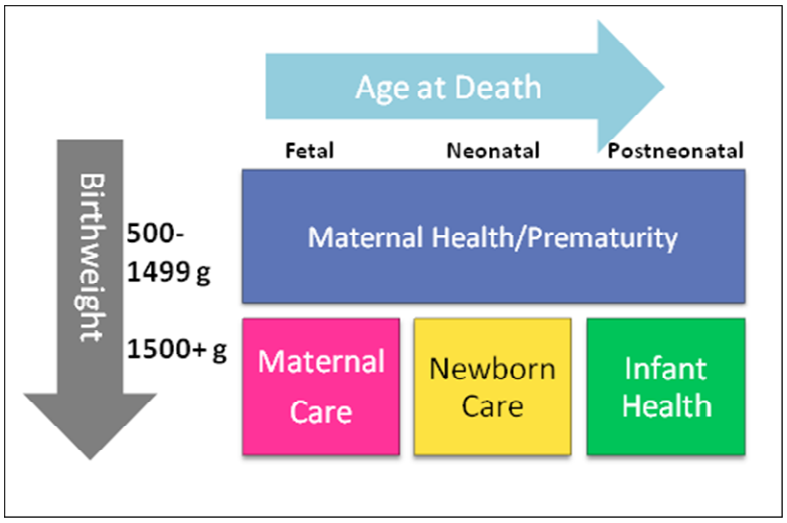
Mobilizing Communities to Action:

Perinatal Periods of Risk (PPOR) Approach to

Infant Mortality in Hamilton County, TN

2001-2005



Chattanooga-Hamilton County Health Department
Hamilton County, Tennessee
921 E. Third Street
Chattanooga, TN 37403

http://health.hamiltontn.org/

Chattanooga-Hamilton County Health Department

Mission:

To do all we can to assure a healthy community.

Vision:

Healthy people in healthy communities.

Values:

Compassion
Integrity
Diversity
Excellence
Respect

Core Functions:

Prevention
Education
Promotion
Policy Development
Assurance
Outreach
Protection
Assessment and Planning
Monitoring/Surveillance
Regulatory Compliance

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Executive Summary

The Chattanooga-Hamilton County Health Department

Infant Mortality Reduction Initiative
(423) 209-8060

Perinatal Periods of Risk in Hamilton County

NOVEMBER 2008

At a Glance

Infant Mortality Rate per 1,000:
- Hamilton: 11.2
- TN: 8.7
  U.S.: 6.8

Low Birthweight:
- Hamilton: 12%
- TN: 9.4%
- U.S.: 8.2%

***Healthy People 2010* goals:**
- Infant mortality rate: 4.5 infant deaths per 1,000 live births in the U.S.
- LBW prevalence: 5% of total births in the U.S.

Sources:

Tennessee Department of Health, Division of Health Statistics.

CityMatCH. University of Nebraska Medical Center: www.citymatch.org .

Health, United States 2007. Centers for Disease Control and Prevention.

Different Approach to Addressing Infant Mortality

Traditional methods for assessing infant mortality do not readily identify potential gaps in a community, and do not directly lead to action and prevention activities.

The Perinatal Periods of Risk (PPOR) approach provides newer insight into infant and fetal deaths by including fetal deaths, mapping fetal and infant mortality into four periods of risk, and comparing rates to a reference group with the "best" outcome.

The four periods of risk are Maternal Health/ Prematurity, Maternal Care, Newborn Care, and Infant Health.

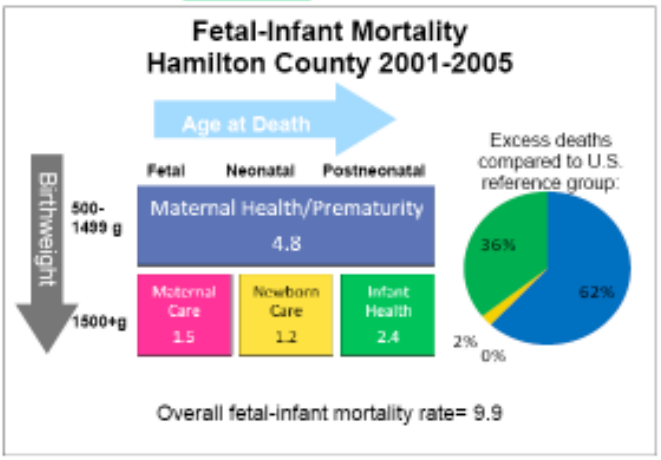
PPOR is about ACTION

Maternal Health/ Prematurity	Preconception Health Health Behaviors Perinatal Care
Maternal Care	Prenatal Care High Risk Referral Obstetric Care
Newborn Care	Perinatal Management Neonatal Care Pediatric Surgery
Infant Health	Sleep Position Breast Feeding Injury Prevention

From 2001-2005, there were 195 fetal and infant deaths in Hamilton County.

The overall fetal and infant mortality rate in Hamilton County from 2001-2005 is 9.9 per 1,000 births.

The periods of risk with the highest rates were:
- Maternal Health/Prematurity (62% excess deaths)
- Infant Health (36% excess deaths).



Enhancing outreach to women before or between pregnancies is the greatest opportunity to reduce Hamilton County's fetal and infant mortality rate. Interventions recommended by CityMatCH:
- Preconception health screening tools and curricula
- Healthy behaviors (smoking cessation, drug /alcohol use cessation, nutrition, fitness, and healthy sexual behaviors)
- Specialized perinatal care.

To reduce excess Infant Health deaths, it will be important to target areas such as:
- SIDS prevention: co-sleeping and bedding
- Smoking cessation
- Increasing access to medical home
- Breast feeding promotion and counseling
- Injury prevention.

MISSION: TO DO ALL WE CAN TO ASSURE A HEALTHY COMMUNITY

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Acknowledgements

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Introduction

In the scope of public health, infant mortality is not only a terrible tragedy to occur to a family, but it is also an important indicator of our overall community's health. The death of an infant not only reflects the current status of health in a community or population, but it also is an indicator of the overall social development of a community, whether it be maternal health, quality of care and access, socioeconomic conditions and public health interventions.

In the beginning of the 20th century, public health leaders in the U.S. began focusing resources on mothers and children to reduce infant mortality. Along with health education, improved nutrition, access to prenatal care, and advances in medicine the infant mortality rate (the rate at which babies less than one year of age die) has fallen dramatically in the U.S. from 100 deaths to fewer than 10 deaths per 1000 live births[i].

In 2005, the infant mortality rate for the United States was 6.87 deaths per 1,000 live births. Even though the U.S. has the most advanced health care in the world, the U.S. is ranked 29th in the world in infant mortality. The low infant mortality ranking for the U.S. is due in large part to the disparities continue to exist among various racial and ethnic groups in this country, particularly African Americans[ii]. Deaths among African-American infants are almost double the national figure[iii].

In 2006, Tennessee's infant mortality rate was ranked 45th in the nation (8.7 per 1,000), with only five states with higher rates. Within the state of Tennessee, Hamilton County has the 2nd highest infant mortality rate (6.9 per 1,000 live births) compared to other metropolitan areas and has the highest African American infant mortality rate (23.7 per 1,000). The goal of the Tennessee Department of Health is to reduce infant mortality in Tennessee to an incidence of no more than 7.0 infant deaths per 1,000 live births by the year 2010.

The growing disparity gap in infant mortality calls for a different approach to investigate potential causes and to identify solutions. The Perinatal Periods of Risk Approach (PPOR)[iv] is a different approach which examines infant and fetal deaths to help communities focus on prevention efforts and strategies. There are six comprehensive steps to the PPOR approach:

1. Assure analytic and community readiness
2. Conduct analytic phases of PPOR
3. Develop strategic actions for targeted prevention
4. Strengthen existing and/or launch new prevention initiatives
5. Monitor and evaluate approach
6. Sustain Stakeholder investment and political will.

The purpose of this report is to guide community mobilization, resources, and program development to reduce fetal and infant deaths based on the PPOR analysis. This report will first use the traditional methods for reporting infant mortality, low birthweight, and prematurity. The next section of this report will define and outline the PPOR approach provided by CityMatCH, present the results of the Phase I and Phase II analysis, and provide recommendations for mobilizing the data into action.

History of Chattanooga-Hamilton County Infant Mortality[v]

1875 Chattanooga appointed the first Registrar of Vital Statistics and the first City Physician.

1916 A baby clinic was established under the Kosmos Civic Club and other women's organizations. It was held in the home of Dr. J.H. Atlee. Dr. Atlee and Dr. J.A. Smith gave their time while the women's organizations provided formula, medicine, and the services of a trained nurse.

1921 Hamilton County Health Department was established.

1938 Infant mortality rate was reported in Hamilton County as 37.7 per 1,000 births for the past three years, a decrease of 4.5 from 1937.

1948 Dr. Howard Robertson was assigned at the Health Department to promote prenatal care and to assist in the maternal-child health program.

1949 On October 1, 1949, the Center for Premature Infants opened at T.C. Thompson Children's Hospital.

1952 The Health Department reported that approximately 400 women entered public health prenatal care, with over 800 field nursing visits. Approximately 130 premature infants were admitted to T.C. Thompson Children's Hospital.

1970 The Prenatal Care Program was established to provide prenatal care services within community health centers in Hamilton County. This was the result of the Health Department's and Erlanger Hospital's desire to reduce Hamilton County's infant and maternal death rate.

1985 To help narrow the disparity between black and white infant mortality, the Tennessee Department of Health allocated funds for special projects in four areas of the State where Black infant mortality was extremely high. Chattanooga was one of the chosen areas, and four census tracts were identified as high risk areas for infant mortality. Alton Park and Dodson Avenue Community Health Centers provided interventions in the areas of teen pregnancy, healthy pregnancy and low birthweight prevention, and infant mortality prevention.

1989 To ensure healthy pregnancy and development, HUGS program (Help Us Grow Successfully) was established as a home visiting program that also coordinates additional services for pregnant and postpartum women up to 2 years and children ages birth through 5 years. HUGS coordinators assist clients in getting health care as well as social, educational, and many other services.

2002 The Regional Health Council and Chattanooga-Hamilton County Health Department established the Low Birth Weight Task Force to study low birth weight prevalence, identify risk factors, and promote community interventions. The LBW Task Force set a goal to reduce LBW births to 8.4% of live births by 2007.

2003 Barbara Laymon, Health Planner at the Chattanooga-Hamilton County Health Department, conducted the first Perinatal Period of Risk analysis for Hamilton County, identifying Maternal Health/Prematurity and Infant Health as areas for intervention.

2005 The Low Birth Weight Task Force transitioned under the auspices of the March of Dimes as a way of sustaining efforts at developing and implementing strategies to address low birthweight.

2007 The Health Department partnered with the Governor's Office of Children's Care Coordination to establish an Infant Mortality Reduction Initiative in Hamilton County. The initiative assesses infant and birth data, researches infant mortality factors, and collaborates with community partners to identify problems and strategize solutions for improving birth outcomes.

2008 The Hamilton County Infant Mortality Reduction Initiative and Core Leadership Group, in partnership with the Governor's Office of Children's Care Coordination, oversaw the establishment of the Women's Health for Underserved Areas Initiative in Hamilton County. This initiative currently involves seven community-based prenatal and obstetric service and education programs with the goal of improving birth outcomes.

Chapter 1: Historical and Current Trends of Infant Mortality, Low Birthweight and Prematurity

Infant Mortality

Infant mortality is an important health measure that not only reflects the current health status of a community or population, but also is a measure of the overall social development of a community, including maternal care, quality of and access to care, socioeconomic conditions, and public health interventions. The infant mortality rate (IMR) is the rate at which babies less than one year of age die.

Since the 1940s, the national trend in infant mortality has been steadily decreasing (Figure 1)[vi]. In 2006, the infant mortality rate for the United States was 6.71 deaths per 1,000 live births. The United States was ranked 29th in the world in infant mortality in 2004, with the U.S. international ranking falling from 12th in 1960 to 23rd in 1990 and 29th in 2004[vii]. In 2006, Tennessee's infant mortality rate was ranked 45th in the nation (8.7 per 1,000), with only five states with higher rates.

Overall, the trend in infant mortality rates in Hamilton County has been decreasing since the 1940s. However, the African American infant mortality has begun to increase since 1995, reaching to the same infant mortality rates as in the 1970s (Figure 2).

