4.3	75	4.2
<b>South Central</b>	13,835	5.8	91	5.1
<b>East</b>	23,833	10.0	154	8.6
<b>Upper-Cumberland</b>	11,530	4.8	74	4.1
<b>Knox</b>	15,518	6.5	90	5.0
<b>Mid-Cumberland</b>	43,963	18.4	250	14.0
<b>Tennessee</b>	239,009	100	1,789	100

Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Infant Mortality Rates Counties

- Between 2010 and 2012, the average, annual infant mortality rate in Tennessee counties ranged from 0 deaths per 1,000 live births in Jackson, Moore and Perry counties to 24.2/1,000 in Van Buren County.\*
- The ten counties with the lowest infant mortality rates during this time period were: Jackson, Moore, Perry, Campbell, Lewis, Smith, McNairy, Giles, Putnam and Trousdale counties.
- The ten counties with the highest infant mortality rates during this time period were: Hardeman, Obion, Henry, Morgan, Union, Dyer, Lauderdale, Haywood, Polk and Van Buren counties.
- The above listed counties with the ten lowest and ten highest infant mortality rates are all rural areas. Among the state's six metro counties, Knox had the lowest infant mortality rate (5.8/1,000) and Shelby had the highest (10.2/1,000).

**Infant Mortality by County  
Tennessee, 2010-2012**



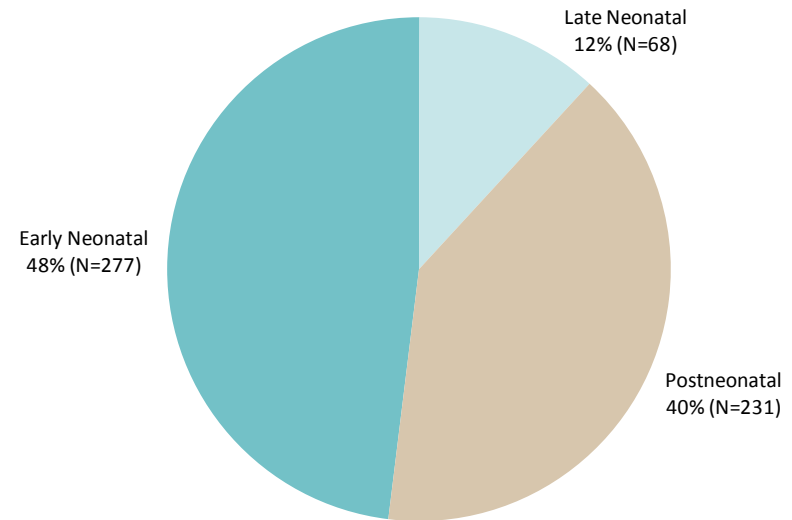
Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

\*See appendix for detailed list of county-specific infant death counts and mortality rates.

## Infant Mortality Rates Age at Death

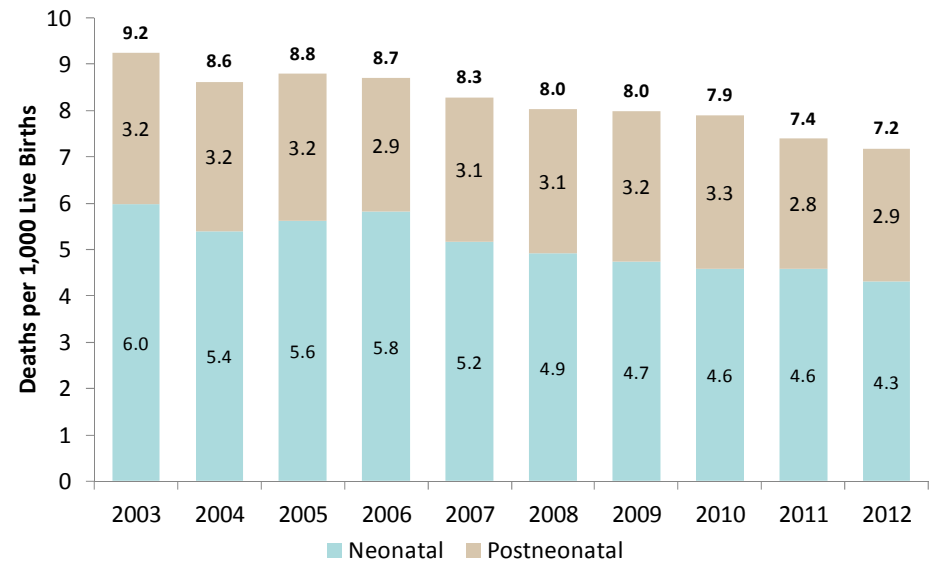
- In 2012, 60% of infant deaths in Tennessee occurred during the neonatal time period (i.e. from birth to 27 days of age). The remaining 40% occurred during the postneonatal period (28 days of age and older).
- Deaths that occur between birth and 6 days of age are referred to as *early* neonatal deaths. In 2012, 48% of all infant deaths and 80% of neonatal infant deaths occurred during the early neonatal period.
- Between 2003 and 2012, there was a statistically significant decrease in the neonatal mortality rate in Tennessee, from 6.0 deaths per 1,000 live births to 4.3/1,000.
- Although the postneonatal mortality rate also decreased during this time period, the change was not statistically significant.

Infant Deaths by Age at Death  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Infant Mortality by Age at Death  
Tennessee, 2003-2012

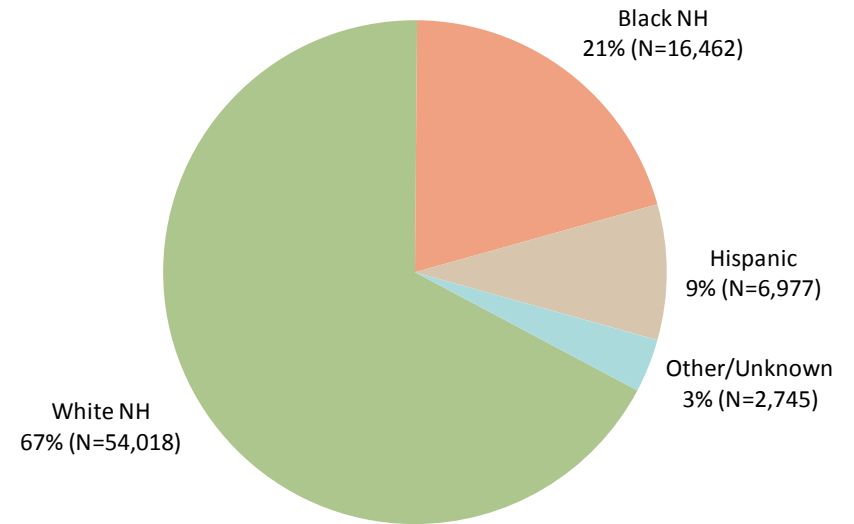


Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Infant Mortality Rates Race and Ethnicity

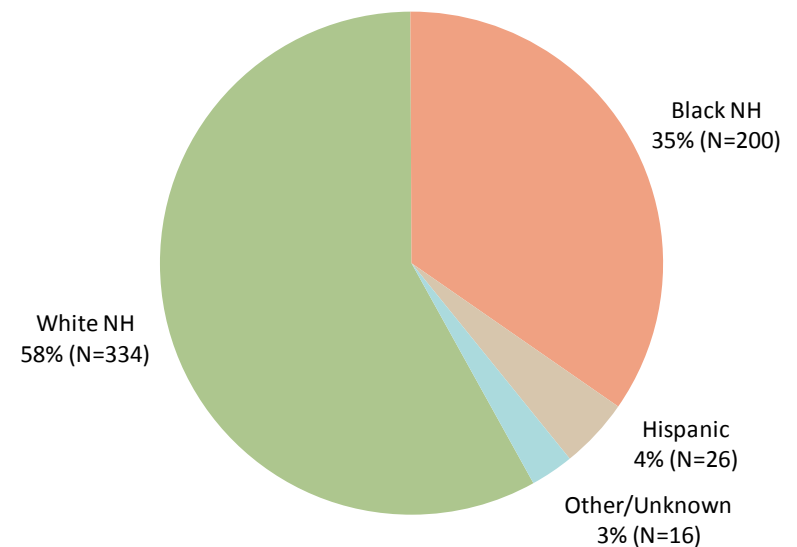
- Black non-Hispanics (black NH) represent a higher percentage of infant deaths than of live births, indicating that they are disproportionately affected by infant mortality.
- In 2012, 35% of infant deaths occurred among black non-Hispanics, but just 21% of live births were to black non-Hispanic women.
- Conversely, white non-Hispanics (white NH) represented 67% of live births, but only 58% of infant deaths.
- Hispanics represented 9% of live births and 4% of infant deaths.

**Live Births by Race and Ethnicity  
Tennessee, 2012**



*Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.*

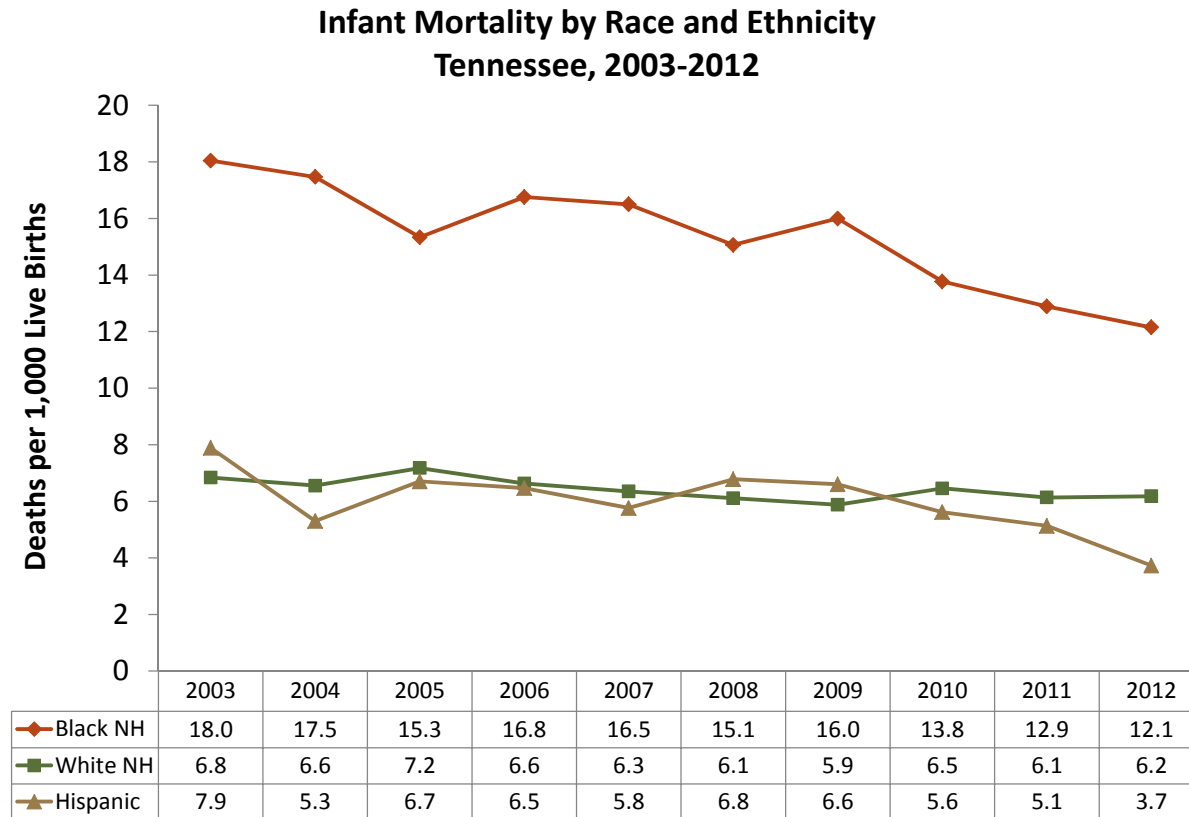
**Infant Deaths by Race and Ethnicity  
Tennessee, 2012**



*Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.*

## Infant Mortality Rates Race and Ethnicity cont.

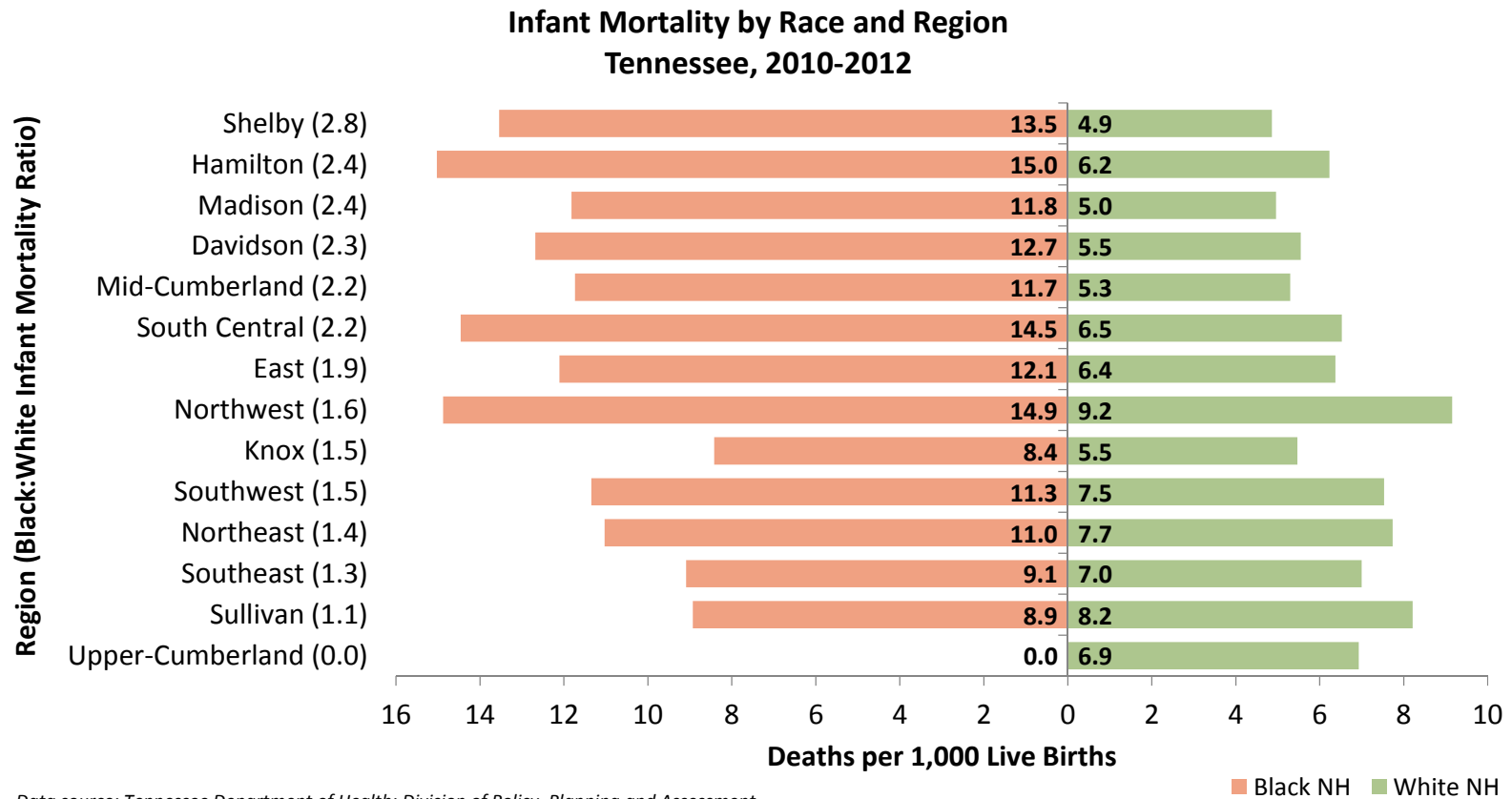
- Between 2003 and 2012, there was a statistically significant decline in the infant mortality rate among all three racial/ethnic groups. This change was largest among Hispanics (53% decrease), followed by black non-Hispanics (33% decrease) and white non-Hispanics (9% decrease).
- Because of the larger decrease among black versus white non-Hispanics, the disparity in infant mortality between these two groups narrowed during this time period.
- However, the infant mortality rate among black non-Hispanics in Tennessee was still almost double that of white non-Hispanics in 2012 (12.1 deaths per 1,000 live births versus 6.2/1,000, respectively). The infant mortality rate among Hispanics was lowest at 3.7/1,000.
- The infant mortality rate among black non-Hispanics in 2012 was similar to the rate among whites in 1980. In other words, blacks are approximately 32 years behind whites with respect to infant mortality.



