



Maternal and Infant Health Assessment Chartbook

Hamilton County, Ohio

2007-2009

HAMILTON COUNTY PUBLIC HEALTH

250 William Howard Taft Road, 2nd Floor
Cincinnati, OH 45219 • 513.946.7800
hamiltoncountyhealth.org

Acknowledgements

This report was prepared by Hamilton County Public Health, Department of Community Health Services with input from Cincinnati Children's Hospital Medical Center.

Hamilton County Staff

- David Carlson, MPH, Epidemiologist
- Ted Folger, PhDc, MS, Director of Epidemiology and Assessment

Cincinnati Children's Hospital Staff

- John Besl, MA, Demographer/Analyst

Assistant Health Commissioner
Kathy Lordo
Department of Community Health Services

Health Commissioner
Timothy Ingram

For questions regarding this report, contact:
David Carlson
Epidemiologist
Hamilton County Public Health
513-946-7933
David.Carlson@hamilton-co.org

Copyright Information
All material in this report is in the public domain and may be used and reprinted without special permission. Citation as to source, however, is appreciated.

Suggested citation:
Folger AT, Carlson D, Besl J, Lordo KL. Hamilton County Maternal and Infant Health Assessment, 2007-2009. Hamilton County, Ohio: Hamilton County Public Health, Department of Community Health Services. August 2012.

Table of Contents

Index of Tables and Figures

Introduction

The *Maternal and Infant Health Assessment Chartbook* is part of a county-wide initiative to improve maternal and infant health and to reduce infant mortality. In order to take effective actions to improve the health and safety of infants in the community, it is important to identify and describe the factors that impact local birth outcomes. It is a goal of the public health community to raise awareness of these local health issues by identifying characteristics of mothers who experienced an infant death and/or preterm birth, reviewing the causes of infant death and highlighting risk factors that may be amenable to intervention.

Three-Year Surveillance of Infant Deaths/Preterm Births

- **Maternal Characteristics**
- **Maternal Risk Factors**
- **Infant Characteristics**
- **Seasonal and Spatial Factors**

One of the most common ways to measure infant health is through the use of the infant mortality rate. The **Infant Mortality Rate (IMR)** is defined as the number of deaths among children less than **one year of age** per 1,000 live births[1]. Although infant death is a relatively rare event, the IMR is an important indicator of the overall health of a community. Nationally, infant mortality has declined considerably over the past three decades, from the 1970 rate of 20 deaths per 1,000 live births to 6.39 in 2009.[2] Despite intense community efforts to reduce the number of infant deaths, the IMR in Hamilton County has remained elevated above national levels and was the highest of all urban Ohio counties from 2007-2009.[3] The Healthy People 2020 goal for infant mortality is 6.0 deaths per 1,000 live births (Table 1). Table 1 shows the infant mortality rates at the national, state, and local levels.

Table 1. National, State, County and City Infant Mortality Rates, 2007 -2009

Year	US	State of Ohio	Hamilton County	City of Cincinnati	Healthy People 2020 Goal[4]
2007	6.75	7.7	10.9	13.5	6.0
2008	6.61	7.7	11.1	13.6	6.0
2009	6.39	7.4	9.9	13.4	6.0

Infant deaths can be sub-classified as neonatal deaths (deaths occurring to infants less than 28 days old) or as post-neonatal deaths (deaths occurring to infants whose age is between 28 days and one year). The IMR can be presented as a neonatal infant mortality rate (NIMR) and a post-neonatal infant morality rate. The summation of the NIMR and post-neonatal infant mortality rate is equal to the IMR. Figure 1 below shows the breakdown of IMRs for 2007-2009. Approximately 71.0 percent of the IMR was driven by the NIMR (2007-2009). The NIMR represented a percentage of the IMR that was relatively the same throughout 2007-2009, varying only from 68.7 percent - 74.3 percent. The NIMR is largely affected by prematurity, known as preterm births and explored later in the chartbook. This predictable pattern in infant mortality has given researchers more insight about where to focus future research and interventions; however, there is still much to be learned in this area.

---

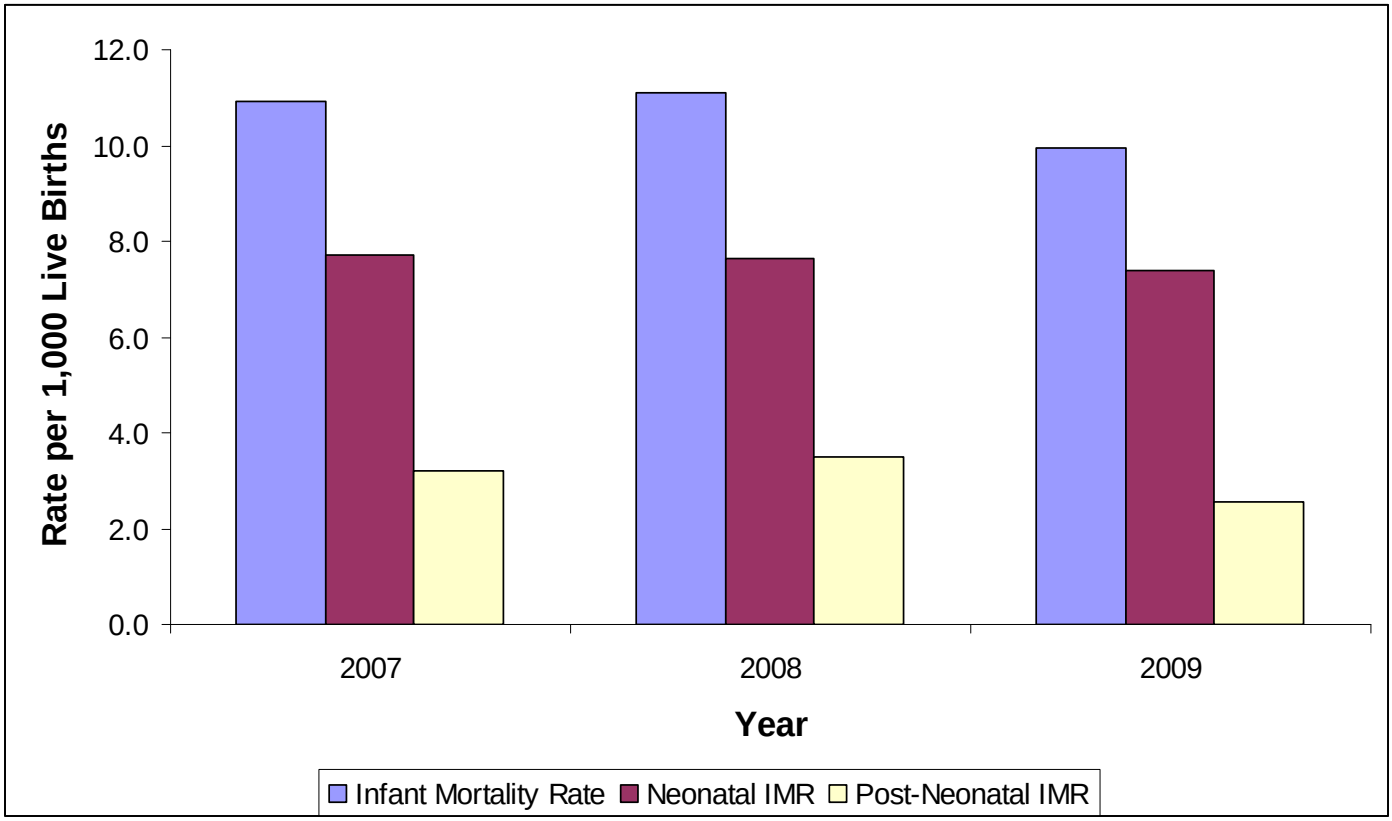
[1] National Center for Health Statistics

[2] National Vital Statistics Report: *Deaths: Final Data for 2009*. Vol 60(3). January 2012. http://www.cdc.gov/nchs/fastats/infant_health.htm. Accessed 2/2/2012.

[3] Ohio Department of Health. *Number of Infant Deaths and Infant Mortality Rates by County Ohio 2006-2010*. http://www.odh.ohio.gov/odhprograms/cfhs/octpim/latestoimd.aspx. Accessed 4/2/2012.

[4] Health People 2020. *About Healthy People*. http://www.healthypeople.gov/2020/about/default.aspx. Accessed 6/7/2012.

Figure 1. Distribution of Infant Mortality Rates and Neonatal Infant Mortality Rates, Hamilton County, 2007-2009



The Chartbook

This chartbook report incorporates birth and death certificate data provided by the Ohio Department of Health (ODH) and the National Center for Health Statistics. The data gathered for this chartbook reflect live births and infant deaths among Hamilton County residents during 2007-2009. Infant death records were linked to their respective birth records by epidemiologists at Hamilton County Public Health (HCPH) to enable in-depth analysis of risk factors. Through linking the birth and death certificates, it becomes possible to identify and compare maternal risk factors and infant characteristics related to infant mortality. See the Appendix B for more information on the methodology.

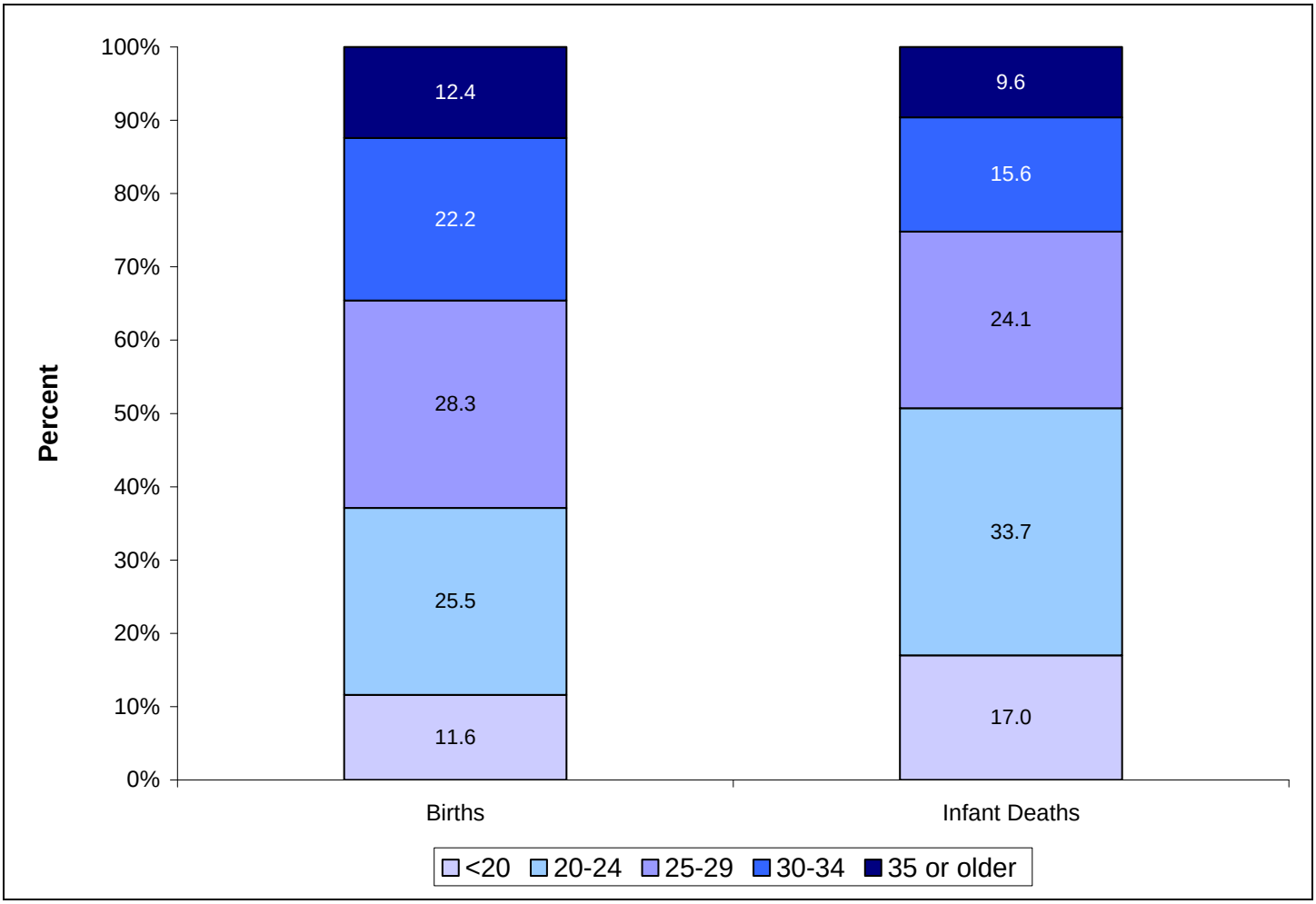
The first section of the chartbook (**Section I: Maternal Characteristics**) examines select demographic and socio-economic characteristics of women in Hamilton County who gave birth during 2007-2009. **Section I** highlights the distribution of several maternal characteristics among all live births and the infant deaths in Hamilton County. The second section, **Section II: Maternal Risk Factors**, provides a review of the maternal risk factors associated with infant mortality and preterm birth in Hamilton County. The third section, **Section III: Infant Characteristics**, provides information about the infants who died in Hamilton County; this includes important information such as the leading causes of infant death. The final section, **Section IV: Seasonal and Spatial Distribution**, examines the seasonal and geographical differences associated with infant deaths in Hamilton County. Within each section of the chartbook, charts (e.g., bar charts, maps) are provided to emphasize the salient findings of this analysis. Directly below each chart are bullets (Quickfacts) that succinctly describe the findings.

Section I: Maternal Characteristics

Identification of the populations at highest risk for infant death is important for the development of targeted prevention measures. This section highlights selected characteristics of Hamilton County mothers who experienced an infant death in 2007-2009. The percent distributions in Figure 2A through Figure 6 below were calculated from either 353 linked birth-infant death records or 34,967 Hamilton County resident live births (See Appendix B).

Maternal Age

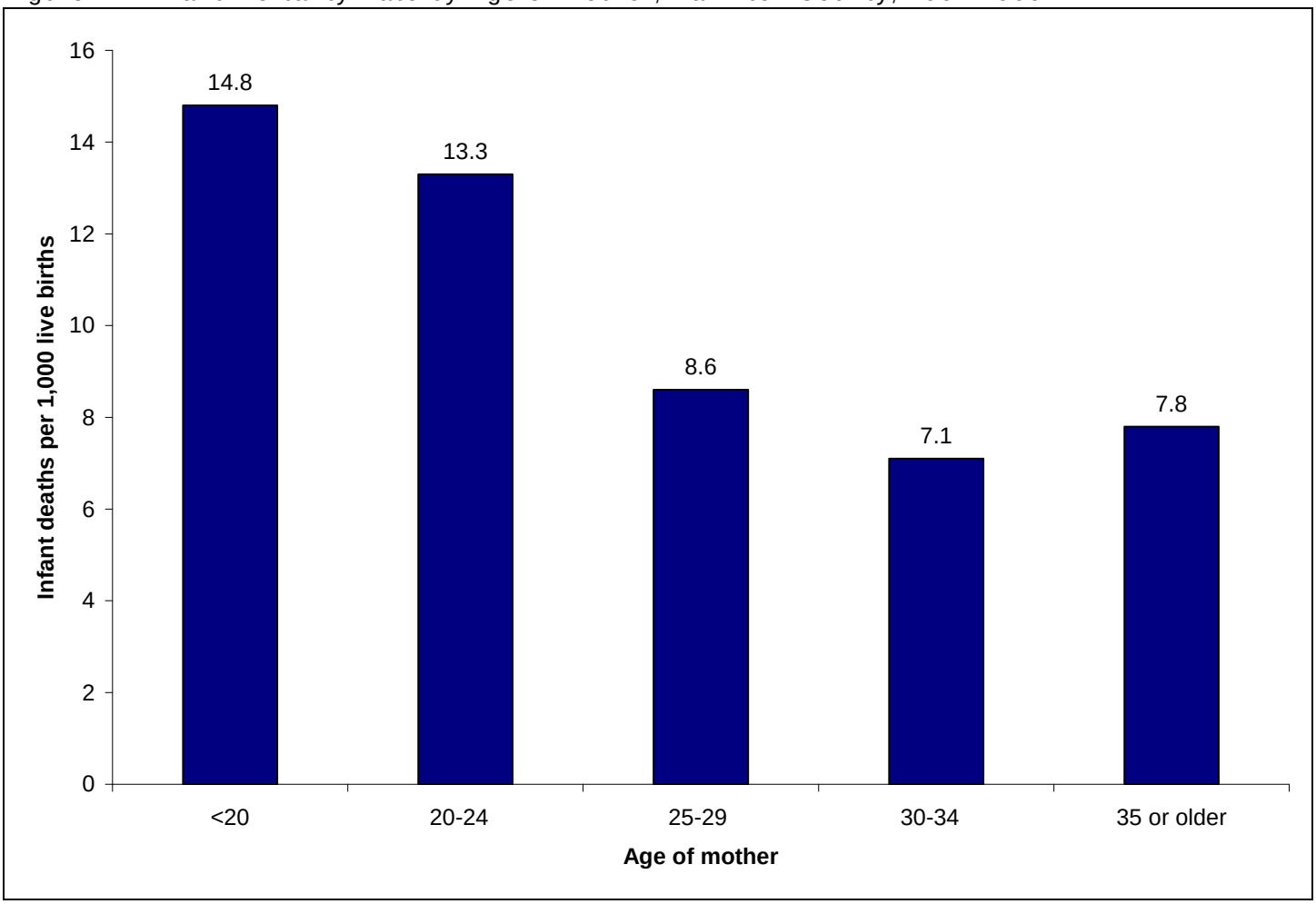
Figure 2A. Percent Distribution of Births and Infant Deaths by Age of Mother, Hamilton County, 2007-2009



Summary:

- The average maternal age for all Hamilton County resident births during 2007-2009 (N=34,967) was 27 years.
- Infants born to mothers under the age of 25 accounted for 50 percent of the infant deaths in the 2007-2009 period, but only 37 percent of births.
- Infants of teen mothers represented 17 percent of 2007-2009 infant deaths, yet accounted for less than 12 percent of all births.

Figure 2B. Infant Mortality Rate by Age of Mother, Hamilton County, 2007-2009



Summary:

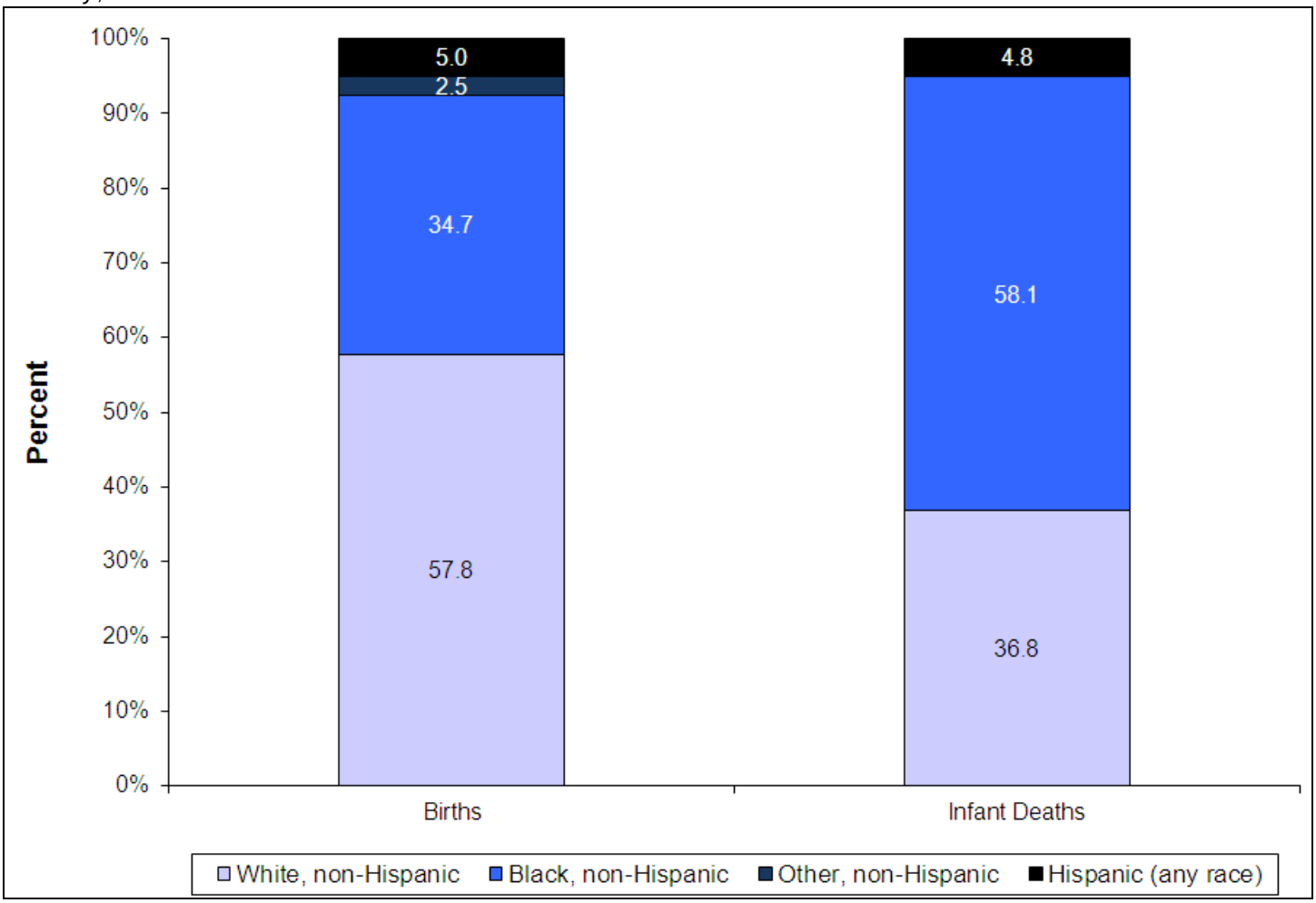
- Infants born to teen mothers had the highest mortality rate (14.8 per 1,000 live births). This observation was consistent with national-level statistics and with studies that have reported a direct association between young maternal age (< 20 years) and higher infant mortality rates.[5,6]
- Infants of mothers between the ages of 30 and 34 years had the lowest mortality rate (7.1 per 1,000 live births), but their rate was still above the 2007-2009 national average infant mortality rate (6.58 per 1,000 live births).

[5] Gage, T.B.; Fang F.; O'Neill, E.; Stratton H. (2009). "Maternal Age and Infant Mortality: A Test of the Wilcox-Russell Hypothesis". *Am J Epidemiology*. 169:294-303. http://aje.oxfordjournals.org. Accessed 6/5/2011.

[6] Mathews T.J., MacDorman M.F. "Infant Mortality Statistics from the 2005 Period Linked Birth/Death Data Set". *CDC Natl Vital Statistics Report*. 57(2):1-27. http://www.cdc.gov/nchs/data/nvsr/nvsr57/nvsr57_02.pdf. Accessed 6/2/2011.