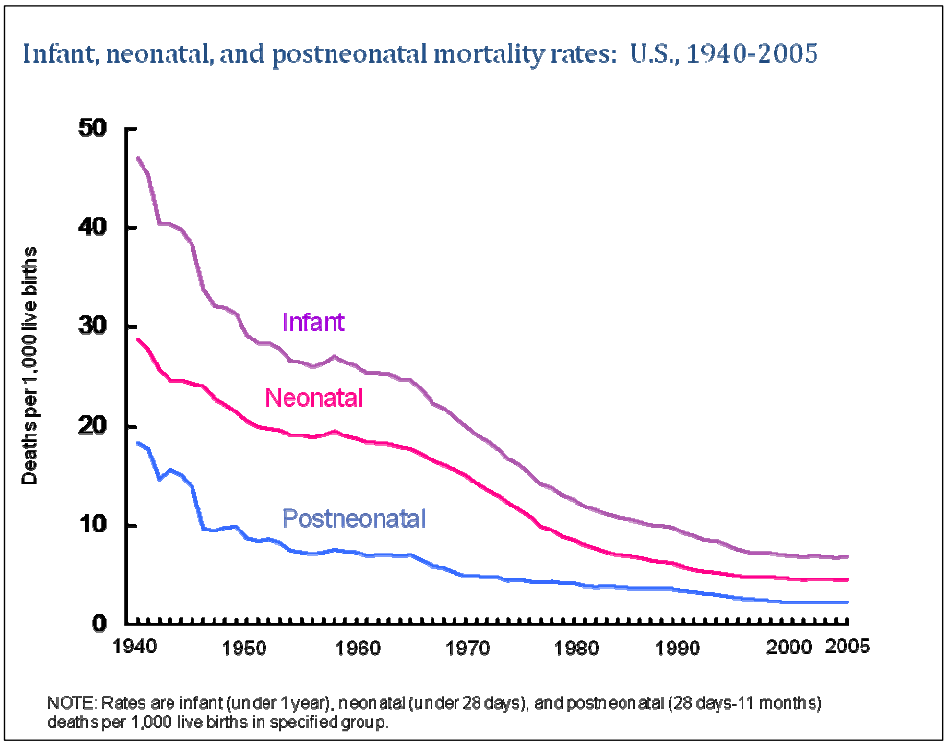


Figure 1. U.S. Infant Mortality Rate Trends

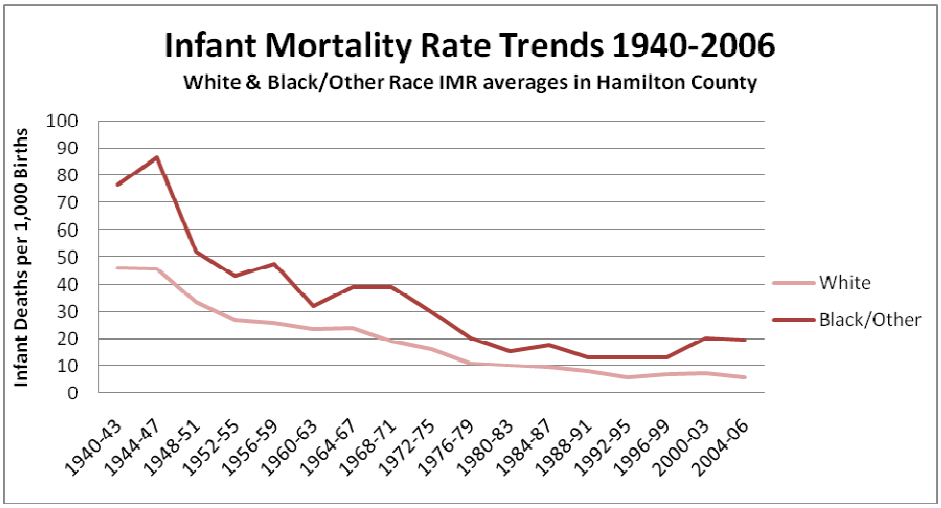


Figure 2. Infant Mortality Rate Trends in Hamilton County

In 2006, Hamilton County had the 2nd highest infant mortality rate (11.2 per 1,000 live births) compared to other metropolitan areas in Tennessee, and the highest African American infant mortality rate (23.7 per 1,000) (Figure 3). In a broad snapshot of international infant mortality rates, in Hamilton County is worse than several developing countries (Table 1). From 2001-2005 in Hamilton County, there were 4 zip codes with rates higher than 16 per 1,000: 37410, 37408, 37406, and 37403 (Map 1, Appendix).

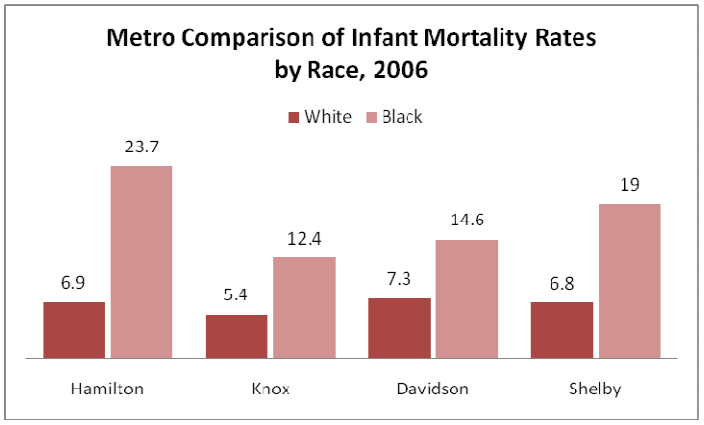


Figure 3. Metro Comparison of Infant Mortality, TN

The *Healthy People 2010* target goal for the U.S. infant mortality rate is 4.5 infant deaths per 1,000 live births[viii]. The current U.S. rate is about 50% higher than the goal. The goal of the Tennessee Department of Health is to reduce infant mortality in Tennessee to an incidence of no more than 7.0 infant deaths per 1,000 live births by the year 2010.

Table 1. Infant Mortality Rates and International Rankings (*Note: Some reporting differences among countries*)

Country**	IMR per 1,000	Ranking
Singapore	2.0	1
Hong Kong	2.5	2
Japan	2.8	3
Sweden	3.1	4
Norway	3.2	5
Finland	3.3	6
Spain	3.5	7
Czech Republic	3.7	8
France	3.9	9
Portugal	4.0	10
Germany	4.1	11
Greece	4.1	11
Italy	4.1	11
Netherlands	4.1	11
Switzerland	4.2	15
Belgium	4.3	16
Denmark	4.4	17
Austria	4.5	18
Israel[5]	4.5	18
Australia	4.7	20
Ireland	4.9	21
Scotland	4.9	21
England and Wales	5.0	23
Canada	5.3	24
Northern Ireland	5.5	25
New Zealand	5.7	26
Cuba	5.8	27
Hungary	6.6	28
Poland	6.8	29
Slovakia	6.8	29
United States	6.8	29
Hamilton County Whites (2006)	6.9	
Puerto Rico	8.1	32
Chile	8.4	33
Costa Rica	9.0	34
Hamilton County Overall (2006)	11.2	
Russian Federation	11.5	35
Bulgaria	11.7	36
Romania	16.8	37
Hamilton County African Americans (2006)	23.7	

The African American infant mortality rate in Hamilton County is worse than*:

Colombia (17)
Thailand (18)
Panama (19)
Paraguay (21)
Saudi Arabia (21)
Tunisia (21)
Ecuador (23)
Jordan (23)
Mexico (23)

**2004 data from the National Center for Health Statistics. Health, United States, 2007.
*2004 IMR data rounded from UNICEF State of the World's Children Report, 2006.

Low Birthweight Births

Low birthweight (less than 5.5 lbs or 2,500 grams) is the single most important factor affecting neonatal mortality (infants less than 28 days old) and a significant determinant of postneonatal mortality (infants 28 days-1 year old). In the first year of life, low birthweight (LBW) babies are 20 or more times more likely to die than heavier babies[ix]. Infants born at a low birthweight are at increased risk of long-term disability and impaired development[x]. LBW infants are also more likely than heavier infants to experience delayed motor and social development[xi].

Low birthweight can be caused by either preterm delivery (less than 37 weeks) or fetal growth retardation. The LBW rate in the United States has risen 17% since 1990 to 8.2% in 2005, matching levels reported nearly 40 years ago[xii]. The *Healthy People 2010* target goal for LBW prevalence is 5% of total births[xiii].

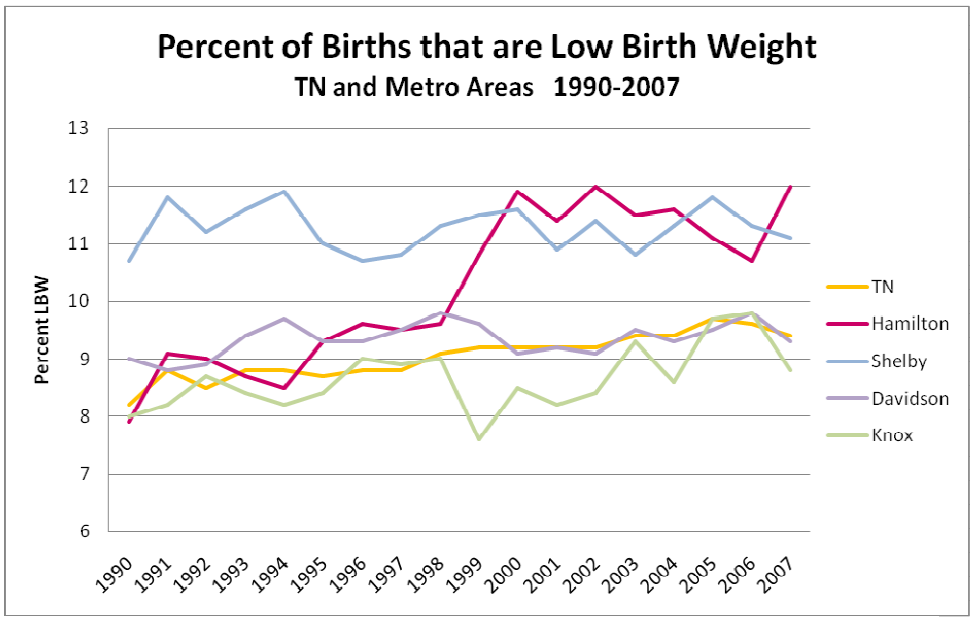


Figure 4. Metro Comparison of LBW Births, TN

In Tennessee, 9.4% of all live births were born with low birthweight in 2007. Hamilton County has the highest prevalence of low birthweight births (12%) compared to other metropolitan areas in Tennessee for 2007. In Hamilton County, the percent of low birthweight births among African Americans is almost double (18.6%) the percent of low birthweight births for whites (9.7%). Since 1998, the prevalence of low birthweight births has risen dramatically in Hamilton County, compared to other metropolitan areas (Figure 4).

From 2001-2005 in Hamilton County, there are five zip codes with percent of low birthweight births higher than 17%: 37410, 37403, 37406, 37402, and 37408 (Map 2, Appendix).

Very Low Birthweight Births

Very Low Birthweight births are births born less than 3.3 lbs or 1,500 grams. Babies who are very low in birthweight have a 25 percent chance of dying before age one[xiv]. The majority of all very low birthweight (VLBW) infants born are a result of premature delivery.

In 2005, very low birthweight births were 1.5% of all live births in the United States. In 2007, 1.7% of Tennessee births were born low birthweight, and 2.2% in Hamilton County. In Hamilton County, the

percent of African American VLBW births (3.7%) is more than double the percent of white VLBW births (1.7%). The *Healthy People 2010* target goal for VLBW prevalence of is 0.9% of total births[xv].

Sixty percent of the infant deaths occurring in Hamilton County from 2001-2005 were born very low birthweight. The zip codes with the highest percent of very low birthweight births in Hamilton County from 2001-2005 were: 37403, 37410, 37350, and 37308 (Map 3, Appendix).

Preterm Births

Preterm birth (births at less than 37 completed weeks of gestation) is a key risk factor for infant death. In 2005, preterm births were 12.7% of all births in the United States. In 2005, 36.5% of infant deaths in the United States were due to preterm-related causes of death, a 5% increase since 2000 (34.6%)[xvi].

In the United States, the percentage of infants delivered at less than 37 completed weeks of gestation has risen 20% since 1990, and the increase from 2004-2005 was primarily associated with a rise in late preterm (34-36 weeks) infants[xvii]. In 2005, the infant mortality rate for late preterm births was three times that for term births (37-41 weeks)[xviii]. The *Healthy People 2010* target goal for preterm births in the U.S. is 7.6% of total births[xix].

From 2001-2005, approximately 16% of all live births in Hamilton County were born preterm, and 72% of all infant deaths in Hamilton County were born preterm. The zip codes with the highest percent of preterm births in Hamilton County from 2001-2005 were: 37408, 37406, 37410, 37403, and 37407 (Map 4, Appendix).