Data source: Tennessee Department of Health; Division of Policy Planning and Assessment.

## Infant Mortality Rates Race and Ethnicity cont.

- Between 2010 and 2012, the average, annual infant mortality rate among black non-Hispanics in TDH regions ranged from 0 deaths per 1,000 live births in the Upper-Cumberland region to 15.0/1,000 in the Hamilton County metropolitan region.
- During this same time period, the infant mortality rate among white non-Hispanics ranged from 4.9/1,000 in the Shelby County metropolitan region to 9.2/1,000 in the Northwest region.
- The infant mortality rate was higher among black versus white non-Hispanics in all but the Upper-Cumberland region. However, these differences were statistically significant in the following regions only: Davidson, Hamilton, Mid-Cumberland and Shelby.
- The Shelby County metropolitan region had the highest black:white infant mortality ratio (2.8) among TDH regions. The infant mortality rate among black non-Hispanics in Shelby was almost three times as high as the rate among white non-Hispanics.



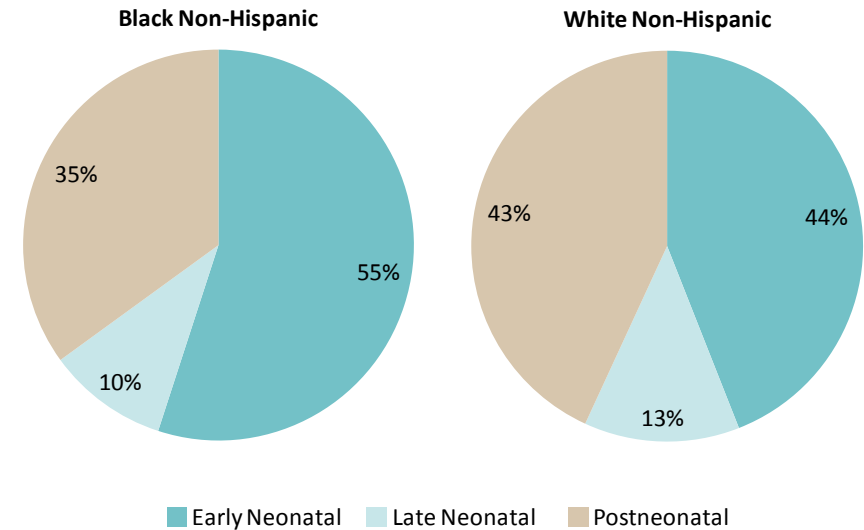
Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.



## Infant Mortality Rates Race and Ethnicity cont.

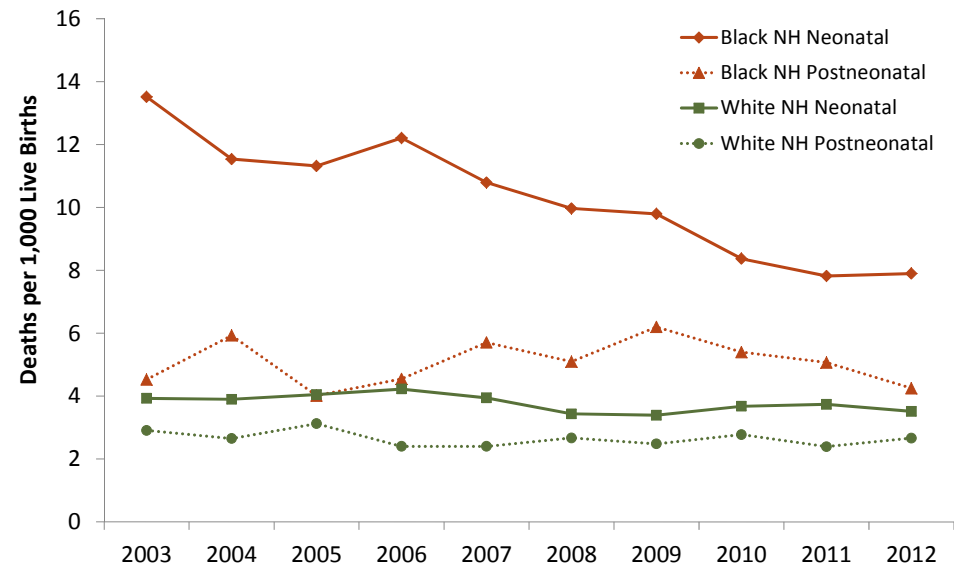
- In 2012, 65% of infant deaths among black non-Hispanics occurred during the neonatal period, compared to 57% among white non-Hispanics.
- Between 2003 and 2012, the neonatal infant mortality rate declined among both black and white non-Hispanics. (42% decrease and 10% decrease, respectively).
- Although the racial disparity in neonatal mortality narrowed during this time period, in 2012 the neonatal mortality rate among black non-Hispanics was still more than double that among white non-Hispanics (7.9 deaths per 1,000 live births versus 3.5/1,000, respectively).
- There was not a statistically significant upward or downward trend in the postneonatal mortality rate among black or white non-Hispanics between 2003 and 2012.

Infant Deaths by Race and Age at Death  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Infant Mortality by Race and Age at Death  
Tennessee, 2003-2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

# Leading Causes of Infant Deaths

## Leading Causes of Infant Deaths

### Overall Leading Causes

- In 2012, birth defects were the leading cause of infant death in Tennessee, followed by preterm birth and low birthweight and accidents. Together, these three causes accounted for 2 out of every 5 infant deaths in the state.
- Sudden infant death syndrome (SIDS) was the 5<sup>th</sup> leading cause of infant death.
- Nationally, birth defects were the leading cause of infant death in 2011, followed by preterm birth and low birthweight and SIDS. Accidents were the 5<sup>th</sup> leading cause of infant death nationally.<sup>3</sup>

Leading Causes of Infant Deaths Tennessee, 2012			
Rank	Cause of Death	Number of Deaths	Percent of Deaths
1	Birth defects	109	18.9
2	Preterm birth and low birthweight	81	14.1
3	Accidents	38	6.6
4	Maternal complications of pregnancy	26	4.5
5	Sudden infant death syndrome (SIDS)	25	4.3
6	Diseases of the circulatory system	21	3.6
7	Respiratory distress of newborn	19	3.3
8	Atelectasis (partial lung collapse)	14	2.4
9	Complications of placenta, cord, and membranes	12	2.1
10	Bacterial sepsis of newborn	11	1.9
--	All other causes*	220	38.2
--	<i>All Causes</i>	<i>576</i>	<i>100</i>

*Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.*

\*Among deaths due to all other causes, 91 were due to unknown cause. This represents 41% of deaths due to other causes and 16% of all infant deaths.

## Leading Causes of Infant Deaths

### Overall Leading Causes *cont.*

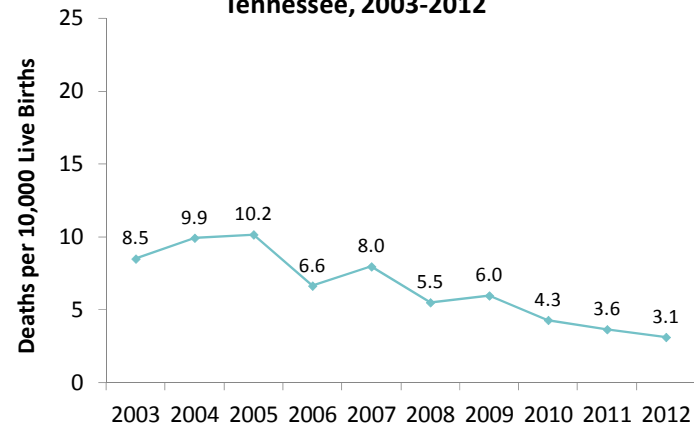
- Between 2003 and 2012, the infant mortality rate declined for deaths due to preterm birth and low birthweight (34% decrease) and for those due to SIDS (64% decrease).
- During this same time period, there was not a statistically significant upward or downward trend in the infant mortality rate for deaths due to birth defects or for those due to accidents.

**Infant Mortality Due to Preterm Birth and Low Birthweight  
Tennessee, 2003-2012**



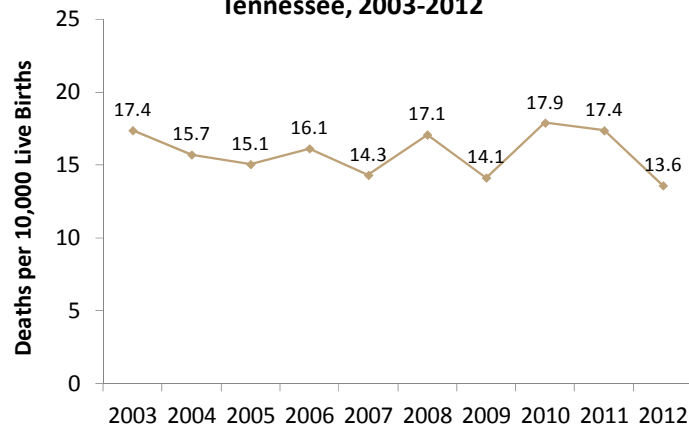
Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

**Infant Mortality Due to SIDS  
Tennessee, 2003-2012**



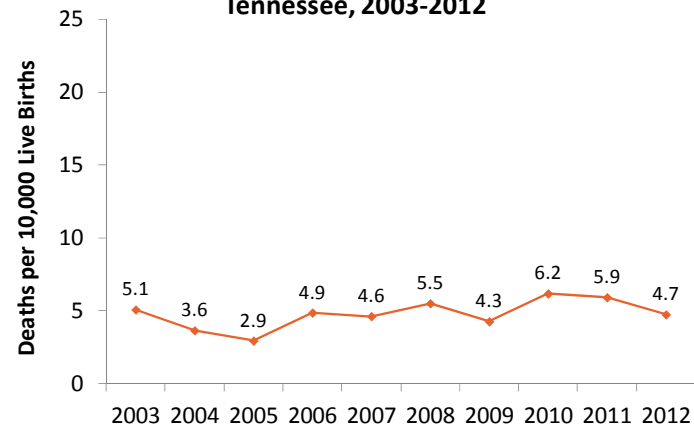
Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

**Infant Mortality Due to Birth Defects  
Tennessee, 2003-2012**



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

**Infant Mortality Due to Accidents  
Tennessee, 2003-2012**

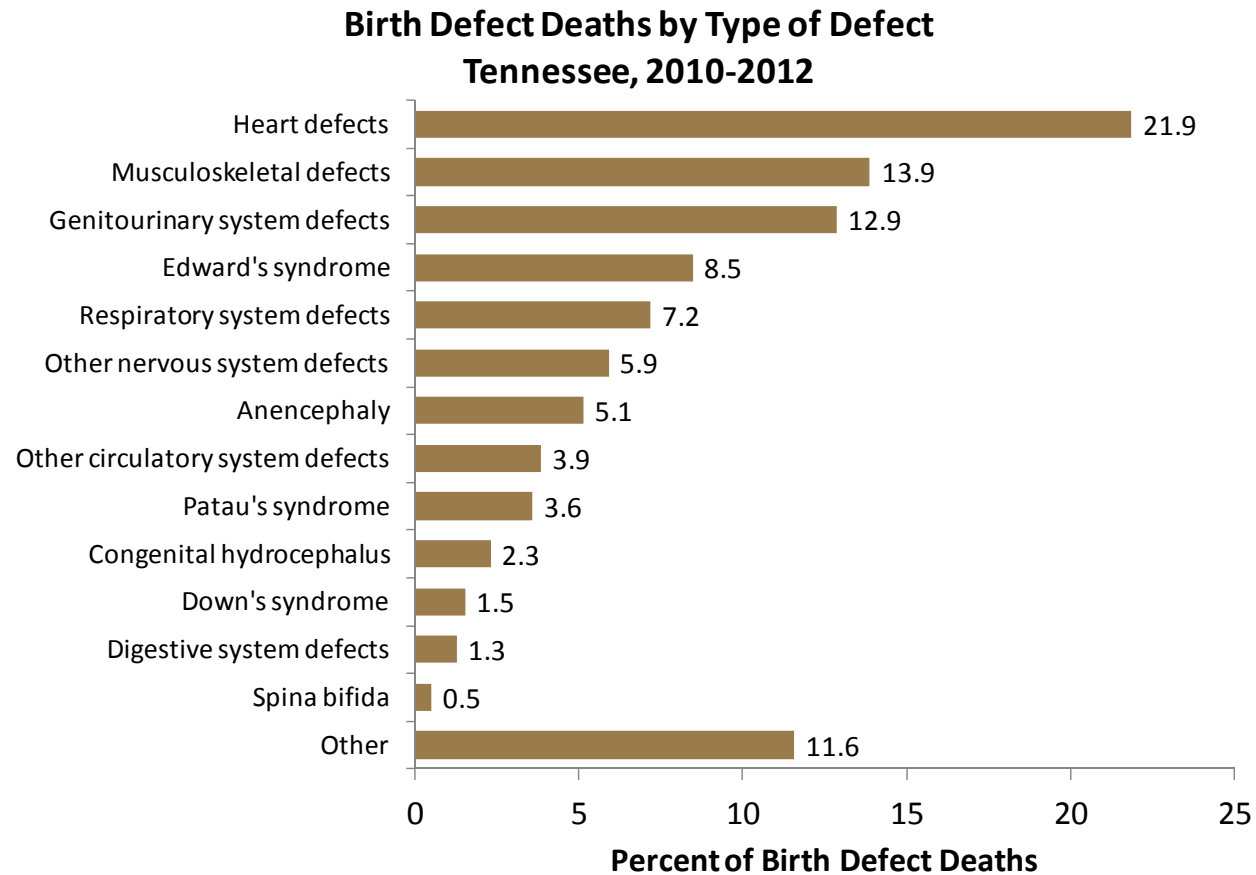


Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Leading Causes of Infant Deaths