Maternal Race and Ethnicity

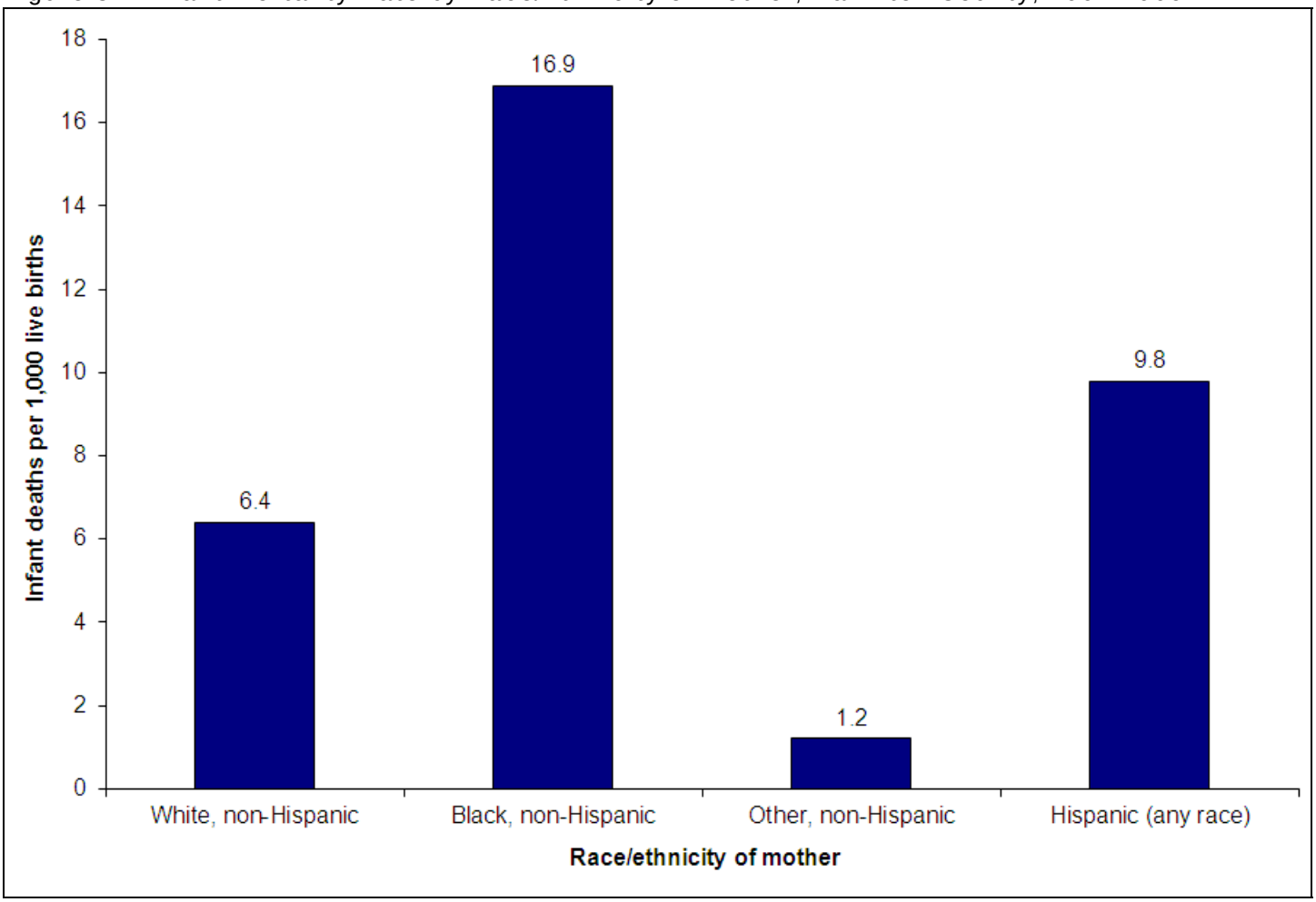
Figure 3A. Percent Distribution of Births and Infant Deaths by Race/Ethnicity of Mother, Hamilton County, 2007-2009



Summary:

- Infants born to black, non-Hispanic mothers accounted for 58 percent of infant deaths in Hamilton County, but fewer than 35 percent of the Hamilton County births.
- Infants of white, Non-Hispanic mothers, on the other hand, represented 58 percent of 2007-2009 births, but 37 percent of infant deaths.
- Hispanics accounted for equal proportions of births and infant deaths in the three-year assessment period.

Figure 3B. Infant Mortality Rate by Race/Ethnicity of Mother, Hamilton County, 2007-2009

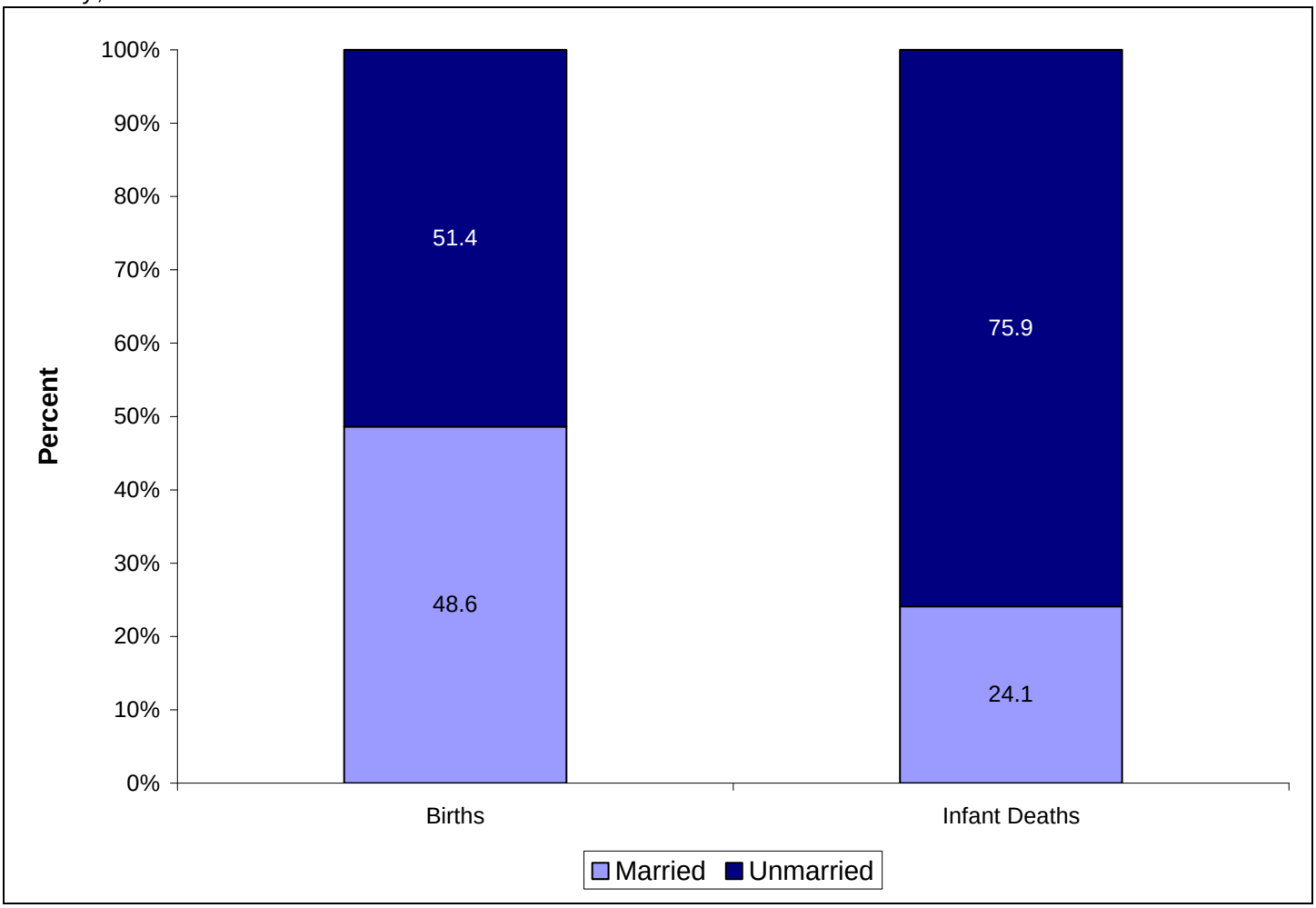


Summary:

- Infant mortality among births to black, non-Hispanic mothers (16.9 per 1,000 live births) was nearly three times higher than the comparable rate for white non-Hispanic births (6.4 per 1,000 live births).
- The lowest infant mortality rate was recorded for the "Other" race category; births in this race classification were primarily comprised of Asian mothers. The IMR for this group is considered unreliable for statistical comparisons, however, because it was based on a single infant death in the three-year assessment period.

Maternal Marital Status

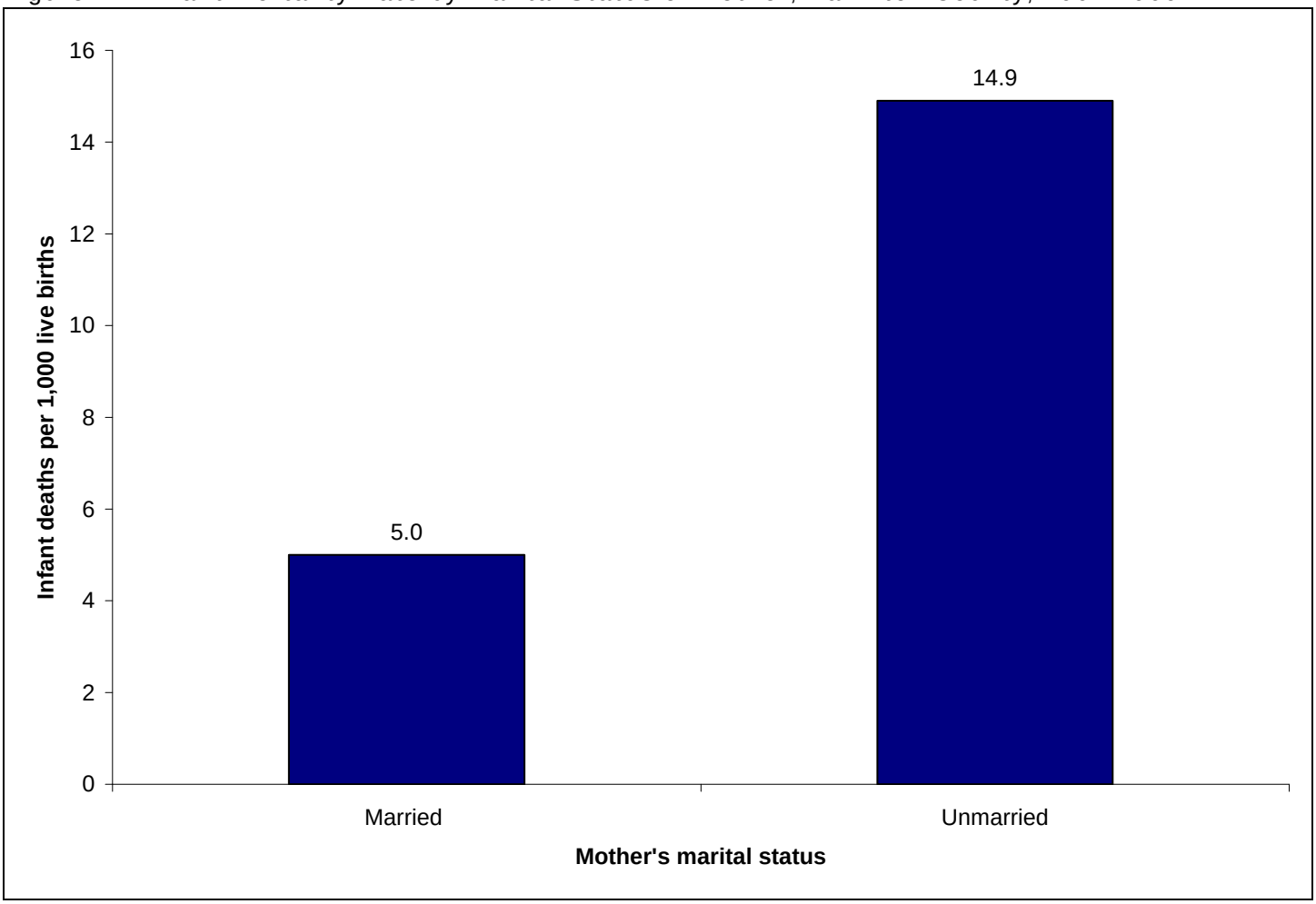
Figure 4A. Percent Distribution of Births and Infant Deaths by Marital Status of Mother, Hamilton County, 2007-2009



Summary:

- Births to unmarried mothers accounted for three of four (75.9 percent) infant deaths among Hamilton County residents and just over one-half (51.4 percent) of all births.
- Conversely, married women accounted for 24.1 percent of infant deaths, but nearly one-half of all county births (48.6 percent).

Figure 4B. Infant Mortality Rate by Marital Status of Mother, Hamilton County, 2007-2009



Summary:

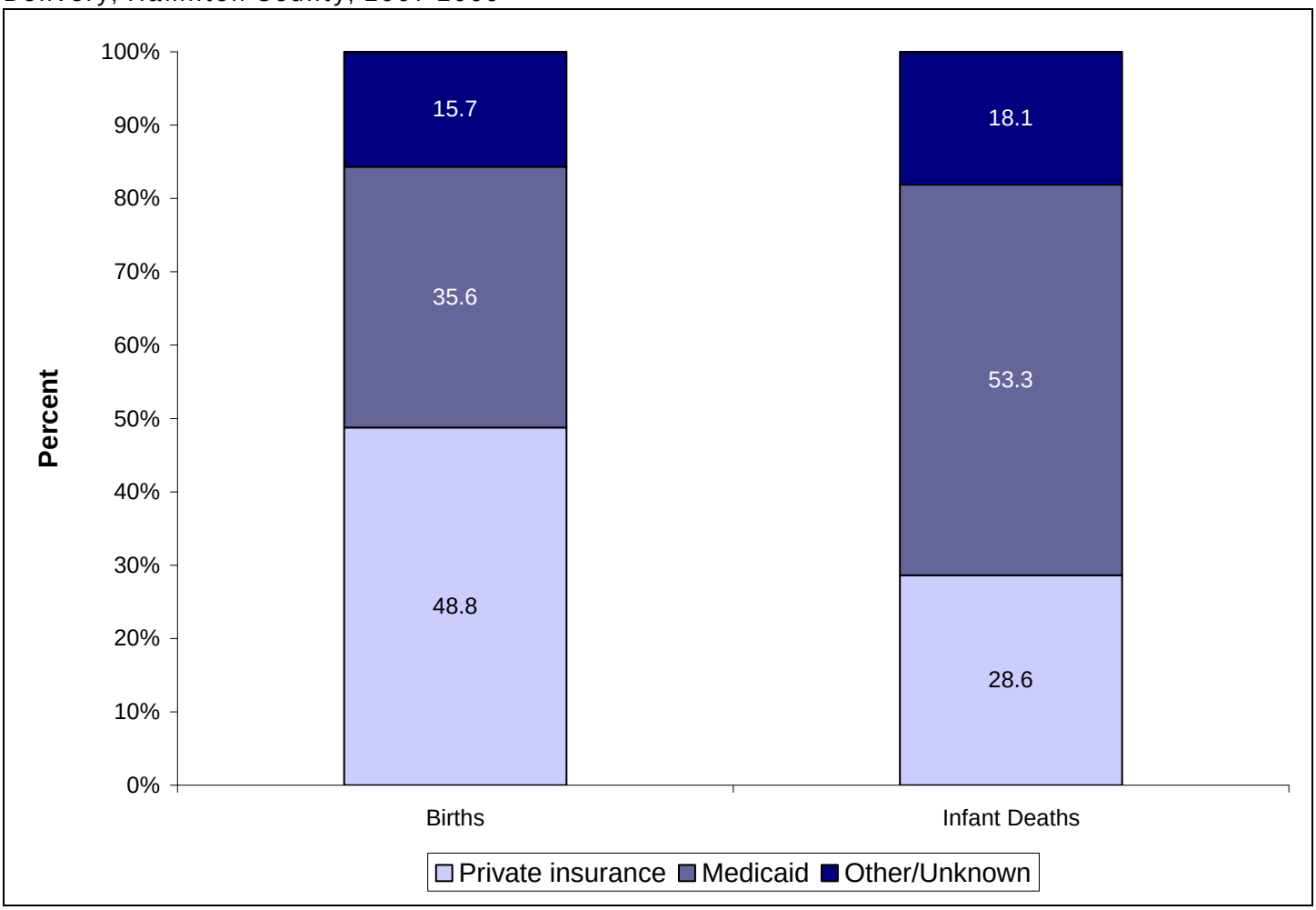
- The infant mortality rate among births to unmarried women (14.9 per 1,000 live births) was three times higher than the comparable rate for married women (5.0 per 1,000 live births).
- The county's disparity in infant mortality by marital status of mother was considerably wider than the comparable statewide rates. According to the National Center for Health Statistics, Ohio's 2007 infant mortality rates were 5.6 for married women and 10.7 for unmarried women.[7]

[7] National Center for Health Statistics. CDC Wonder: Linked Birth/Infant Death Records for 2007 with ICD 10 codes. http://wonder.cdc.gov/lbd- current.html. Accessed 12/5/2011.

Payment Source for Delivery

Income information is unavailable on vital statistics files, but payment by Medicaid for the birth delivery is a reasonable proxy indicator for low socio-economic status.

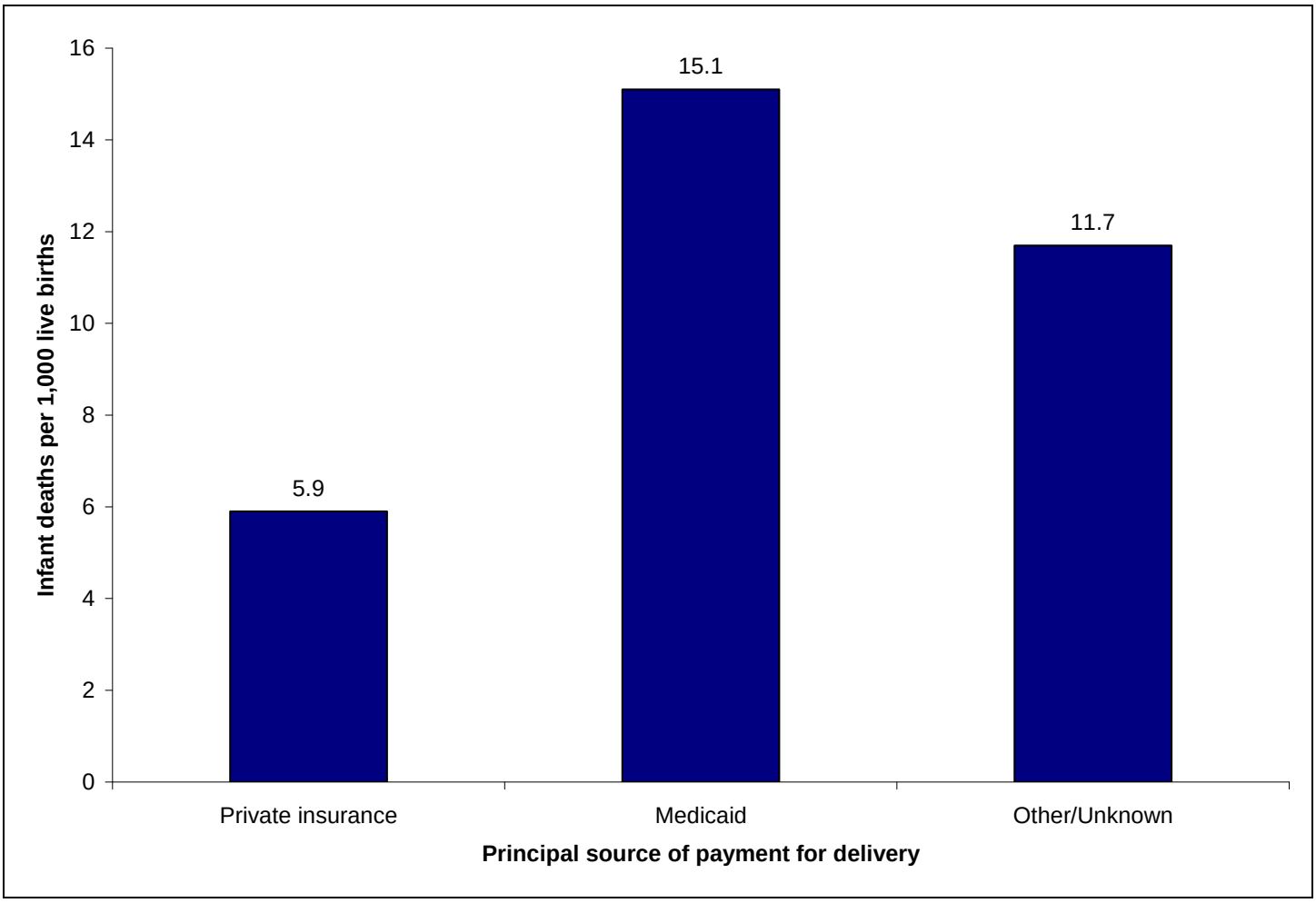
Figure 5A. Percent Distribution of Births and Infant Deaths by Principal Payment Source for Delivery, Hamilton County, 2007-2009



Summary:

- Births to mothers with Medicaid coverage accounted for just over one-third (35.6 percent) of Hamilton County resident births and more than one-half (53.3 percent) of infant deaths.
- Women covered by private insurance at the time of delivery accounted for 48.8 percent of all births and only 28.6 percent of infant deaths.

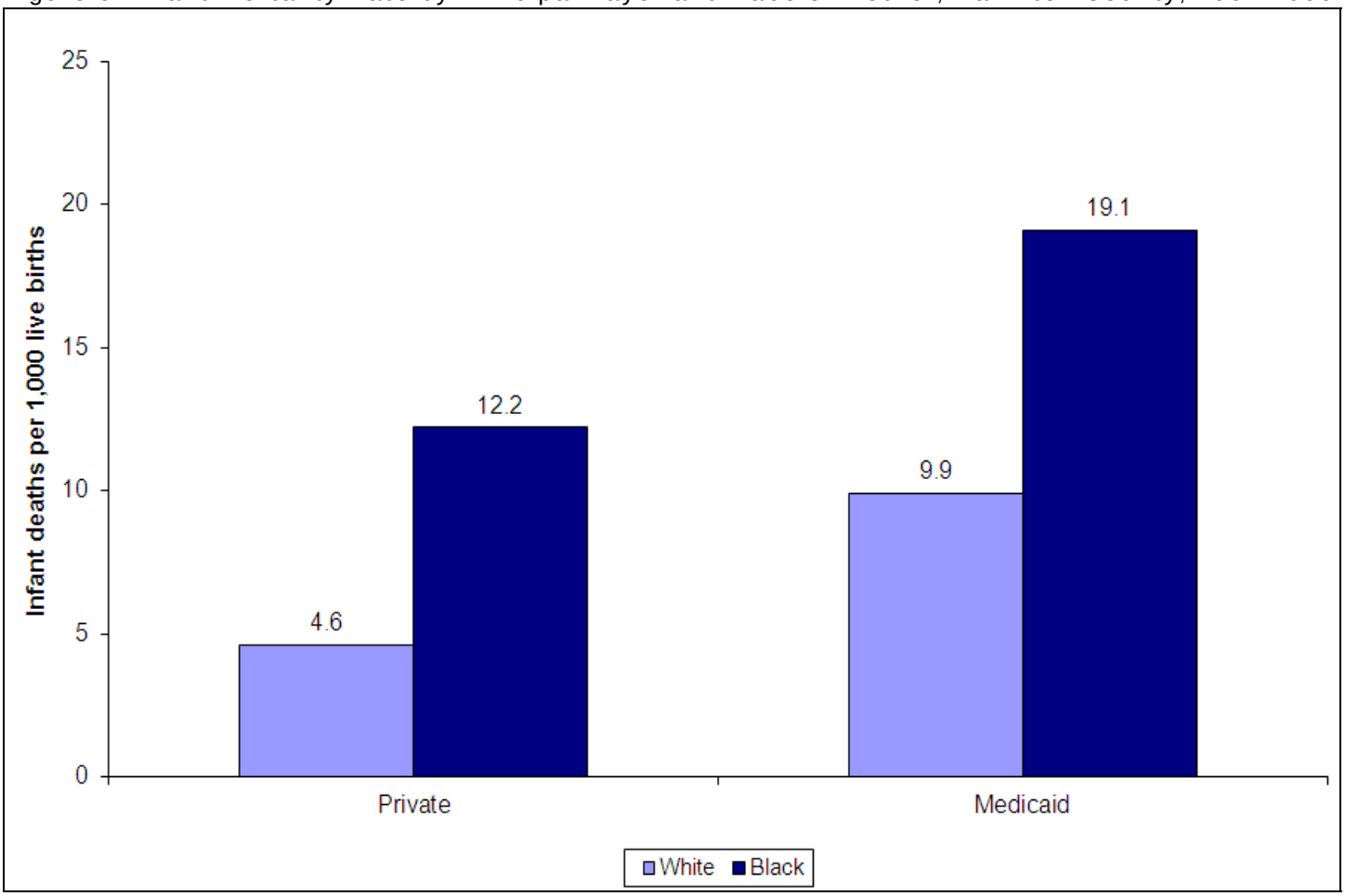
Figure 5B. Infant Mortality Rate by Principal Payment Source for Delivery, Hamilton County, 2007-2009



Summary:

- Births to women with Medicaid coverage had an infant mortality rate 2.6 times higher than the rate for births covered by private insurance.
- Births in the "Other/Unknown" category used payment sources such as self-pay, Indian Health Service, CHAMPUS/TRICARE (military), or other forms of government insurance.