Chapter 2: Perinatal Periods of Risk (PPOR)

The traditional methods for assessing infant mortality in a community do not readily identify potential gaps in the community for further reductions and do not directly lead to action and prevention activities. The Perinatal Periods of Risk (PPOR) approach provides newer insight into infant and fetal deaths in two ways: 1) the analysis includes fetal deaths, which is an important perinatal health indicator, but is not a regular practice when examining infant deaths and 2) PPOR divides the overall fetal-infant mortality rate of a community into four periods aimed at prevention:

- Maternal Health/Prematurity (infant and fetal deaths weighing less than 1,500g/ 3.3 lbs)
- Maternal Care (fetal deaths weighing 1,500g or more)
- Newborn Care (neonatal deaths weighing 1,500g or more)
- Infant Health (postneonatal deaths weighing 1,500g or more)

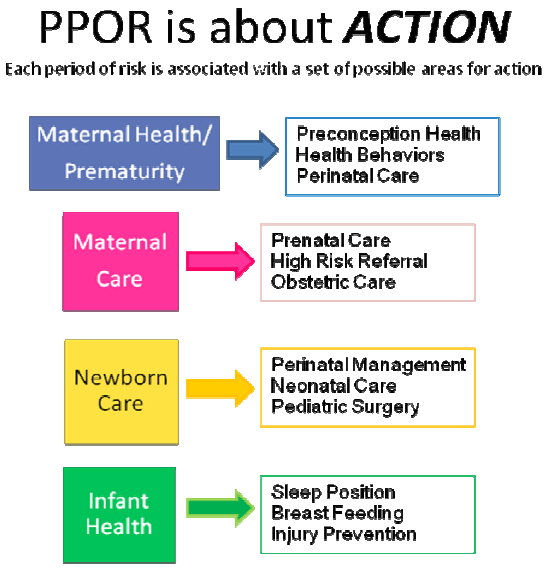


Figure 5. The PPOR Approach to Action

The PPOR analysis compares fetal-infant mortality rates of a community to a reference group that has the "best" birth outcomes. In this report, the reference group is a group of births in the U.S. to non-Hispanic white women who 20 or more years of age with 13 or more years of education. The PPOR analysis then calculates excess deaths from the target and comparison groups to determine the target community's "opportunity gap".

The PPOR mapping of fetal-infant mortality into these four periods of risk enables communities to identify and further investigate periods where there are the greatest opportunities for local impact (Figure 5).

The PPOR approach is a joint initiative of CityMatCH at the University of Nebraska Medical Center, the Centers for Disease Control and Prevention (CDC), the March of Dimes, and the Health Resources and Services Administration/Maternal and Child Health Bureau. The PPOR approach has been used by Dr. Brian McCarthy of the CDC in both developed and developing countries to monitor and investigate fetal-infant mortality. Since 1997, CityMatCH has led national efforts to validate and adapt this approach to use in U.S. urban areas. The PPOR analysis was first conducted in Hamilton County in 2003 by Barbara Laymon, Health Planner.

The overall intent of the PPOR approach is to develop a standard, simple method of examining fetal-infant mortality that can be used by communities to mobilize and prioritize prevention efforts. The entire PPOR process includes six comprehensive steps:

1. Assure analytic and community readiness
2. Conduct analytic phases of PPOR
3. Develop strategic actions for targeted prevention
4. Strengthen existing and/or launch new prevention initiatives
5. Monitor and evaluate approach
6. Sustain Stakeholder investment and political will.

The data analysis in PPOR is actually just one part of a *larger* process of community partnership, understanding, consensus, and mobilization to address fetal-infant mortality.

PPOR Analysis Phase I: Mapping Rates of Fetal and Infant Mortality

In Phase I of the PPOR analysis, Hamilton County fetal-infant mortality rates are sorted and mapped into four periods of risk: Maternal Health/Prematurity, Maternal Care, Newborn Care, and Infant Health. Mapping the fetal-infant mortality rate will identify periods of risk with the most deaths and highest rates in Hamilton County. Using comparison groups (target vs. reference) will estimate excess deaths and the community's opportunity gap.

The four periods of risk used in Phase I mapping of fetal-infant mortality are categorized by two dimensions: age at death and birthweight (Figure 6). The first dimension, age at death, is important because problems can occur at different developmental stages due to differing risk factors. High mortality during a specific time period may reflect an opportunity for intervention. The second dimension is birthweight. According to CityMatCH, the causes of death and preventive actions for babies born below 1,500 grams tend to be different from those for babies born above 1,500 grams.

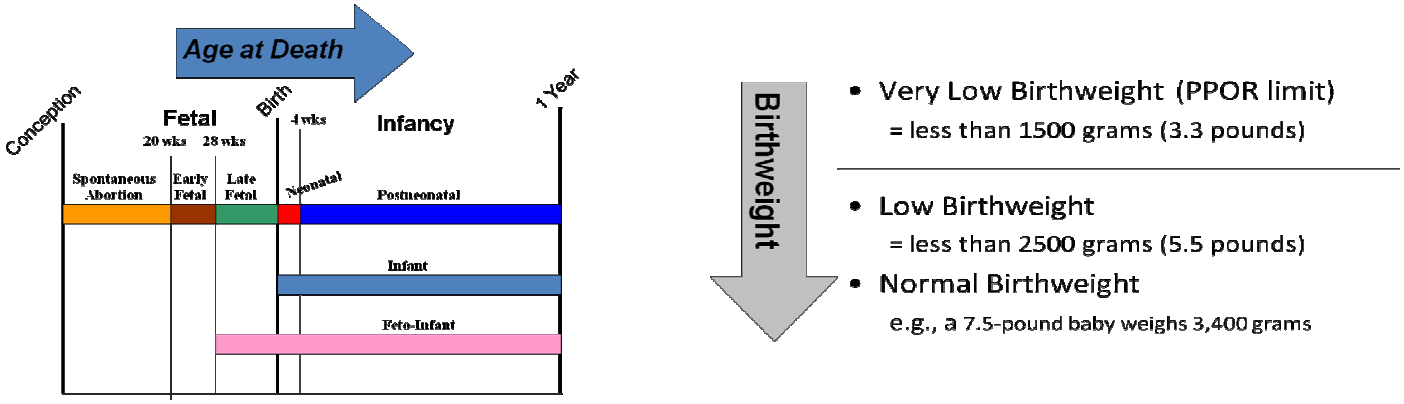


Figure 6. Two Dimensions of PPOR: Age at Death and Birthweight

Fetal deaths less than 24 weeks of gestation, live births, and fetal deaths weighing less than 500 grams, as well as spontaneous and induced abortions and births with unknown birthweight, are excluded from the analysis to ensure comparability across regions and time periods through the use of uniform reporting criteria. Such exclusion is necessary because there are large reporting differences in vital records across U.S. cities for events below the limits of 500 grams or 24 weeks gestation, and generally limits pregnancy events to those that are physically viable, assuming no underlying congenital defect or

medical condition. Many deaths such as early spontaneous abortions/miscarriages and induced abortions are not included because they were not recorded with Vital Statistics.

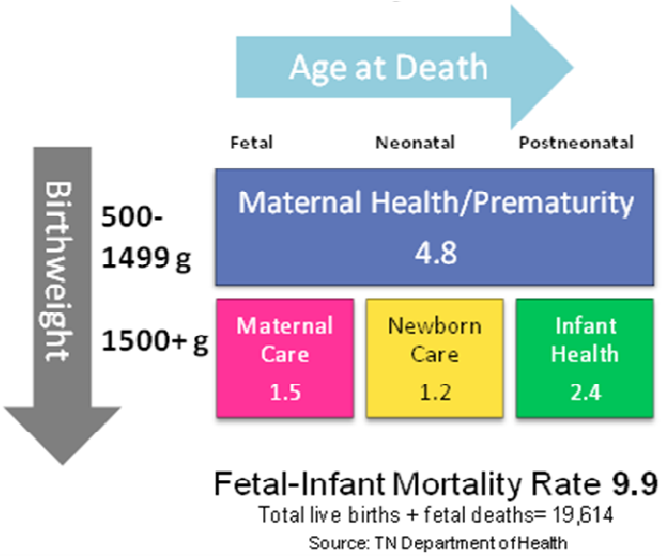


Figure 7. Fetal-Infant Mortality Rates in Hamilton County, 2001-2005

From 2001-2005, there were 195 fetal and infant deaths in Hamilton County and 19,614 total resident in-state births. The fetal and infant deaths in Hamilton County are mapped into the four periods of risk. The overall fetal-infant mortality rate in Hamilton County is 9.9 per 1,000 births (Figure 7).

The periods of risk with the highest rates are the Maternal Health/Prematurity (4.8 per 1,000) and Infant Health (2.4 per 1,000), suggesting that the greatest potential for reduction of Hamilton County's fetal-infant mortality rate is in the Maternal Health/Prematurity period followed by the Infant Health period.

According to CityMatCH, focusing on preconception health, health behaviors, and specialized perinatal care can help reduce mortality in the Maternal Health/Prematurity group. Focusing on SIDS prevention, injury prevention, and breastfeeding can help reduce mortality in the Infant Health group[xx].

From 2001-2005, there were 112 white fetal and infant deaths and 76 African American deaths. PPOR fetal-infant mortality maps were created for race sub-populations to explore disparities or "gaps". There is a disparity when comparing fetal-infant mortality rates between whites and African Americans in Hamilton County. The African American fetal-infant mortality rate is 15.3 compared to the white rate of 7.9 (Figure 8).

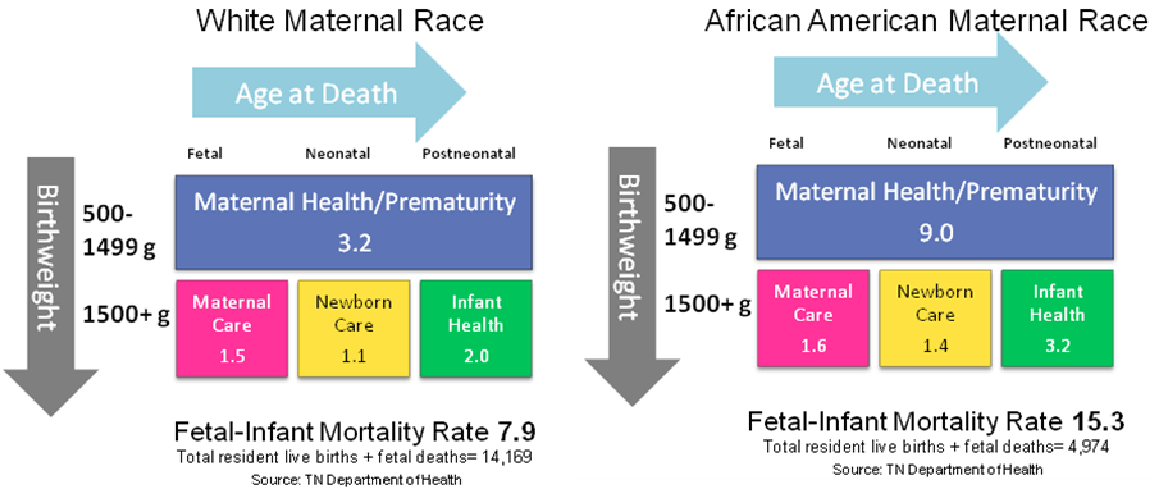


Figure 8. Fetal-Infant Mortality Rates by Race in Hamilton County, 2001-2005

Figure 9 illustrates the PPOR 2001-2005 results for Hamilton County, with racial groups and the national reference group. The reference group used in this analysis is a U.S. group of births to women 20 or more years of age, with 13 or more years of education, and who are non-Hispanic white (2000-2002 data provided by CityMatCH).

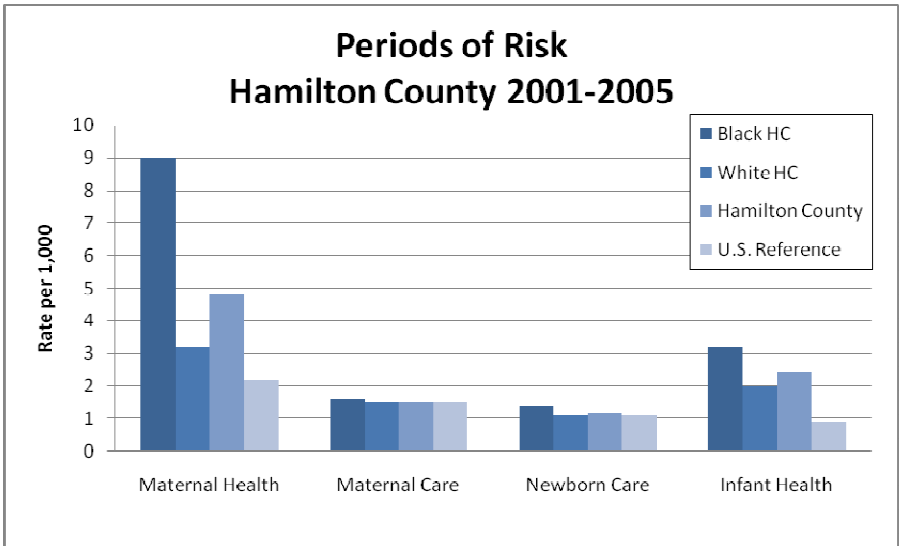


Figure 9. Fetal-Infant Mortality Rates by Period of Risk

Identifying "opportunity gaps" are an important part of the PPOR methodology. To identify potential opportunity gaps, the next step in mapping fetal-infant mortality is to calculate excess deaths by comparing the target population of Hamilton County to a reference group.

Excess deaths are measures of the potential reduction in infant and fetal deaths in Hamilton County, or an estimate of "preventable deaths".

Excess fetal-infant mortality rates are calculated by subtracting the U.S. reference population from the target population for each of the periods of risk. The excess fetal-infant mortality rate for Hamilton County compared to the national reference group is 4.2 per 1,000 births (Figure 10).