### Birth Defects

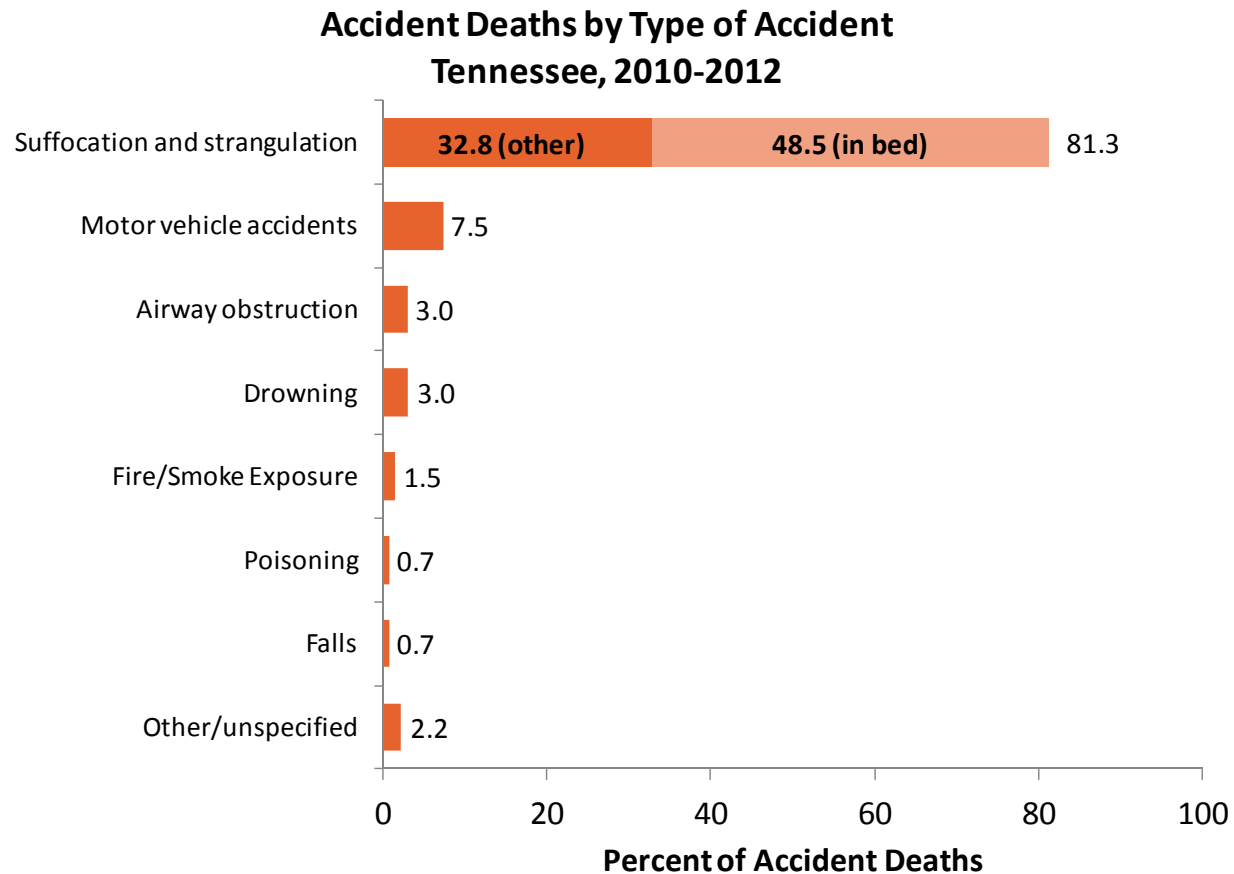
- Between 2010 and 2012, heart defects accounted for the highest percentage of infant deaths due to birth defects (21.9%), followed by musculoskeletal defects (13.9%) and genitourinary system defects (12.9%).
- Together, these three types of defects accounted for almost half of all infant deaths due to birth defects.



*Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.*

## Leading Causes of Infant Deaths Accidents

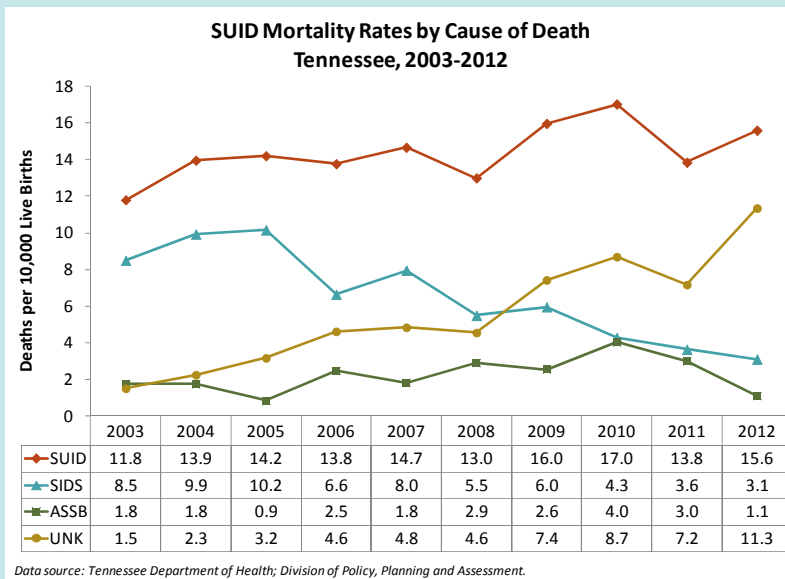
- Between 2010 and 2012, suffocation and strangulation accounted for the majority of accidental infant deaths (81.3%), followed by motor vehicle accidents (7.5%) and airway obstruction/drowning (3.0% each).
- Almost two-thirds of suffocation and strangulation deaths occurred in bed (e.g. as a result of bed linens, pillows, or someone's body). The remaining one-third were classified as 'other.'



*Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.*

## Sudden Unexplained Infant Deaths

Sudden unexplained infant deaths (SUIDs) are defined as infant deaths that occur suddenly and unexpectedly, and whose causes are not immediately obvious prior to investigation. SUIDs include deaths due to sudden infant death syndrome (SIDS), accidental suffocation and strangulation in bed (ASSB), and unknown cause (UNK). These causes were grouped together due to evidence that some deaths previously classified as SIDS are now being assigned to other sleep-related causes of death.<sup>6,7</sup>



- Between 2003 and 2012, the SUID mortality rate in Tennessee increased 32%.
- During this time period, the SIDS mortality rate decreased 64%. In 2003, SIDS represented 72% of SUID deaths, but in 2012 made up just 20% of these deaths.
- In 2012, infant deaths due to unknown cause represented 73% of SUID deaths.

In 2012, there were 125 SUIDs in Tennessee. Although SUID is not a rankable cause of death, when taken in combination these deaths outnumber infant deaths due to birth defects (125 vs. 109), which was the leading cause of infant death in 2012.

The state's Child Fatality Review (CFR) teams reviewed 121 SUID deaths in 2012. The purpose of these reviews is to create a thorough description of the factors related to child deaths in order to understand and prevent future deaths.

Among the SUID deaths reviewed, 92 (76%) were determined to be sleep-related. This is consistent with studies showing that a large proportion of SUIDs involve hazards in the sleep environment.<sup>8,9</sup>

<b>Contributing Factors to Sleep-related SUID Deaths, TN, 2012<sup>8</sup></b>	
<b>Risk Factor</b>	<b>Percent of Deaths*</b>
Infant not sleeping in crib or bassinette	75%
Infant sleeping with person/animal	61%
Infant found in non-back sleeping position	64%
Unsafe bedding/toys in sleep area	54%

\*Percentages do not sum to 100% because some infants had multiple risk factors.

### Recommendations for creating a safe sleep environment and preventing sleep-related infant deaths:<sup>10</sup>

- Place babies on their back for every sleep
- Place babies to sleep in the same room but *not* the same bed as adults, other children or pets
- Place babies to sleep in a crib and on a firm sleeping surface
- Keep soft objects, toys and loose bedding out of the crib
- Do not use crib bumpers
- Avoid commercial devices marketed to reduce the risk of SIDS
- Offer a pacifier at nap time and bedtime
- Avoid overheating
- Avoid smoke exposure and alcohol and illicit drug use during pregnancy and after birth
- Breastfeed for at least 6 months
- Get regular prenatal care during pregnancy

## Leading Causes of Infant Deaths Regions

- Between 2010 and 2012, the leading cause of infant death in TDH regions was either birth defects or preterm birth and low birthweight.
- Accidents were among the top three leading causes of death in 8 out of 14 regions.
- SIDS was among the top three leading causes of death in 5 out of 14 regions.

### Leading Causes of Infant Deaths by Region Tennessee, 2010-2012

Cause of Death	Rank*														
	Tennessee	Davidson	East	Hamilton	Knox	Madison	Mid-Cumberland	Northeast	Northwest	Shelby	South Central	Southeast	Southwest	Sullivan	Upper-Cumberland
Birth defects	1	1	1	2	1	2	1	1	1	2	1	1	1	1	1
Preterm birth and low birthweight	2	2	3	1	3	1	2	2	3	1		3	1	3	2
Accidents	3	3	2		2				2	3	2	2	3		
Sudden infant death syndrome (SIDS)	4			3		3		3			2			2	
Maternal complications of pregnancy	5					3	3								
Complications of placenta, cord, and membranes	6													3	
Diseases of the circulatory system	6					3									
Respiratory distress of newborn	8													3	
Bacterial sepsis of newborn	9					3									
Atelectasis (partial lung collapse)	11					3									2
Neonatal hemorrhage	12					3									
Diarrhea and gastroenteritis of infectious origin	15					3									
Chronic respiratory disease originating in the perinatal period	19					3									

\*In cases of ties (i.e. multiple causes with the same number of deaths), causes were assigned the same ranking.

Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.



## Leading Causes of Infant Deaths Age at Death

- Leading causes of infant death varied across age groups.
- Between 2010 and 2012, preterm birth and low birthweight were the leading cause of early neonatal deaths.
- Birth defects were the only leading cause common to all age groups. They were the leading cause of late neonatal deaths, and the second leading cause of early neonatal and postneonatal deaths.
- Accidents were the leading cause of postneonatal deaths.

### Leading Causes of Infant Deaths by Age at Death Tennessee, 2010-2012

Cause of Death	Rank		
	Early Neonatal	Late Neonatal	Postneonatal
Preterm birth and low birthweight	1		
Birth defects	2	1	2
Maternal complications of pregnancy	3		
Complications of placenta, cord, and membranes	4		
Respiratory distress of newborn	5	5	
Bacterial sepsis of newborn		2	
Neonatal hemorrhage		3	
Sudden infant death syndrome (SIDS)		4	3
Accidents			1
Diseases of the circulatory system			4
Homicide			5

Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Leading Causes of Infant Deaths Race and Ethnicity

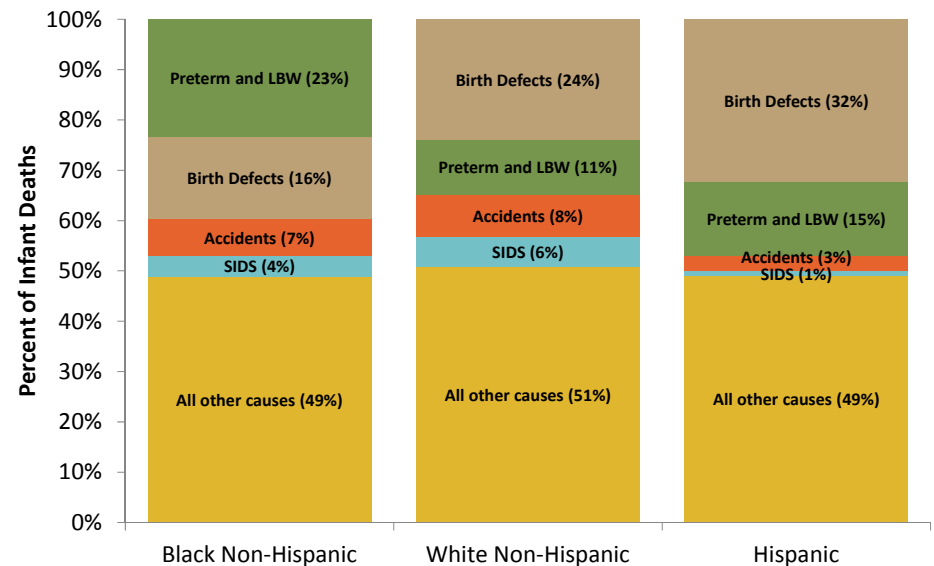
- Between 2010 and 2012, preterm birth and low birthweight were the leading cause of infant death among black non-Hispanics and the second leading cause among white non-Hispanics and Hispanics.
- Birth defects were the leading cause of death among white non-Hispanics and Hispanics and the second leading cause among black non-Hispanics.
- Accidents were the third leading cause of death among black and white non-Hispanics and the fourth leading cause among Hispanics.
- Combined, preterm birth and low birthweight, birth defects, accidents and SIDS made up approximately one-half of infant deaths among all three racial/ethnic groups.

## Leading Causes of Infant Deaths by Race Tennessee, 2010-2012

Cause of Death	Rank*		
	Black NH	White NH	Hispanic
Preterm birth and low birthweight	1	2	2
Birth Defects	2	1	1
Accidents	3	3	4
Maternal complications of pregnancy	4	8	9
Sudden infant death syndrome (SIDS)	5	4	9
Complications of placenta, cord, and membranes	6	7	3
Diseases of the circulatory system	7	6	4
Respiratory distress of newborn	8	5	6

\*In cases of ties (i.e. multiple causes with the same number of deaths), causes were assigned the same ranking.  
Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Distribution of Infant Deaths by Race and Cause Tennessee, 2010-2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

# Infant Mortality Risk Factors

Information in previous sections of this report was based on data collected from death certificates. Although these data are crucial for describing trends and causes of infant deaths, they provided limited information on important predictors of infant mortality, such as a baby's birthweight and gestational age. By linking birth and death certificates, however, it becomes possible to examine infant deaths by these characteristics, as well as by other factors collected on the birth certificate.