Figure 6. Infant Mortality Rate by Principal Payer and Race of Mother, Hamilton County, 2007-2009



Summary:

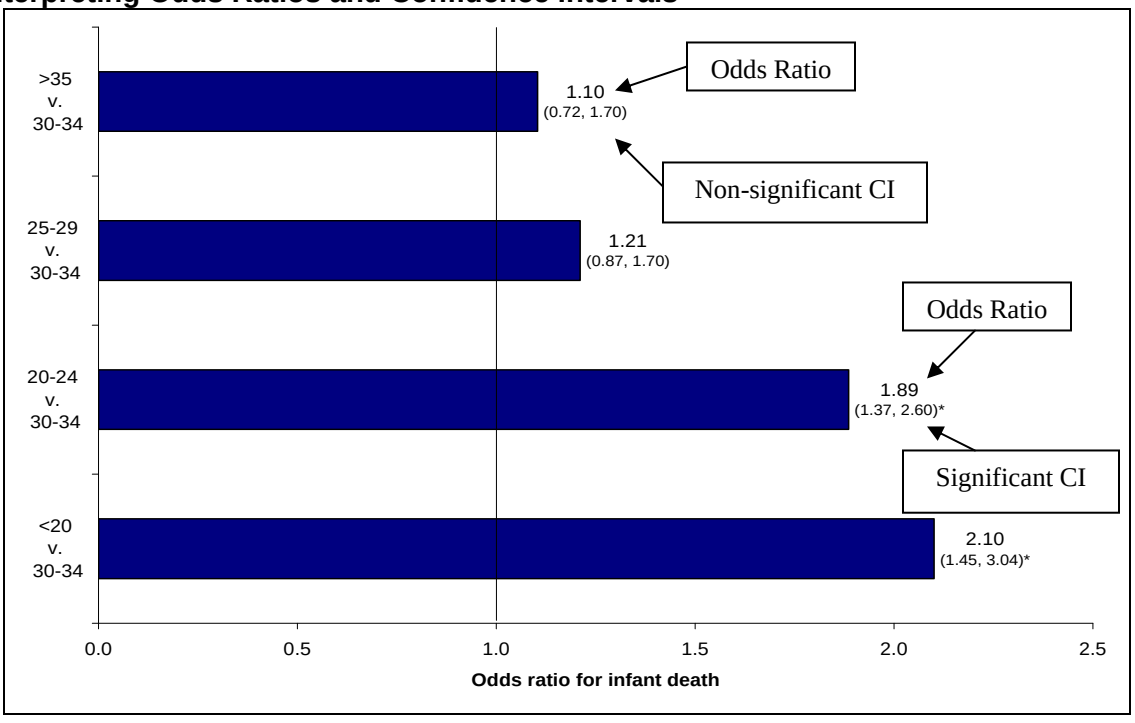
- The infant mortality rate for black mothers insured through Medicaid at the time of delivery (19.1 per 1,000 live births) was nearly two times higher than the comparable rate for white mothers insured through Medicaid at the time of delivery (4.6 per 1,000 live births).
- Interestingly, a similar disparity was discovered for births to privately insured women. The infant mortality rate for black, privately insured births (12.2 per 1,000 live births) was greater than two times the IMR for white, privately insured births (4.5 per 1,000 live births).
- Births to white mothers with Medicaid coverage had a lower infant mortality rate than births to black mothers with private insurance.

Section II: Maternal Risk Factors- Infant Mortality and Preterm Birth

In Section I, many demographic and socio-economic factors appeared to have an association with infant death. In this section, the risks associated with specific maternal characteristics are further explored. There are several maternal characteristics including demographic, social, behavioral and medical factors that can increase the risk for infant mortality and preterm birth. Preterm birth, defined as a live birth before 37 weeks gestation, is the most important contributing factor to infant death. Moreover, estimations by the Institute of Medicine of the National Academies suggest that preterm births result in an average of $33,200 in medical care costs per preterm infant.[8] Throughout this section several factors are evaluated in terms of the strength of association with infant mortality and preterm birth. In other words, the risk of infant mortality and preterm birth in Hamilton County is compared among several different maternal factors.

A convenient approach to evaluating risk is to produce odds ratios for each risk factor of interest. The odds ratio is an estimation of the risk level associated with a particular factor such as maternal race or gestational diabetes. An odds ratio (OR) of 1.0 implies the maternal risk factor was equally likely in the groups being compared (infants who died before their first birthday versus infants who survived). An odds ratio greater than 1.0 implies the maternal risk factor was more likely among women who had an infant death or preterm birth. The 95 percent confidence interval (CI) for each odds ratio is provided in parentheses. The CI provides an indication of statistical significance; that is to say, a degree of confidence that the factor truly conveys an elevated risk. If the value of 1.0 is not within the confidence interval, then the odds ratio can be considered statistically significant (Figure 7). Statistical significance is denoted with an asterisk (*) beside the confidence interval. In Figure 7 below, for example, mothers over age 35 had a 10 percent higher odds of infant death compared to mothers 30-34 years old (OR is 1.10). The confidence interval for this OR contains the value of 1.0, meaning that the result is not statistically significant. However, in Figure 7, the OR of 1.89 for births to women age 20-24 is statistically significant, indicating the risk is likely elevated and estimated to be 89 percent higher. For more information on the odds ratios and confidence intervals, please see Appendix B.

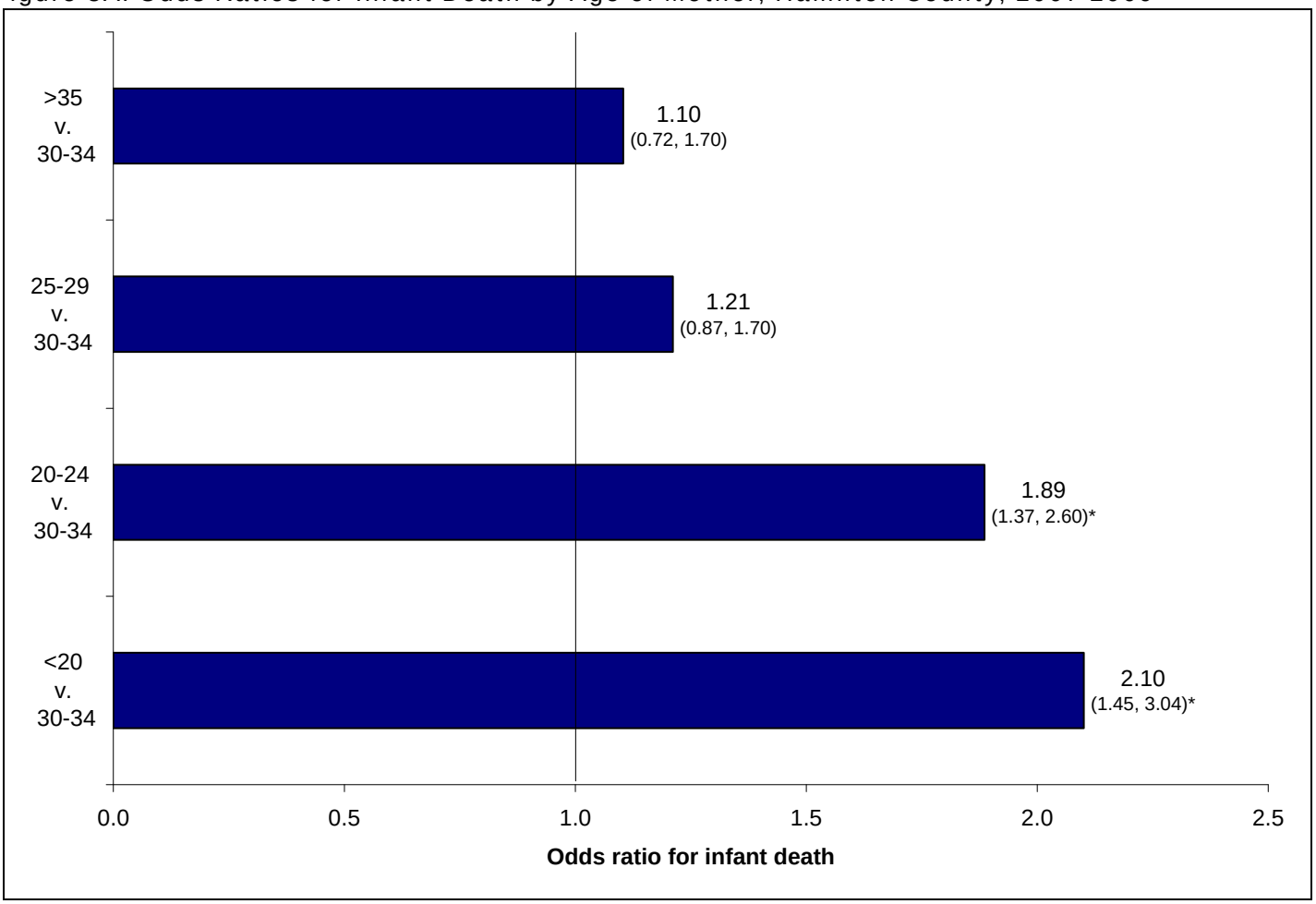
Figure 7. Interpreting Odds Ratios and Confidence Intervals



[8] Behrman RE, Butler AS, editors; Institute of Medicine of the National Academies. *Preterm Birth Causes, Consequences, and Prevention*. Washington D.C.: National Academy Press; 1997. 47 p.

Figures 8A through 13C provide estimates of the risk for infant mortality and preterm birth associated with selected maternal factors. The estimated risks (i.e., odds ratios) for infant mortality and preterm birth (independently) were compared by presence or absence of select maternal factors. Only linked infant birth and death records were used in determining the odds ratios for each maternal factor. In examining characteristics such as age of mother and race/ethnicity of mother it was necessary to identify reference groups for the comparisons. In each case, the reference group is generally the age or race group that had the lowest rates of infant death or preterm birth.

Figure 8A. Odds Ratios for Infant Death by Age of Mother, Hamilton County, 2007-2009

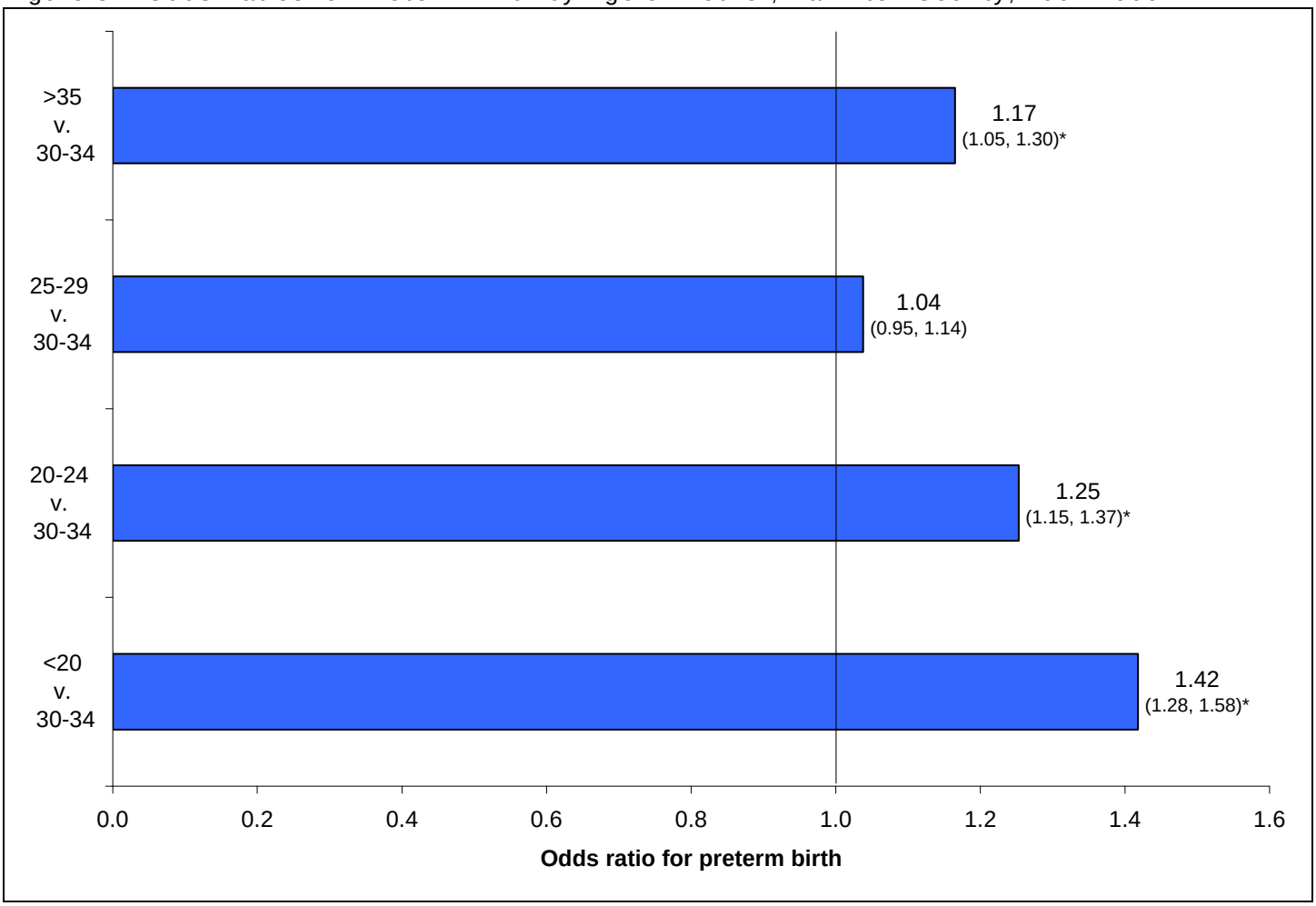


Summary:

- The reference group was mothers 30-34 years old. The highest odds ratio, 2.10 (1.45-3.04), was associated with mothers under 20 years of age. The risk of losing an infant was estimated to be twice as high for a teen mother compared to a mother 30-34 years of age.
- Mothers who were 20-24 years of age were also significantly more likely to experience an infant death (OR: 1.89, 95 percent CI 1.37-2.60).
- Compared to the reference group, births to women ages 25-29 or 35 years and older did not face significantly higher odds of infant death.
- Low maternal age was a risk factor for infant death in Hamilton County, which aligns with the national trends.[9]

[9] MacDorman M.F., Kirmeyer S. *The Challenge of Fetal Mortality*. CDC NCHS Data Brief. April 2009. 16: 4. http://www.cdc.gov/nchs/data/databriefs/db16.htm#fetal_maternal. Accessed 2/9/2012.

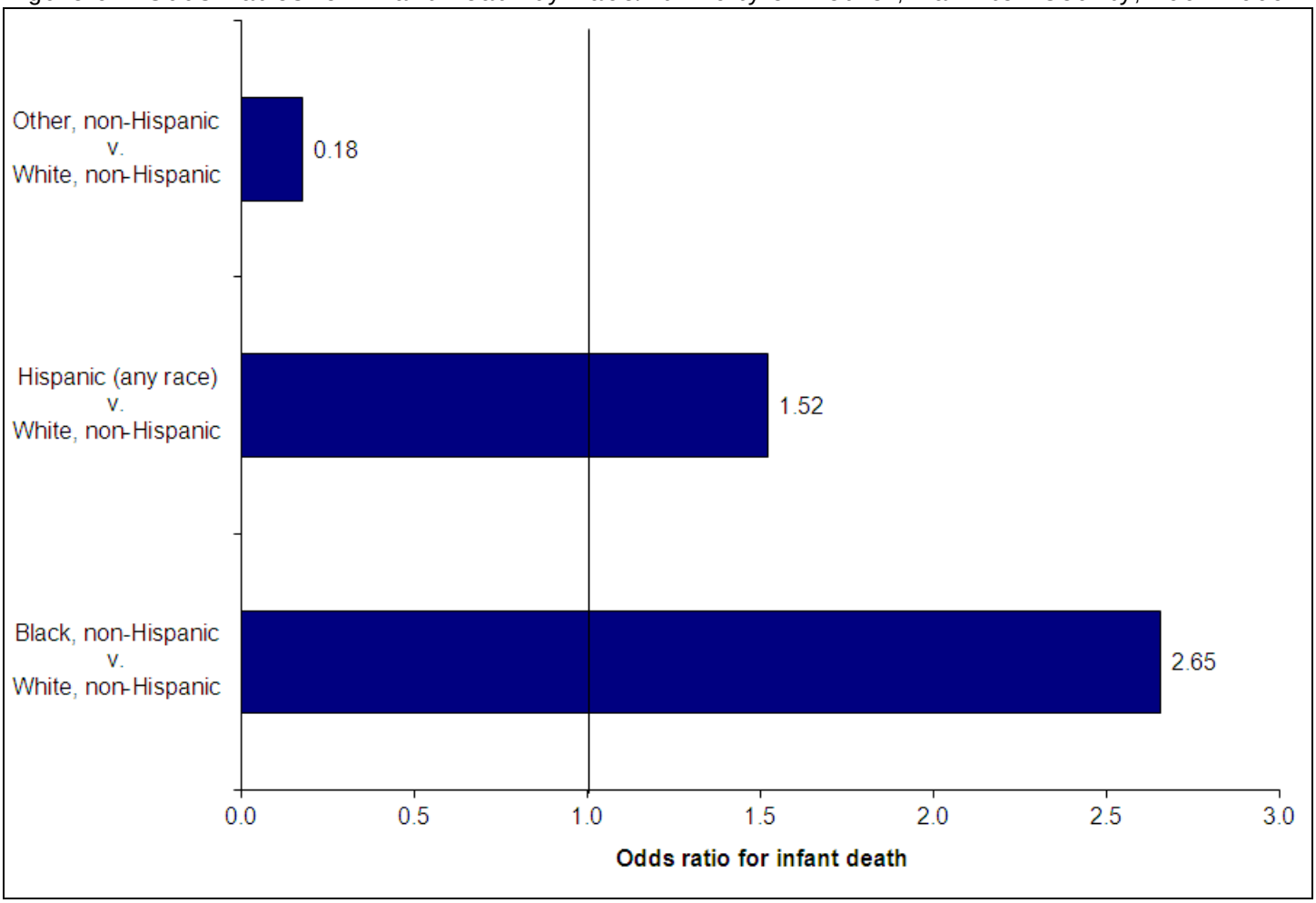
Figure 8B. Odds Ratios for Preterm Birth by Age of Mother, Hamilton County, 2007-2009



Summary:

- The reference group was births to mothers 30-34 years of age.
- Infants born to teen mothers were approximately 40 percent more likely to die in the first year of life than infants born to women in the 30-34 age range (OR: 1.42, 95 percent CI 1.28-1.58).
- The odds of delivering a preterm birth declined as maternal age increased from the teen years through ages 25-29.
- The estimated risk of having a preterm delivery was marginally, but not significantly, elevated for women age 35 years or older (OR: 1.17, 95 percent CI 1.05-1.30).

Figure 9A. Odds Ratios for Infant Death by Race/Ethnicity of Mother, Hamilton County, 2007-2009

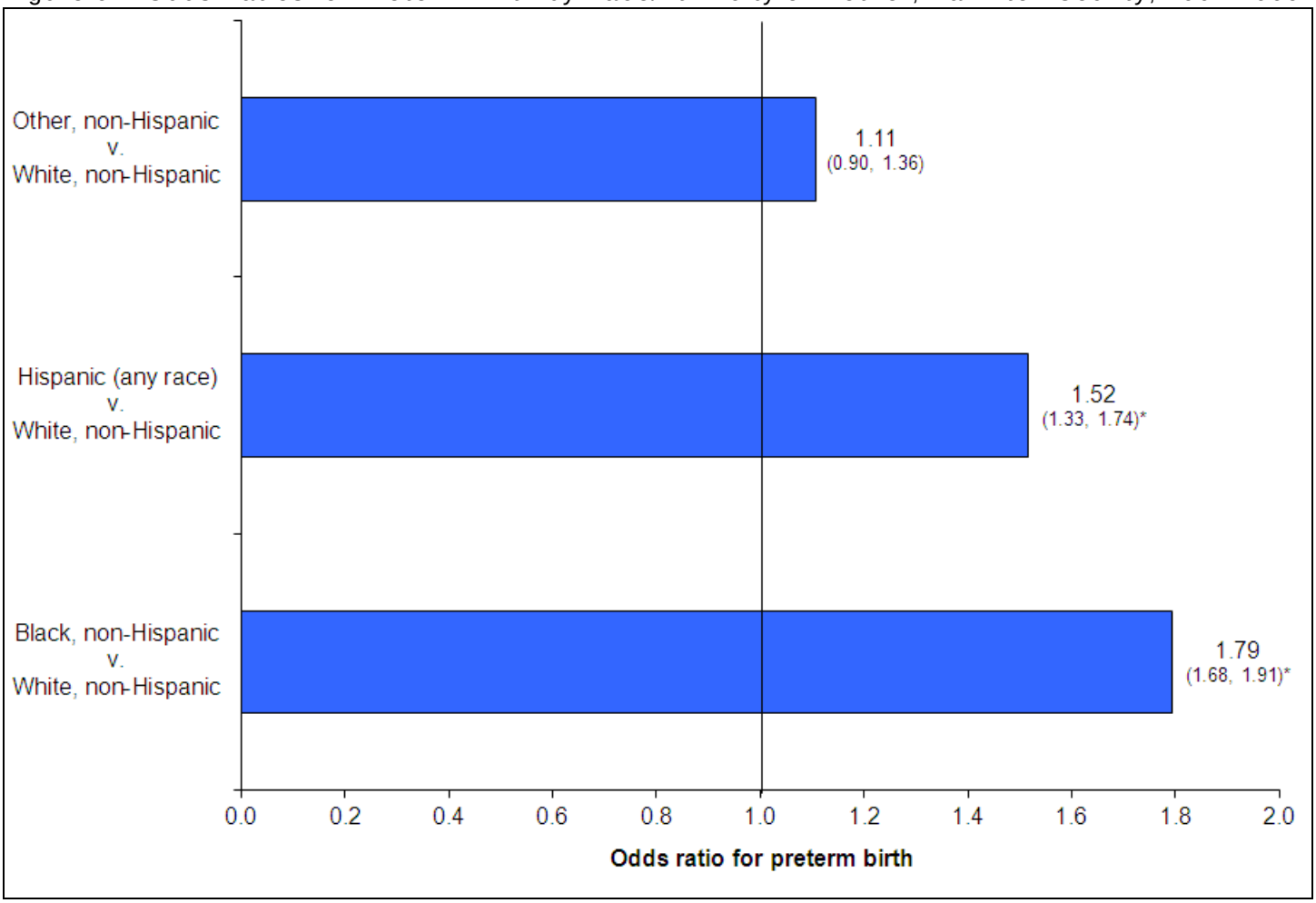


Summary:

- The reference group was infants born to white, non-Hispanic women.
- Infants born to black, non-Hispanic mothers faced a significantly higher risk of dying before their first birthday (OR: 2.65, 95 percent CI 2.13-3.31). This risk was estimated to be between two and three times higher for black, non-Hispanic women. Similar disparities were documented by MacDorman and Mathews (2011).[10]
- The risk of infant death for infants born to Hispanic mothers (OR: 95% CI 1.52, 0.92-2.53) was not significantly different from the risk faced by white, non-Hispanic infants; however, the data indicate the risk was elevated for this demographic.
- There was no statistical significant difference in the odds of infant death among white, non-Hispanic births and other, non-Hispanic births. It should be noted that the estimated risk for other, non-Hispanic was difficult to interpret due to a low number of live births and deaths in this group.

[10] MacDorman M.F., Mathews T.J. "Understanding Racial and Ethnic Disparities in U.S. Infant Mortality Rates". *CDC NCHS Data Brief*. 74:1-8. http://www.cdc.gov/nchs/data/databriefs/db74.pdf. Accessed 12/5/2011.