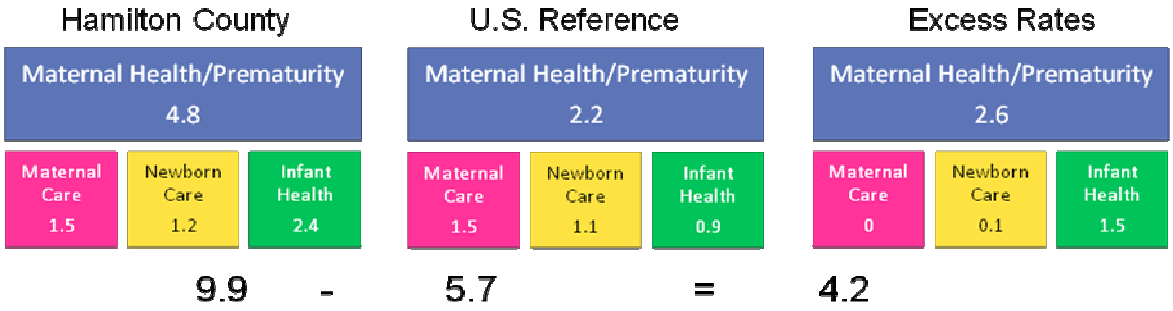


Figure 10. Excess Fetal-Infant Mortality Rates: Hamilton County and U.S. Reference Group

Comparing Hamilton County to a U.S. reference group with optimal birth outcomes helps target deaths that could be prevented. With an excess fetal-infant mortality rate of 4.2, a total of 82 excess, or preventable, fetal and infant deaths occurred in Hamilton County from 2001-2005.

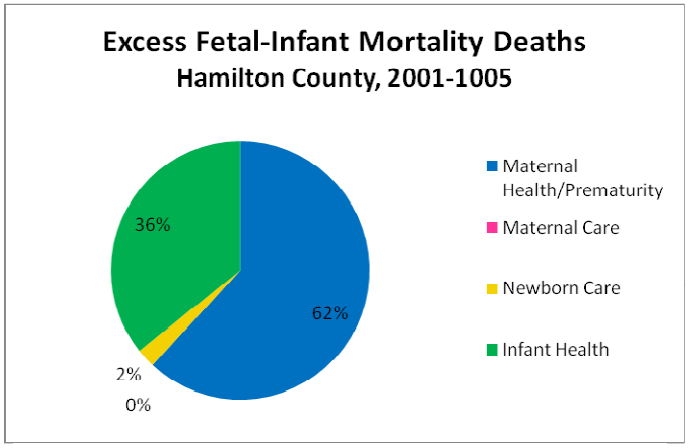


Figure 11. Excess Fetal-Infant Mortality by Period of Risk

In Hamilton County, approximately 62% of the excess fetal-infant mortality deaths were in the Maternal Health/Prematurity group following 36% in the Infant Health group. Only 2 % of excess deaths were in the Newborn Care group, and no excess deaths in the Maternal Care group (Figure 11).

Excess fetal-infant mortality rates for the African American population in Hamilton County are more than double than the excess rates for overall Hamilton County when compared to the U.S. reference group, with an excess rate of 9.6 per 1,000 (Figure 12).

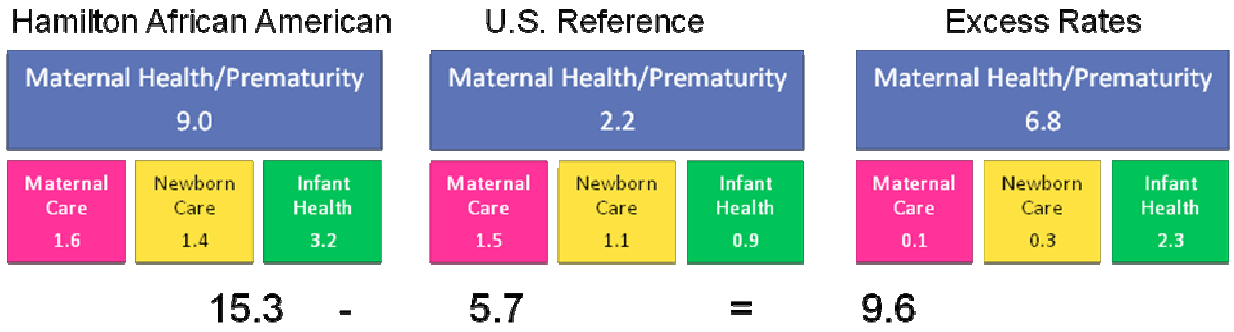


Figure 12. Excess Fetal-Infant Mortality Rate: African American Race in Hamilton County and U.S. Reference Group

Among births to African American women in Hamilton County, approximately 72% of the excess fetal-infant mortality deaths were in the Maternal Health/Prematurity group following 24% in the Infant Health group. Only 3 % of excess deaths were in the Newborn Care group, and 1% of excess deaths in the Maternal Care group (Figure 13).

With almost ¾ of excess fetal and infant deaths in the Maternal Health/Prematurity group among African Americans, prioritizing efforts and lowering risks in the areas of preconception health, health behaviors, and specialized perinatal care can help reduce the excess mortality.

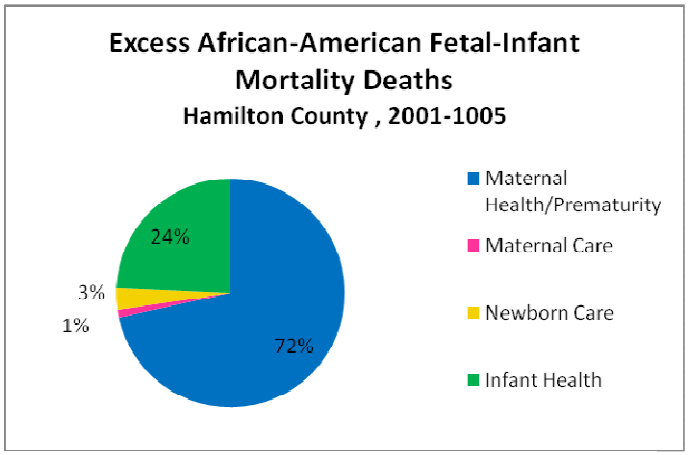


Figure 13. Excess Fetal-Infant Mortality by Period of Risk

Phase I Summary

Excess fetal and infant deaths in Hamilton County are occurring in the perinatal periods of Maternal Health/Prematurity and Infant Health. Because the reference group did not suffer these losses, all excess deaths may be considered to be preventable. The greatest opportunity to reduce fetal and infant mortality rates is to focus on Maternal Health/Prematurity and Infant Health periods, particularly among African American mothers.

According to CityMatCH, strategies that focus on contributing social and behavioral risk factors, preconception health, and their impacts on medical factors, as well as SIDS, injury prevention, and breast feeding promotion, can make a significant impact on excess fetal-infant mortality. Based on the results of this analysis, the smallest opportunity to reduce fetal and infant mortality is in the periods of Maternal and Newborn Care. According to the data, these periods of risk are high-functioning, as Maternal Care and Newborn Care are periods where mothers and their infants are interacting most with the health care system as well as where most of the maternal and child health resources are directed.

Phase II of PPOR analysis further investigates the excess deaths in the Maternal Health/Prematurity period and in the Infant Health period.

PPOR Analysis Phase II: Explain Excess Deaths & Direct Prevention Efforts

Phase II of the PPOR analysis will focus on the Maternal Health/Prematurity and Infant Health periods of risk, the areas identified as having the greatest potential for reduction of Hamilton County's fetal and infant mortality.

Maternal Health/Prematurity Period of Risk:
Examining Excess Maternal Health/Prematurity

In Hamilton County, 62% of overall excess fetal and infant deaths were in the Maternal Health/Prematurity period of risk. The Maternal Health/Prematurity period includes all fetal deaths with 24 or more weeks of gestation and infant deaths which weigh 500 to 1,499 grams (less than 3.3 lbs) at birth. In Hamilton County, there were 51 excess Maternal Health/Prematurity fetal and infant deaths from 2001-2005.

The underlying cause of death for fetal or infant deaths weighing less than 1,500 grams is often complex, multi-factorial, inconsistently reported, and unreliable for comparison when multiple hospitals and physicians are responsible for reporting. One goal of the Phase II PPOR analysis is to explore reasons for these excess Maternal Health/Prematurity deaths occur by examining two possible pathways: birthweight distribution and birthweight-specific mortality:

Is the excess mortality in the Maternal Health/Prematurity period of risk from the high frequency of very low birthweight babies being born in Hamilton County, or is the excess mortality the result higher mortality rates once the baby is born a very low birthweight (VLBW)?

In other words, should the community examine the prevalence and impact of risk factors causing very low birthweight pregnancies, or should the community examine aspects of their perinatal care system that are responsible for higher birthweight-specific infant mortality rates once the VLBW baby is born in their community?

The high frequency of very low birthweight births or "birthweight distribution" generally relates to behavioral, social, health, and economic disparities of the mothers and primarily manifests itself as delivering a VLBW birth. "Birthweight-specific mortality" among VLBW babies generally relates to the perinatal or medical care provided to the mother and infant prior to, during, or after the VLBW birth. This analysis will determine which of the two pathways is the predominant cause for excess Maternal Health/Prematurity deaths in Hamilton County.

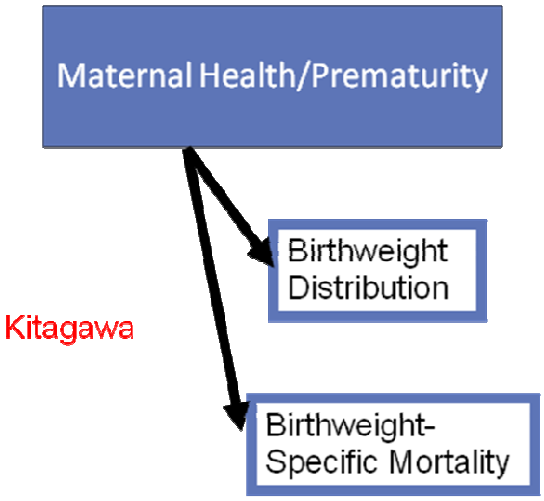


Figure 14. Kitagawa and the Two Possible Paths

The Kitagawa formula is one approach for determining if birthweight distribution or birthweight-specific mortality is the predominant cause for excess Maternal Health/Prematurity deaths in Hamilton County. The formula partitions the two possible pathways using an algebraic formula (Figure 14).

Partitioning these two pathways is helpful because the factors and services that generally affect birthweight distribution are different from the factors and services that affect birthweight-specific mortality rates. The Kitagawa analysis can help communities determine whether to focus on risk factors causing VLBW births or aspects of the perinatal care system that are responsible for higher birthweight-specific infant mortality rates.

Figure 15 illustrates the results of the Kitagawa analysis. From 2001-2005, birthweight distribution contributed to 69% of the Maternal Health/Prematurity excess mortality in Hamilton County when compared to the U.S. Reference group. The predominant cause of death for very low birthweight babies in Hamilton County is birthweight distribution: too many babies are born at very low birth weights.

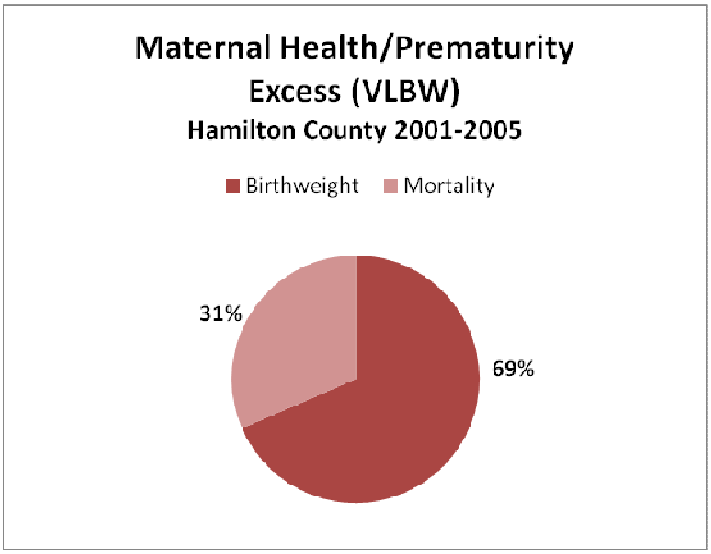


Figure 15. Kitagawa Results

However, almost one third of excess mortality is attributable to birthweight-specific mortality. Birthweight-specific mortality in Hamilton County is not as good as the national reference group, and babies born very low birth weight could be surviving at higher rates.

Since the majority of Maternal Health/Prematurity excess mortality is the result of birthweight distribution, the focus of the PPOR analysis shifts from studying the deaths of these small babies to studying risk and preventative factors for VLBW births among all births in Hamilton County (Figure 16).