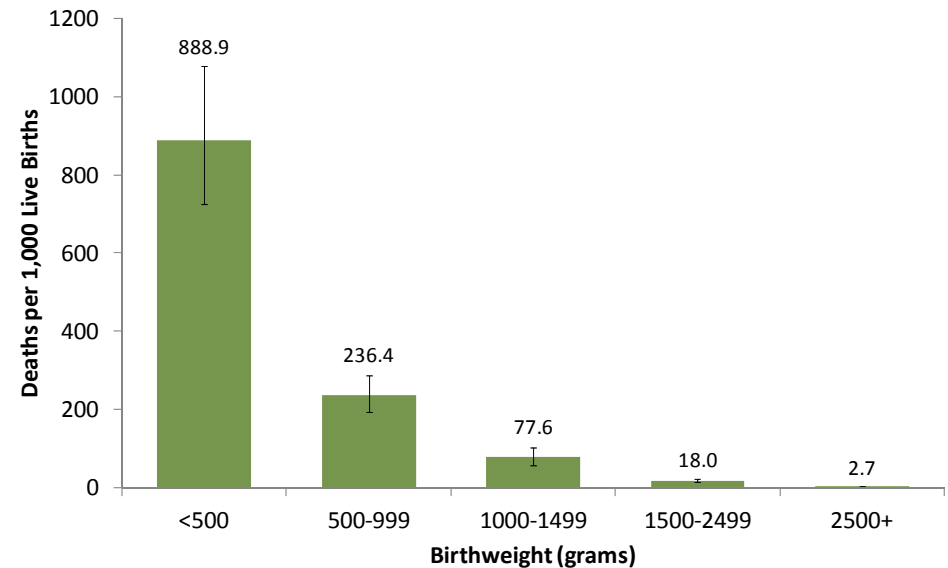
The information in this section of the report is based on birth cohort-linked birth and death files. This means that birth certificates for a given year (e.g. 2012) are linked to certificates for infant deaths in that or the next year (e.g. 2012 and 2013). This linked file, along with all data analyses based on the file, are limited to in-state births to Tennessee resident women. This is slightly different from analyses of unlinked birth and death files, which are only limited to Tennessee residents, without any limitations on where a vital event occurred (i.e. whether it occurred in or out-of-state). Because of the above differences, mortality rates calculated from the linked file may be slightly different than those calculated using the unlinked files. Similarly, the prevalence of infant mortality risk factors (e.g. the percentage of babies born low birthweight) calculated from the linked file may be slightly different than those calculated using the birth file alone. However, these differences should be negligible.<sup>11</sup>

## Infant Mortality Risk Factors

### Birthweight

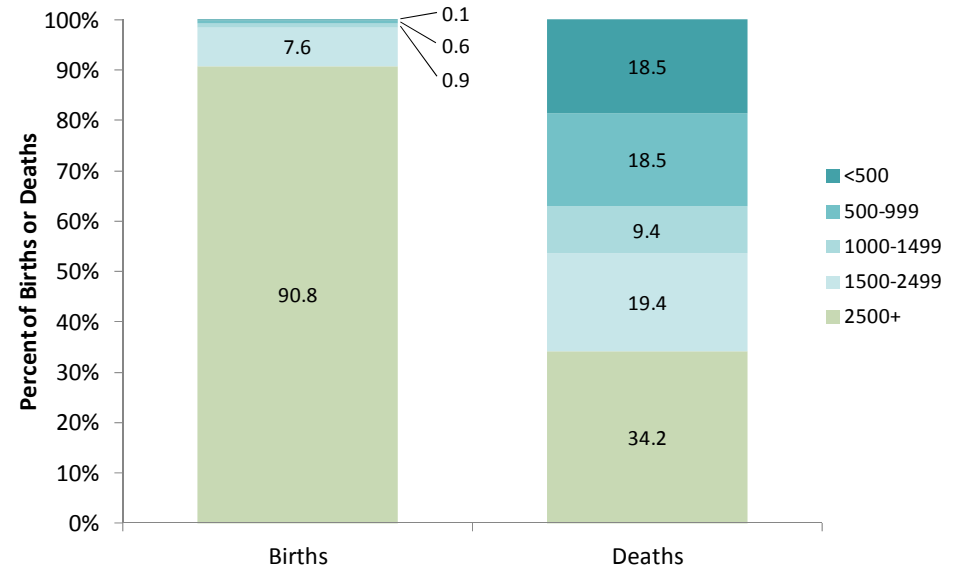
- Birthweight is an important predictor of infant mortality. In 2012, low birthweight infants in Tennessee (i.e. those born weighing less than 2,500 grams) were 18 times more likely to die in their first year of life than those born at higher weights (50.8 deaths per 1,000 live births vs. 2.7/1,000, respectively).
- Infant mortality rates were highest for the smallest infants and decreased sharply as birthweight increased. Almost nine out of every ten infants born at less than 500 grams died in their first year of life, compared to less than one out of every hundred with birthweights of 2,500 grams or more.
- Because of their much higher mortality rates, infants born at the lowest birthweights have a large impact on overall mortality rates. For example, very low birthweight infants (i.e. those born weighing less than 1,500 grams) accounted for less than 2% of live births, but almost half of infant deaths.
- Although normal weight infants (i.e. those born weighing 2,500 grams or more) have the lowest mortality rates, they account for over one-third of infant deaths, primarily because they represent over 90% of live births.

Infant Mortality by Birthweight  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Births and Infant Deaths by Birthweight  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Infant Mortality Risk Factors

### Birthweight *cont.*

- Over four-fifths of infant deaths among very low birthweight infants occur in the neonatal period.
- Conversely, over two-thirds of infant deaths among normal weight infants occur in the postneonatal period.

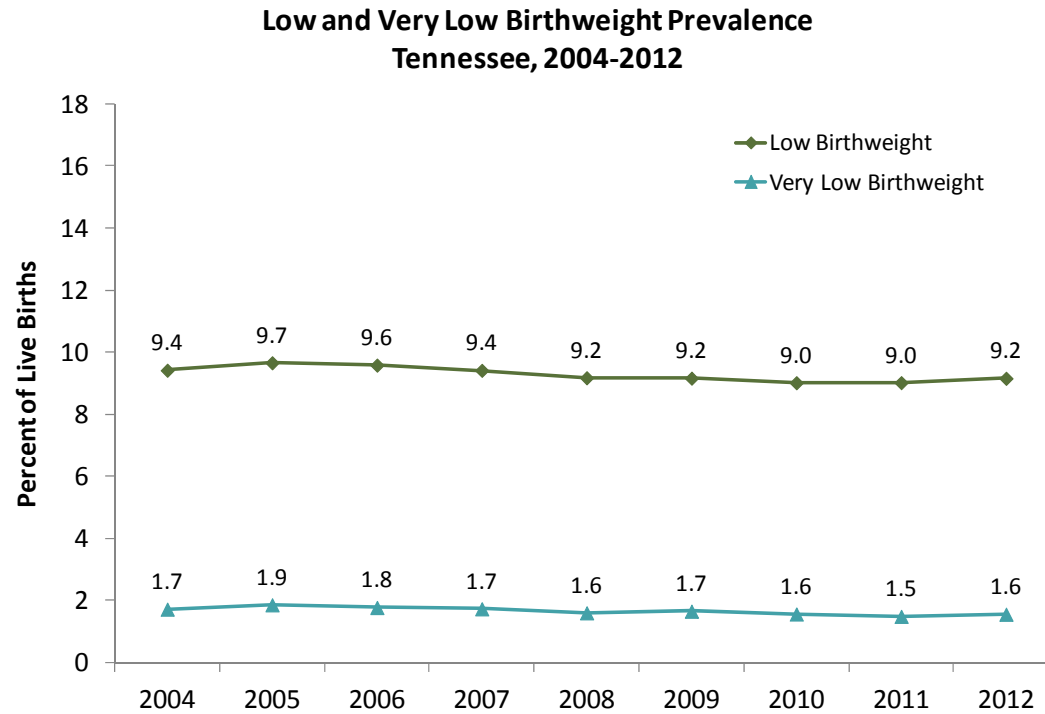
<b>Neonatal and Postneonatal Deaths by Birthweight, Tennessee, 2012</b>						
<b>Birthweight (grams)</b>	<b>Number (%) of Infant Deaths</b>			<b>Infant Mortality Rate (per 1,000 Live Births)</b>		
	<b>Neonatal</b>	<b>Postneonatal</b>	<b>Infant</b>	<b>Neonatal</b>	<b>Postneonatal</b>	<b>Infant</b>
<b>&lt;1500</b>	218 (84%)	43 (16%)	261 (100%)	175.8	34.7	210.5
<b>1500-2499</b>	52 (48%)	57 (52%)	109 (100%)	8.6	9.4	18.0
<b>2500+</b>	61 (32%)	131 (68%)	192 (100%)	0.8	1.8	2.7

*Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.*

## Infant Mortality Risk Factors

### Birthweight *cont.*

- Between 2004 and 2012, the percentage of Tennessee infants born at a low birthweight decreased from 9.4% to 9.2%.
- During this same time period, the percentage of infants born at a very low birthweight decreased from 1.7% to 1.6%.
- Although small, these changes were statistically significant.

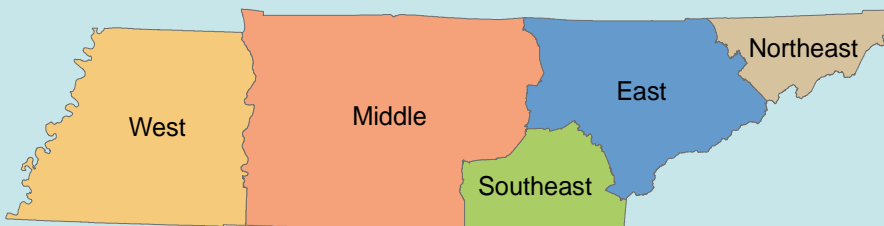


*Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.*

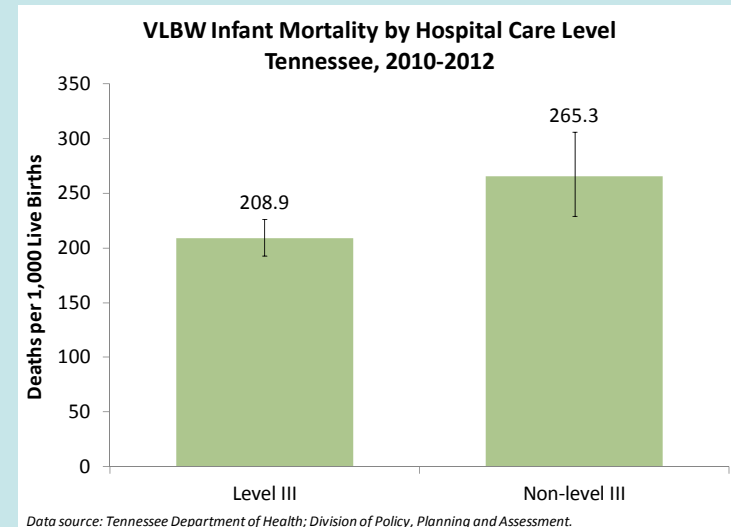
## Perinatal Regionalization and Very Low Birthweight Infants

Perinatal regionalization is a system of designating where infants are born or transferred based on the amount of care that they need at birth. In a regionalized system, hospitals in a designated geographic area are categorized by the scope of perinatal services they provide. In Tennessee, there are 5 perinatal regions and hospitals in these regions are grouped into 6 care levels: I, II-A, II-B, III-A, III-B and III-C. Level I hospitals provide basic, uncomplicated neonatal care; level II hospitals care for moderately ill infants; and level III hospitals are equipped to handle serious neonatal illness and abnormalities, including very low birthweight infants (<1,500 grams). Perinatal regionalization ensures that newborns receive risk-appropriate care and reduces infant morbidity and mortality. Research has shown that very low birthweight infants born outside of level III facilities have an increased likelihood of predischarge and neonatal death.<sup>12,13,14</sup>

### Tennessee Perinatal Regions



- Between 2010 and 2012, there were approximately 3,600 very low birthweight (VLBW) infants born in Tennessee. The majority of these infants (80%) were born at level III hospitals, while the remaining 20% were born at non-level III hospitals.
- During this time period, the very low birthweight infant mortality rate was higher among infants born at non-level III hospitals than among those born at level III facilities [Risk ratio = 1.27 (95% CI 1.10-1.40)].



- The prevalence of very low birthweight varied across perinatal regions, from 1.3% in the Middle to 2.0% in the West.
- The percentage of very low birthweight deliveries at level III hospitals was lower in the East region compared to other perinatal regions.

### Very Low Birthweight by Perinatal Region, TN, 2010-2012

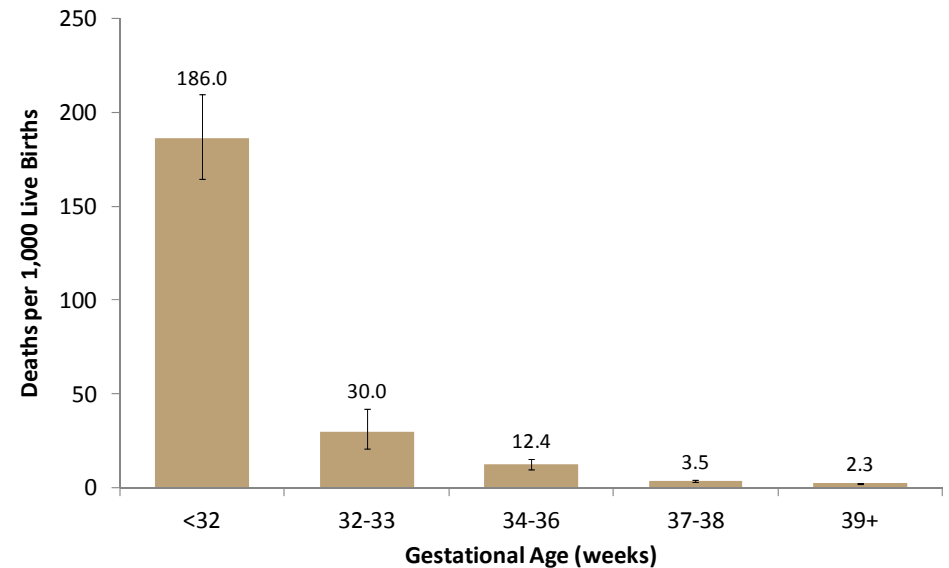
Perinatal Region	VLBW Prevalence (% of Live Births)	Level III VLBW Deliveries (% VLBW Births)
East	1.4%	49%
Middle	1.3%	84%
Northeast	1.4%	86%
Southeast	1.7%	95%
West	2.0%	86%

Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Infant Mortality Risk Factors Gestational Age

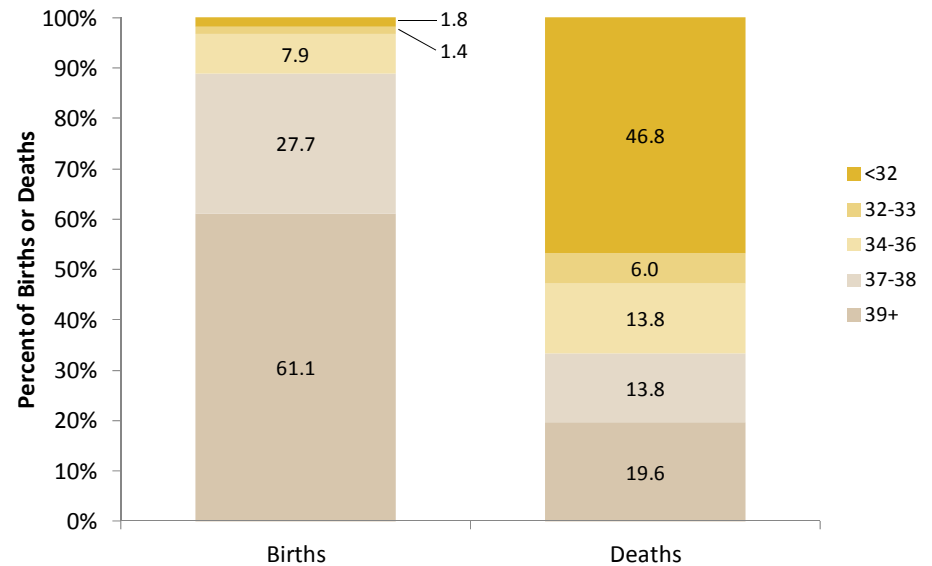
- Gestational age is another important predictor of infant mortality. In 2012, preterm infants in Tennessee (i.e. those born at less than 37 weeks) were 15 times more likely to die in their first year of life than those with longer gestational ages (42.6 deaths per 1,000 live births vs. 2.7/1,000, respectively).
- Infant mortality rates were highest for the most premature infants and decreased sharply as gestational age increased. Almost one out of every five infants born at less than 32 weeks died in their first year of life, compared to less than one out of every hundred with gestational ages of 37 weeks or more.
- Because of their much higher mortality rates, infants born at the lowest gestational ages have a large impact on overall mortality rates. For example, preterm infants accounted for about one-tenth of live births, but for two-thirds of infant deaths.