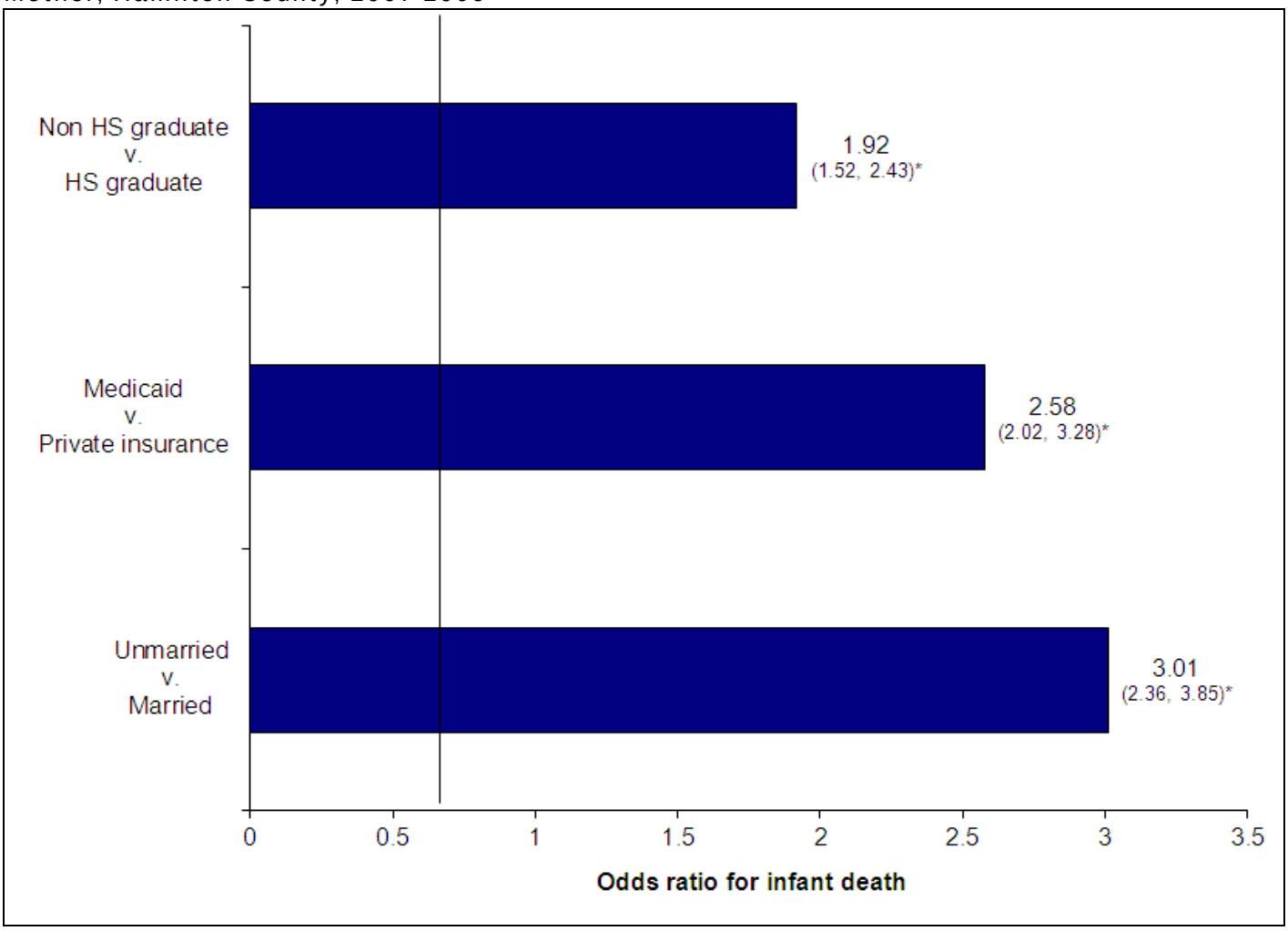
Figure 9B. Odds Ratios for Preterm Birth by Race/Ethnicity of Mother, Hamilton County, 2007-2009



Summary:

- The reference group was infants born to white, non-Hispanic women.
- The risk of delivering a preterm birth was estimated to be about 80 percent higher for black, non-Hispanic women (OR: 1.79, 95 percent CI 1.68-1.91) compared to white, non-Hispanic women.
- Mothers of Hispanic ethnicity were approximately 50% more likely to have a preterm infant (OR: 1.52, 95 percent CI 1.33-1.74) than white, non-Hispanic mothers.
- There was no significant difference in the risk of preterm birth between white, non-Hispanic mothers and other, non-Hispanic mothers.

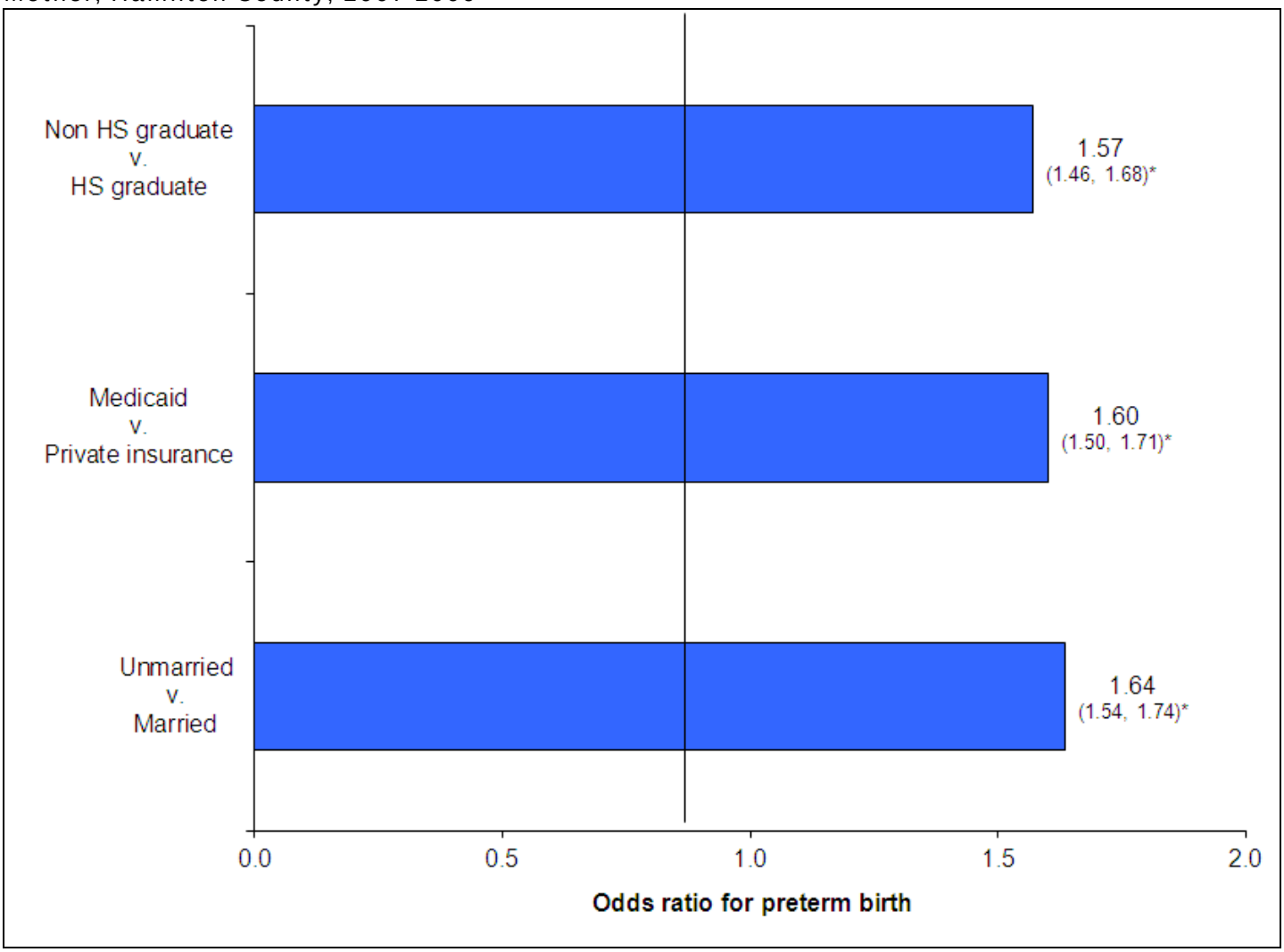
Figure 10A. Odds Ratios for Infant Death by Selected Social and Economic Characteristics of Mother, Hamilton County, 2007-2009



Summary:

- Certain social factors are strongly correlated with the risk of infant death. Mothers who have not completed high school, have health insurance coverage through Medicaid or are unmarried are more likely to have a child die in infancy.
- An infant born to an unmarried mother was three times more likely to die before his/her first birthday than an infant whose mother was married.
- The risk of infant death was estimated to be 2.5 times higher for infants born to women with Medicaid coverage (OR: 2.58, 95 percent CI 2.02-3.28) compared to women with private insurance.
- Also, the risk of infant death was estimated to be nearly two times higher for infants born to women who had not completed high school education at the time of delivery (OR: 1.96, 95 percent CI 1.52-2.43) compared to women who had completed high school.

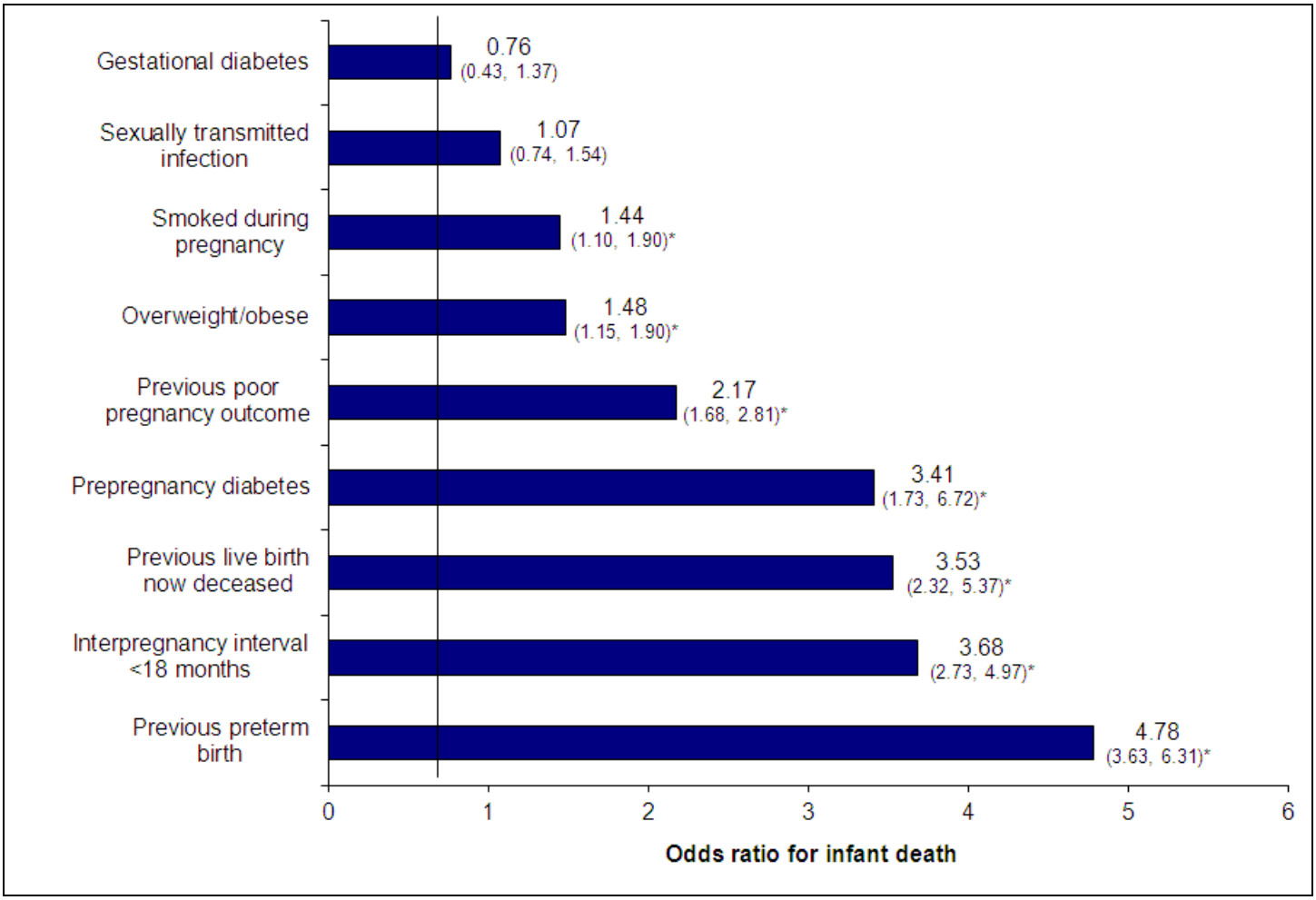
Figure 10B. Odds Ratios for Preterm Birth by Selected Social and Economic Characteristics of Mother, Hamilton County, 2007-2009



Summary:

- Hamilton County women had an approximately 60 percent higher risk of delivering a preterm infant indicated by low educational attainment, Medicaid coverage at delivery, or a status of unmarried.

Figure 11A. †Odds Ratios for Infant Death by Selected Maternal Medical and Behavioral Factors, Hamilton County, 2007-2009

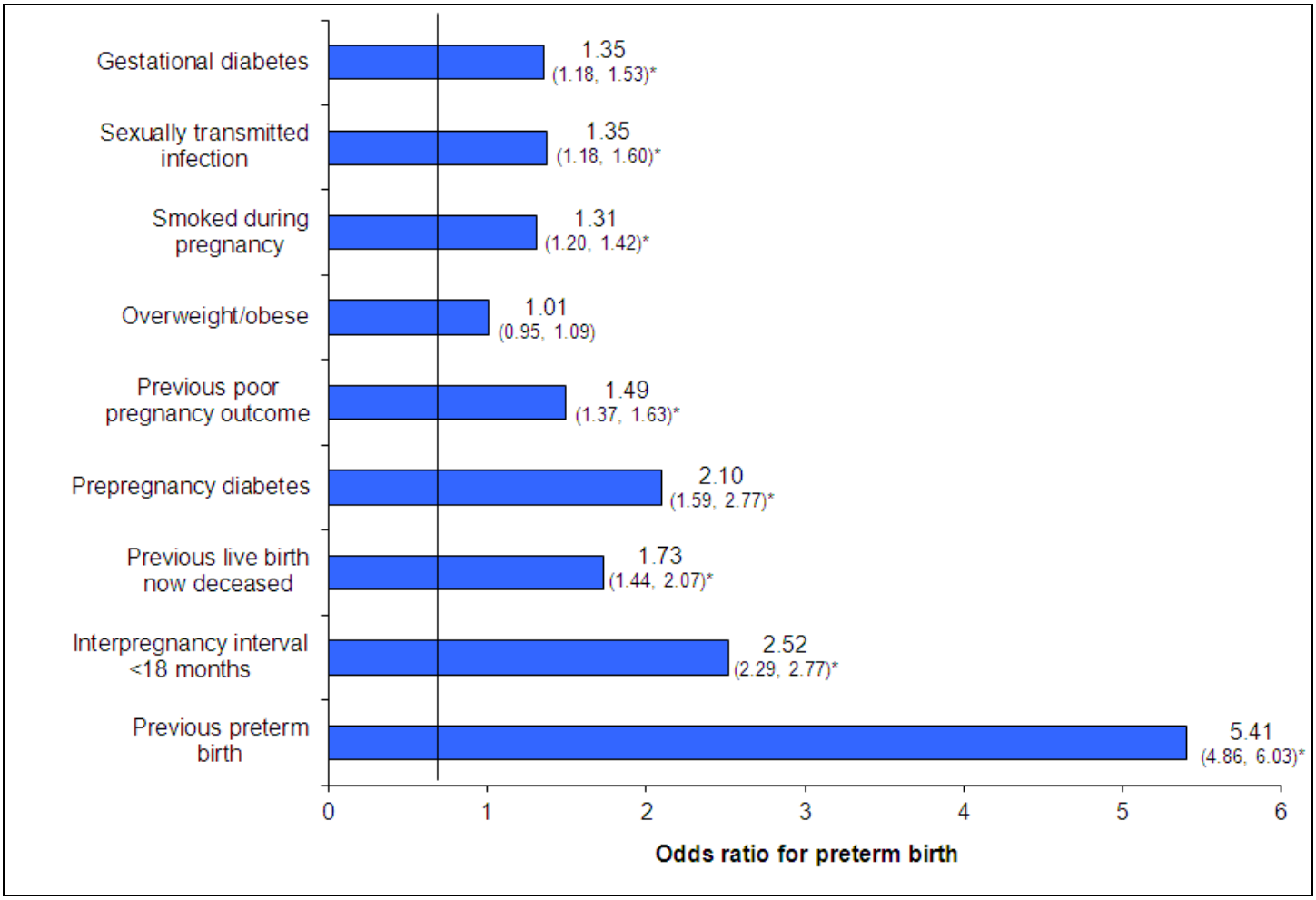


†*Adjusted for age and race of mother*

Summary:

- Reference groups were comprised of infants born to mothers without the corresponding risk factors. Odds ratios were adjusted for both age and race of mother.
- The risk of infant death was estimated to be nearly five times higher for births to women who had a previous preterm birth (OR: 4.78, 95 percent CI 3.63-6.31). For women with an inter-pregnancy interval of less than 18 months, the risk of infant death was elevated three to four times (OR: 3.68, 95 percent CI 2.73-4.97). Women who had lost an older child to death had a similarly elevated risk of having an infant die (OR: 3.53, 95 percent CI 2.32-5.37).
- Previous poor pregnancy outcomes include premature births, miscarriages, stillbirths and infants with low birth weight.
- The odds ratio associated with sexually transmitted infections was calculated by linking birth data with communicable disease data. Only chlamydia, gonorrhea and syphilis infections were used in determination of STI status. Maternal genitourinary infections caused by these STIs can lead to perinatal transmission causing infection of the infant (e.g., conjunctivitis and pneumonia).
- Only women 20 years of age or older were used in odds ratio calculations for overweight/obese. BMI for women less than 20 years old are calculated differently than women over 20 years old.

Figure 11B. †Odds Ratios for Preterm Birth by Selected Maternal Medical and Behavioral Factors, Hamilton County, 2007-2009

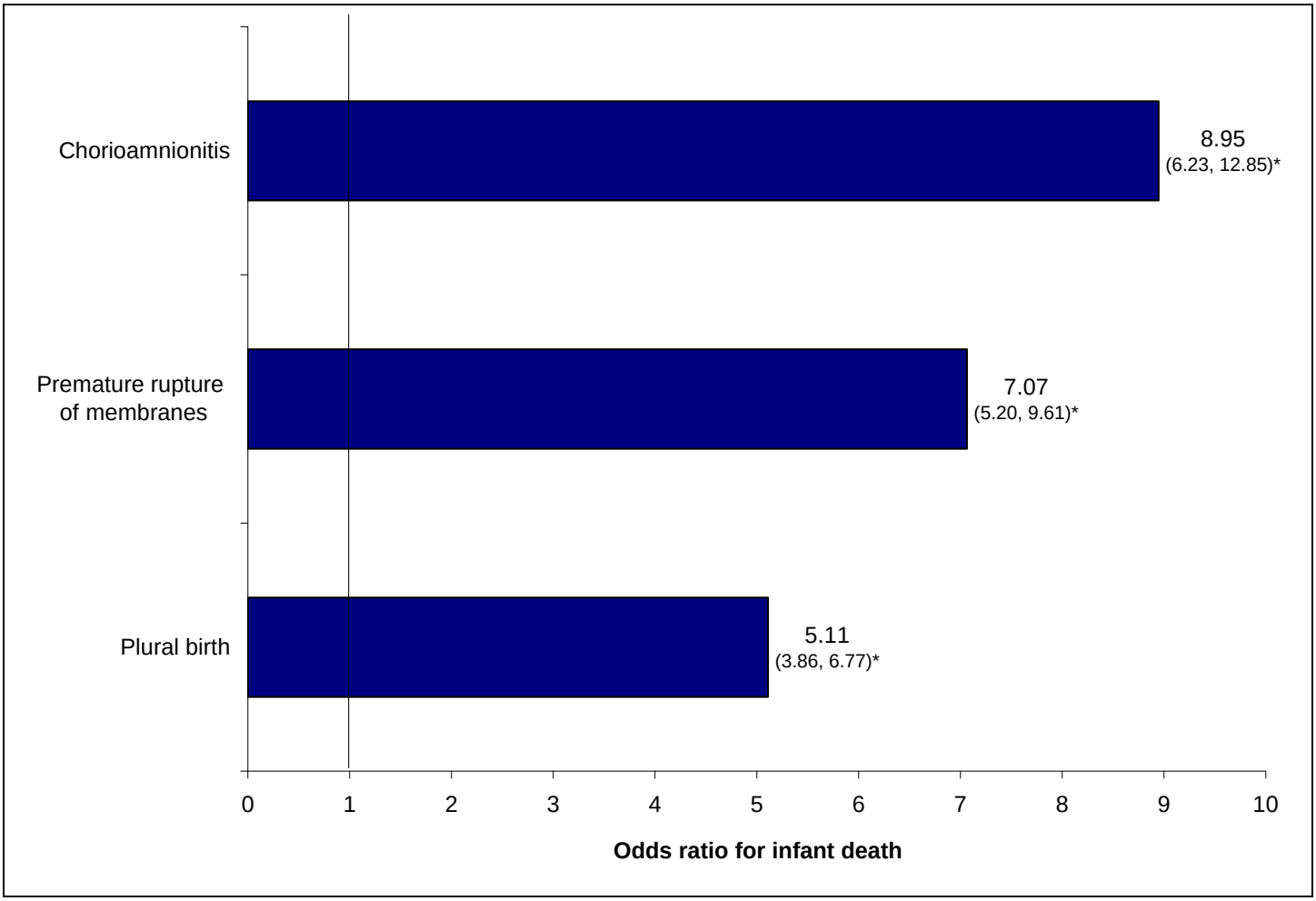


†*Adjusted for age and race of mother*

Summary:

- Reference groups were comprised of infants born to mothers without the corresponding risk factors. The odds ratios were adjusted for race and age.
- All of the adverse health factors in Figure 11B, except Overweight/obese, were associated with a significantly increased likelihood of preterm birth.
- The risk factors listed in Figure 11B that were associated with the highest likelihood of preterm birth were previous preterm birth (OR: 5.41, 95 percent CI 4.86-6.03) and a short inter-pregnancy interval (OR: 2.52, 95 percent CI 2.29-2.77).
- The odds ratio associated with sexually transmitted infections was calculated by linking birth data with communicable disease data. Only chlamydia, gonorrhea and syphilis infections were used in determination of STI status.
- The odds ratio analysis for STIs in Figure 11B used spontaneous preterm births while the other risk factors utilized all preterm births for their analyses.
- Only women 20 years of age or older were used in odds ratio calculations for Overweight/obese. BMI for women less than 20 years old calculate differently than women over 20 years old.

Figure 12A. Odds Ratios for Infant Death by Selected Pregnancy Risk Factors, Hamilton County, 2007-2009



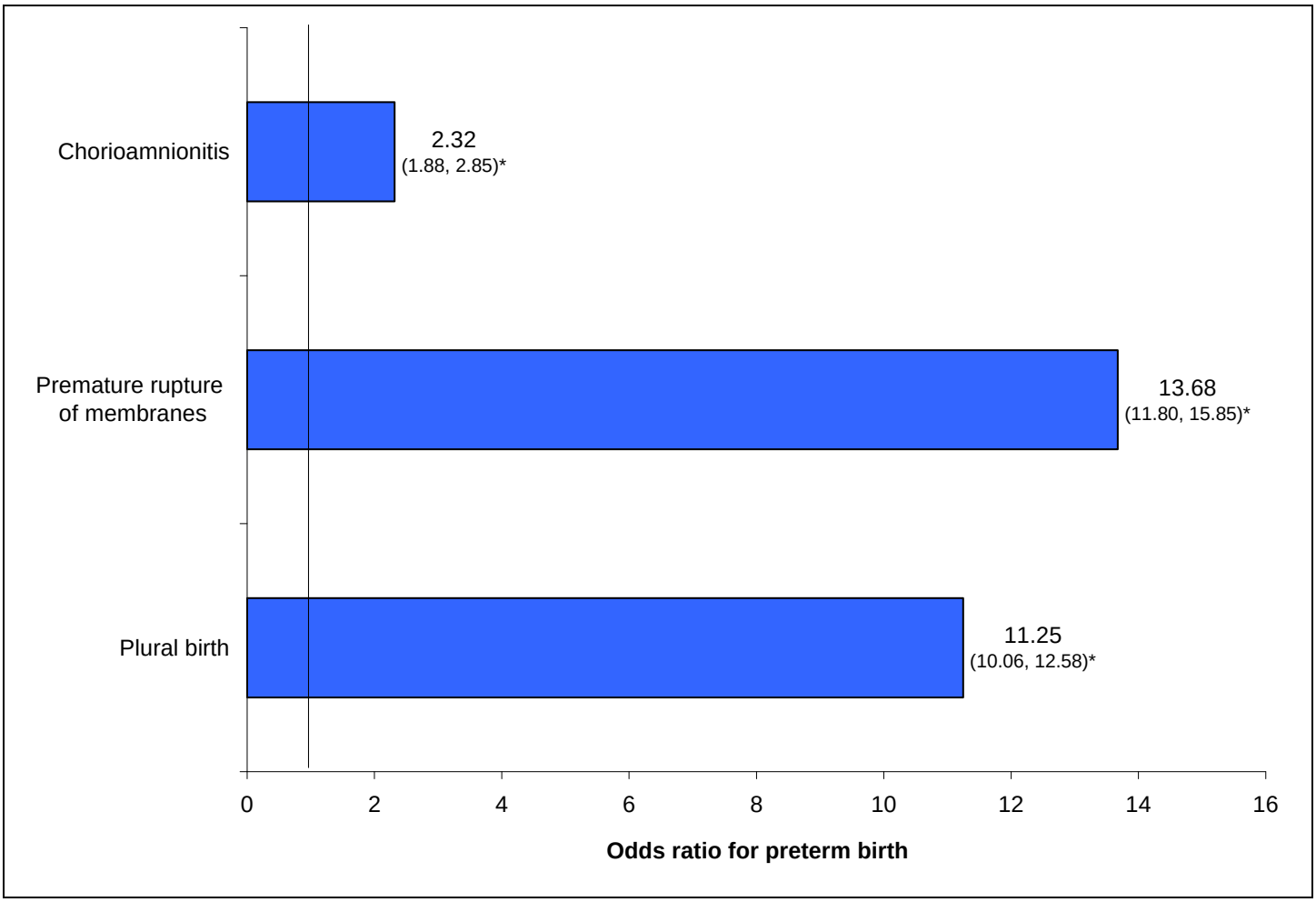
Summary:

- The reference groups were infants born to mothers without chorioamnionitis, without premature rupture of membranes, or who had a singleton birth (see Figure 12A).
- Chorioamnionitis is caused by a bacterial infection of the fetal membranes (chorion and amnion) and amniotic fluid. Risk factors for chorioamnionitis are premature birth and prolonged premature rupture of fetal membranes.[11]
- Premature rupture of membranes (PROM) is the rupturing of the amniotic sac before labor begins, often due to an infection that occurs before 37 completed weeks of gestation. PROM can lead to chorioamnionitis, premature birth and postpartum infection.[12]
- Chorioamnionitis (OR: 8.95, 95 percent CI 6.23-12.85), premature rupture of membranes (OR: 7.07, 95 percent CI 5.20-9.61) and multiple birth (OR: 5.11, 95 percent CI 3.86-6.77) were each associated with a large increase in the likelihood of infant death. In fact, each factor was associated with an estimated risk that was at least five times that of the respective reference groups.