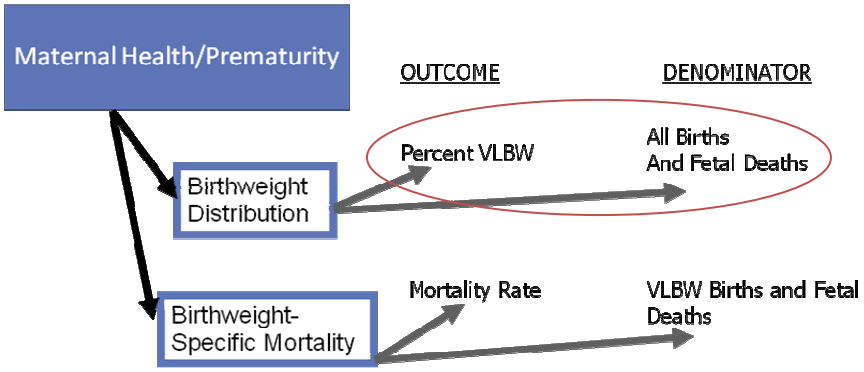


Figure 16. Birthweight Distribution: Studying Risks and Factors for all VLBW births

A logistic regression model was built in the 2001-2005 combined birth file data to look for association between documented risk factors and very low birthweight (VLBW) births in Hamilton County. The odds ratio (OR) compares whether the probability of a certain event is the same for two groups. If the OR is greater than 1, then the event is more likely to occur in group being examined.

Risk factors recommended by CityMatCH were programmed into the logistic regression model, including: late/no prenatal care (defined as starting prenatal care after the first trimester or not at all), previous birth(s), smoking, pre-pregnancy diabetes, pre-pregnancy hyptertension, previous pre-term birth(s), preterm, mother's race (African American/Black), risky age (<20 and >34 years), education less than 12 years (no high school diploma/GED), residential risky zip codes identified in previous LBW assessments (37402, 37403, 37406, and 37410) and being diagnosed with a sexually transmitted disease (lifetime).

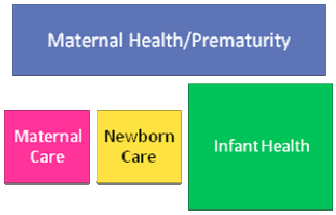
The risk factors with the highest associations to VLBW frequency were previous preterm birth (2.8), preterm birth (380.6), and maternal race African-American/Black (1.7) (Table 2).

Table 2. Logistic regression results for VLBW births weighing less than 1,500 grams or 3.3lbs at birth.

VLBW Risk Factor	Odds Ratio	95% Confidence Interval
Preterm (less than 37 weeks)*	380.56	(121.45, >999.9)
Previous Preterm Birth*	2.80	(1.39, 5.64)
Mother's Race: African American/ Black*	1.66	(1.23, 2.23)
Previous Births	0.69	(0.51, 0.93)
Late/No Prenatal Care	0.70	(0.47, 1.03)
Pre-pregnancy Diabetes	0.42	(0.21, 0.83)

*Statistically significant associations

The odds of having a very low birthweight birth are significantly higher for preterm infants born less than 37 completed weeks of gestation, and also higher for women who have had a previous preterm birth and for women who are African American or Black.



Infant Health Period of Risk:
Examining Excess Infant Health Deaths

In Hamilton County, 36% of overall excess fetal and infant deaths were in the Infant Health period of risk. Infant Health deaths include infant deaths weighing 1,500 grams (3.3 lbs) or greater who die between 28 days to one year of life (postneonatal deaths). According to the Phase I analysis, there were 29 excess, or preventable, Infant Health deaths from 2001-2005 in Hamilton County when compared to the national reference group.

A cause of death analysis was conducted for postneonatal deaths weighing 3.3 lbs or more at birth. The underlying cause of infant death was obtained from death files linked to the 2001-2005 Hamilton County birth files. The causes of death were grouped by International Classification of Diseases (ICD-10) codes into 7 categories proposed by the CDC's Postneonatal Mortality Surveillance System: perinatal conditions, congenital anomalies, infections, injury, ill-defined, sudden infant death syndrome (SIDS), and other category[xxi].

A total of 49 postneonatal deaths weighing 3.3 lbs or more at birth were categorized into the underlying causes of death categories. The cause-specific mortality rates were calculated by dividing the number of deaths in each category for the target and reference population by their respective number of live births. The excess cause-specific mortality rates were calculated by subtracting the U.S. reference population from Hamilton County (Table 3).

Table 3: Excess cause specific mortality rates for Infant Health (IH) period, Hamilton County 2001-2005.

Hamilton County	Number of Infant Health (IH) Deaths	IH Death Rate*	Reference Population IH Death Rate**	Excess Cause-Specific Mortality Rate
Perinatal Conditions	0	0	0.031	-0.031
Congenital Anomalies	6	0.309	0.263	0.046
Infections	10	0.515	0.037	0.478
Injury	6	0.309	0.1	0.209
Ill-Defined	2	0.103	0.069	0.034
Sudden Infant Death Syndrome	16	0.823	0.218	0.605
Other	9	0.463	0.232	0.231
TOTAL Infant Health	**49**	**2.52**	**0.37**	**2.15**
*Per 1,000 live births >=1500g in Hamilton County : 19,433 **National Reference Group calculated by CityMatCH: 2000-2002				

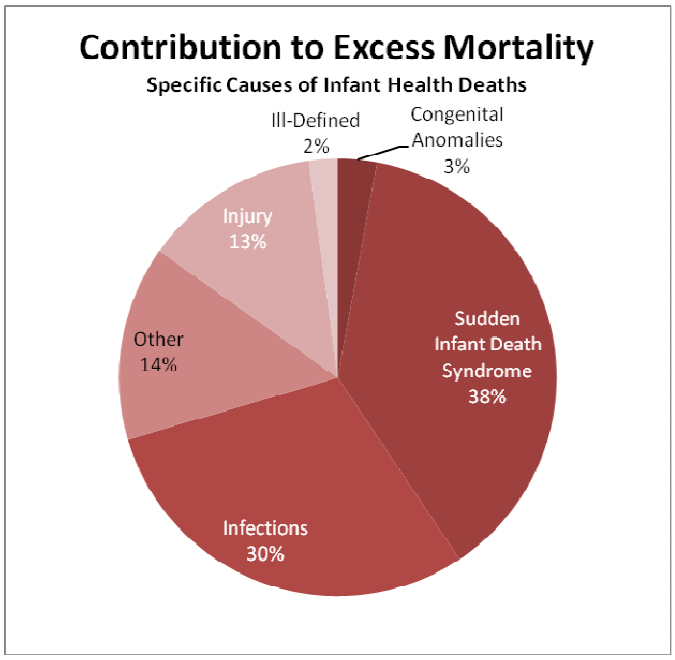


Figure 17. Infant Health Excess Mortality and Causes

Figure 17 illustrates that of the causes studied, Sudden Infant Death Syndrome (38%) and Infections (30%) were the largest contributors to excess Infant Health mortality in Hamilton County compared to the U.S. reference group.

Sudden Infant Death Syndrome (SIDS), accounting for 38% of excess Infant Health deaths, is the sudden death of an infant less than one year of age that cannot be explained after an investigation is conducted, including a complete autopsy, examination of the death scene, and review of the clinical history. Although a diagnosis of exclusion, SIDS is the leading cause of death among infants aged 1 to 12 months, and is the third leading cause of overall infant mortality in the United States[xxii].

Infections accounted for 30% of excess Infant Health deaths. Nearly half of Infant Health deaths caused by infections were respiratory infections, followed by septicemia.

The "Other" category, designed to catch any cause of infant death that does not fall in the other 6 categories, accounted for 14% of the excess Infant Health deaths. The "Other" category included deaths from: immunodeficiencies, malignant neoplasm of liver, cerebral palsy, unspecified diabetes,

other disorders of fluid and electrolyte balance, status epilepticus, other cerebrovascular disease, and ill-defined descriptions of heart disease. Injuries included deaths from assault, car accident, accidental suffocation/strangulation in bed, drowning/submersion in bathtub, and unspecified threat to breathing.

Each cause-of-death category has its own specific set of risk or preventive factors (Table 4). Therefore, further investigation can focus on specific underlying causes and their related risk and preventive factors.

Table 4. Underlying Cause of Infant Death with Corresponding Factors and Interventions.

Underlying Cause of Infant Death	Potential Factors & Interventions	
SIDS	• Passive smoking • Sleep position • Breast feeding	• Bedding • Death scene investigation • Maternal age & education
Infection	• Medical home • Immunization level • Type of infection • Maternal age & education	• Breast feeding • Smoking • Prenatal care participation
Congenital Anomalies	• Folic acid intake • Genetic counseling • Alpha fetoprotein screen	• Ultrasound • Delivery site • Alcohol & drug abuse
Injuries	• Type of injury • Bedding • Co-sleep	• Death scene investigation • Car seat use • Abuse
Perinatal Conditions	• Type of condition • Medical home	• Smoking • High-risk follow up
Ill-defined conditions	• Autopsy rate • Death scene investigation	

SIDS interventions include smoking cessation, breastfeeding promotion, sleep position and bedding education. In four different Women, Infants, and Children (WIC) programs in the U.S., researchers have identified specific barriers to placing infants on their back position to sleep in low-income, primarily African American mothers that should be considered when designing SIDS interventions: lack of or wrong advice, lack of trust in providers, knowledge and concerns about safety and comfort[xxiii].

For Infection interventions, CityMatCH recommends promoting medical home/primary care providers among women and their children, up-to-date immunizations, breast feeding, and smoking cessation.

In addition to grouping underlying cause of death, potential risk factors for Infant Health deaths were examined using odds ratios, relative risk, and population attributable risk . The relative risk (RR) is the ratio of the probability of an event occurring in the exposed group versus a non-exposed group. Population attributable risk (PAR) is the percent that represents the proportion of the outcome (in this case, postneonatal infant deaths weighing over 1,500 grams at birth) that can be attributed to a particular risk factor within that population. The interpretation of PAR is the percent of the population that would be prevented from Infant Health deaths if the corresponding risk factor were eliminated from the entire population.

Risk factors such as preterm birth, mother's age (<20 and >34 years), marital status, cigarette smoking, LBW, maternal race, mother's education (less than 13 years, less than 12 years), and no or late prenatal care (initiated after 1st trimester) were examined.

Mother's education less than 13 years (4.03), smoking (3.05), late/no prenatal care (2.53), and unmarried marital status (2.8) are most likely to be contributing to excess postneonatal deaths weighing more than 1,500 grams at birth (Table 5).

Table 5. Infant Health Period of Risk: Factors for Postneonatal Deaths > 3.3 lbs

Infant Death Risk Factors	Odds Ratio	95% CI	Relative Risk	PAR%
Mother's education < 13 years*	4.03	(2.01, 8.08)	1.62	0.16
Smoking during pregnancy*	3.05	(1.66, 5.61)	2.43	0.36
Late or no prenatal care*	2.53	(1.44, 4.46)	1.88	0.22
Marital status: unmarried*	2.8	(1.18, 3.65)	2.79	34.04
Preterm (less than 37 weeks)	1.89	(0.982, 3.62)	1.67	0.17
Mother's race: African American/Black	1.61	(0.89, 2.9)	1.4	0.1
LBW (less than 2,500 grams or 5.5 lbs)	1.79	(0.84, 3.83)	1.66	0.17
Mother's age >34 years	1.43	(0.57, 3.62)	1.39	0.10
Mother's education <12 years	0.84	(0.48, 1.48)	0.91	-0.02
Mother's age <20 years	0.86	(0.367, 2.03)	0.88	-0.03

*Statistically significant associations

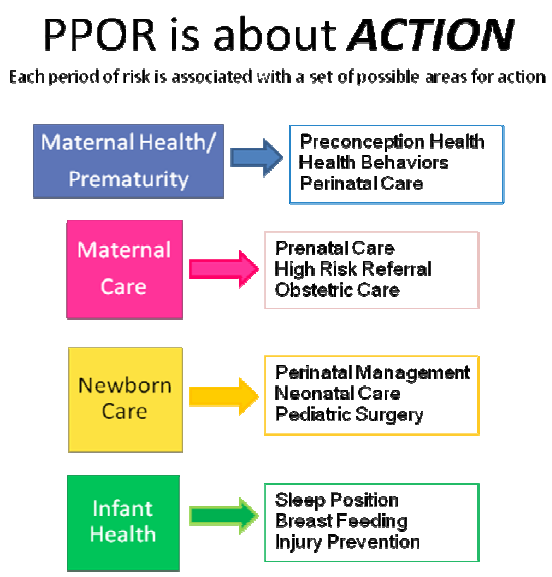
Phase II Summary

In Hamilton County, 62% of overall excess fetal and infant deaths were in the Maternal Health/Prematurity period of risk. For the Maternal Health/Prematurity excess deaths, the results of the Kitagawa analysis reveal that a major contributor to the overall fetal-infant mortality rate in Hamilton County is a high frequency of very low birthweight births (less than 1,500g or 3.3 lbs). In Tennessee, 1.7% of all live births were born very low birthweight, with 2.2% in Hamilton County in 2007. In Hamilton County, the percent of African American VLBW births is more than double the percent of VLBW white births. Logistic regression analysis revealed that the risk factors documented in Tennessee birth certificates such as: previous preterm birth, preterm birth, and mother's race African-

American/Black, are most likely to be contributing factors to the prevalence of VLBW births. Therefore, providing and enhancing existing preconception health programs and services to African American women, women who have had previous preterm births, and to infants born preterm can help reduce Maternal Health/Prematurity excess deaths.