Infant Mortality by Gestational Age  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Births and Infant Deaths by Gestational Age  
Tennessee, 2012



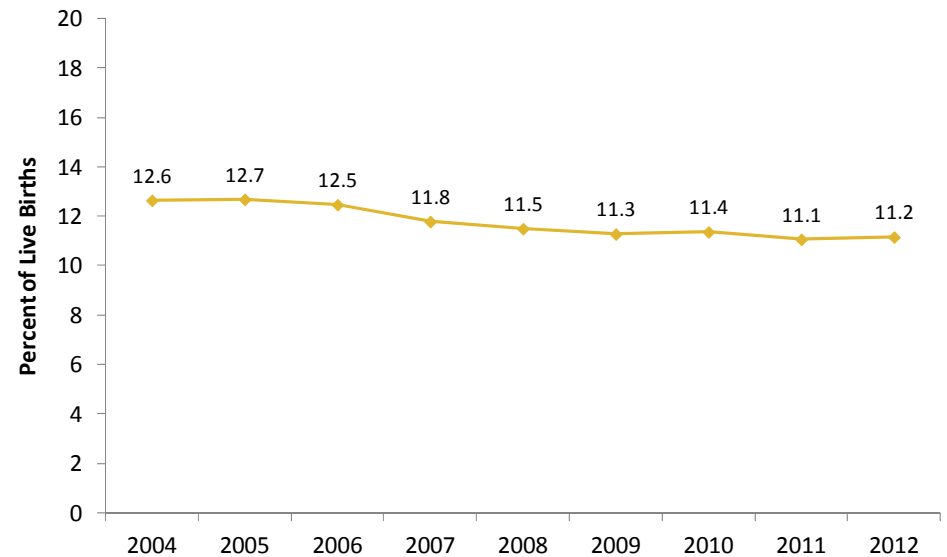
Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.



## Infant Mortality Risk Factors Gestational Age *cont.*

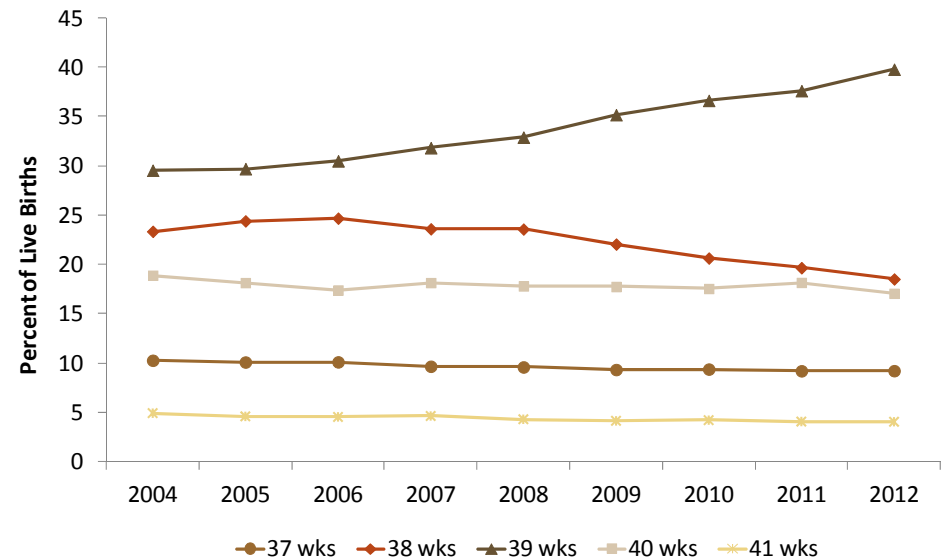
- Between 2004 and 2012, the percentage of Tennessee infants born preterm decreased from 12.6% to 11.2%.
- During this same time period, the percentage of infants born at 37 and 38 weeks gestation (i.e. early term deliveries) decreased by 10% and 21%, respectively.
- This decrease in early term deliveries was matched by a 34% increase in the percentage of full term infants born at 39 weeks.
- In 2012, 39.8% of infants were born at 39 weeks, compared to 29.5% in 2004.
- Between 2004 and 2012, the percentage of infants born at 40 and 41 weeks remained stable at approximately 18% and 4%, respectively.

**Preterm Birth Prevalence  
Tennessee, 2004-2012**



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

**Prevalence of Term Births by Gestation Week  
Tennessee, 2004-2012**



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Early Term Deliveries

Historically, a term pregnancy has been defined as occurring at 37 weeks of gestation or later. However, babies are not fully developed until they reach at least 39 weeks. For this reason, the American College of Obstetricians and Gynecologists (ACOG) recommends dividing term deliveries into the following categories:

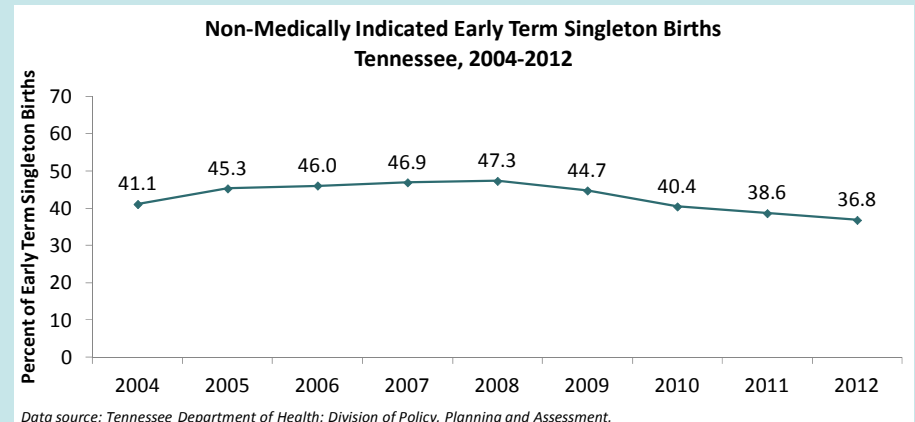
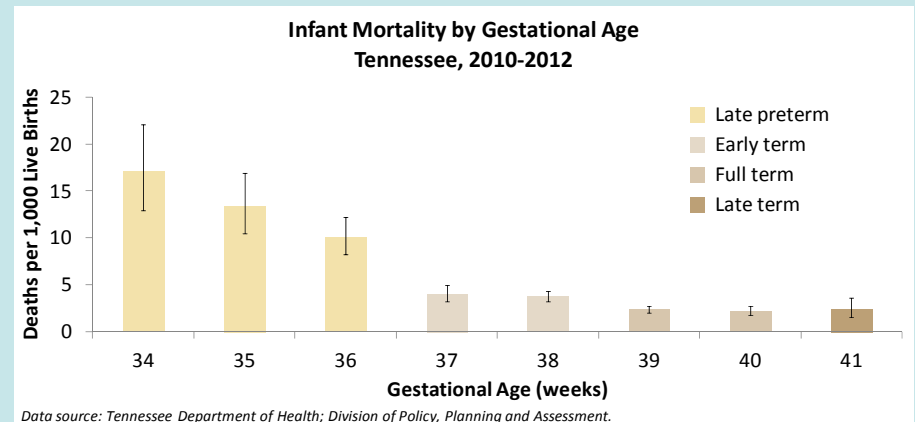
Recommended Classification of Deliveries from 37 Weeks Gestation <sup>15</sup>	
Early term	37-38 weeks
Full term	39-40 weeks
Late term	41 weeks
Post term	42+ weeks

The risk of adverse outcomes is greater for early term infants compared to those born full term. For example, they are more likely to have respiratory and feeding problems, as well as increased mortality rates.<sup>16,17</sup>

There are numerous fetal and maternal indications for deliveries prior to 39 weeks gestation. However, early *elective* delivery prior to this time exposes infants to the above risks and has not been shown to benefit the mother or infant.<sup>17</sup> For this reason, ACOG cautions against the practice of elective deliveries prior to 39 weeks.<sup>16</sup>

The Tennessee Department of Health has partnered with the March of Dimes, the Tennessee Initiative for Perinatal Quality Care, and the Tennessee Hospital Association to lower the number of babies born before 39 weeks. Efforts have included the “Healthy Babies are Worth the Wait” media campaign; a pledge by all hospitals in the state to enact hard-stop policies for early elective deliveries; and the Governor’s declaration of November as “Prematurity Awareness Month.”

- Between 2010 and 2012, the mortality rate for early term infants in Tennessee was 65% higher than for full term infants (3.8 deaths per 1,000 live births versus 2.3/1,000, respectively).



- Between 2004 and 2008, approximately 45% of early term singleton deliveries in Tennessee were not medically indicated.\*
- From 2008 to 2012, the percentage of non-medically indicated early term singleton deliveries dropped by over 20%, from 47.3% to 36.8%.

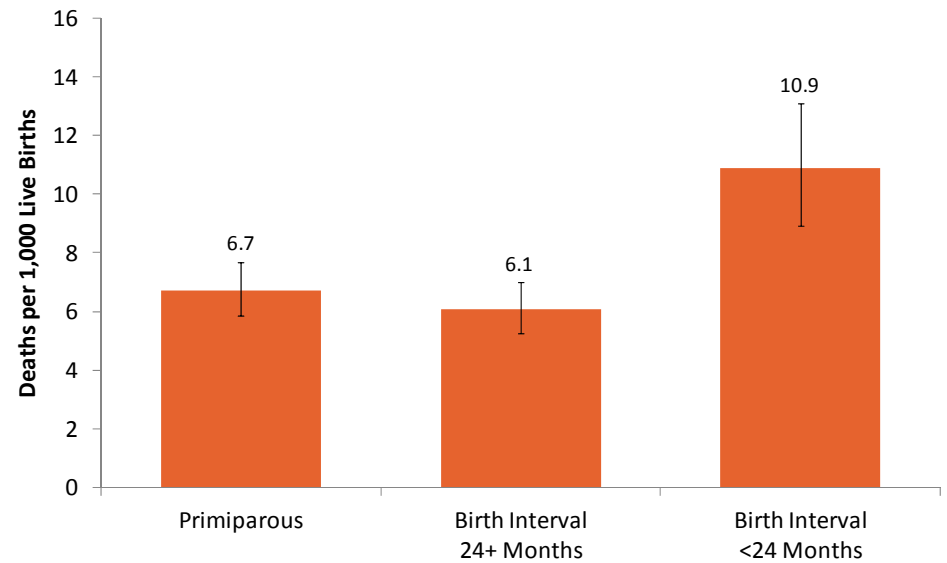
\*See technical notes for methods used to identify non-medically indicated early term singleton births.

## Infant Mortality Risk Factors

### Birth Interval

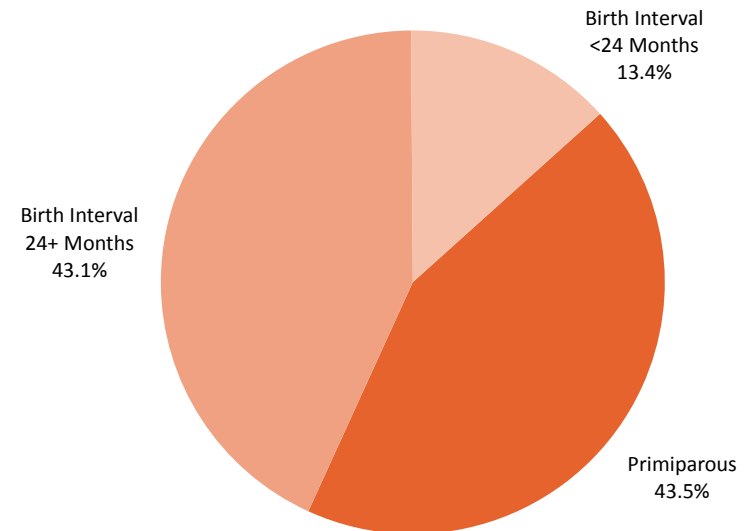
- In 2012, the infant mortality rate among Tennessee infants born to primiparous women (i.e. those giving birth for the first time) was similar to the rate among infants born to multiparous women whose last live birth was at least 24 months previous (6.7 and 6.1 deaths per 1,000 live births, respectively).
- Compared to infants born to primiparous women and those with birth intervals of at least 24 months, infants born to women with shorter birth intervals had a higher infant mortality rate (10.9/1,000).
- In 2012, 13.4% of infants were born to multiparous women with birth intervals of less than 24 months. Although this was a decrease from 2004, the difference was not statistically significant.