[11] Cleveland Clinic. *Diseases and Conditions: Chorioamnionitis.* http://my.clevelandclinic.org/healthy_living/pregnancy/hic_chorioamnionitis.aspx. Accessed 12/9/2011.

[12] Children's Hospital of Wisconsin. *Premature Rupture of Membranes (PROM) / Preterm Premature Rupture of Membranes (PPROM).* http://www.chw.org/display/PPF/DocID/23201/router.asp. Accessed 12/9/2011.

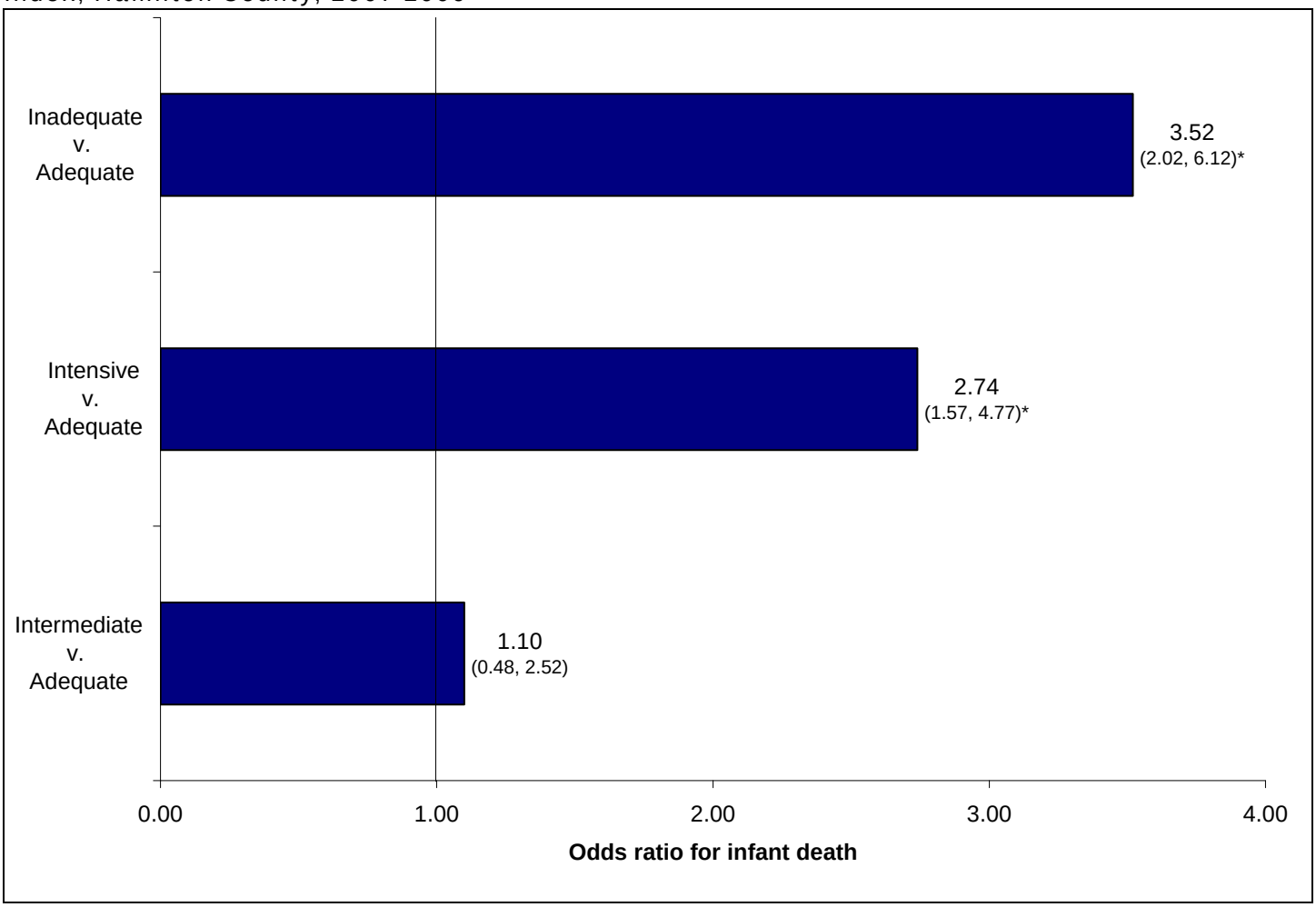
Figure 12B. Odds Ratios for Preterm Birth by Selected Pregnancy Risk Factors, Hamilton County, 2007-2009



Summary:

- The risk of having a preterm birth was heightened significantly when any of the following risk factors were present: premature rupture of membranes (OR: 13.68, 95 percent CI 11.80-15.85); multiple birth (OR: 11.25, 95 percent CI 10.06-12.58) and chorioamnionitis (OR: 2.32, 95 percent CI 1.88-2.85).
- Among the three selected pregnancy risk factors, chorioamnionitis had the highest odds of infant death (OR: 8.95, 95 percent CI 6.23-12.85), but the lowest odds of preterm birth (OR: 2.32, 95 percent CI 1.88-2.85).
- The odds of preterm birth were increased by factors of greater than 11 and 13 for mothers with either a multiple birth or PROM, respectively.
- See page 21 for factor definitions.

Figure 13A. Odds Ratios for Infant Death by Kotelchuck Adequacy of Prenatal Care Utilization Index, Hamilton County, 2007-2009

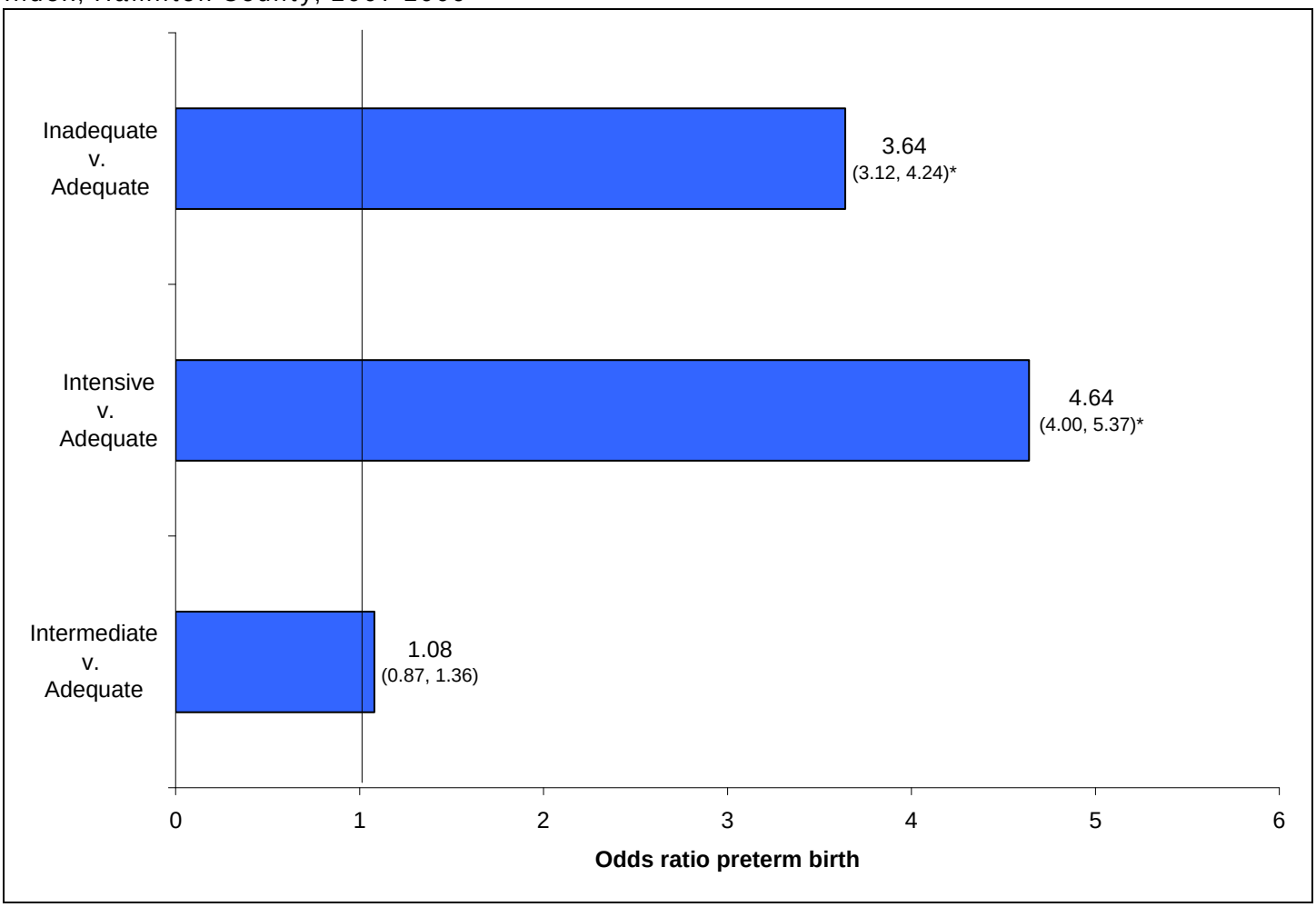


Summary:

- The reference group consisted of infants born to mothers who received adequate prenatal care according to Kotelchuck's Adequacy of Prenatal Care Utilization Index.[13]
- The Kotelchuck Index is calculated using the month of pregnancy in which prenatal care was started, along with the number of prenatal care visits.
- Births to mothers who received a level of prenatal care that was rated as inadequate or intensive faced an elevated risk of infant death compared to the reference group. This risk was estimated to be close to three times higher for intensive prenatal care and 3.5 times higher for inadequate care; the former representing mothers with co-morbidities that require more frequent medical evaluation.
- There was no difference in the risk of infant death for mothers who received prenatal care rated as intermediate compared to those who received adequate care (OR: 1.10, 95 percent CI 0.48-2.52).

[13] Alexander, G.R., Kotelchuck, M. *Quantifying the Adequacy of Prenatal Care: A Comparison of Indices.* Public Health Reports, 111, 408-418.

Figure 13B. Odds Ratios for Preterm Births by Kotelchuck Adequacy of Prenatal Care Utilization Index, Hamilton County, 2007-2009

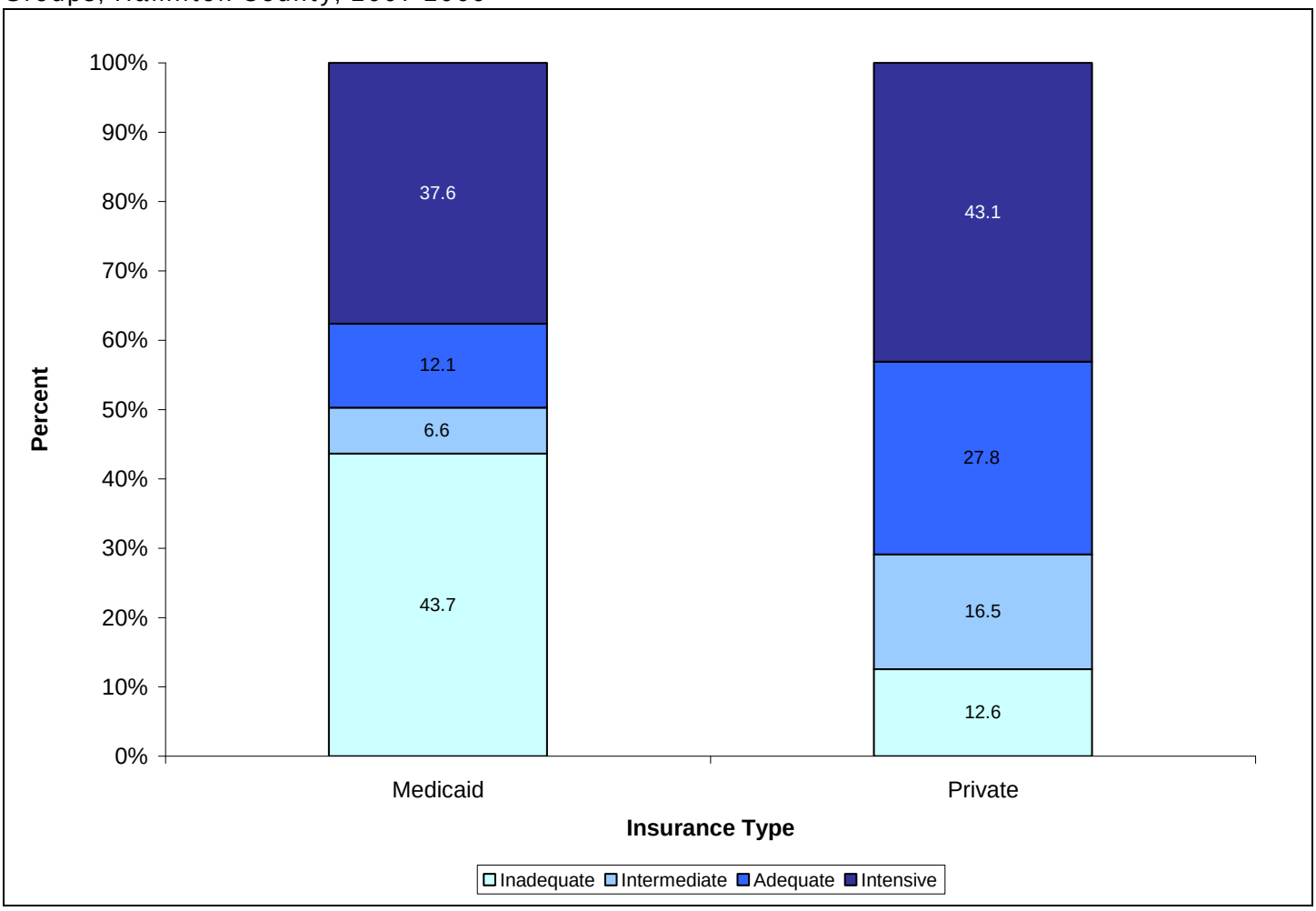


Summary:

- The reference group consisted of infants born to mothers who received adequate prenatal care according to Kotelchuck's Adequacy of Prenatal Care Utilization Index.[13]
- The Kotelchuck Index is calculated using the month of pregnancy in which prenatal care was started, along with the number of prenatal care visits.
- Mothers who received prenatal care rated as inadequate or intensive were three to five times more likely to have a preterm delivery than mothers who received adequate levels of prenatal care.
- The highest odds of infant death were associated with inadequate prenatal care, while the highest odds of preterm births were observed for women who received intensive prenatal care. Women in the intensive prenatal care category started care earlier and had more prenatal care visits than women who received inadequate care. Intensive prenatal care, therefore, may enable more effective monitoring and prevention of conditions associated with infant death.

[13] Alexander, G.R., Kotelchuck, M. *Quantifying the Adequacy of Prenatal Care: A Comparison of Indices.* Public Health Reports, 111, 408-418.

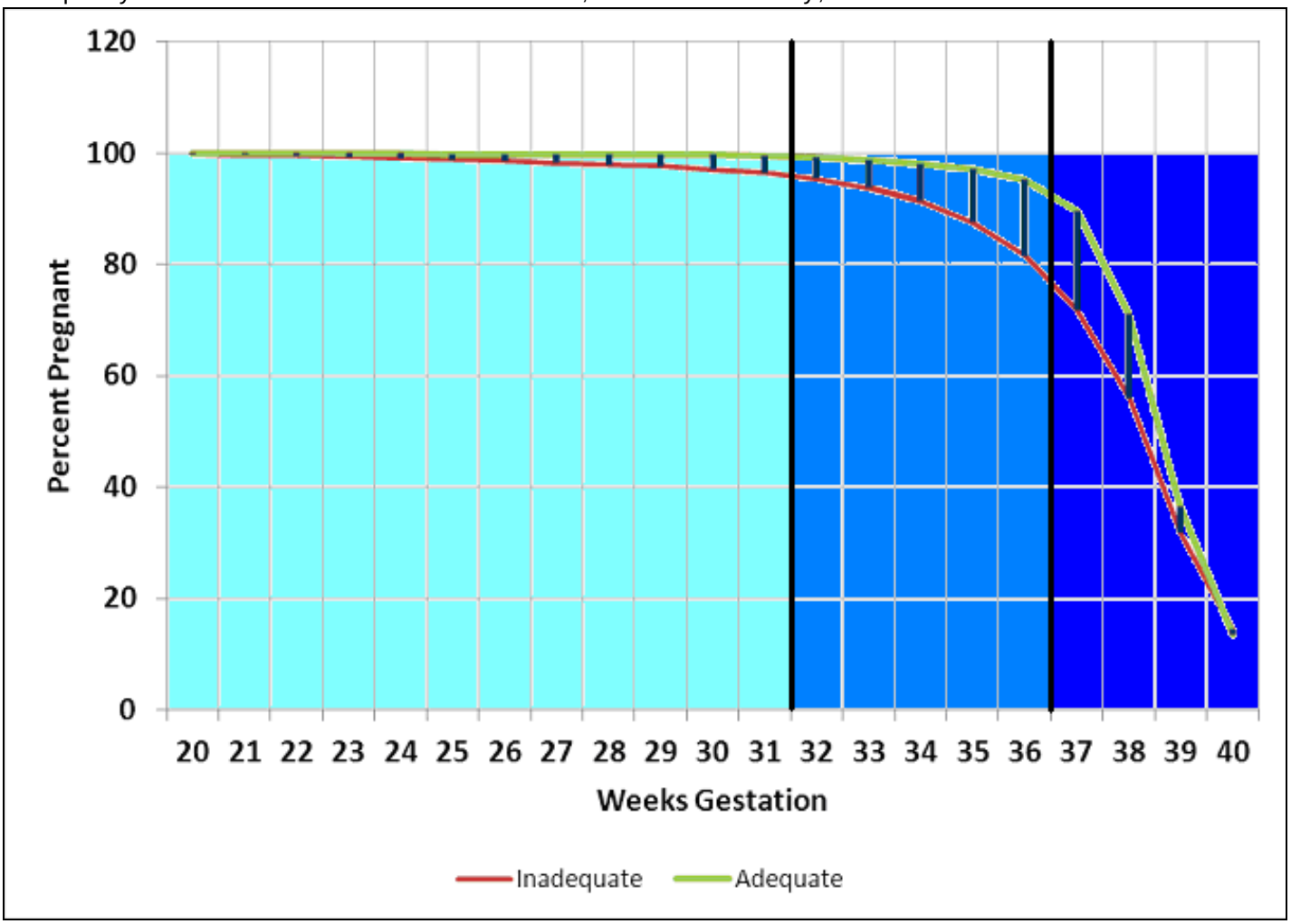
Figure 13C. Percent Distribution of Births by Kotelchuck Adequacy of Prenatal Care Utilization Groups, Hamilton County, 2007-2009



Summary:

- Figure 13C shows the distribution regarding adequacy of prenatal care to mothers who delivered a live birth using either Medicaid or private insurance as payment for delivery.
- A very high percentage of mothers using Medicaid as payment for delivery received inadequate prenatal care (43.7 percent). A much lower percentage of inadequate prenatal care was present for mothers who used private insurance as the payment for delivery (12.6 percent).
- Additionally, a higher percentage of mothers received adequate prenatal care when using private insurance (27.8 percent) for payment of delivery versus Medicaid (12.1 percent).

Figure 13D. Pregnancy Curve by the Adequacy of Prenatal Care as Determined by the Kotelchuck Adequacy of Prenatal Care Utilization Index, Hamilton County, 2007-2009



Summary:

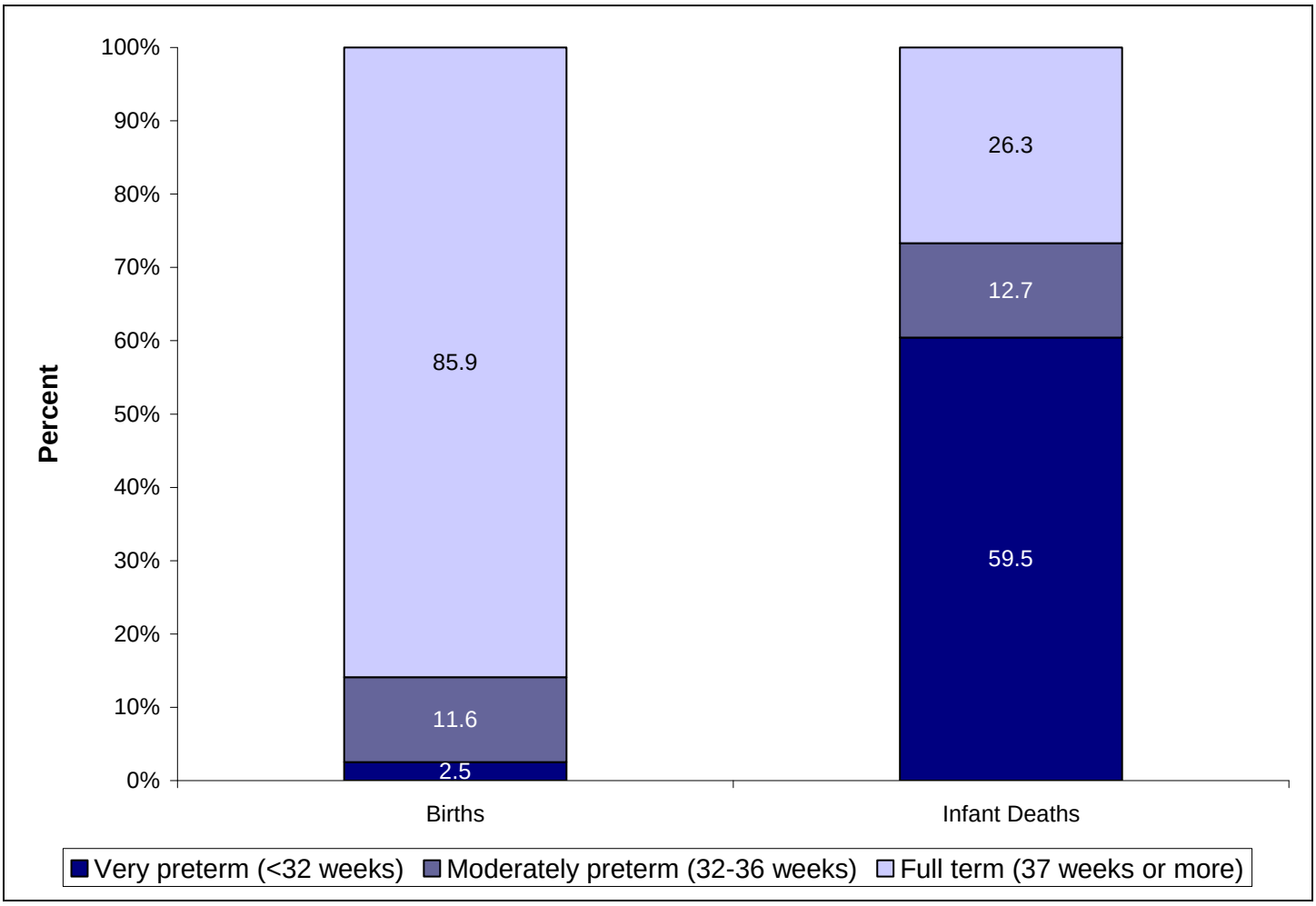
- Prenatal care is an important predictor of infant mortality and preterm birth in Hamilton County (Figures 13 A-B). The impact of inadequate prenatal care is also depicted in Figure 13D. The adequacy of prenatal care seemed to impact the percentage of women who remained pregnant between 20 and 40 weeks gestation.
- Important, large differences were observed at 36 and 37 weeks gestation. During week 36 of pregnancy, 95 percent of women who received adequate prenatal care remained pregnant (i.e., these women did not deliver their babies); 82 percent of women who received inadequate prenatal care remained pregnant. The discrepancy was larger at 37 weeks gestation: 90 percent and 72 percent of women remained pregnant who had adequate and inadequate prenatal care, respectively.
- The Kotelchuck Index was used to determine the adequacy of care. This index was calculated using the month of pregnancy in which prenatal care began, along with the number of prenatal care visits.[13]

[13] Alexander, G.R., Kotelchuck, M. *Quantifying the Adequacy of Prenatal Care: A Comparison of Indices.* Public Health Reports, 111, 408-418.