In Hamilton County, 36% of overall excess fetal and infant deaths were in the Infant Health period of risk. For the Infant Health excess deaths, the majority of excess deaths were caused by Sudden Infant Death Syndrome, followed by infections. Odds ratios, relative risk, and population attributable risk reveal that the risk factors collected on the Tennessee birth certificates such as: mother's education less than 13 years, smoking, no/late prenatal care, and unmarried marital status are most likely to be contributing factors to excess postneonatal deaths weighing more than 1,500 grams at birth. Providing early SIDS and injury prevention, smoking cessation, and breast feeding promotion programs to mothers who are unmarried and have lower education levels can help reduce Infant Health excess deaths.

Chapter 3: Recommendations for Action



Excess fetal and infant deaths in Hamilton County, deaths that can be considered preventable, are occurring in the perinatal periods Maternal Health/Prematurity (62%) and Infant Health (36%). The greatest opportunity to reduce fetal and infant mortality rates is to focus on Maternal Health/Prematurity and Infant Health periods, particularly among African American mothers.

For the Maternal Health/Prematurity period, recommendations should be considered from the Centers for Disease Control and Prevention (CDC). In 2006, the Centers for Disease Control and Prevention developed recommendations to improve both preconception health and care based on a review of published research and the opinions of specialists from the CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care[xxiv].

The goal of these recommendations is to improve the health of women and couples, before conception of a first or subsequent pregnancy. The recommendations are aimed at achieving four goals to:

1) Improve the knowledge and attitudes and behaviors of men and women related to preconception health.

2) Assure that all women of childbearing age in the United States receive preconception care services (i.e., evidence-based risk screening, health promotion, and interventions) that will enable them to enter pregnancy in optimal health.
3) Reduce risks indicated by a previous adverse pregnancy outcome through interventions during the interconception period, which can prevent or minimize health problems for a mother and her future children.
4) Reduce the disparities in adverse pregnancy outcomes.

The recommendations focus on changes in consumer knowledge, clinical practice, public health programs, health-care financing, data, and research activities. According to the report, each recommendation is accompanied by a series of specific action steps and, when implemented, can yield results within 2-5 years, and will help achieve *Healthy People 2010* objectives.

Many existing programs can benefit from enhancing outreach to women before or between pregnancies. Some suggested action steps taken from the 2006 report are listed below for reducing Maternal Health/Prematurity mortality:

Preconception Health

- Enhance Family Planning services to prevent unintended pregnancies.
- Integrate reproductive health messages in existing health promotion and marketing campaigns.
- Promote preconception health curricula in school health programs.
- Increase provider awareness of the importance of preconception health among all women of childbearing age.
- Provide screening tools in primary care for preconception risk assessments (e.g. reproductive history, genetic and environmental factors).
- Enhance and improve follow up in post-partum visits to promote interconception health.

Health Behaviors

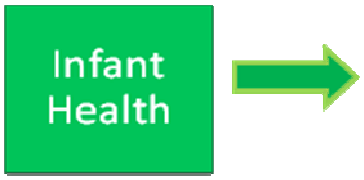
- Educate and promote healthy behaviors that will prevent preconception risk factors.
- Provide interventions to address preconception risk factors in primary care: alcohol and drug abuse, tobacco, diabetes, obesity, STDs, HIV/AIDS, hypothyroidism, PKU, dental.

Perinatal Care

- Increase access to specialized perinatal care.

According to the analysis of Maternal Health/Prematurity excess deaths, providing and enhancing preconception health, health behaviors, and perinatal care programs and services to African American women, women who have had previous preterm births, and to infants born preterm can also help reduce Maternal Health/Prematurity excess deaths.

For the Infant Health Period of Risk, CityMatCH recommends targeting areas such as Sudden Infant Death Syndrome prevention, breast feeding promotion, and injury prevention can help reduce Infant Health mortality:



SIDS Prevention

- Provide sleep position and infant bedding education.
- Provide smoking cessation promotion and referrals to mother and household.
- Increase access to "Medical Home" or primary care provider.

Breast Feeding Promotion

- Educate and promote benefits of breastfeeding.
- Provide and enhance breastfeeding counseling.
- Increase access to breast pumps.

Injury Prevention

- Provide or refer to car seat programs.
- Provide drug and alcohol cessation referrals.

In Hamilton County, the prevention of infections, particularly respiratory infections and septicemia, will also be important in reducing excess Infant Health mortality. A national study published in 2006 concluded that infants who breastfed exclusively for at least the first 6 months of an infant's life (recommended by the American Academy of Pediatrics) were associated with a decreased risk of respiratory tract infection[xxv].

Results from risk factor analysis of Infant Health deaths also reveal that socioeconomic and behavioral factors can also contribute to excess mortality. Promoting higher education for women, smoking cessation, early and continued primary/prenatal care, and increasing services to women who are unmarried may help in reducing Infant Health mortality.

Discussion

The Perinatal Periods of Risk approach provides new insight into fetal and infant deaths by examining potential gaps in the community for further reductions and by linking data results with community action and prevention activities. The goal of this report is to help focus community initiatives for reducing fetal-infant mortality and for improving maternal and infant health. According to the PPOR results for Hamilton County, efforts to lower fetal-infant mortality in the overall population, as well as the African American population, can be achieved through promoting education, eliminating risk factors, and enhancing community services in the areas of Maternal Health/Prematurity (62% of overall excess fetal-infant deaths) and Infant Health (36% of overall deaths).

The PPOR analysis does identify known and documented risk factors that contribute to Maternal Health/Prematurity and Infant Health periods of risk. In Maternal Health/Prematurity, the analysis demonstrates that 69% of excess deaths are the result of the high frequency of very low birthweight

births in Hamilton County. Factors that contribute to the frequency of VLBW births include previous preterm birth, preterm birth, and mother's race African-American/Black. Efforts to prevent excess Maternal Health/Prematurity deaths include promoting women's health prior to and between pregnancies, promoting healthy behaviors, and increasing access to specialized perinatal care. For Infant Health, Sudden Infant Death Syndrome and infections were the primary underlying causes of death for postneonatal infants weighing more than 3.3 lbs at birth. Risk factors for Infant Health deaths include mother's education less than 13 years, smoking, no/late prenatal care, and unmarried marital status. Efforts to prevent excess Infant Health deaths include SIDS prevention, breast feeding promotion, and injury prevention. However, both Maternal Health/Prematurity and Infant Health deaths can also be reduced by promoting health equity, health care access, and empowerment of women in Hamilton County that will help improve their overall socioeconomic status.

Fetal-infant mortality is a complex, multifactorial problem. Risk factors identified in this analysis are only risk factors currently being recorded in vital records and existing data. It cannot be expected that vital records can solely prove the contribution to this complex problem. PPOR is an observational study using data elements collected on birth and death certificates, because they include known risk factors in the population. As a result, the PPOR analysis is unlikely to identify *new* causes of fetal-infant deaths and disparities. Instead, PPOR uses a logical strategy that allows a community to eliminate factors that are unlikely to be contributing to fetal-infant mortality and to find and target factors that are most likely to be contributing.

More research into potential and new risk factors of infant mortality can help direct future interventions. Sources that go beyond vital statistics such as the Fetal Infant Mortality Reviews (FIMR) can provide in-depth understanding of particular infant death cases. If FIMR includes all deaths or a representative sample of deaths, it is possible to make inferences about infant mortality based on FIMR results. Factors such as nutritional status, breast feeding, co-sleeping, physical and psychosocial stress, domestic violence, and environment will also need to be examined as potential risks and contributors to fetal-infant mortality.

The PPOR analysis is just one step in the overall PPOR process. The next step beyond this report is the community coming together to target interventions with the goal of making sustainable system changes.

The six steps of the PPOR process:

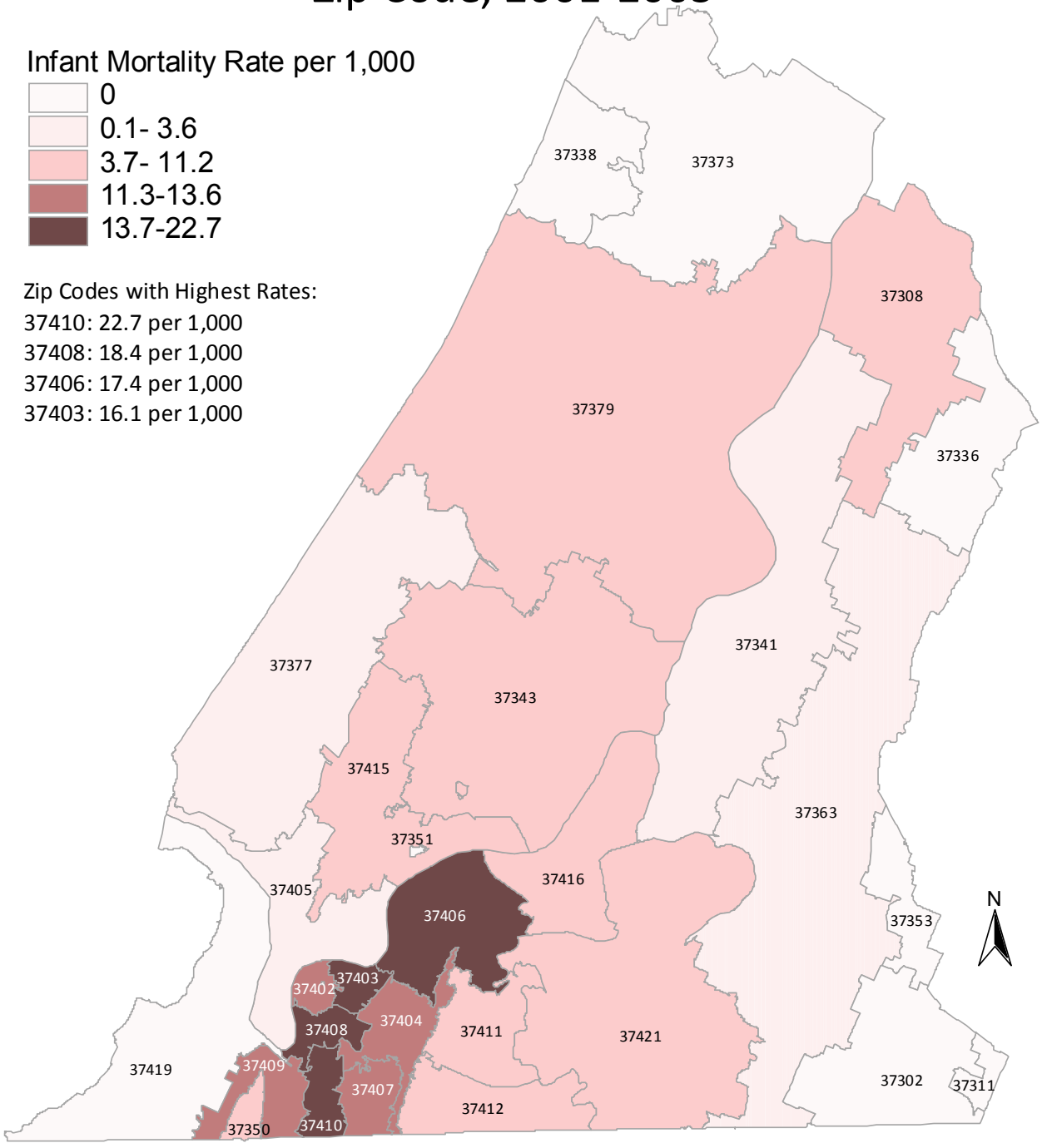
1. Assure analytic and community readiness
2. Conduct analytic phases of PPOR
3. Develop strategic actions for targeted prevention
4. Strengthen existing and/or launch new prevention initiatives
5. Monitor and evaluate approach
6. Sustain Stakeholder investment and political will.