Infant Mortality by Birth Interval  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Births by Birth Interval  
Tennessee, 2012



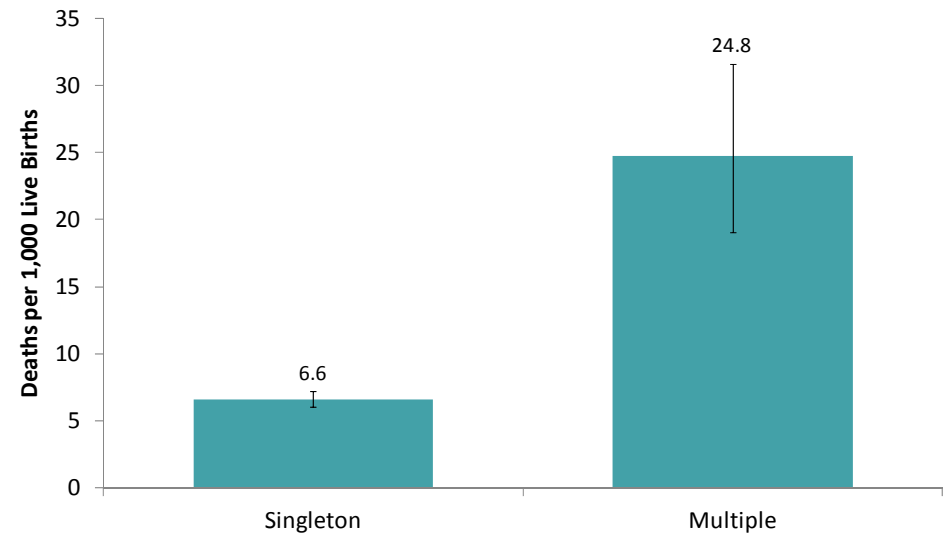
Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Infant Mortality Risk Factors

### Plurality

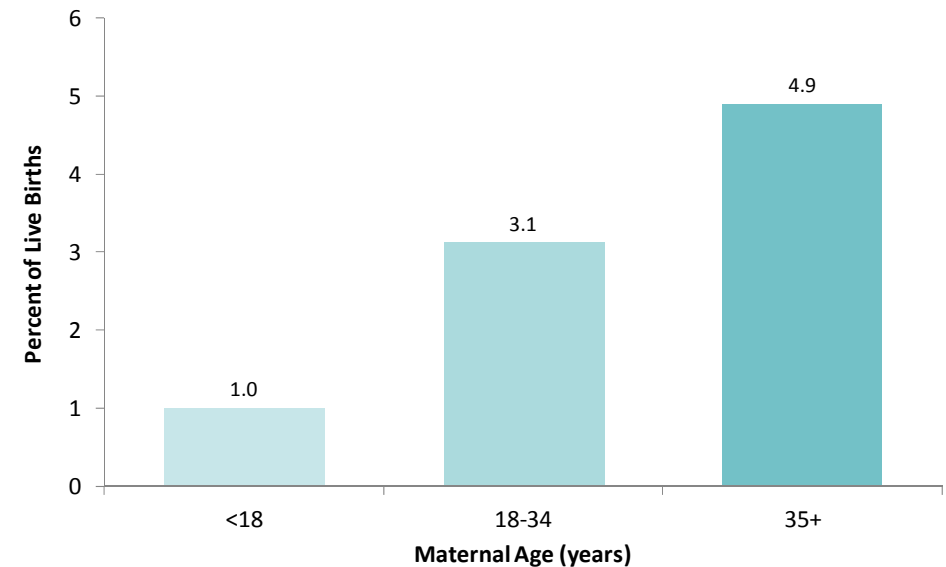
- In 2012, the infant mortality rate among multiples (i.e. twins, triplets, etc.) was almost three times higher than among singleton infants (24.8 deaths per 1,000 live births vs. 6.6/1,000, respectively).
- There was not a statistically significant upward or downward trend in the prevalence of multiple births between 2004 and 2012. Approximately 3% of infants were born as multiples each year during this time period.
- The prevalence of multiple births was higher among women 35 years of age and older (4.9%) than among younger women (3.1%) and teens (1.0%).

Infant Mortality by Plurality  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Multiple Births by Maternal Age  
Tennessee, 2012



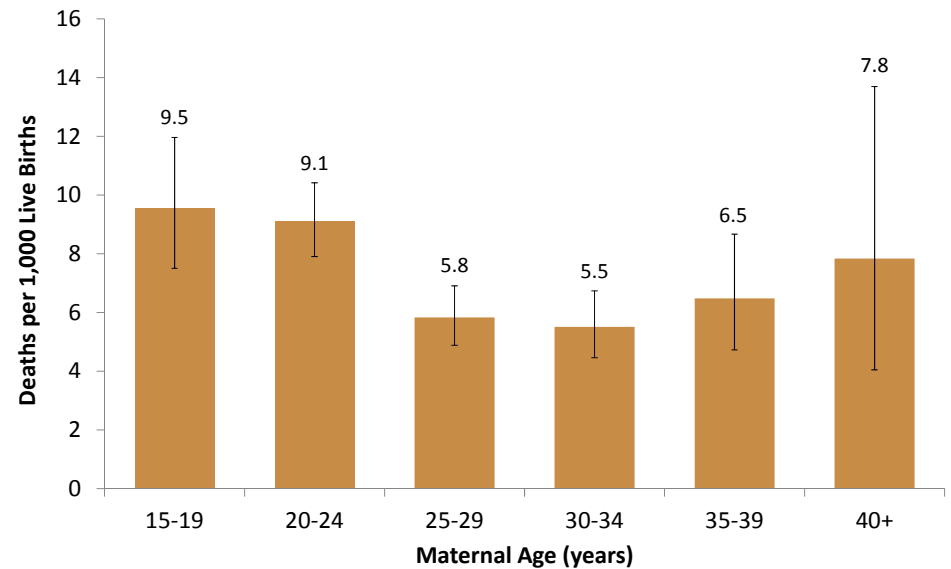
Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Infant Mortality Risk Factors

### Maternal Age

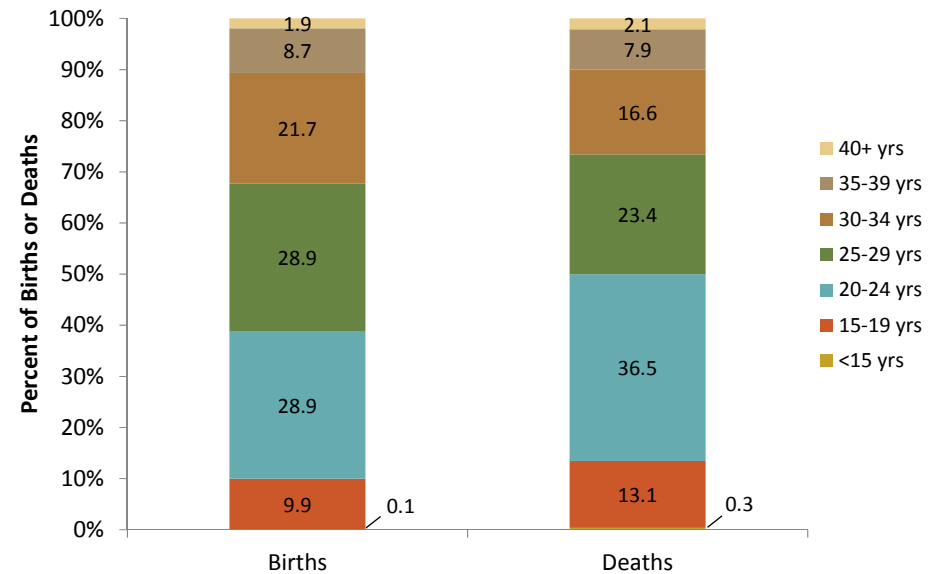
- In 2012, the infant mortality rate in Tennessee was lowest among infants born to women between the ages of 25-34 years, and relatively higher among those born to younger and older women.
- The infant mortality rate was similar among infants born to teens 15-19 years of age and among those born to women aged 20-24 years (9.5 deaths per 1,000 live births and 9.1/1,000, respectively). However, 20-24 year olds represented a much larger proportion of infant deaths (37% compared to 13% among teen moms) due to the larger number of births that occur among this group.
- Although the infant mortality rate among infants born to 35-39 year olds and to those 40 years or older was higher than that among 25-34 year olds, these differences were not statistically significant.

Infant Mortality by Maternal Age  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Births and Infant Deaths by Maternal Age  
Tennessee, 2012

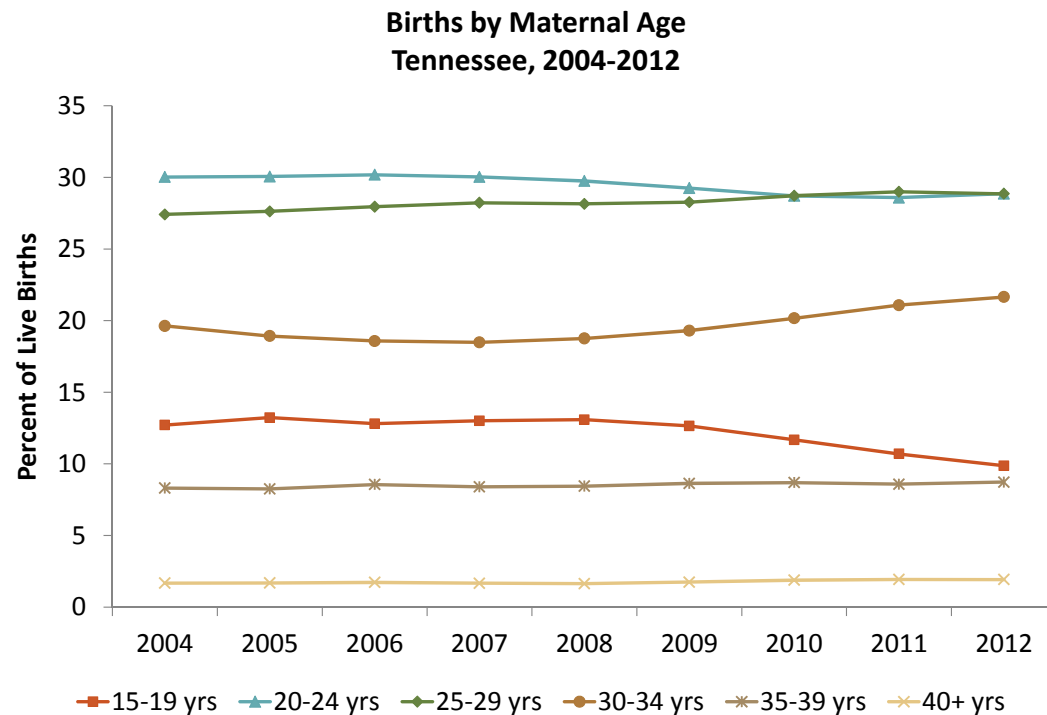


Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Infant Mortality Risk Factors

### Maternal Age *cont.*

- Between 2004 and 2012, the percentage of Tennessee infants born to younger women (less than 25 years of age) decreased, while the percentage born to older women increased. During this time period, the average maternal age increased from 26.3 to 26.9 years.
- The largest decrease (22%) was observed in births to teens 15-19 years of age. There was also a 4% decrease in the percentage of births to women aged 20-24 years.
- The largest increase (15%) was observed in births to women 40 years and older. However, these births still make up less than 2% of all births.



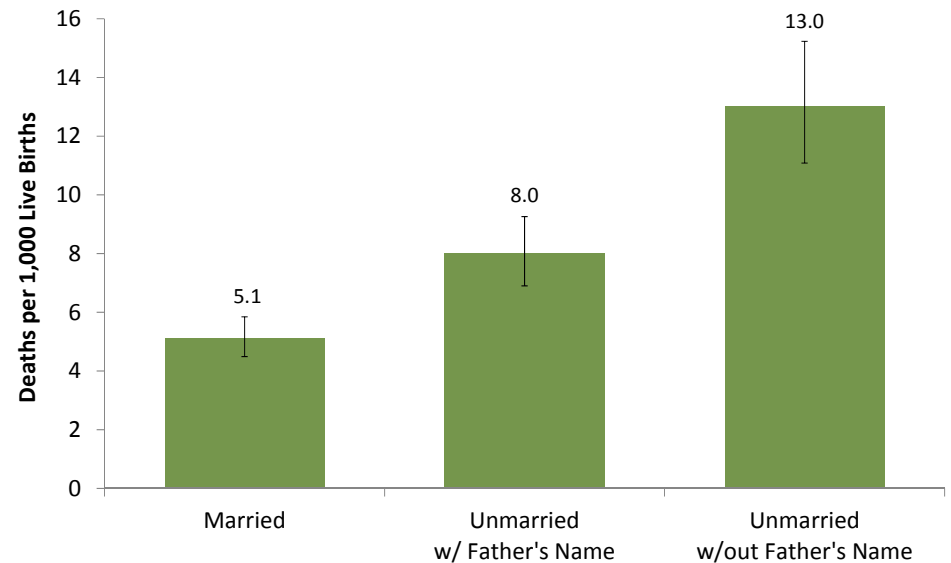
*Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.*

## Infant Mortality Risk Factors

### Marital Status

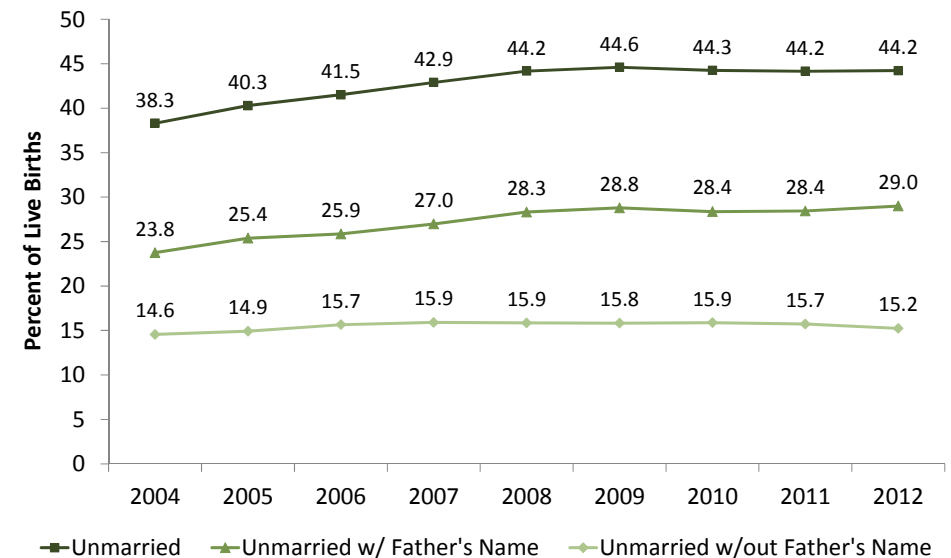
- In 2012, the infant mortality rate in Tennessee was higher among infants born to unmarried women than among those whose mothers were married (9.7 deaths per 1,000 live births vs. 5.1/1,000, respectively).
- Among infants born to unmarried women, the infant mortality rate was higher when the father's name was not identified on the birth certificate. The infant mortality rate was 13.0/1,000 among this group, compared to 8.0/1,000 when the father's name was listed on the birth certificate.
- In 2012, 44.2% of Tennessee infants were born to unmarried women. Approximately one-third of these infants did not have the father's name identified on the birth certificate.
- Between 2004 and 2012, the prevalence of births to unmarried women increased 15%. The greatest increase in this category was among births with the father's name identified on the birth certificate.
- There was a 22% increase in the prevalence of births with the father's name listed. Although there was also a 4% increase in births without a name listed, this change was not statistically significant.