Section III: Infant Characteristics

Gestational Age

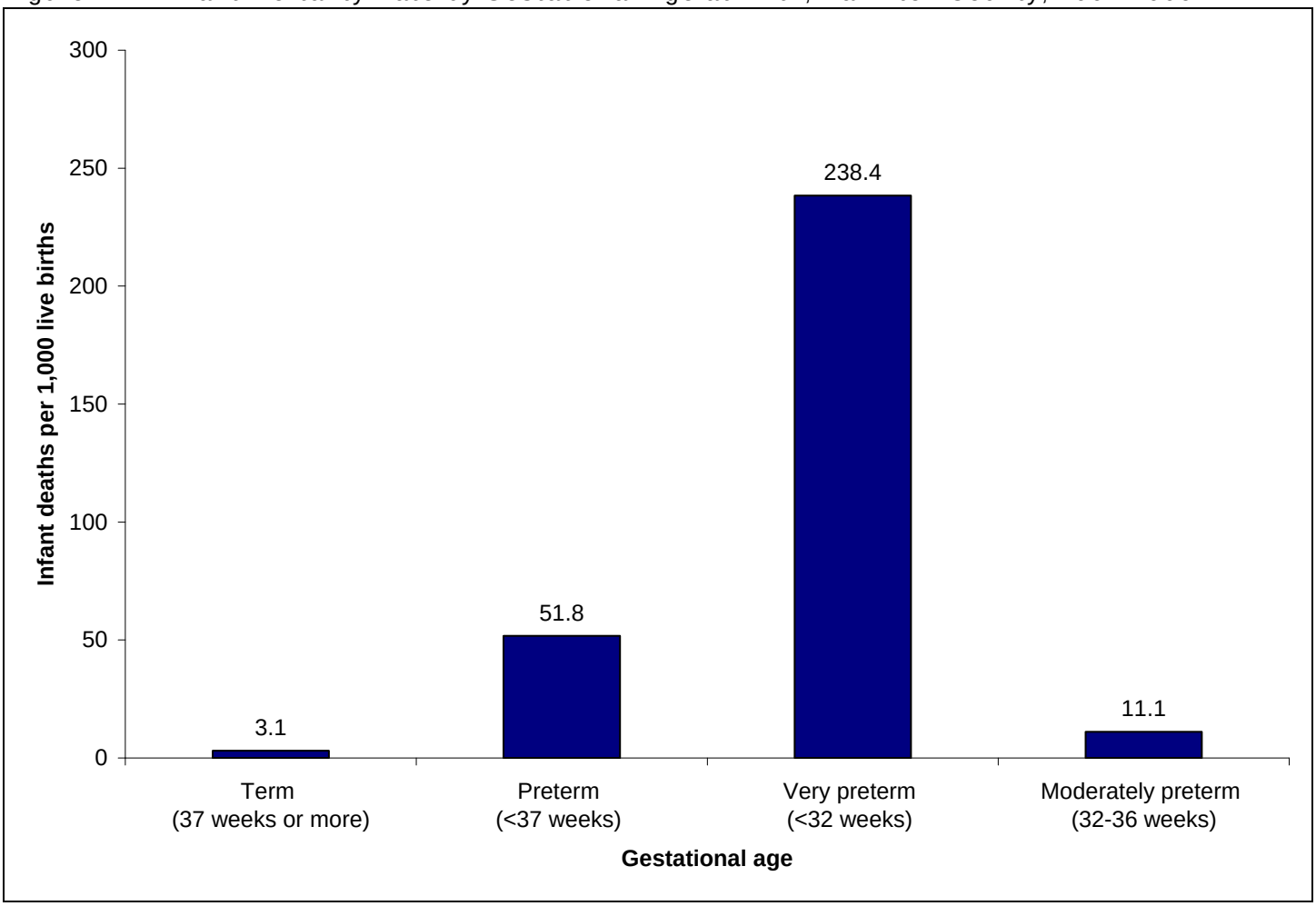
Figure 14A. Percentage of Births and Infant Deaths by Gestational Age at Birth, Hamilton County, 2007-2009



Summary:

- Infants born preterm (before 37 completed weeks of gestation) faced the greatest risk of dying in infancy and the earlier the birth, the higher the risk.
- While a relatively small number of Hamilton County births were delivered before 32 weeks of gestation, these very preterm deliveries accounted for nearly 60 percent of Hamilton County infant deaths.
- About one in seven (14.1 percent) Hamilton County births were delivered preterm, but nearly six of eight (72.2 percent) infants who died before their first birthday were born preterm.

Figure 14B. Infant Mortality Rate by Gestational Age at Birth, Hamilton County, 2007-2009

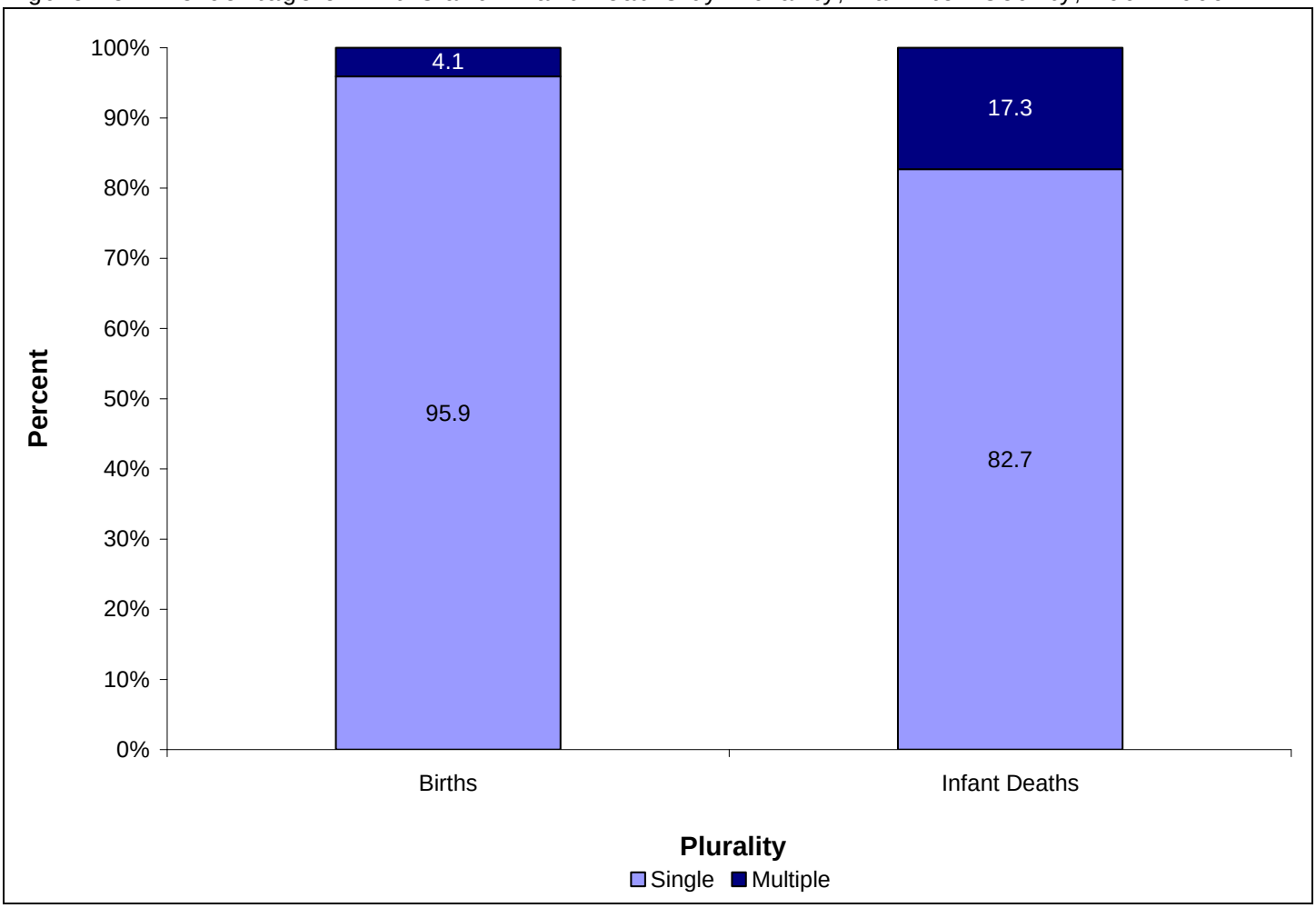


Summary:

- Among live births delivered full-term (37 weeks or more), the infant mortality rate was 3.1 per 1,000 live births, which is less than one-half of the 2009 national IMR (6.4 per 1,000 live births). Reducing the preterm births in Hamilton County would significantly improve the rates of infant mortality.
- Delivering preterm significantly increased the likelihood of infant mortality.
- The infant mortality rate for infants born preterm was almost 17 times higher than the comparable full-term IMR; births in the very preterm range (less than 32 weeks gestation) had an IMR (238.4 per 1,000 live births) that was 76 times higher than the full-term IMR.
- Almost one in four births delivered before 32 weeks of gestation died in infancy. The IMR for these very preterm infants was 21 times higher than the IMR for preterm infants born at 32-36 weeks.

Plurality

Figure 15A. Percentage of Births and Infant Deaths by Plurality, Hamilton County, 2007-2009

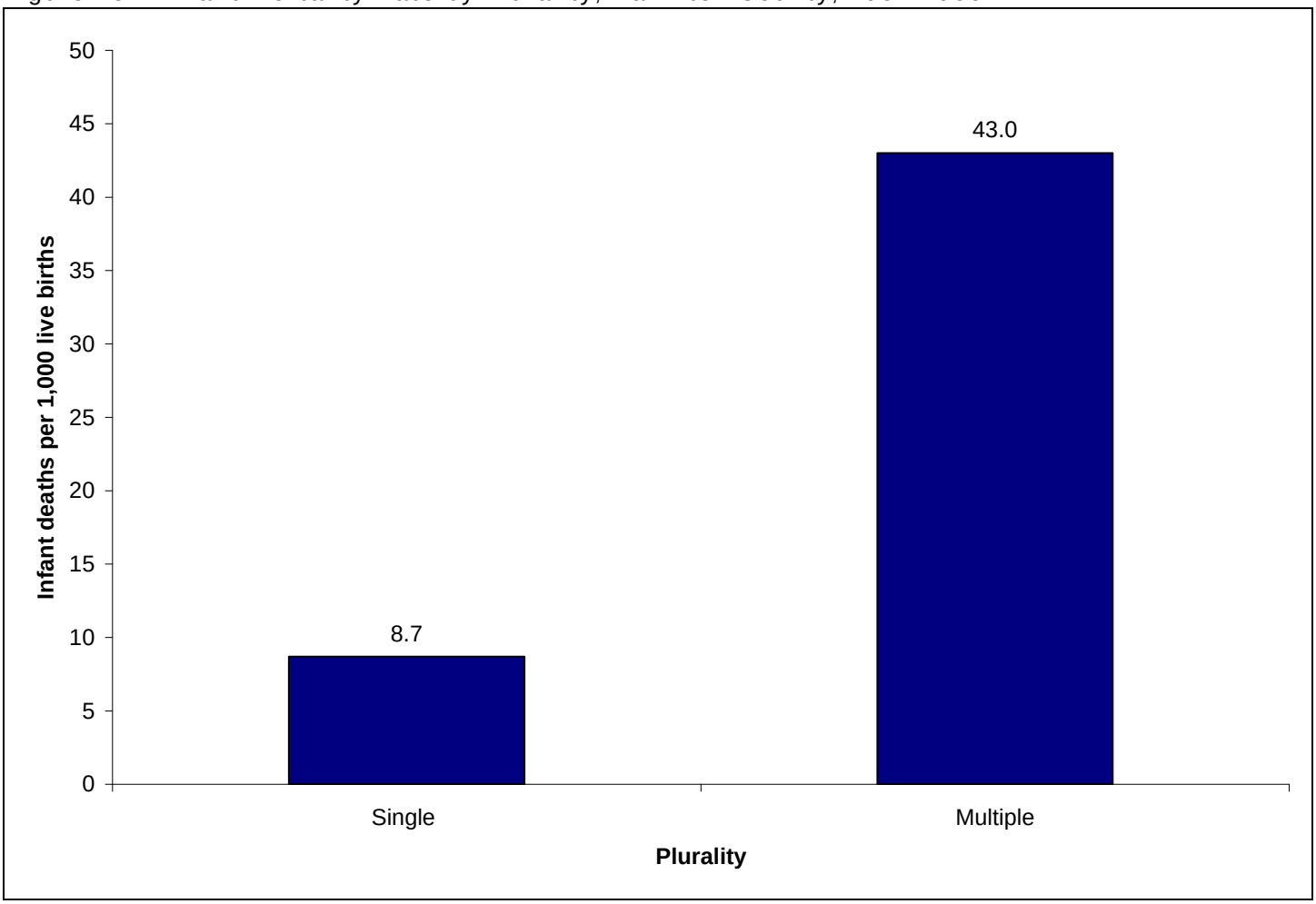


Summary:

- Plurality refers to the number of births that result from a single pregnancy. Singletons are one infant at delivery and multiples are more than one infant at delivery.
- The majority (96 percent) of Hamilton County births were singleton deliveries.
- Although multiple births (twins, triplets, etc.) accounted for only *one in 25* births (4.0 percent), these births accounted for more than *one in six* (17.3 percent) infant deaths in the county.
- According to the CDC, multiple births were almost four times more likely than singleton births to be delivered in the late preterm stage (34-36 weeks); multiple births also face a higher risk for complications at birth, long-term developmental problems and death during the first year of life.[14]

[14] Centers for Disease Control and Prevention. *MMWR QuickStats:Late Preterm Birth Rates,by Plurality.* January 8, 2010. 58 (51&52); 1445. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5851a7.htm. Accessed 2/24/2012.

Figure 15B. Infant Mortality Rate by Plurality, Hamilton County, 2007-2009



Summary:

- There is a well-established relationship between multiple births and preterm delivery. An annual study of 2004 vital statistics data showed that over half of multiple births are preterm compared to 12.5 percent of all births.[15]
- Gardner *et al*. demonstrated a five-fold increase in the number of preterm births among twins compared to singletons – 54 percent compared to 9.6 percent, respectively.[16] Figure 15B displays a similarly large disparity in the infant mortality rate for multiple and singleton births (43.0 deaths per 1,000 multiple births compared to the singleton IMR of 8.7).

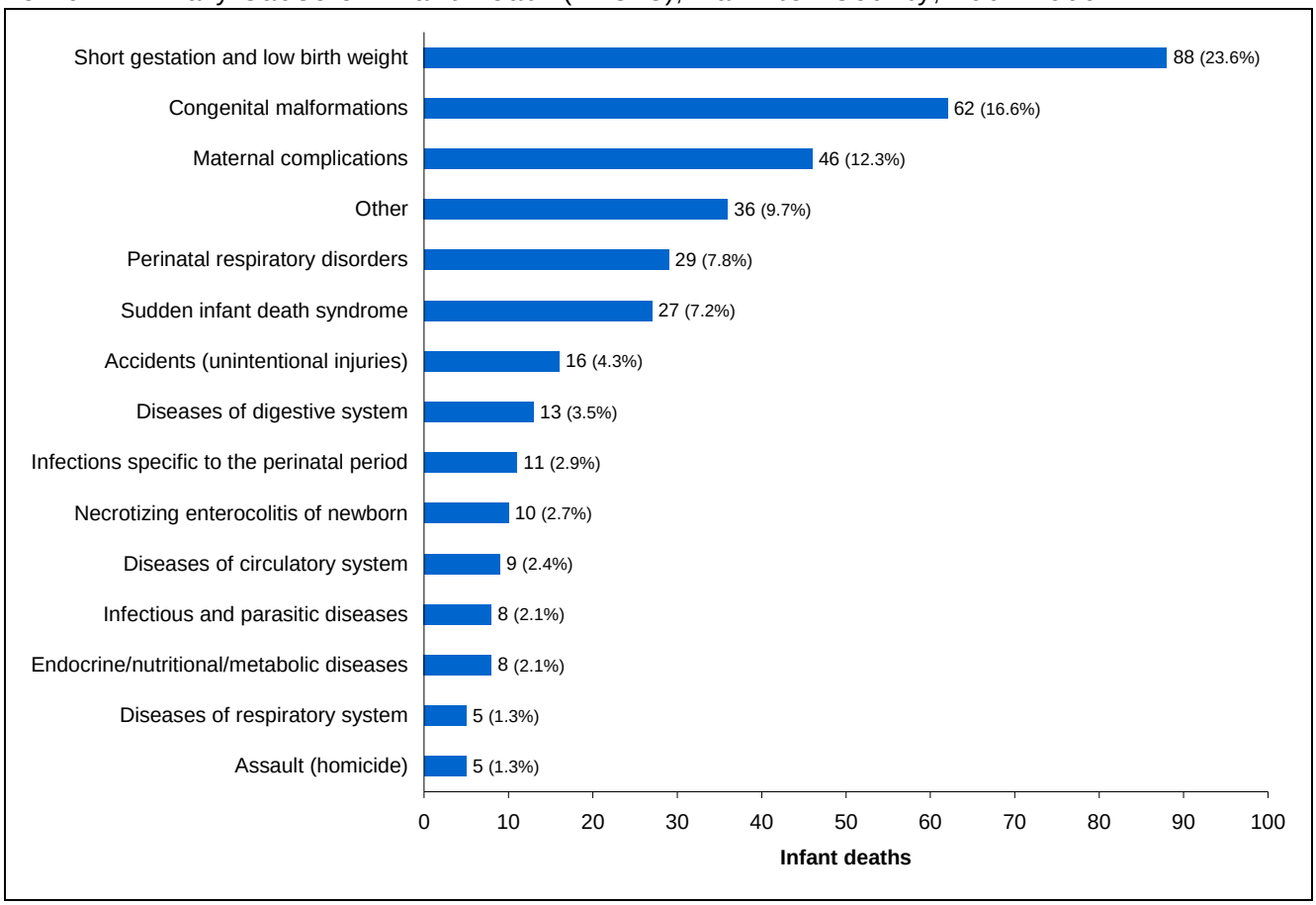
[15] Hoyert DL; Mathews TJ; Menacker F et al. 2006. *Annual Summary of Vital Statistics*. Pediatrics. Vol. 117(1). http://pediatrics.aappublications.org/content/117/1/168.full.pdf+html. Accessed 2/2/2012.

[16] Gardner MO; Goldenber RL; Cliver SP et al. 1995. *The origin and outcome of preterm twin pregnancies.* Obstetrics and Gynecology. Vol. 85(4). http://www.sciencedirect.com/science/article/pii/002978449400455M. Accessed 6/8/2012.

Cause of Death

The causes of death for all 373 infant deaths that occurred during 2007-2009 were reviewed and categorized. See Appendix B for additional information on the methods used to assign primary causes of death

Figure 16A. Primary Cause of Infant Death (N=373), Hamilton County, 2007-2009



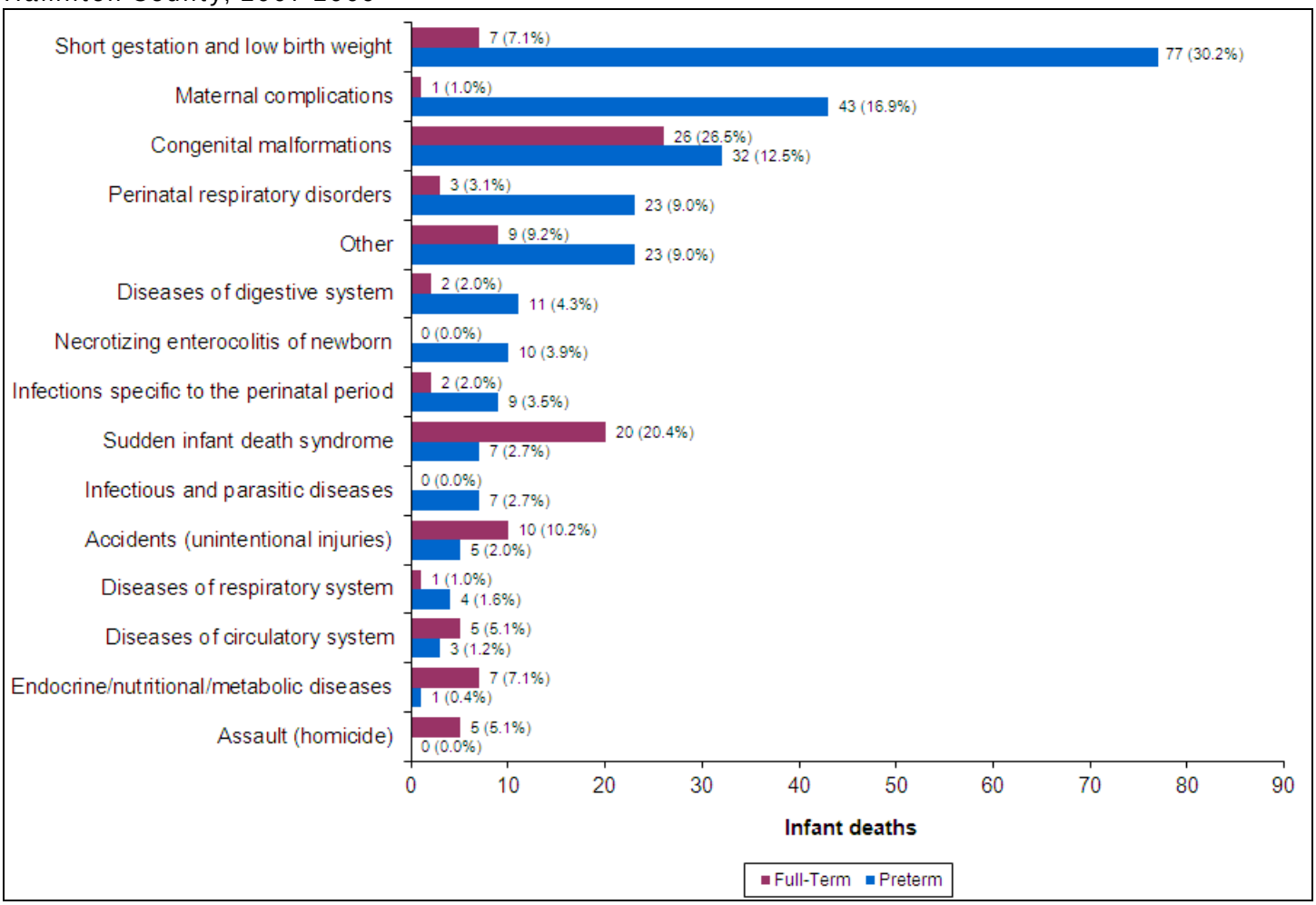
Summary:

- The largest number of infant deaths was attributed directly to short gestation and low birth weight (*i.e.,*, immaturity.) One in four infant deaths (23.6 percent) in Hamilton County was due to immaturity.
- Congenital malformations and maternal complications of pregnancy accounted for another sizable proportion of Hamilton County infant deaths (16.6 percent). The National Center for Health Statistics reports that the leading causes of infant death in 2009 were congenital malformations, disorders related to short gestation and low birth weight, Sudden Infant Death Syndrome and maternal complications.[17]
- The "Other" category included diseases that were listed as 'Other and Unspecified' (N=18), 'Other Conditions of Perinatal Period' (N=8), or had a frequency of less than five during the three year period.
- The 27 cases of SIDS include many instances where an inappropriate sleeping arrangement was documented. The Hamilton County Family and Children First Council Child Fatality Review identified nine cases of inappropriate sleep arrangements for 2009 alone.[18]

[17] Minino AM, Murphy SL, Jiaquan X, Kochanek KD. *Deaths: Final Data for 2008.* National Vital Statistics Reports: Vol 59 No. 10. 12/7/2011. National Center for Health Statistics. http://www.cdc.gov/nchs/deaths.htm. Accessed 2/2/2012.