Appendix *Maps*

Map Key

Map 1

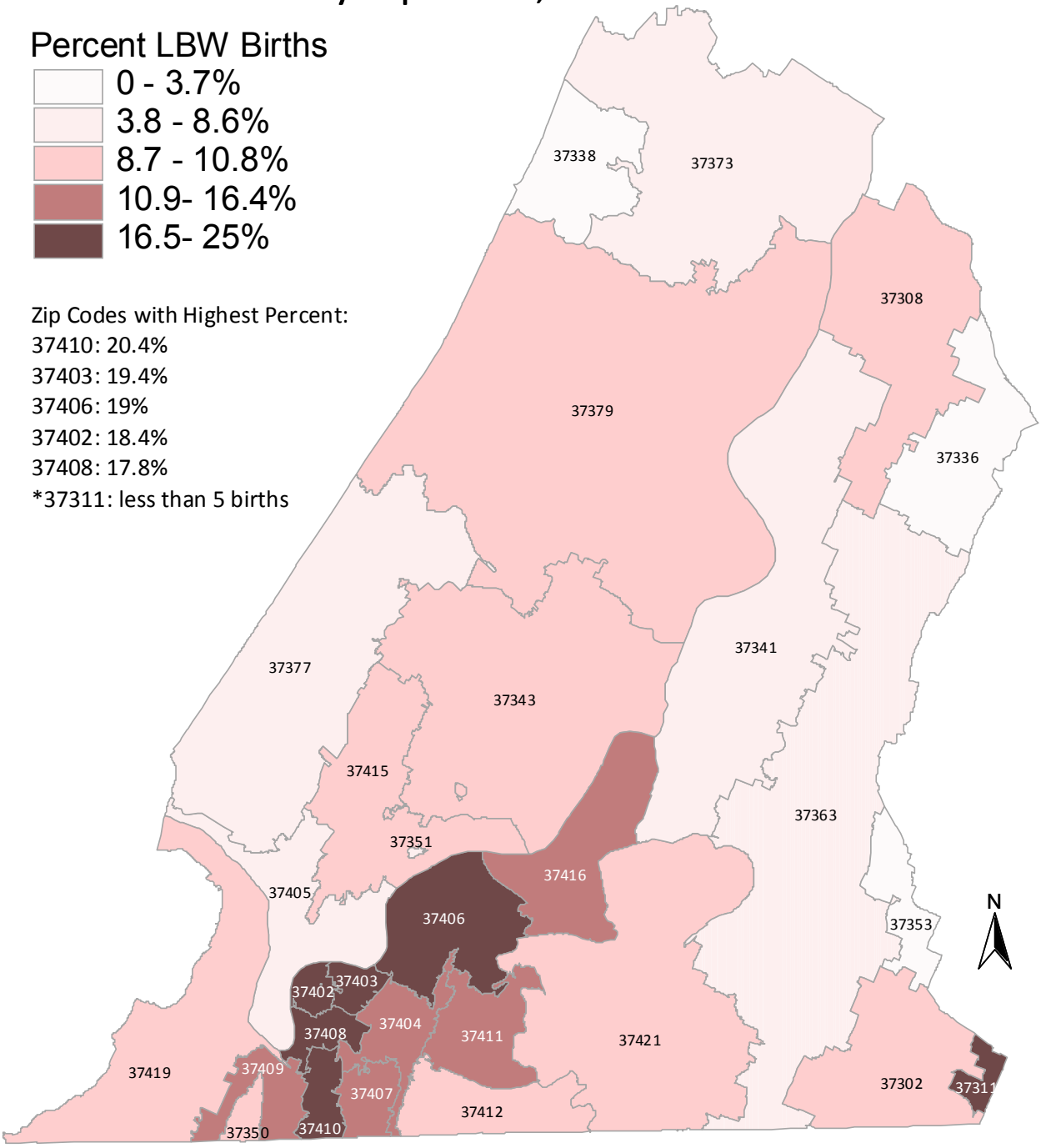
Hamilton County Infant Mortality Rate by Zip Code, 2001-2005



Source: TN Department of Health
Birth Files with missing Zip Codes were excluded

Map 2

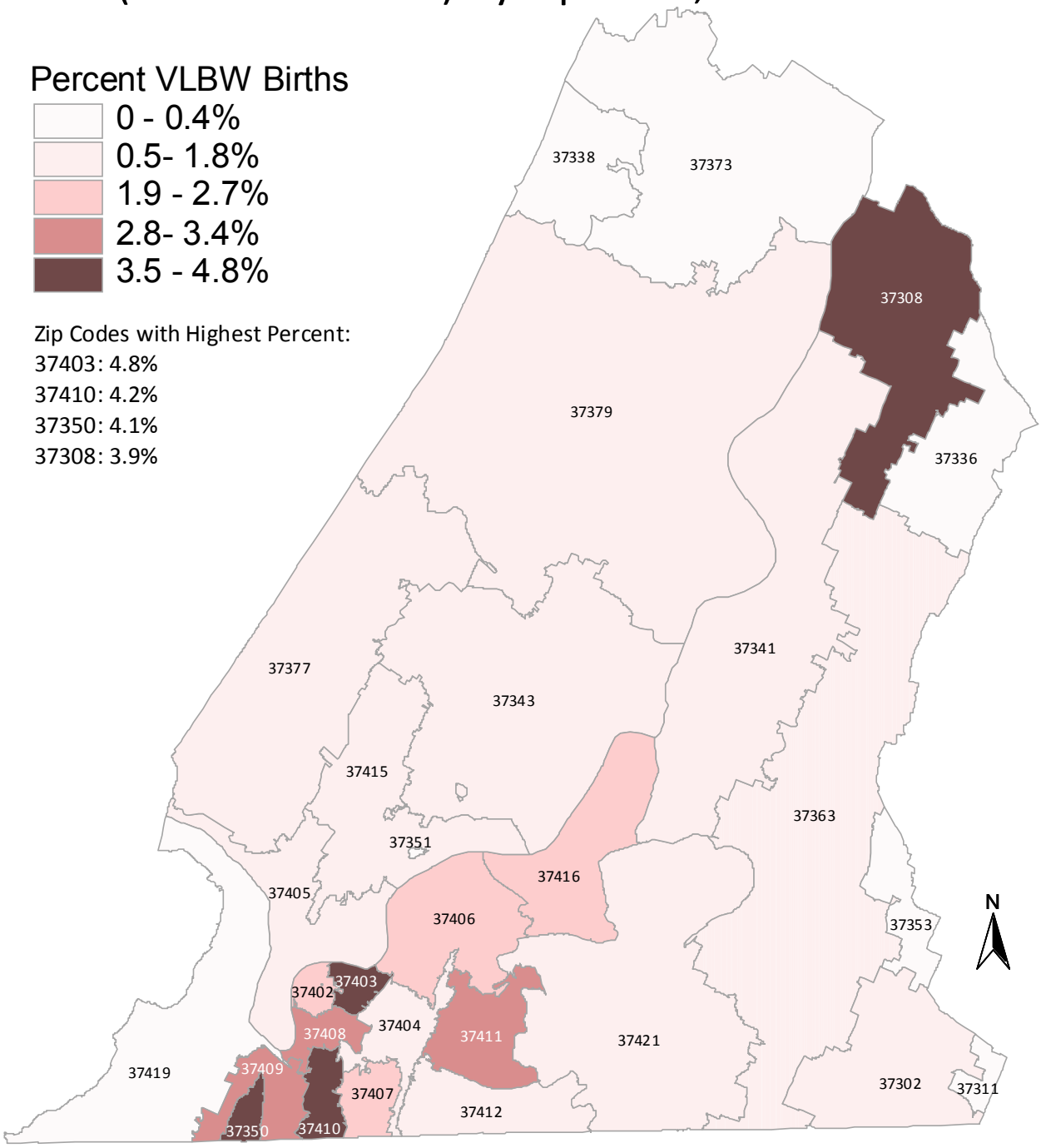
Percent of Births Low Birthweight (less than 5 .5lbs) by Zip Code, 2001-2005



Source: TN Department of Health
Birth Files with missing Zip Codes were excluded

Map 3

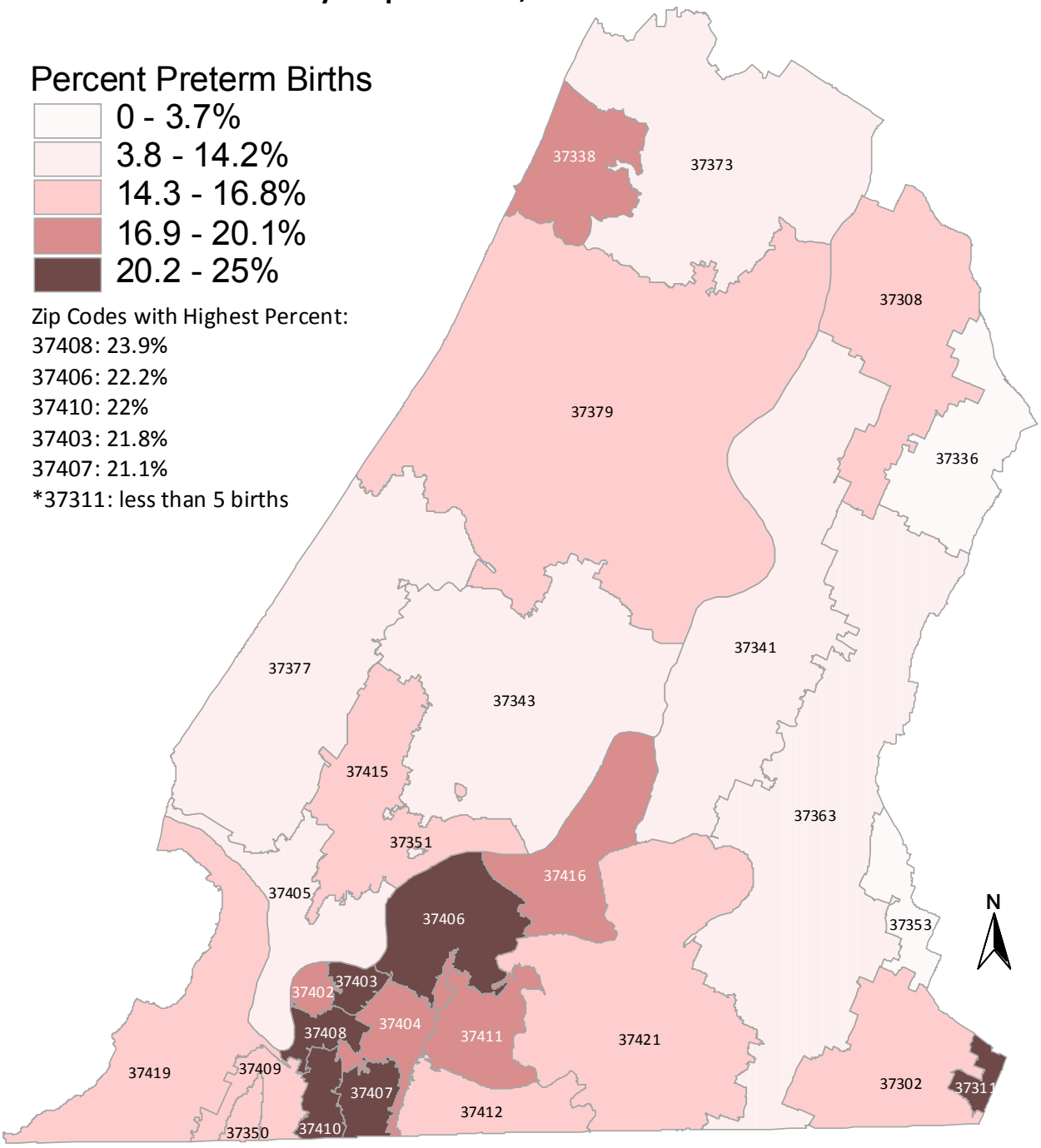
Percent of Very Low Birthweight Births (less than 3.3 lbs) by Zip Code, 2001-2005



Source: TN Department of Health
Birth Files with missing Zip Codes were excluded

Map 4

Percent of Births Born Preterm (less than 37 weeks) by Zip Code, 2001-2005



Source: TN Department of Health
Birth Files with missing Zip Codes were excluded

Technical Notes

Phase I Analysis

The data used in the Phase I Analysis came from the Tennessee Department of Health, Office of Policy, Planning and Assessment, Surveillance, Epidemiology and Evaluation. Data were calculated from the linked Tennessee Birth/Death Statistical Systems and the Fetal Death Statistical System. For infant deaths, the data year was based on year of birth; for fetal deaths, the data year was based on year of fetal death. Fetal deaths with gestational age of less than 24 weeks were excluded from the analysis, totaling 7 fetal deaths or 9% of all fetal deaths. Fetal deaths and live births weighing less than 500 grams were also excluded from the analysis (48 infant deaths or 27% were excluded). These exclusions are necessary because there are large reporting differences in vital records across U.S. cities for events below these two cutoffs. For an added benefit, these cutoffs generally limit pregnancy events to those that are physically viable, assuming no underlying congenital defect or medical condition. CityMatCH analysis has also showed that fetal deaths are not reported consistently across the country unless they're over 500 grams and 24 weeks gestation, and infant deaths are consistently reported provided they are over 500 grams at birth.

For the Hamilton County fetal and infant death data, gestational age was based on estimated/clinical gestational age. For infant deaths, if estimated gestational age was missing or invalid, generated gestational age (based on last menstrual period) was substituted.

A total of 195 fetal and infant deaths from 2001-2005 were used in the PPOR analysis. CityMatCH recommends studying at least 60 fetal and infant deaths in a population. Studying fewer than 60 deaths would result in numbers that fluctuate extremely from year to year simply due to randomness, and it is unwise to make policy decisions based on random changes. According to CityMatCH, studying at least 60 deaths allows communities to differentiate between real underlying changes or differences and random fluctuations. Communities may combine up to 5 years of data to reach the adequate number of deaths, but no more due to changes in medical practice. In Hamilton County, 5 years of data were analyzed so that we could also examine the fetal and infant mortality rates of our African American population (76 total deaths from 2001-2005).

To calculate the fetal-infant mortality rate, deaths in each period of risk were multiplied by 1,000 and then divided by the denominator. The specific rates in each of the four periods of risk are added up to create the overall fetal-infant mortality rate. In Hamilton County, there were 19,807 total live births from 2001-2005. The overall Hamilton County fetal-infant mortality rate was calculated using a different denominator (19,614) for two reasons: the PPOR analysis used linked Tennessee Birth/Death Statistical Systems, which is restricted to in-state resident births and 204 out of state births were not included. Second, in the PPOR analysis, when calculating the fetal-infant mortality rate, both the numerator and the denominator are limited to infants weighing 500 grams or more at birth. In Hamilton County from 2001-2005, the number of live births with a birthweight of 500 grams or more in the linked Birth/Death file was 19,549 (54 births with missing birthweight or birthweight <500 grams were excluded). Add 65 total fetal deaths and the denominator is 19,614, which is what was used in the calculations.