Infant Mortality by Marital Status  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Prevalence of Births by Marital Status  
Tennessee, 2004-2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

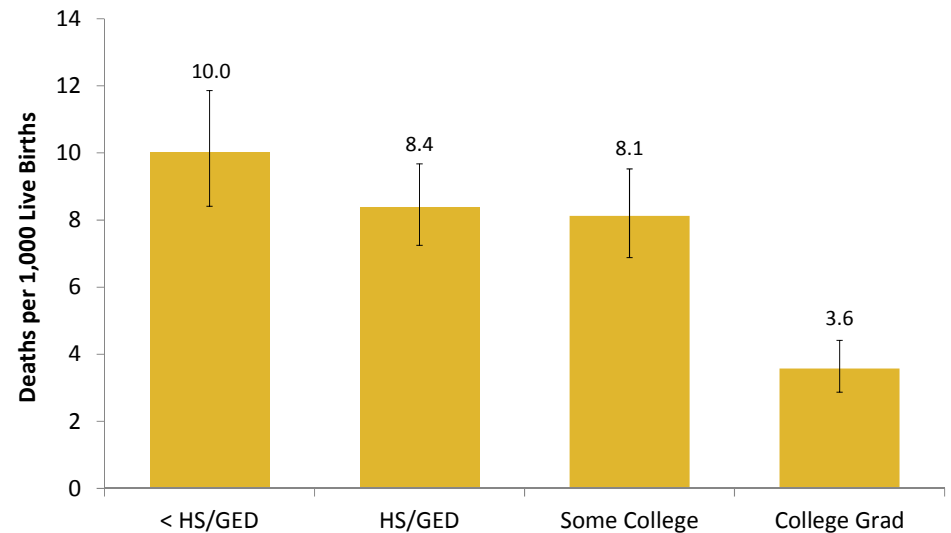
## Infant Mortality Risk Factors Maternal Education

- In 2012, the infant mortality rate in Tennessee was higher among infants born to women without a college degree than among those with a degree.\*
- The infant mortality rate was similar among infants born to women who completed high school and among those born to women with some college education. Although the infant mortality rate among infants born to women who did not complete high school was comparatively higher, this difference was not statistically significant.†
- In 2012, 17.1% of Tennessee infants were born to women who did not complete high school and 30.6% were born to women with a college degree.
- Between 2004 and 2012, the percentage of births to women who did not complete high school decreased 24% and the percentage to high school graduates decreased 5%.
- During this same time period, the percentage of births to women with some college and to those with a college degree both increased (16% and 14% increase, respectively).

\*College degree includes associate, bachelor's, master's, and doctorate/professional degrees.

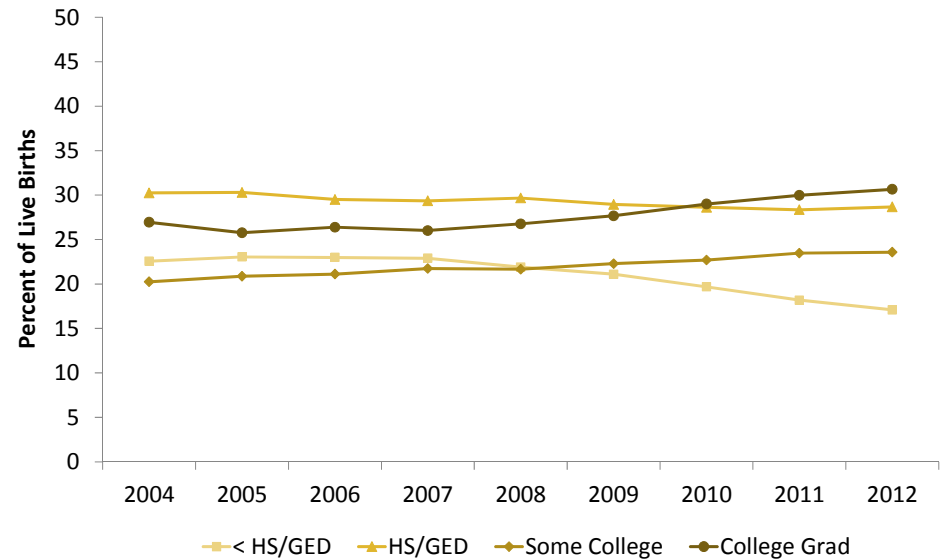
†High school includes high school diploma and GED.

Infant Mortality by Maternal Education  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Prevalence of Births by Maternal Education  
Tennessee, 2004-2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

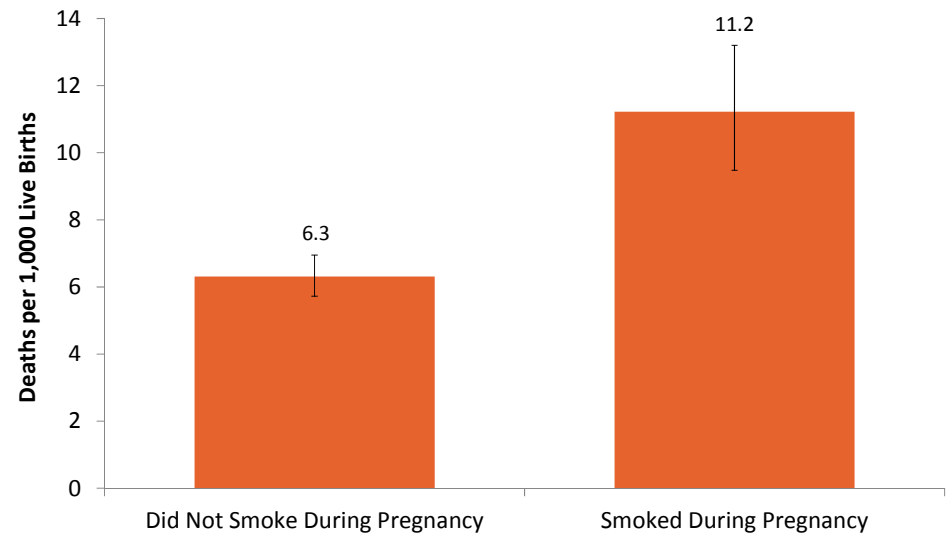


## Infant Mortality Risk Factors

### Maternal Smoking

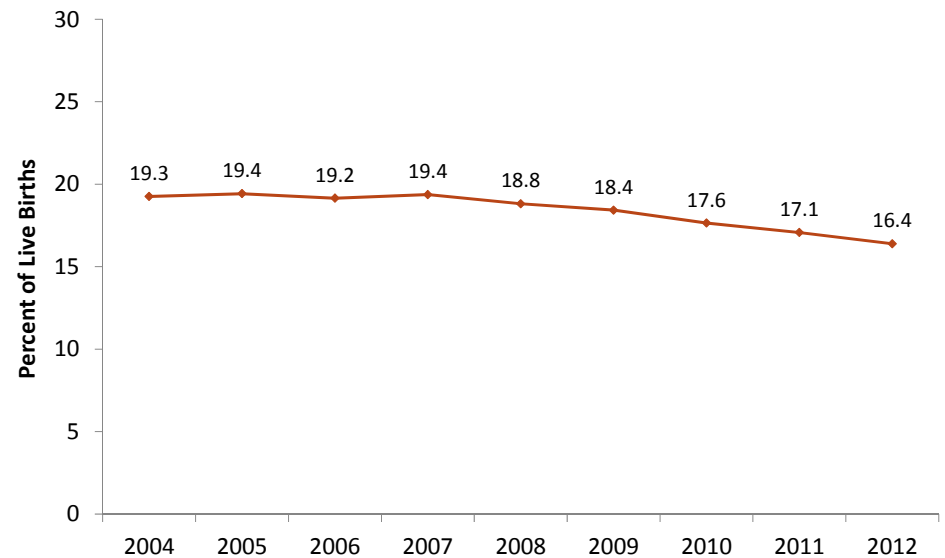
- In 2012, the infant mortality rate in Tennessee was higher among infants born to women who smoked cigarettes at any time during pregnancy than among those born to women who did not smoke (11.2 deaths per 1,000 live births vs. 6.3/1,000 respectively).
- In 2012, 16.4% of women smoked at any time during pregnancy. This was a 15% decrease compared to 2004.
- The percentage of women who smoked during each trimester of pregnancy decreased from 15.8% in the first trimester, to 13.8% in the second and 13.1% in the third.
- Among women who smoked during the first trimester, the majority (80%) continued to smoke in the 3<sup>rd</sup> trimester, while just 20% had quit by the third trimester.

Infant Mortality by Maternal Cigarette Smoking  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Prevalence of Maternal Cigarette Smoking  
Tennessee, 2004-2012



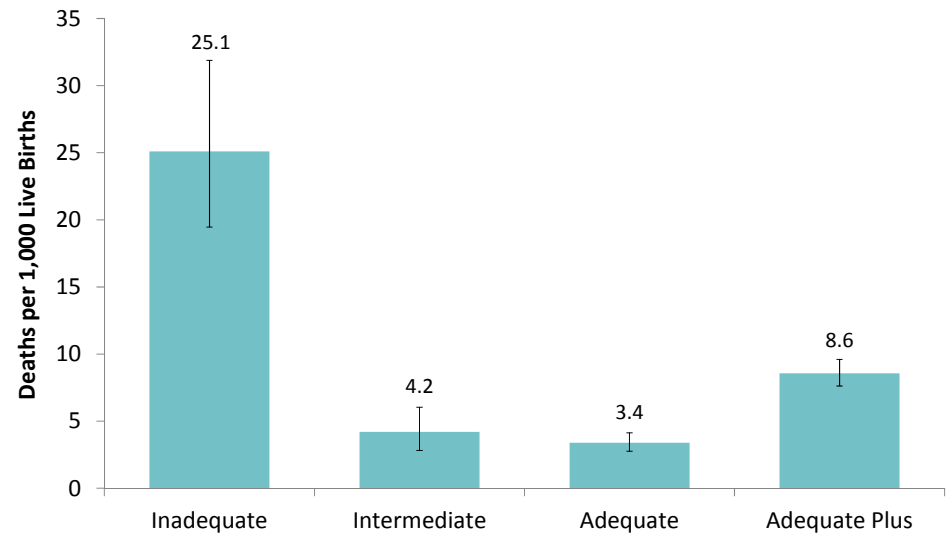
Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Infant Mortality Risk Factors Prenatal Care

- In 2012, the infant mortality rate in Tennessee was highest among infants who received inadequate prenatal care (25.1 deaths per 1,000 live births), followed by those with adequate plus care (8.6/1,000) and those with intermediate or adequate care (4.2 and 3.4/1,000 respectively).\*
- In 2012, the majority of infants (87%) received adequate or adequate plus prenatal care.
- Although the infant mortality rate was higher among infants receiving inadequate care, just 4% of births occurred among this group of infants.
- There was not a statistically significant upward or downward trend in the prevalence of inadequate prenatal care between 2004 and 2012.

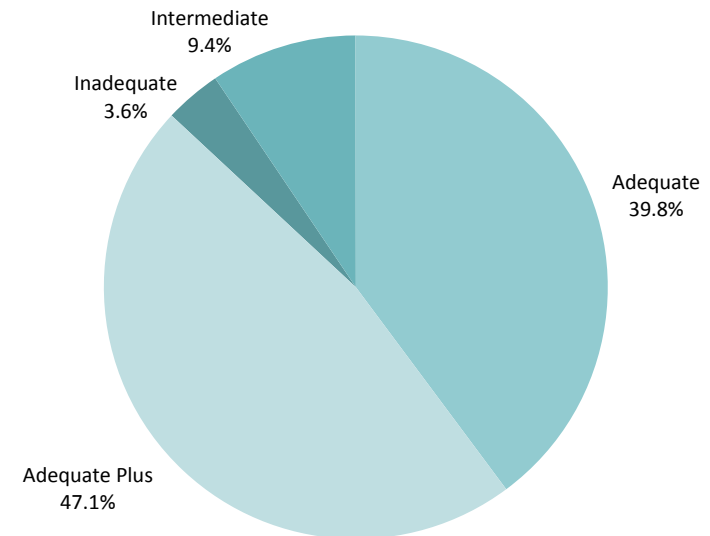
\*Adequacy of care was determined using the Kotelchuck Index. See technical notes for a detailed description of care levels.

Infant Mortality by Adequacy of Prenatal Care  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

Births by Adequacy of Prenatal Care  
Tennessee, 2012



Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

## Infant Mortality Risk Factors Risk Factors by Maternal Race and Ethnicity

- In 2012, the prevalence of the following risk factors was higher among infants born to black non-Hispanic women than among those born to white non-Hispanics and Hispanics: low birthweight, preterm birth, short birth interval, teen mom, unmarried mom and inadequate prenatal care.
- Infants born to Hispanic women had the highest prevalence of older maternal age and high school or lower educational level.
- Infants born to white non-Hispanic women had the highest prevalence of maternal smoking.

## Infant Mortality Risk Factors by Maternal Race and Ethnicity Tennessee, 2012

Risk Factor	Risk Factor Prevalence (% of Live Births)*		
	Black NH	White NH	Hispanic
Low birthweight	14.0	8.1	6.2
Preterm birth	14.3	10.6	9.0
Birth intervals <24 months	16.9	12.5	13.4
Multiple birth	3.3	3.4	2.3
Teen mom (15-19 years)	14.4	8.8	9.7
Older mom (35+ years)	7.9	10.8	13.0
Unmarried mom	78.7	33.9	50.9
Education ≤ high school/GED	53.7	39.6	79.6
Smoking during pregnancy	9.1	20.9	2.5
Inadequate prenatal care	7.9	2.1	5.8

*Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.*

\*For each risk factor, the racial/ethnic group with the highest prevalence rate is highlighted in red and the group with the lowest prevalence is highlighted in green. For a given risk factor, if more than one group is highlighted the same color it indicates that the difference between those groups was not statistically significant.

## Infant Mortality Risk Factors

### Risk Factors by Maternal Race and Ethnicity *cont.*

Low birthweight and preterm birth are the second leading cause of infant mortality in Tennessee. Low birthweight infants are 18 times more likely to die than those born at higher weights, while preterm infants are 15 times more likely to die than those with longer gestations. Although the infant mortality rate in Tennessee has continued to decline in the past decade, racial disparities have persisted. These disparities occur not only in Tennessee but in the nation as a whole, and several studies have observed that they stem in part from the fact that black women are much more likely to deliver preterm, low birthweight infants.<sup>18,19</sup>

- In 2012, 14.0% of infants born to black mothers in Tennessee were low birthweight, compared to 8.1% of infants born to white mothers. During this same year, 14.3% of infants born to black mothers were preterm, compared to 10.6% of infants born to white mothers.
- Racial disparities in the prevalence of low birthweight and preterm birth were more pronounced among the smallest and earliest infants, and it is these infants that have the highest mortality rates.
- Although mortality rates among black and white infants born at <500 grams were similar, black infants were four times as likely as white infants to be born at this weight. Similarly, although the mortality rates for infants born at 500-999 and 1,000-1,499 grams were similar among black and white infants, black infants were more than twice as likely as white infants to be born at these weights.