[18] The Hamilton County Family and Children First Council. *Child Fatality Review Team Annual Report 2009.* http://www.hamiltoncountyohio.gov/hcfcfc/ChildFatalityReport2009.pdf. Accessed 2/24/2012.

Figure 16B. Primary Cause of Death for Infants Born Full-Term (N=98) vs. Preterm (N=255), Hamilton County, 2007-2009



Summary:

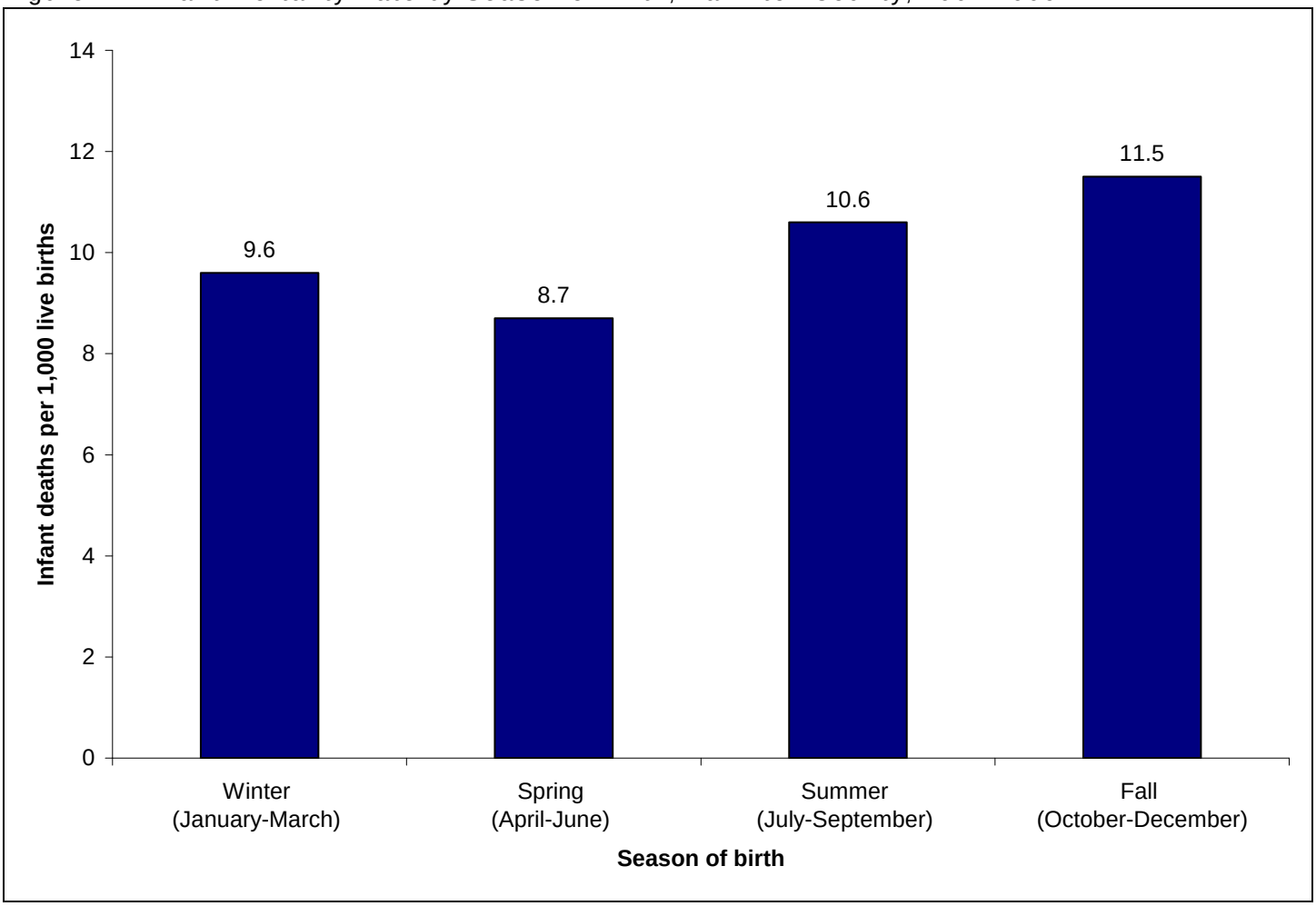
- Gestational age is an important predictor of infant health and survival. Matthews and MacDorman reported that infants born too early have a greater risk of death, as well as short-term and long-term disability. [19]
- Although 30 percent of preterm infant deaths were caused directly by short gestation or low birth weight, 61.8 percent of infant deaths were preterm-related as defined by the CDC.[19]
- The majority of infants who died (73.3 percent) had a gestational age of less than 37 weeks.
- The primary cause of death for preterm infants is displayed in Figure 16B. The factors most responsible for preterm deaths included short gestation and low birth weight (N=77), maternal complications (N=43) and congenital malformations (N=32).
- The factors most responsible for full-term infant deaths included congenital malformations (N=25), sudden infant death syndrome (N=20) and unintentional injuries (N=10).
- The "Other" category included diseases that were listed as 'Other and Unspecified', 'Other Conditions of Perinatal Period' or had a frequency of less than five for preterm infant deaths during the three year period.

[19] Mathews TJ, MacDorman MF 2010. Infant Mortality Statistics from the 2006 period linked birth/infant data set. *National Vital Statistics Reports*; Vol 58 No. 17. Hyattsville, MD: National Center for Health Statistics.2010.

Section IV: Seasonal and Spatial Distribution

Seasonality

Figure 17. Infant Mortality Rate by Season of Birth, Hamilton County, 2007-2009

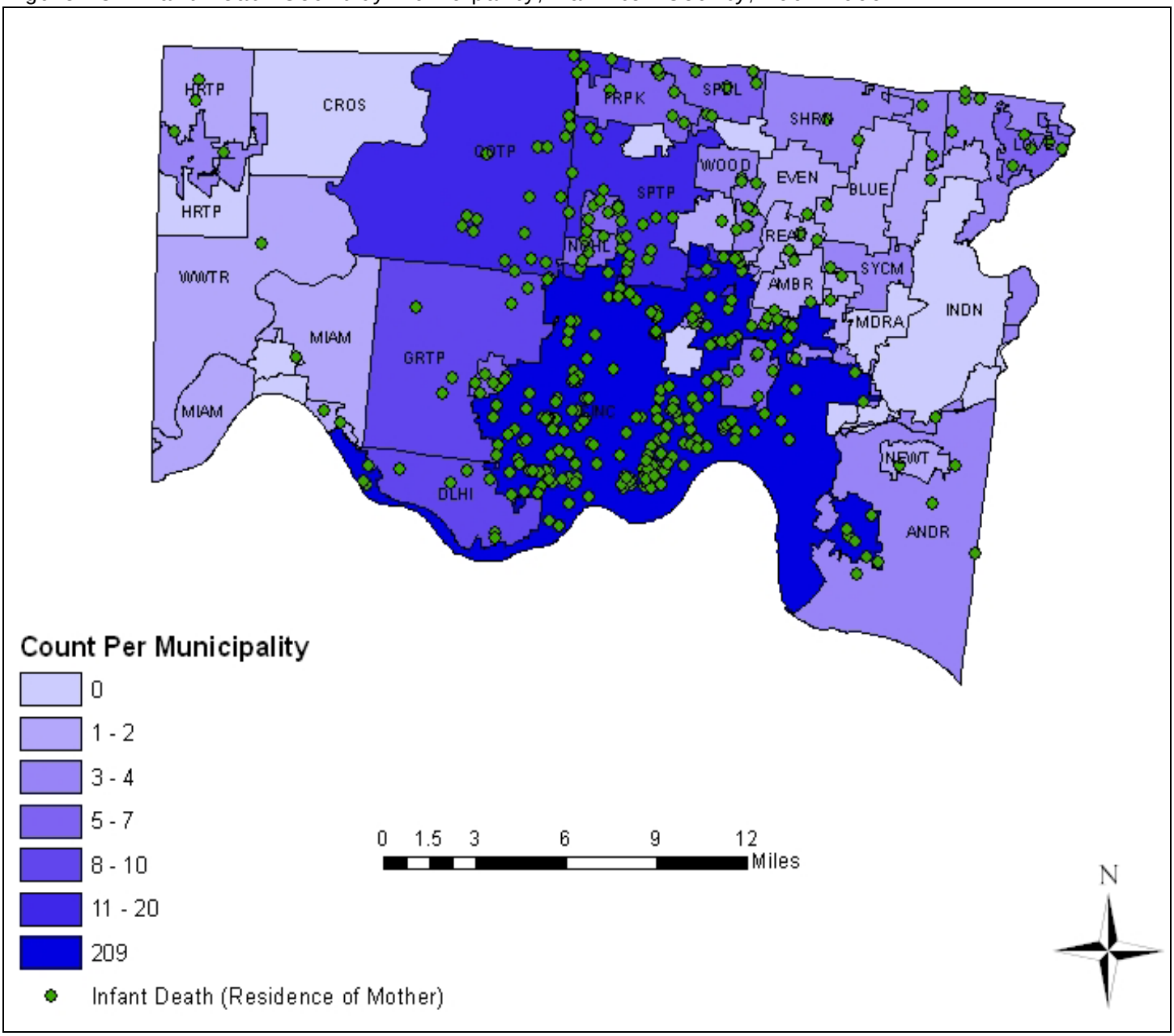


Summary:

- Seasonal variation in infant mortality is evident within Hamilton County.
- Infants born during the spring (April to June) experienced the lowest rate of infant mortality (8.7 per 1,000 live births) over the 2007-2009 study period.
- In contrast, infants born during the fall (October to December) experienced the highest rate of infant death (11.5 per 1,000 live births).

Geographic Distribution

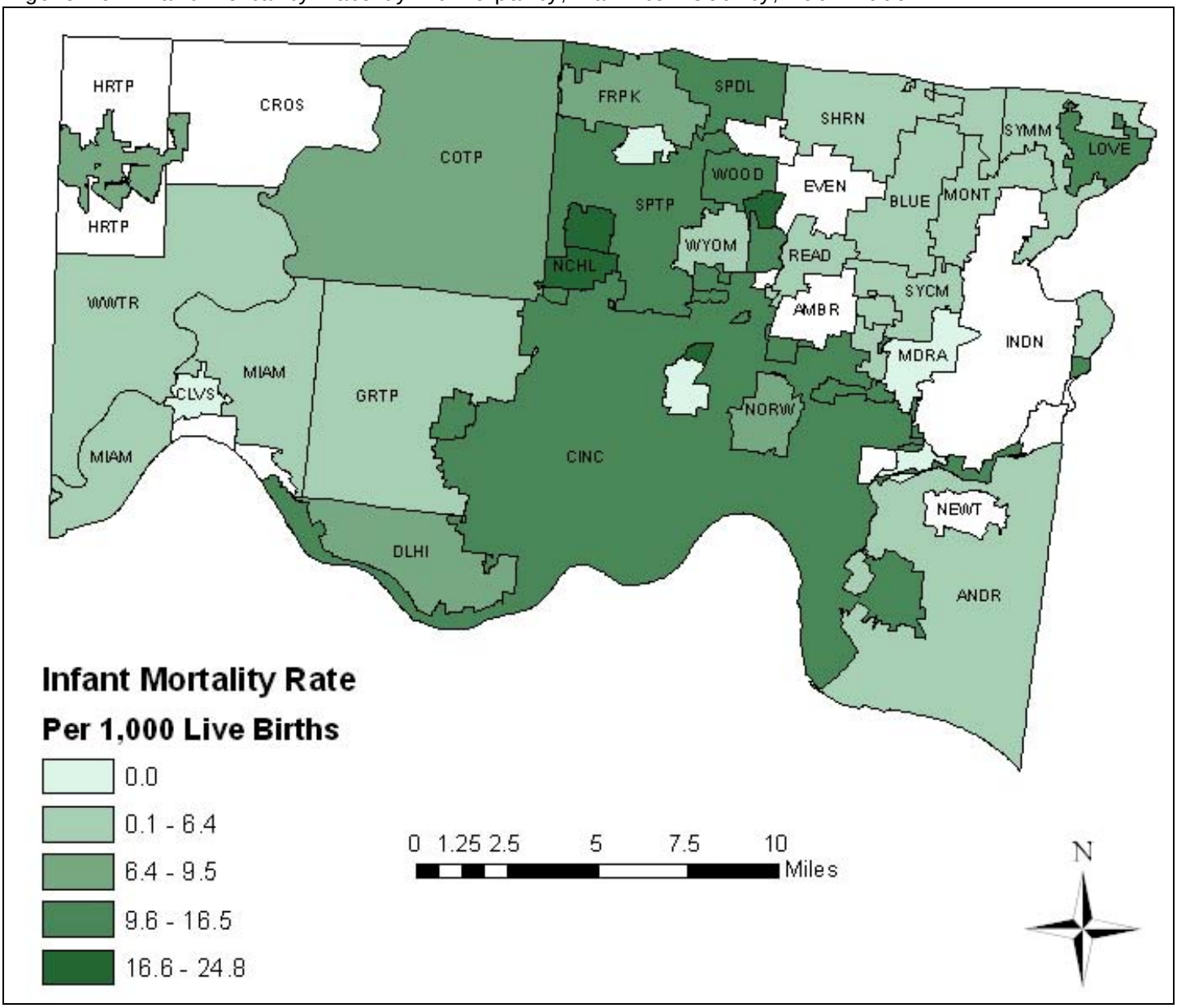
Figure 18. Infant Death Count by Municipality, Hamilton County, 2007-2009



Summary:

- The municipalities within Hamilton County that accounted for the greatest number of infant deaths were Cincinnati (N=209), Colerain Township (N=20) and Springfield Township (N=19).
- There were several municipalities that recorded zero deaths from 2007-2009. These included Cleves, Crosby Township, Fairfax, Glendale, Greenhills, Indian Hill, Madeira, Mariemont, North Bend, Saint Bernard and Terrace Park.

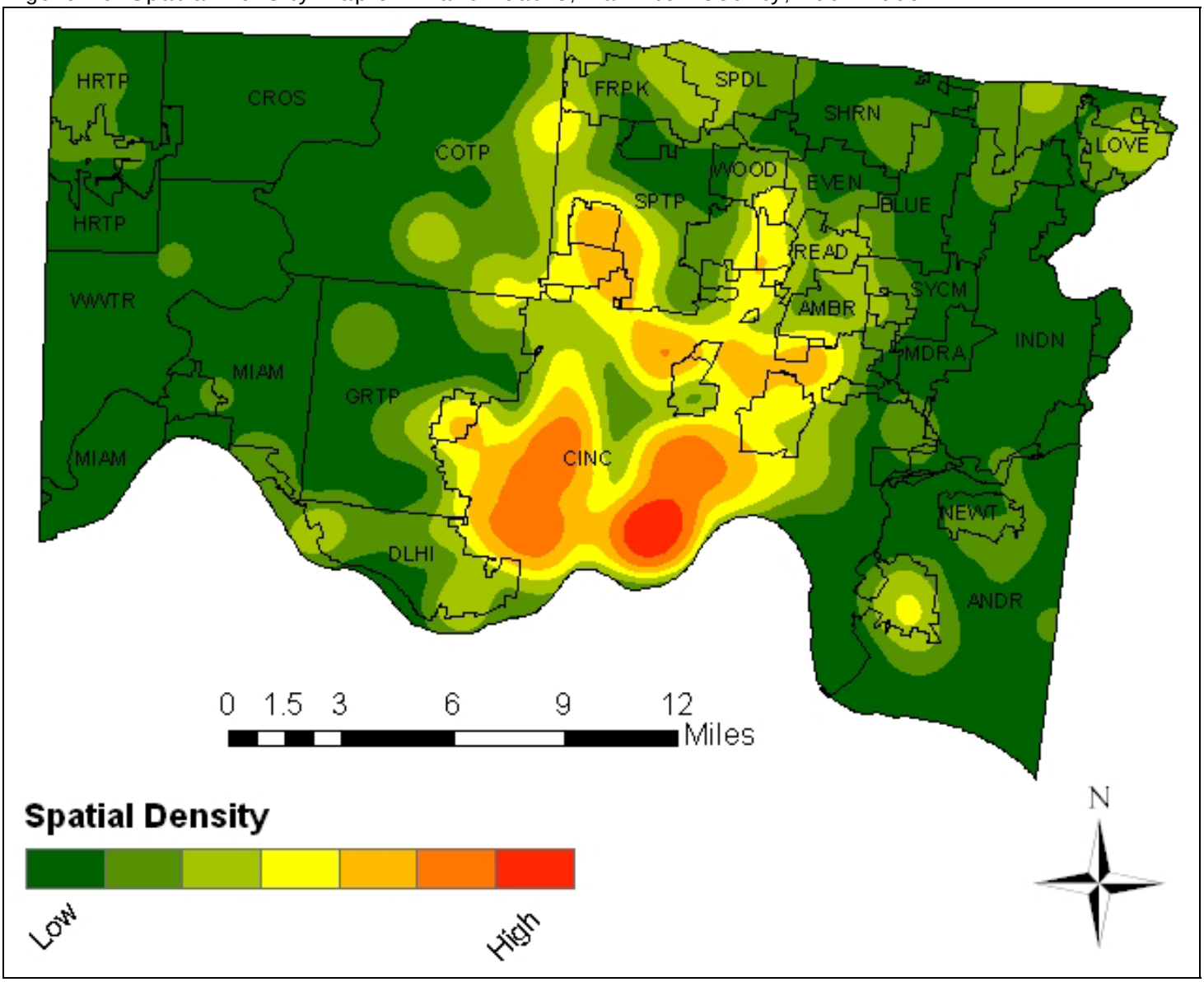
Figure 19. Infant Mortality Rate by Municipality, Hamilton County, 2007-2009



Summary:

- The infant mortality rate gives a different perspective of infant deaths within the community by comparing the number of infant deaths to the number of live births. This number is then standardized per 1,000 live births.
- Elmwood Place (24.8), Lincoln Heights (21.5) and Mount Healthy (19.6) had the three highest infant mortality rates among municipalities in Hamilton County that had at least 100 live births in the 2007-2009 review period. Cincinnati neighborhoods also experienced high IMRs during this period.
- Several municipalities with a minimum 100 live births had an IMR of zero: Cleves, Greenhills, Madeira, Mariemont, and Saint Bernard.
- Areas that are white did not meet the minimum threshold for rate calculation and were thus suppressed from the chart.

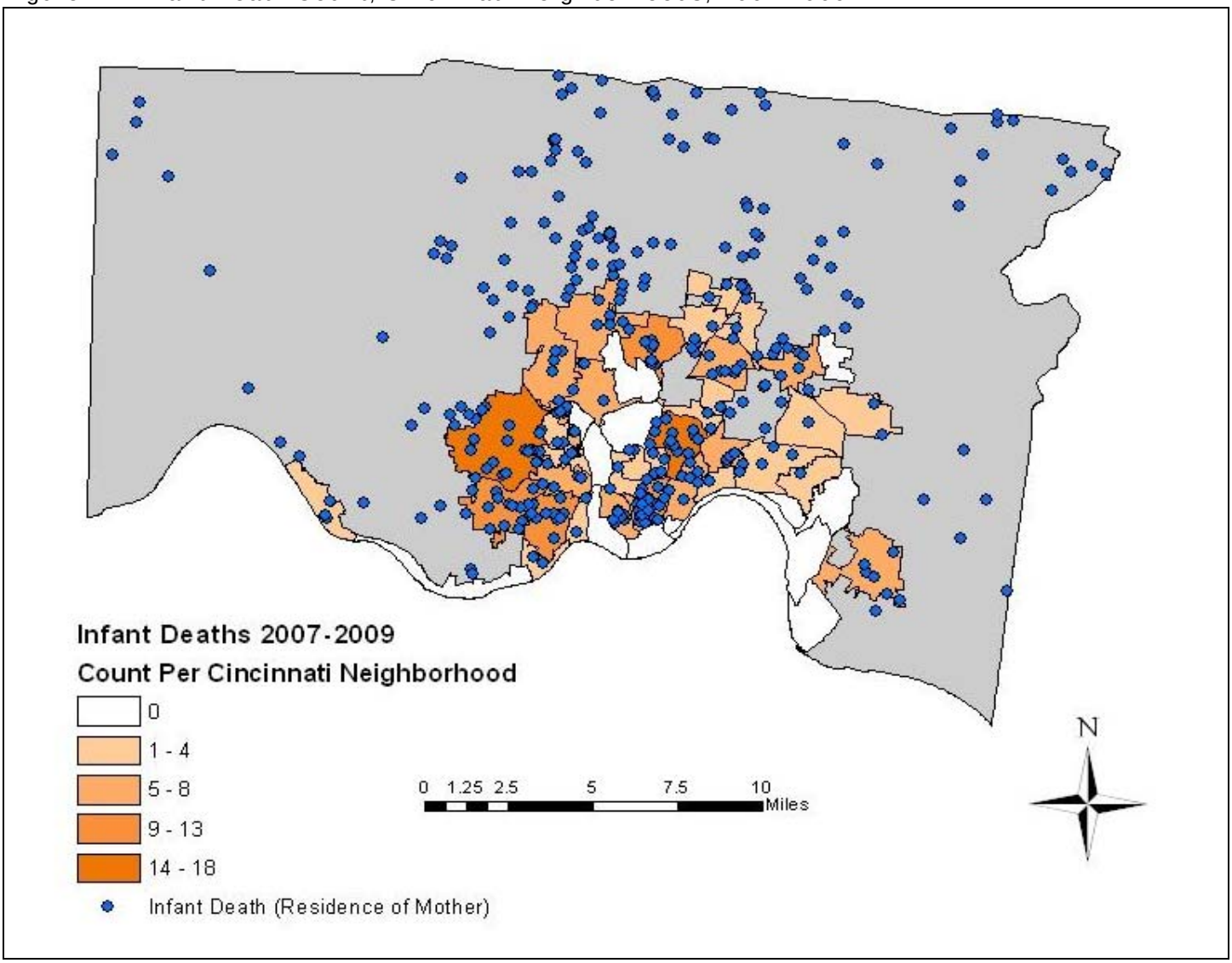
Figure 20. Spatial Density Map of Infant Deaths, Hamilton County, 2007-2009



Summary:

- Figure 20 shows the spatial density of all infant deaths from 2007-2009. Green areas denote low spatial density of infant mortality, while red areas designate high spatial density of infant mortality.
- The highest spatial density of infant deaths from 2007-2009 occurred within Cincinnati.

Figure 21. Infant Death Count, Cincinnati Neighborhoods, 2007-2009



Summary:

- The neighborhoods within the City of Cincinnati that accounted for the greatest number of infant deaths were Westwood (N=18), Avondale (N=15) and West Price Hill (N=13).
- There were several neighborhoods that recorded zero deaths from 2007-2009. These included Queensgate, East End, Linwood, Columbia Tusculum, California, Riverside, Central Business District/Riverfront, Mount Adams, Camp Washington, South Cumminsville, Clifton, Kennedy Heights and Spring Grove Village.