For Phase I PPOR analysis, a U.S. reference group was used to calculate excess fetal-infant mortality rates. The U.S. reference group, 2000-2002 data provided by CityMatCH, consists of non-Hispanic white mothers of 20 or more years of age having 13 or more years of education. This group usually represents more than 15% of the population and has the optimal outcomes in most U.S. cities. Moreover, the mortality rates for this population group are readily available through current vital records system.

Phase II Analysis

The Kitagawa formula is used to determine if the contributing factor to excess Maternal Health/Prematurity deaths is the result of birthweight distribution or birthweight-specific mortality. The formula averages birthweight distribution between Hamilton County (2001-2004) and the U.S. reference group (1998-2000 data provided by CityMatCH), and multiplies by the difference in specific mortality. The second term averages the specific mortality rates between the target and reference groups, and multiplies by the difference in birthweight distribution. The formula estimates the percentage of excess mortality due to birthweight distribution and the percentage of excess mortality due to high birthweight-specific mortality rates.

CityMatCH provides an Excel spreadsheet with the formula calculations. Local data on live births, infant deaths, and fetal deaths greater than 24 weeks are categorized by birthweight categories: 500-749 grams, 750-999 grams, 1000-1249 grams, 1250-1499 grams, 1500-1999 grams, 2000-2499 grams and 2500 grams or greater. The Kitagawa formula is below:

$$MR_1 - MR_2 = \sum_1^n \left(\left(\frac{(P_{1n} + P_{2n})}{2} \times (M_{1n} - M_{2n}) \right) + \left(\frac{(M_{1n} + M_{2n})}{2} \times (P_{1n} - P_{2n}) \right) \right),$$

{Overall difference} ={Birthweight-specific mortality} + {Frequency of lower birthweights}

Where: *n*= Number of birthweight categories (birthweight "strata")

MR_1=Overall feto-infant mortality rate for high (target) mortality group
MR_2=Overall feto-infant mortality rate for the reference group

P_{1n}=Proportion of births for a specific birthweight category for the high mortality group
P_{2n}=Proportion of births for a specific birthweight category for the reference group

M_{1n}=Birthweight specific mortality rate for high mortality group
M_{2n}=Birthweight specific mortality rate for the reference group

This formula directly estimates the amount of excess mortality due to VLBW versus the amount due to birthweight specific mortality rates. The contributions can be added up across birthweight categories. More information on this method can be found at http://www.citymatch.org/ppor_how.php.

If the predominant component is birthweight distribution, the focus of the PPOR analysis shifts from studying the deaths of these small babies to studying the percentage of all births weighing 500 to 1,499

grams or very low birthweight live births (VLBW). The analysis examines the prevalence of risk and preventative factors for VLBW births among all live births, which is often available from sources other than vital records, allowing analysis of additional factors. Selected risk factors were examined using a combined 2001-2005 birth file in Hamilton County. A step-wise logistic regression model was built by Amanda Wilburn, Epidemiologist, in SAS and was used to model the risk of all VLBW births (fetal death files were not available, and thus fetal deaths were excluded from this analysis). The following selected risk factors were used in the model: late/no prenatal care (defined as starting prenatal care after month three of the pregnancy or not at all), previous birth(s), smoking, diabetes (pre-pregnancy), hyptertension (pre-pregnancy), previous pre-term birth(s), pre-term, race (black or African American), risky age (<20 years and >34 years), education less than 12 years (no high school diploma/GED), residential risky zip codes from a identified from a previous LBW assessment (37402, 37403, 37406, and 37410) and being diagnosed with an sexually transmitted disease (lifetime).

For the Infant Health period, the biologic mechanism is determined by studying the underlying cause of death as captured on the death certificate. This may not be the same cause of death as listed on the death certificate by the certifying physician. Underlying cause of death is assigned by an NCHS computer algorithm based on all of the causes listed by the certifying physician (National Center for Health Statistics. Vital statistics of the United States: Mortality, 1999 Technical Appendix. Hyattsville, Maryland: http://www.cdc.gov/nchs/data/statab/techap99.pdf). CityMatCH recommends categorizing the underlying cause of death according to the classification system used by CDC's Postneonatal Mortality Surveillance System which includes birth defects, infections, injuries, perinatal conditions, SIDS and other causes. Coding instructions for ICD-10 underlying causes of death into the Postneonatal Morality Surveillance System can be found at http://www.citymatch.org/ppor_how.php.

The contribution of each underlying cause of death category to the excess Infant Health mortality for each population can be calculated. The cause-specific excess mortality rate is the cause-specific rate for the study population minus the cause-specific mortality rate for the reference population. The contribution is calculated by dividing the cause-specific excess mortality rate by the total excess mortality rate for the period.

According to CityMatCH, the percentage of deaths by cause of death should not be used for comparison because these percentages do not take into account differences in overall mortality rates. For example, the percentages by cause may be the same for two populations while the mortality rate for is one is twice to three times the mortality rate for the other (fetal deaths are not included in the infant health period analysis).

Potential risk factors for Infant Health deaths were examined using odds ratios (OR), relative risk (RR), and population attributable risk (PAR). Selected risk factors were cross-tabbed in SPSS using linked birth/death files. The Maternal and Child Health Population Attributable Risk calculator from the University of Rochester, Division of Public Health Practice, was used to calculate OR, RR, and PAR[xxvi].

Limitations

One potential limitation throughout this analysis is the change in the Tennessee birth certificate format in 2004. Therefore, data from 2001-2003 uses a different birth certificate from the data in 2004-2005. The new birth certificate in Tennessee is modeled after the 2003 Revision of the United States Standard Certificate of Live Birth. One of the major changes in the 2004 birth certificate was to allow a parent to specify more than one choice in response to the question asking for his/her race. To enable comparison between birth data for 2004 and data for prior years when only one race could be reported, the National Center for Health Statistics of the Centers for Disease Control and Prevention provides a computer modeling program to all states to use to assign multiple race responses to a single race based on a statistical algorithm. The original parental choices are maintained on our data files as well as the assigned race. The assigned race is for statistical tabulation purposes only and has no other use.

A change in the birth certificate during the years of data analysis can effect reporting, the evaluation of certain risk factors, and the classification and coding of variables. It is also important to consider that many risk factors documented on birth certificate forms (such as tobacco use, education, and income) are self-reported by the mother. Risk factors such as tobacco use, alcohol use, and substance abuse tend to be underreported by the mother. Death certificate data are overall less reliable than birth certificate data; therefore, this analysis used mother's race, mother's zip code and other factors from the birth certificate, although some of this information is also recorded on the death certificate.

The revised U.S. Standard Birth Certificate, with the revised race and Hispanic origin formats, may be found by going to the following web site, where the data collection, transmission, edit, and file layout specifications are also posted: http://www.cdc.gov/nchs/vital_certs_rev.htm .

For Phase I analysis, there are more than the minimum of 60 deaths being studied in Hamilton County and in the racial sub-populations. However, precision in the fetal-infant mortality rates would be greater with larger numbers of deaths. When there are more deaths in a community, it is less likely to see large fluctuations in the rates from year to year. An external U.S. reference group was used in this analysis to calculate excess deaths, because there were not enough deaths in an internal reference group of non-Hispanic white women, age 20 years or more with 13 years or more of education.

There are several limitations to consider when conducting Phase II analysis. A large number of deaths are needed to obtain statistically significant results, because models are complex and effect sizes are small. This is true for both the Maternal Health/Prematurity (less than 200 deaths) and the Infant Health death analysis of postneonatal deaths weighing 1,500 grams or more at birth (a total of 49 deaths).

Another limitation to Phase II analysis is that it is unlikely to identify new causes or risk factors of Infant Health deaths or VLBW births, because this phase of the analysis is an observational study using vital records and existing data. Risk factors identified in this analysis are only risk factors currently being recorded in vital records, and it cannot be expected that vital records can solely prove the contribution of certain factors to excess deaths in a community. Third, it is unlikely to find a single cause for excess

mortality because the fetal-infant mortality is a complex, multifactorial problem. Instead, the PPOR Phase II uses a logical strategy that allows a community to eliminate factors that are unlikely to be contributing and to find and target factors that are most likely to be contributing.

In studying the Infant Health deaths, many risk factors such as co-sleeping, breast feeding, stress, etc., are not currently available in Hamilton County. However, Hamilton County is participating in the Tennessee Pregnancy Risk Assessment and Monitoring System (PRAMS), and will have such access to data in the future. Other data that would be helpful to assess during the Phase II analysis: Pregnancy and Pediatric Nutrition Surveillance Systems, newborn screening, hospital discharge systems, child abuse reporting systems, and Fetal Infant Mortality Review (FIMR).

Definitions

Birth to Unmarried Woman: A mother is considered to be unmarried if she was not married at the time of conception and did not marry at any time between conception and delivery.

Birth Weight: The first weight of the fetus or newborn obtained after birth. This weight preferably is measured within the 1st hour of life, before a significant postnatal weight loss has occurred.

Congenital Anomalies: the abnormality of the structure of a body part. 'Birth defect' is a widely-used term for a congenital malformation or anomaly which is recognizable at birth.

Fetal Death: Stillbirth or death prior to the expulsion or extraction from its mother of a product of human conception; death is indicated by the fetus not breathing or showing other evidence of life, such as the beating of a heart, pulsation of the umbilical cord or definite movement of voluntary muscles (Tennessee Code Annotated 68-3-102(4). Each fetal death of 500 grams or more, or in the absence of weight, of 22 completed weeks of gestation or more shall be reported to the office of vital records in Tennessee within 10 days after delivery (Tennessee Code Annotated 68-3-504 (a).

Gestation age: Completed weeks of pregnancy from the first day of the mother's last normal menstrual period.

Healthy People 2010: Initiative started in January 2000 by the United States Department of Health and Human Services. It is a nationwide health promotion and disease prevention plan that is composed of 467 specific objectives, 28 goals, and two overarching goals to be achieved by 2010.

Infant death: Death of an infant before his or her first birthday.

Infant mortality rate (IMR): Number of infant deaths per 1,000 live births.

ICD-10: Classification codes for causes of death, or International Classification of Diseases, regulated by the World Health Organization. ICD-10 is the tenth revision classification for deaths occurring after 1999.

Late Prenatal Care: Medical care during pregnancy that is initiated after the first trimester (after the 3 month).

Late Preterm Birth: Births from 34 to 36 completed weeks of gestation.

Live Birth: The complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy, which, after such separation, breathes, or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered live born (Tennessee Code Annotated 68-3-102(9).

Logistic Regression: A method for determining whether each of a set of independent variables has a unique predictive relationship to a dichotomous dependent variable (such as VLBW or not). Modeling with logistic regression allows one to contrast different theoretical sets of predictor variables. Logistic regression methods are analogous to multiple linear regression methods when the dependent measure is dichotomous (coded into variables of 0 and 1). A common way of assessing the influence of an independent variable on the dependent variable is to look at the odds-ratio which is an index of how likely it is that a baby is born VLBW given values of the independent variable.

Low Birthweight (LBW): Birth weight of less than 2,500 grams (5.5 lbs or less). A **very low weight birth (VLBW)** is less than 1500 grams (less than 3.3 lbs).

Multiple Birth/Plurality: More than one child born resulting from a single pregnancy. Also called plural birth.

Neonatal Mortality: Death of a live-born baby within the first month (28 days) of life.

Odds Ratio (OR): The ratio of the odds of an event occurring in one group to the odds of it occurring in another group. The odds ratio is a way of comparing whether the probability of a certain event is the same for two groups. An odds ratio of 1 implies that the event is equally likely in both groups. An odds ratio greater than one implies that the event is more likely in the first group.

Perinatal: Pertaining to or occurring in the period shortly before and after birth. There are several commonly used definitions for the perinatal period, extending from 20 weeks of gestation to 4 weeks after birth.

Population Attributable Risk (PAR): Represents the proportion of the deaths (in a specified time) in the whole population that may be preventable if a cause of mortality were totally eliminated.

Postneonatal Mortality: Death of a live-born baby after the first month (28 days) of life up to 1 year.

Postterm: Births occurring at a gestational age greater than or equal to 42 weeks (>293 days).

Premature Birth: Birth occurring prior to 37 completed weeks of gestation, but after that stage of viability at about 20 weeks gestation.

Prenatal: Existing or occurring before birth.

Prenatal Care: Medical care during pregnancy before birth.

Preterm: Births occurring prior to 37 completed weeks of gestation (<259 days).

Relative Risk (RR): The risk of an event (or of developing a disease) relative to exposure. Relative risk is a ratio of the probability of the event occurring in the exposed group versus a non-exposed group.

Singleton: Single birth.

Term: Births occurring between 37 and 41 completed weeks of gestation (259-293 days).

Trimester: A 3-month period of time. First trimester care, for example, refers to care initiated in the 1st three months of pregnancy.

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