<b>Births and Infant Deaths by Birthweight and Race/Ethnicity, Tennessee, 2012</b>						
<b>Birthweight (grams)</b>	<b>Prevalence (% of Live Births)</b>			<b>Mortality (Deaths per 1,000 Live Births)</b>		
	<b>Black NH</b>	<b>White NH</b>	<b>B:W Ratio</b>	<b>Black NH</b>	<b>White NH</b>	<b>B:W Ratio*</b>
<b>&lt;500</b>	0.4	0.1	4.0	866.7	918.4	0.9
<b>500-999</b>	1.1	0.4	2.5	237.0	226.7	1.0
<b>1000-1,499</b>	1.5	0.7	2.2	75.4	78.9	1.0
<b>1500-2,499</b>	11.1	6.9	1.6	18.7	18.6	1.0
<b>2,500+</b>	86.0	91.9	0.9	3.7	2.6	1.4

*Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.*

\*Racial differences in infant mortality rates for all birthweight categories were *not* statistically significant.

## Infant Mortality Risk Factors

### Risk Factors by Maternal Race and Ethnicity *cont.*

- Although mortality rates among black and white infants born at <32 and 32-33 weeks were similar, black infants were approximately twice as likely as white infants to be born at these gestational ages.

Births and Infant Deaths by Gestational Age and Race/Ethnicity, Tennessee, 2012						
Gestational Age (weeks)	Prevalence (% of Live Births)			Mortality (Deaths per 1,000 Live Births)		
	Black NH	White NH	B:W Ratio	Black NH	White NH	B:W Ratio*
<32	3.3	1.4	2.3	209.7	171.0	1.2
32-33	2.1	1.3	1.6	31.4	30.0	1.0
34-36	8.9	7.9	1.1	13.7	12.3	1.1
37-38	27.8	27.7	1.0*	4.4	3.8	1.2
39+	58.0	61.7	0.9	3.7	2.1	1.8

Data source: Tennessee Department of Health; Division of Policy, Planning and Assessment.

\*Racial differences in infant mortality rates for all gestational age categories were *not* statistically significant. The difference in the prevalence of births at 37-38 weeks also lacked statistical significance.

## Technical Notes

### DATA SOURCES

**Death Statistical System (DSS):** The DSS is an annual state-based compilation of mortality data. All data included in this report are for TN resident deaths. Infant mortality rates were calculated by dividing the number of infant deaths in a calendar year(s) by the number of live births registered for the same period of time. An infant death is defined as one that occurs before one year of age. The DSS was used to calculate overall infant mortality rates, as well as infant mortality rates by county/region, age at death and race/ethnicity, and to determine leading causes of death.

**Birth Statistical System (BSS):** The BSS is an annual state-based compilation of birth data. All data included in this report are for births to TN resident women. For 2003, data were collected on the 1989 revision of the Tennessee version of the U.S. Standard Certificate of Live Birth. Beginning in 2004, data were collected on the 2003 revision of the Tennessee version of the U.S. Standard Certificate of Live Birth. The BSS was used to determine the denominator for infant mortality rates based on the DSS (see above discussion).

**Linked Birth and Death Statistical System:** The BSS and DSS are linked based on birth cohort to create the Linked Birth and Death Statistical System. This means that birth certificates for a given year (e.g. 2012) are linked to certificates for infant deaths in that or the next year (e.g. 2012 and 2013). This linked file, along with all data analyses based on the file, are limited to in-state births to Tennessee resident women. This is slightly different from analyses of unlinked birth and death files, which are only limited to Tennessee residents, without any limitations on where a vital event occurred (i.e. whether it occurred in or out-of-state). The linked file was used to determine infant mortality rates for infants with and without specific risk factors (e.g. low birthweight, preterm birth, maternal cigarette smoking) for which information is collected on the birth but not the death certificate, and the prevalence of these risk factors. Because of the above differences, mortality rates calculated from the linked file may be slightly different than those calculated using unlinked death and birth files. Similarly, the prevalence of infant mortality risk factors (e.g. the percentage of babies born low birthweight) calculated from the linked file may be slightly different than those calculated using the birth file alone. However, these differences should be negligible.<sup>11</sup> Because of changes to the Tennessee version of the U.S. Certificate of Live Birth implemented in 2004, data for some infant mortality risk factors are not comparable to earlier years. For this reason, risk factor data are only presented for 2004-2012, rather than for 2003-2012 as in other sections of the report.

### METHODOLOGY

**Causes of death:** Underlying cause of death was identified using International Classification of Diseases, Tenth Revision (ICD-10). Procedures used for ranking causes of death were the same as used by the National Center for Health Statistics (NCHS). Causes of death were ranked according to the number of deaths assigned to the 71 rankable causes selected by the NCHS from the ICD-10 "List of 130 Selected Causes of Infant Death."<sup>20</sup> Sudden unexplained infant deaths (SUID) were identified using ICD-10 codes R95 (sudden infant death syndrome), W75 (accidental suffocation and strangulation in bed) and R99 (unknown cause).

**Statistical significance:** Statistical significance of time trends was determined using linear regression with a significance level of 0.05. Statistical significance for differences in infant mortality rates and risk factor prevalence was determined based on non-overlapping of 95% confidence intervals. In general, a confidence interval is a range of values that describes the level of certainty or precision surrounding an estimate. In the

## Technical Notes *cont.*

case of a 95% CI, we can be 95% certain that the interval contains the true value for the population. A narrow interval indicates a more precise estimate, while a wide interval indicates a less precise estimate. The overlap in 95% confidence intervals can be used as a way to check for a statistically significant difference between two rates. If the intervals do not overlap, the difference can be considered statistically significant. The comparison of confidence intervals method is a conservative test of statistical significance, and findings of non-significant differences should be interpreted with caution, especially when the two confidence intervals overlap only slightly.

**Race and ethnicity:** Race and ethnicity in the DSS are the infant's recorded race/ethnicity from the death certificate. Race and ethnicity in the BSS and the linked DSS/BSS are the mother's self-reported race/ethnicity from the birth certificate.

**Gestational age:** Gestational age was based on estimated/clinical gestational age. If estimated gestational age was missing or invalid (<17wks or >49wks), generated gestational age (based on last menstrual period) was substituted.

**Identification of non-medically indicated (NMI) early term singleton births:** NMI births were identified using an algorithm developed by Dr. William Sappenfield and used by the Health Resources and Services Administration's Collaborative Improvement & Innovation Network (CoIIN) to Reduce Infant Mortality. A detailed description of the algorithm can be found here: <http://www.astho.org/Instructions-Description-of-Coding-for-NMI-Early-Term-Singleton-Births>.

**Adequacy of prenatal care:** Adequacy of prenatal care was determined using the Kotelchuck Adequacy of Prenatal Care Utilization Index (see table below).

Kotelchuck Adequacy of Prenatal Care Utilization Index <sup>21</sup>	
Inadequate	Prenatal care began after the 4 <sup>th</sup> month or less than 50% of recommended prenatal visits were received
Intermediate	Prenatal care began by the 4 <sup>th</sup> month and 50-75% of recommended prenatal visits received
Adequate	Prenatal care began by the 4 <sup>th</sup> month and 80-109% of recommended prenatal visits received
Adequate Plus	Prenatal care began by the 4 <sup>th</sup> month and 110% or more of recommended prenatal visits received

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# Appendix

## Appendix – Infant Mortality by Region and County, Tennessee, 2010-2012

Metropolitan Regions/Counties		
Region/County	Number of Infant Deaths	Infant Mortality Rate [per 1,000 Live Births (95% CI)]
Davidson	214	7.4 (6.5-8.5)
Hamilton	105	8.5 (7.0-10.3)
Knox	90	5.8 (4.7-7.1)
Madison	29	7.6 (5.1-10.9)
Shelby	424	10.2 (9.2-11.2)
Sullivan	38	8.1 (5.7-11.1)

East Region		
Region/County	Number of Infant Deaths	Infant Mortality Rate [per 1,000 Live Births (95% CI)]
Anderson	19	7.7 (4.7-12.1)
Blount	21	5.6 (3.5-8.6)
Campbell	3	2.4 (0.5-7.1)
Claiborne	8	8.6 (3.7-16.9)
Cocke	5	4.4 (1.4-10.2)
Grainger	6	8.8 (3.2-19.2)
Hamblen	15	6.3 (3.5-10.4)
Jefferson	12	7.5 (3.9-13.1)
Loudon	6	3.8 (1.4-8.3)
Monroe	7	4.9 (2.0-10.0)
Morgan	7	12.2 (4.9-25.1)
Roane	12	8.0 (4.1-14.0)
Scott	5	6.5 (2.1-15.1)
Sevier	19	6.1 (3.7-9.6)
Union	9	13.1 (6.0-24.9)
<b>Region Total</b>	<b>154</b>	<b>6.5 (5.5-7.6)</b>

Mid-Cumberland Region		
Region/County	Number of Infant Deaths	Infant Mortality Rate [per 1,000 Live Births (95% CI)]
Cheatham	10	7.8 (3.7-14.3)
Dickson	10	5.5 (2.6-10.1)
Houston	2	7.8 (0.9-28.1)
Humphreys	5	7.9 (2.6-18.6)
Montgomery	66	6.7 (5.2-8.5)
Robertson	15	5.6 (3.1-9.2)
Rutherford	58	5.3 (4.0-6.8)
Stewart	2	4.9 (0.5-17.6)
Sumner	41	7.2 (5.1-9.7)
Trousdale	1	3.8 (0.0-21.2)
Williamson	24	4.1 (2.6-6.0)
Wilson	16	3.9 (2.3-6.4)
<b>Region Total</b>	<b>250</b>	<b>5.7 (5.0-6.4)</b>

Northeast Region		
Region/County	Number of Infant Deaths	Infant Mortality Rate [per 1,000 Live Births (95% CI)]
Carter	15	9.0 (5.1-14.9)
Greene	12	6.6 (3.4-11.5)
Hancock	1	4.8 (0.1-26.5)
Hawkins	17	10.2 (5.9-16.3)
Johnson	4	9.0 (2.4-23.1)
Unicoi	4	8.2 (2.2-21.1)
Washington	27	6.7 (4.4-9.7)
<b>Region Total</b>	<b>80</b>	<b>7.7 (6.1-9.6)</b>

## Appendix – Infant Mortality by Region and County, Tennessee, 2010-2012 *cont.*

Northwest Region		
Region/County	Number of Infant Deaths	Infant Mortality Rate [per 1,000 Live Births (95% CI)]
Benton	3	6.3 (1.3-18.3)
Carroll	8	8.3 (3.6-16.3)
Crockett	5	9.3 (3.0-21.7)
Dyer	20	13.7 (8.3-21.1)
Gibson	13	7.0 (3.7-12.0)
Henry	12	12.0 (6.2-21.0)
Lake	1	4.8 (0.1-26.5)
Obion	12	11.2 (5.8-19.6)
Weakley	11	10.1 (5.0-18.1)
<b>Region Total</b>	<b>85</b>	<b>9.8 (7.8-12.1)</b>

South Central Region		
Region/County	Number of Infant Deaths	Infant Mortality Rate [per 1,000 Live Births (95% CI)]
Bedford	15	8.1 (4.5-13.3)
Coffee	12	6.3 (3.2-11.0)
Giles	3	3.4 (0.7-10.1)
Hickman	4	5.1 (1.4-13.1)
Lawrence	13	7.8 (4.1-13.3)
Lewis	1	2.7 (0.0-15.0)
Lincoln	11	10.2 (5.1-18.3)
Marshall	8	7.3 (3.1-14.4)
Maury	20	6.0 (3.7-9.3)
Moore	0	0.0 (0.0-25.5)
Perry	0	0.0 (0.0-13.1)
Wayne	4	9.0 (2.4-23.0)
<b>Region Total</b>	<b>91</b>	<b>6.6 (5.3-8.1)</b>

Southeast Region		
Region/County	Number of Infant Deaths	Infant Mortality Rate [per 1,000 Live Births (95% CI)]
Bledsoe	2	5.4 (0.6-19.4)
Bradley	22	6.4 (4.0-9.7)
Franklin	8	6.9 (3.0-13.5)
Grundy	3	6.5 (1.3-19.1)
Marion	6	6.8 (2.5-14.8)
McMinn	9	5.4 (2.5-10.2)
Meigs	2	6.1 (0.7-21.9)
Polk	9	20.4 (9.3-38.7)
Rhea	11	9.5 (4.8-17.1)
Sequatchie	3	6.7 (1.4-19.7)
<b>Region Total</b>	<b>75</b>	<b>7.2 (5.7-9.1)</b>

Southwest Region		
Region/County	Number of Infant Deaths	Infant Mortality Rate [per 1,000 Live Births (95% CI)]
Chester	5	9.0 (2.9-21.0)
Decatur	2	6.5 (0.7-23.6)
Fayette	9	6.9 (3.2-13.2)
Hardeman	9	10.9 (5.0-20.7)
Hardin	5	6.0 (1.9-14.0)
Haywood	11	16.2 (8.1-29.0)
Henderson	8	8.1 (3.5-15.9)
Lauderdale	15	16.1 (9.0-26.5)
McNairy	3	3.4 (0.7-9.9)
Tipton	13	5.8 (3.1-9.9)
<b>Region Total</b>	<b>80</b>	<b>8.4 (6.6-10.4)</b>

**Appendix – Infant Mortality by Region and County, Tennessee, 2010-2012 *cont.***

<b>Upper Cumberland Region</b>		
<b>Region/County</b>	<b>Number of Infant Deaths</b>	<b>Infant Mortality Rate [per 1,000 Live Births (95% CI)]</b>
Cannon	3	6.9 (1.4-20.2)
Clay	1	3.9 (0.1-21.7)
Cumberland	18	10.5 (6.2-16.5)
Dekalb	4	5.8 (1.6-15.0)
Fentress	6	10.7 (3.9-23.4)
Jackson	0	0.0 (0.0-11.4)
Macon	4	4.3 (1.2-11.1)
Overton	3	4.0 (0.8-11.8)
Pickett	1	7.9 (0.1-44.2)
Putnam	10	3.7 (1.8-6.9)
Smith	2	3.1 (0.3-11.2)
Van Buren	4	24.2 (6.5-62.1)
Warren	12	8.5 (4.4-14.8)
White	6	6.9 (2.5-15.0)
<b>Region Total</b>	<b>74</b>	<b>6.4 (5.0-8.1)</b>