Appendix A – Glossary of Terms and Abbreviations

Congenital malformation	Birth defect
Gestational age	Week of pregnancy (Term births occurring at 37 weeks or later)
HCIMSS	Hamilton County Infant Mortality Surveillance System
IMR	Infant Mortality Rate is the number of infant deaths (*i.e.*, infants who die before their first birthday) per 1,000 live births
Neonatal	Less than 28 days old
NIMR	Neonatal Infant Mortality Rate is the number of infants who die at less than 28 days old per 1,000 live births
OMIHIMR	Office of Maternal and Infant Health and Infant Mortality Reduction. Established by joint resolution between health commissioners from the City of Cincinnati and Hamilton County. It wass overseen by a 10-member board, with five appointed by the City of Cincinnati and five by Hamilton County.
Post-neonatal	Age 28 days to one year
Preterm	Less than 37 weeks gestational age
Preterm-related death	Death caused directly by or from a complication of preterm birth
PROM	Premature Rupture of Membranes
SIDS	Sudden Infant Death Syndrome
Very Preterm	Less than 32 weeks gestational age
WIVN	Women and Infant Vitality Network. Business name of OMIHIMR

Rates

Infant Mortality Rate = Number of Infant Deaths (less than 1 year) / Number of Live Births * 1000
Neonatal Infant Mortality Rate = Number of Neonatal Deaths / Number of Live Births * 1000
Post Neonatal Infant Mortality Rate = Number of Post-Neonatal Deaths / Number of Live Births * 1000

Appendix B – Data Source and Technical Notes

Data Source

Data used in this report were generated by local entities and provided by the Ohio Department of Health Division of Vital Statistics. Charts, graphs, and tables were generated and analyses were performed by Hamilton County Public Health.

Datasets

Several datasets were used to provide the best possible data for each analysis. Whenever possible, a dataset containing death records of all 373 infant deaths from 2007-2009 was used (*e.g.*, the chart showing infant deaths by primary cause in Figure 16A). However, in order to examine maternal and infant characteristics related to birth (such as congenital malformations or gestational age), it was necessary to use linked birth-death datasets. A total of 353 infant deaths in the 2007-2009 period were successfully linked to 2006-2009 birth records. This linked data set was used to perform the odds ratio analyses of maternal risk factors. The majority of infants who died in 2007 were born in 2007; only 15 infants who died in 2007 were born in 2006. This linked dataset provided the best true comparison of mothers who did not experience infant death versus mothers who did.

Technical Notes

Primary Cause of Death

Hamilton County Public Health utilized the infant leading cause list to categorize the cause of death. These codes were used for all analyses related to cause of death. This list is contained in Appendix C.

Cause-of-death assignment may vary between the Child Fatality Review and Hamilton County Public Health. The Child Fatality Review uses an assignment made by the Hamilton County Coroner's Office. Hamilton County Public Health uses the Leading Cause 130 code assigned by the National Center for Health Statistics. The Child Fatality Review Team attributed three deaths to SIDS in the 2007-2009 period, whereas 27 are reported here for the same time period.[20] The difference in SIDS assignment may be related to an increasing classification of cause of death as undetermined as opposed to SIDS. A lack of nationwide terminology for sudden infant deaths along with medical examiners/coroners becoming increasingly reluctant to use SIDS as a cause of death may also explain the discrepancy in number of cases.[21]

Cause of death on Ohio vital statistics death records are determined by National Center for Health Statistics using the "Automated Classification of Medical Entities (ACME)" system, which assigns the primary underlying cause of death code to each death based on International Classification of Diseases, Revision 10 (ICD-10). Often death records contain several ICD-10 cause of death codes. The primary underlying cause of death is used to group specific death causes into larger groupings (e.g., malignant neoplasms or diseases of the heart). The ICD-10 cause of death assignment used for each death contained in this report were checked and found to be compatible with the primary cause of death assignments made by the Ohio Department of Health.

[20] Child Fatality Review Team. *SIDS Deaths*. Annual Reports: 2007-2009. http://www.hamiltoncountyohio.gov/hcfcfc/ChildFatalityReview.asp. Accessed 12/1/2011.
[21] CJ Foundation for SIDS. *Unexplained Infant Deaths.* http://www.cjsids.org/grief-and-bereavement/unexplained-infant-deaths.html. Accessed 2/28/2012.

Limitations

Data

The most recent year of vital statistics files that was cleaned and available at the time of analysis was the 2009 data. Finalized data files are better for comprehensive analyses but the lag time from final file to present date makes them less useful for timely surveillance. Birth-death file linkage for comprehensive analyses was limited due to changes in formatting in order to match the National Center for Health Statistics' format. A yearly summary of infant deaths allows comparisons from year to year to identify trends. Three years' (2007-2009) worth of data was used in order to strengthen the reliability of the analyses.

Statistical Methodology

Odds ratios were used as the estimates of risk. When events of interest are infrequent, such as less than 10 percent prevalence, the odds ratios tend to be a good estimate of actual risk.[22] This assumption may become weaker when adjustments are made for confounding factors. The odds ratios and confidence intervals in this chartbook were derived from logistic regression. Although data are population-based, the use of confidence intervals and statistical significance was applied and interpreted as if the data were collected from a sample. This approach was used to provide perspective for the reader and to estimate the actual underlying risk for disease; it should be noted that the analyses were not adjusted for correlated observations (i.e., a women who gave birth more than once during the study period). We will continue to generate new, three-year estimates as the data become available. In the geographical analyses performed for Figure 19, Infant Mortality by Municipality, those municipalities with less than 100 live births had their values suppressed due to statistical limitations and were represented with the color white on the map. Figure 20 was generated using a kernel density function within the GIS software package, ArcMap10. A reach of 7,920 feet (1.5 miles) and a cell size of 25 square feet were used to generate the figure. This function takes into account the number of infant deaths and closeness of those infant deaths to each individual raster cell.

Cause of Death Groupings

The expert primary cause of death assignment on the death record was considered to be the correct primary cause of death. However, the causes of death numbers vary from that reported by the Hamilton County Child Fatality Review Team (CFRT) as the CFRT uses a different coding methodology. These discrepancies highlight the challenge of determining the primary cause of death when multiple factors are present.

Notes on Figures

Figure 2A Percent Distribution of Births and Infant Deaths by Age of Mother, Hamilton County, 2007-2009

Not all maternal age groups experience an infant death; mothers in the less than 15 and greater than 44 age groups did not experience an infant death and therefore are not represented in Figure 2A.

Figure 3B Infant Mortality Rate by Race/Ethnicity of Mother, Hamilton County, 2007-2009

Births and deaths occurred in the other, non-Hispanic and Hispanic, any race categories; however, the numbers of infant deaths in these categories were too small to provide valid infant mortality rates. Whenever Hispanic origin was unknown, infants were placed in the non-Hispanic group. The Hispanic population may be of any race.

Figure 5A Percent Distribution of Births and Infant Deaths by Principal Payment Source for Delivery, Hamilton County, 2007-2009

The other/unknown category refers to those with an insurance not listed, self-pay, other government (federal, state, local) insurance, CHAMPUS/TRICARE or an unknown form of payment.

[22] Gordis L. (2009). *Epidemiology* (4th ed.). Philadelphia, PA: Saunders, Elsevier Inc.

Figure 5B Infant Mortality Rate by Principal Payment Source for Delivery, Hamilton County, 2007-2009
The other/unknown category refers to those with an insurance not listed, self-pay, other government (federal, state, local) insurance, CHAMPUS/TRICARE or an unknown form of payment.

Figure 8A Odds Ratios for Infant Death by Age of Mother, Hamilton County 2007-2009
Not all maternal age groups experience an infant death; mothers in the less than 15 and greater than 44 age groups did not experience an infant death and therefore odds ratios for infant death were not calculated.

Figure 9A Odds Ratios for Infant Death by Race/Ethnicity of Mother, Hamilton County, 2007-2009
Whenever Hispanic origin was unknown, infants were placed in the non-Hispanic group. The Hispanic population may be of any race.

Figure 11A Odds Ratios for Infant Death by Selected Maternal Medical and Behavioral Factors, Hamilton County, 2007-2009
Sexually Transmitted Infections refers to gonorrhea, chlamydia, or syphilis.

Figure 13A Odds Ratios for Infant Deaths by Kotelchuck Adequacy of Prenatal Care Utilization Index, Hamilton County, 2007-2009
Figure 13B Odds Ratios for Preterm Births by Kotelchuck Adequacy of Prenatal Care Utilization Index, Hamilton County, 2007-2009
The Kotelchuck Adequacy of Prenatal Care Utilization was determined for each mother using an adapted SAS code provided by the National Centers for Health Statistics.

Figure 14A Percentage of Births and Infant Deaths by Gestational Age at Birth, Hamilton County, 2007-2009
There were 91 births with an unknown gestational age; this represents close to 0 percent of the total number of births for 2007-2009. These births are not displayed in the chart.

Figure 15A. Percentage of Births and Infant Deaths by Plurality, Hamilton County, 2007-2009
There were 51 triplets born from 2007-2009. These triplets make up 0.1 percent of all births from 2007-2009. These births are not displayed in the chart.

Figure 16A. Primary Cause of Infant Death (N=373), Hamilton County, 2007-2009
There were 46 infants with a cause of death listed as 'Maternal Complications'. Maternal Complications was defined as newborn affected by maternal hypertensive disorder, complications of pregnancy, complications of placenta, cord and membranes, or syndrome of infant with diabetic mother and neonatal diabetes mellitus. There were 36 infants with a cause of death listed as 'Other, specified'. Other specified includes disease of the blood-forming organs, cystic fibrosis, anoxic brain damage and birth asphyxia. Percentages may not total 100 percent due to rounding.

Figure 18. Infant Death Count by Municipality, Hamilton County, 2007-2009
The count data was geo-coded using Health Landscape. Health Landscape geo-coding was found to be in agreement with ODH geo-coding for infant death by municipality 94.6% of the time. Differences present may be due to rounding of ODH geo-codes to six figures after the decimal point.

Figure 19. Infant Mortality Rate by Municipality, Hamilton County, 2007-2009
IMRs were calculated for each municipality designated by ODH geo-coding of infant deaths. Any municipality with less than 100 live births from 2007-2009 had the IMR suppressed from the figure. IMRs with small denominators, such as fewer than 100, allow for a greater amount of statistical error.

Figure 20. Spatial Density Map of Infant Deaths, Hamilton County, 2007-2009
The data were geo-coded using Health Landscape. The spatial analyst function of ArcMap 10 was used to create the figure, using 25 square feet as the raster size and 1.5 miles for the reach.

Figure 21. Infant Death Count, Cincinnati Neighborhoods, 2007-2009
The count data for Figure 21 was geo-coded using Health Landscape.

Appendix C – Infant Death Classification

130 Selected Causes of Infant Death **(Position 336-338)**	*Infant Leading Cause List **(Position 339-340)**	Cause of death (Based on the Tenth Revision, International Classification of Diseases, 1992)	Category codes according to the Tenth Revision (ICD-10) **(1999-2002 Position 297-300)**	Category codes according to the Ninth Revision (ICD-9) **(1989-1998 Position 297-300)**
		Certain infectious and parasitic diseases	A00-B99	001-033,034.1-134,136-139,771.3
1	99	Certain intestinal infectious diseases	A00-A08	001-008
2	1	Diarrhea and gastroenteritis of infectious origin	A09	009
3	2	Tuberculosis	A16-A19	010-018
4	3	Tetanus	A33,A35	037,771.3
5	4	Diphtheria	A36	032
6	5	Whooping cough	A37	033
7	6	Meningococcal infection	A39	036
8	7	Septicemia	A40-A41	038
9	8	Congenital syphilis	A50	090
10	9	Gonococcal infection	A54	098
		Viral diseases	A80-B34	042-079
11	10	Acute poliomyelitis	A80	045
12	11	Varicella (chickenpox)	B01	052
13	12	Measles	B05	055
14	13	Human immunodeficiency virus (HIV) disease	B20-B24	042-044
15	14	Mumps	B26	072
16	99	Other and unspecified viral diseases	A81-B00,B02-B04,B06-B19,B25, B27-B34	046-051,053-054,056-071,073-079
17	15	Candidiasis	B37	112
18	16	Malaria	B50-B54	084
19	17	Pneumocystosis	B59	136.3
20	99	All other and unspecified infectious and parasitic diseases	A20-A32,A38,A42-A49,A51-A53, A55-A79,B35-B36,B38-B49, B55-B58,B60-B99	020-031,034.1-035,039-041,080-083, 085-088,091-097,099-111,114-134, 136.0-136.2,136.4-139
		Neoplasms	C00-D48	140-239
		Malignant neoplasms	C00-C97	140-208
21	18	Hodgkin's disease and non-Hodgkin's lymphomas	C81-C85	200-202
22	18	Leukemia	C91-C95	204-208
23	19	Other and unspecified malignant neoplasms	C00-C80,C88-C90,C96-C97	140-199,203
24	19	In situ neoplasms, benign neoplasms and neoplasms of uncertain or unknown behavior	D00-D48	210-239
		Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	D50-D89	135, 279-289

25	20	Anemias	D50-D64	280-285
26	20	Other diseases of blood and blood-forming organs	D65-D76	286-289
27	20	Certain disorders involving the immune mechanism	D80-D89	135,279
		Endocrine, nutritional and metabolic diseases	E00-E88	240-278
28	21	Short stature, not elsewhere classified	E34.3	259.4
29	22	Malnutrition and other nutritional deficiencies	E40-E64	260-269
30	23	Cystic fibrosis	E84	277.0
31	24	Volume depletion, disorders of fluid, electrolyte and acid-base balance	E86-E87	276
32	99	All other endocrine, nutritional and metabolic diseases	E00-E32,E34.0-E34.2,E34.4-E34.9, E65-E83,E85,E88	240-259.3,259.8-259.9,270-275, 277.1-278
		Diseases of the nervous system	G00-G98	320-359,435
33	25	Meningitis	G00,G03	320-322
34	26	Infantile spinal muscular atrophy, type I (Werdnig-Hoffman)	G12.0	335.0
35	27	Infantile cerebral palsy	G80	343
36	28	Anoxic brain damage, not elsewhere classified	G93.1	348.1
37	99	Other diseases of nervous system	G04,G06-G11,G12.1-G12.9, G20-G72,G81-G92,G93.0, G93.2-G93.9,G95-G98	323-334,335.1-342,344-348.0, 348.2-359,435
38	29	Diseases of the ear and mastoid process	H60-H93	380-389
		Diseases of the circulatory system	I00-I99	390-434,436-459
39	30	Pulmonary heart disease and diseases of pulmonary circulation	I26-I28	415-417
40	30	Pericarditis, endocarditis and myocarditis	I30,I33,I40	420-422
41	30	Cardiomyopathy	I42	425
42	30	Cardiac arrest	I46	427.5
43	30	Cerebrovascular diseases	I60-I69	430-434,436-438
44	30	All other diseases of circulatory system	I00-I25,I31,I34-I38,I44-I45,I47-I51, I70-I99	390-414,423-424,426-427.4, 427.6-429,440-459
		Disease of the respiratory system	J00-J98	034.0,460-519
45	31	Acute upper respiratory infections	J00-J06	034.0,460-465
		Influenza and pneumonia	J10-J18	480-487
46	32	Influenza	J10-J11	487
47	32	Pneumonia	J12-J18	480-486
48	33	Acute bronchitis and acute bronchiolitis	J20-J21	466
49	34	Bronchitis, chronic and unspecified	J40-J42	490-491
50	35	Asthma	J45-J46	493
51	36	Pneumonitis due to solids and liquids	J69	507
52	99	Other and unspecified diseases of respiratory system	J22,J30-J39,J43-J44,J47-J68,J70-J98	470-479,492,494-506,508-519
		Diseases of the digestive system	K00-K92	520-579
53	37	Gastritis, duodenitis, and noninfective enteritis and colitis	K29,K50-K55	535, 555-558
54	38	Hernia of abdominal cavity and intestinal obstruction		

		without hernia	K40-K46,K56	550-553,560
55	99	All other and unspecified diseases of digestive system	K00-K28,K30-K38,K57-K92	520-534,536-543,562-579
		Diseases of the genitourinary system	N00-N95	580-629
56	39	Renal failure and other disorders of kidney	N17-N19,N25,N27	584-589
57	99	Other and unspecified diseases of genitourinary system	N00-N15,N20-N23,N26,N28-N95	580-583,590-629
		Certain conditions originating in the perinatal period	P00-P96	760-771.2,771.4-779
		Newborn affected by maternal factors and by complications of pregnancy, labor and delivery	P00-P04	760-763
58	40	Newborn affected by maternal hypertensive disorders	P00.0	760.0
59	41	Newborn affected by other maternal conditions which may be unrelated to present pregnancy	P00.1-P00.9	760.1-760.6,760.8-760.9
		Newborn affected by maternal complications of pregnancy	P01	761
60	42	Newborn affected by incompetent cervix	P01.0	761.0
61	42	Newborn affected by premature rupture of membranes	P01.1	761.1
62	42	Newborn affected by multiple pregnancy	P01.5	761.5
63	42	Newborn affected by other maternal complications of pregnancy	P01.2-P01.4,P01.6-P01.9	761.2-761.4,761.6-761.9
		Newborn affected by complications of placenta, cord and membranes	P02	762
64	43	Newborn affected by complications involving placenta	P02.0-P02.3	762.0-762.3
65	43	Newborn affected by complications involving cord	P02.4-P02.6	762.4-762.6
66	43	Newborn affected by chorioamnionitis	P02.7	762.7
67	43	Newborn affected by other and unspecified abnormalities of membranes	P02.8-P02.9	762.8-762.9
68	44	Newborn affected by other complications of labor and delivery	P03	763.0-763.4,763.6-763.9
69	45	Newborn affected by noxious influences transmitted via placenta or breast milk	P04	760.7, 763.5
		Disorders related to length of gestation and fetal malnutrition	P05-P08	764-766
70	46	Slow fetal growth and fetal malnutrition	P05	764
		Disorders related to short gestation and low birth weight, not elsewhere classified	P07	765
71	47	Extremely low birth weight or extreme immaturity	P07.0,P07.2	765.0
72	47	Other low birth weight or preterm	P07.1,P07.3	765.1
73	48	Disorders related to long gestation and high birth weight	P08	766
74	49	Birth trauma	P10-P15	767
		Intrauterine hypoxia and birth asphyxia	P20-P21	768
75	50	Intrauterine hypoxia	P20	768.2-768.4
76	50	Birth asphyxia	P21	768.5-768.9
77	51	Respiratory distress of newborn	P22	769

		Other respiratory conditions originating in the perinatal period	P23-P28	770
78	52	Congenital pneumonia	P23	770.0
79	53	Neonatal aspiration syndromes	P24	770.1
80	54	Interstitial emphysema and related conditions originating in the perinatal period	P25	770.2
81	55	Pulmonary hemorrhage originating in the perinatal period	P26	770.3
82	56	Chronic respiratory disease originating in the perinatal period	P27	770.7
83	57	Atelectasis	P28.0-P28.1	770.4-770.5
84	99	All other respiratory conditions originating in the perinatal period	P28.2-P28.9	770.6,770.8
		Infections specific to the perinatal period	P35-P39	771.0-771.2,771.4-771.8
85	58	Bacterial sepsis of newborn	P36	771.8
86	59	Omphalitis of newborn with or without mild hemorrhage	P38	771.4
87	99	All other infections specific to the perinatal period	P35,P37,P39	771.0-771.2,771.5-771.7
		Hemorrhagic and hematological disorders of newborn	P50-P61	772-774, 776
88	60	Neonatal hemorrhage	P50-P52,P54	772
89	61	Hemorrhagic disease of newborn	P53	776.0
90	62	Hemolytic disease of newborn due to isoimmunization and other perinatal jaundice	P55-P59	773-774
91	63	Hematological disorders	P60-P61	776.1-776.9
92	64	Syndrome of infant of a diabetic mother and neonatal diabetes mellitus	P70.0-P70.2	775.0-775.1
93	65	Necrotizing enterocolitis of newborn	P77	777.5
94	66	Hydrops fetalis not due to hemolytic disease	P83.2	778.0
95	99	Other perinatal conditions	P29,P70.3-P76,P78-P81,P83.0-P83.1, P83.3-P96	775.2-775.9,777.0-777.4,777.6-777.9, 778.1-779
		Congenital malformations, deformations and chromosomal abnormalities	Q00-Q99	740-759
96	67	Anencephaly and similar malformations	Q00	740
97	67	Congenital hydrocephalus	Q03	742.3
98	67	Spina bifida	Q05	741
99	67	Other congenital malformations of nervous system	Q01-Q02,Q04,Q06-Q07	742.0-742.2,742.4-742.9
100	67	Congenital malformations of heart	Q20-Q24	745-746
101	67	Other congenital malformations of circulatory system	Q25-Q28	747
102	67	Congenital malformations of respiratory system	Q30-Q34	748
103	67	Congenital malformations of digestive system	Q35-Q45	749-751
104	67	Congenital malformations of genitourinary system	Q50-Q64	752-753
105	67	Congenital malformations and deformations of musculoskeletal system, limbs and integument	Q65-Q85	754-757
106	67	Down's syndrome	Q90	758.0

107	67	Edward's syndrome	Q91.0-Q91.3	758.2
108	67	Patau's syndrome	Q91.4-Q91.7	758.1
109	67	Other congenital malformations and deformations	Q10-Q18,Q86-Q89	743-744,759
110	67	Other chromosomal abnormalities, not elsewhere classified	Q92-Q99	758.3-758.9
		Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	R00-R99	780-799
111	68	Sudden infant death syndrome	R95	798.0
112	99	Other symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	R00-R53,R55-594,R96-R99	780-796,798.1-799
113	99	All other diseases	F01-F99,H00-H57,L00-M99	290-319,360-379,680-739
		External causes of mortality	V01-Y84	E800-E999
		Accidents (unintentional injuries)	V01-X59	E800-E869,E880-E929
		Transport accidents	V01-V99	E800-E848,E920-E929.1
114	69	Motor vehicle accidents	V02-V04,V09.0,V09.2,V12-V14, V19.0-V19.2,V19.4-V19.6,V20-V79, V80.3-V80.5,V81.0-V81.1, V82.0-V82.1,V83-V86,V87.0-V87.8, V88.0-V88.8,V89.0,V89.2	E810-E825
115	69	Other and unspecified transport accidents	V01,V05-V06,V09.1,V09.3-V09.9, V10-V11,V15-V18,V19.3,V19.8, V19.9,V80.0-V80.2,V80.6-V80.9, V81.2-V81.9,V82.2-V82.9,V87.9, V88.9,V89.1,V89.3V89.9,V90-V99	E800-E807,E826-E848,E929.0-E929.1
116	69	Falls	W00-W19	E880-E888
117	69	Accidental discharge of firearms	W32-W34	E922
118	69	Accidental drowning and submersion	W65-W74	E910
119	69	Accidental suffocation and strangulation in bed	W75	E913.0
120	69	Other accidental suffocation and strangulation	W76-W77,W81-W84	E913.1-E913.9
121	69	Accidental inhalation and ingestion of food or other objects causing obstruction of respiratory tract	W78-W80	E911-E912
122	69	Accidents caused by exposure to smoke, fire and flames	X00-X09	E890-E899
123	69	Accidental poisoning and exposure to noxious substances	X40-X49	E850-E869,E924.1
124	69	Other and unspecified accidents	W20-W31,W35-W64,W85-W99, X10-X39,X50-X59	E900-E909,E914-E921,E923-E924.0, E924.8-E929
		Assault (homicide)	X85-Y09	E960-E968
125	70	Assault (homicide) by hanging, strangulation and suffocation	X91	E963
126	70	Assault (homicide) by discharge of firearms	X93-X95	E965.0-E965.4
127	99	Neglect, abandonment and other maltreatment syndromes	Y06-Y07	E967,E968.4
128	99	Assault (homicide) by other and unspecified means	X85-X90,X92,X96-X99,Y00-Y05,	E960-E962,E964,E965.5-E966,

			Y08-Y09	E968.0-E968.3, 968.8-E968.9
129	71	Complications of medical and surgical care	Y40-Y84	E870-E879,E930-E949
130	99	Other external causes	X60-X84,Y10-Y36	E970-E979

* These are the cause groupings eligible to be ranked as leading causes of infant death.

See NCHS: Instruction Manual, Part 9: ICD-10 Cause of death lists for tabulating mortality statistics for further information

This report was prepared for the Office of Maternal and Infant Health and Infant Mortality Reduction, now known as the Women and Infant Vitality Network.

Thank you to John Paulson at the Ohio Department of Health for providing data for this report, the Child Policy Research Center at Cincinnati Children's Hospital Medical Center for ongoing quality improvement support and the HCIMSS Data Work Group for input and guidance.