Perinatal Periods of Risk Analysis for Indiana, 2011

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BACKGROUND

The infant mortality rate (IMR), which is defined as the number of children who die before their first birthday per 1,000 live births, is regarded as an important indicator of a population's health often because factors affecting the health of a nation also impacts the mortality of children (Reidpath & Allotey, 2003) (Centers for Disease Control and Prevention [CDC], 2013).

It is estimated by the Centers for Disease Control and Prevention (CDC) that nearly 25,000 children die each year in the United States before their first birthday (2013). Infant mortality rates in the United States have decreased in the past decades; from 12.6 in 1980, to 9.22 in 1990, and 6.91 in 2000 (CDC, 2014). However, between 2000 and 2005, infant mortality rates in the United States did not decline significantly (MacDorman & Mathews, 2008). The infant mortality rate for the United States in 2011, according to the CDC was 6.07 deaths per 1,000 live births (2014). There is also a clear disparity between races, with Whites having an IMR of 5.12 and Blacks IMR of 11.51 per 1,000 live births (CDC, 2014). Black infants in the U.S. during 2011 were 2.25 times more likely to die than white infants (CDC, 2014).

Indiana had an IMR of 7.68 in 2011 with 643 infants dying before their first birthday (Figure 1) (Indiana State Department of Health [ISDH], 2014). Indiana's IMR has been higher than the U.S rate since at least 1990, with the exception of 1991 (CDC, 2014, ISDH, 2005). The state's rate has been at or above 6.9 for 113 years (Indiana Perinatal Quality Improvement Collaborative [IPQIC], 2013). In 2011, there were only five other states that had higher infant mortality rates than Indiana and included: Alabama (8.21), Delaware (8.71), Louisiana (8.24), Mississippi (9.38), and Ohio (7.88) (CDC, 2014). As with the U.S., there is a clear disparity among races in Indiana, with Black infants being 1.8 times more likely to die than White infants in 2011 (Figure 2) (ISDH, 2014). While Black infant mortality rates have started to decline in Indiana, White infant mortality has started to increase (ISDH, 2013).

In 2012, Governor Mike Pence with the appointment of Dr. William VanNess II as the State Health Commissioner, declared infant mortality as the number one priority for the Indiana State Department of Health (ISDH) (IPQIC, 2013).

PERINATAL PERIODS OF RISK (PPOR)

While infant mortality rates provide values to help determine the burden of infant deaths, they do not provide information about the risk factors contributing to infant deaths (Peck, Sappenfield, Skala, 2010). In 2014, Indiana began conducting the Perinatal Periods of Risk Analysis (PPOR). PPOR is an analytic framework that consists of six overall stages to help communities develop a better understanding of the burden of feto-infant mortality (Table 1).

Table 1: Six stages of PPOR
Stage 1: Readiness • Community engagement, mobilization, and alignment • Community readiness • Analytic readiness
Stage 2: Data and assessment • Analytic preparation • Phase 1 PPOR analysis: Feto-infant mortality map and gaps • Phase 2 PPOR analysis: Further epidemiologic investigations
Stage 3: Strategy and planning • Strategic action plans • Targeted prevention
Stage 4: Implementation • Communication and coordination • Re-assessment of community readiness
Stage 5: Monitoring and evaluation • Monitor local indicators • Assess impact of approach
Stage 6: Investment • Unity of stakeholder efforts • Political will achievement

Stage 2 consists of two analytic phases, both which were completed for the State of Indiana in order to better prioritize prevention strategies. In Phase 1, feto-infant mortality is categorized into four distinct periods of risk defined by age at death and birthweight (Figure 1). Each period of risk corresponds with potential prevention and intervention efforts (Figure 2). This categorization allows researchers to determine where excess mortality is occurring based on a comparison with an internal reference group that observes better overall outcomes. Phase 2 investigates the period(s) of risk and subpopulations with the highest excess mortality from Phase 1 in order to identify risk factors using the following steps: 1) Identify the causal pathway for excess mortality, 2) Estimate the prevalence of risk factors by type of pathway, and 3) Estimate the impact of the risk factors using multivariate analyses and population attributable risk percent (PAR%).

Figure 1: PPOR Feto-Infant Mortality Map

Birthweight ↓ / Age at Death →	Fetal Death >= 24 Weeks	Neonatal Death 0 – 27 Days	Post-Neonatal Death 28 – 364 Days
500 – 1,499 Grams	**Maternal Health / Prematurity (MH/P)**		
1,500 + Grams	**Maternal Care**	**Newborn Care**	**Infant Health**

Figure 2: Perinatal Periods of Risk Prevention Strategies	
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	Safe Sleep Breast Feeding Injury Prevention

METHODS

PPOR Stage 2, Phase 1 analysis methodology is based on all live births in a given year, a linked birth and death cohort, and fetal deaths meeting certain criteria (Sappenfield, Peck, Gilbert, Haynatzka, Bryant III, 2010b). Each of these records is made available to the ISDH Maternal and Child Health Epidemiology Division (MCH) on a nightly basis by the Indiana State Department of Health Vital Records Division through the Division of Maternal and Child Health Integrated Data System agreement. The PPOR analysis for the state of Indiana was conducted in accordance with CityMatCH protocol (Sappenfield et al., 2010b).

Only records for Indiana residents were used in this analysis. A linked infant death cohort for the year 2011 was used; infant deaths occurring in 2011 were linked with their corresponding birth certificate regardless of birth year. Fetal death and live birth records for the year 2011 were used for analysis. Because initiatives to combat the problem of infant mortality in Indiana began in 2012, it was decided that the year 2011 would be used and serve best as a reference year in moving forward. Before eliminating those that did not meet PPOR criteria, there were a total of 83,750 live births, 651 infant deaths and 764 fetal deaths.

Infant deaths were restricted to those weighing at least 500 grams at birth. Fetal deaths were limited to those occurring in 2011, greater than or equal to 24 weeks estimated gestation and a weight of 500 grams or greater. All live births occurring to Indiana residents in 2011, weighing at least 500 grams were eligible for the analysis. These restrictions were placed according to CityMatCH protocol and were established in order to have comparability of reporting both within and across communities. These criteria are necessary because reporting lower birthweight and gestational age varies greatly and can distort analyses (Sappenfield et al., 2010b). Not included in the analyses are fetal and infant deaths and live births that did not meet the criteria, terminations and spontaneous abortions.

The numbers and percentages of those records with missing or unknown birthweight, gestational age and/or age at death were determined for live births, fetal deaths and infant deaths. The number of unlinked infant deaths was also determined. Infant deaths were matched at 92% with birth certificate files, with only 52 unable to be linked to a birth certificate. For analysis, records missing birthweight, gestational age and/or age at death and unlinked infant deaths were not included.

Next, researchers tested for implausible birthweight, gestational age and birthweight/gestational age combinations. There were a total of 26 implausible birthweight/gestation combinations for live births and 11 for infant deaths. All implausible combinations were treated as missing values and deleted from analysis. Methods for determining implausible combinations were established using CityMatCH criteria and can be seen in table 2 (CityMatCH, 2014a).

Table 2: Implausible Methodology Used for Gestational Age and Birthweight Combinations

	Gestational Age							
Birthweight (grams)	0 – 10 Weeks	11 – 20 Weeks	21 – 23 Weeks	24 – 27 Weeks	28 – 31 Weeks	32 – 35 Weeks	36 – 46 Weeks	47+ Weeks
0 – 500								
500 – 999								
1000 – 2000								
2000 – 2999								
3000 – 3999								
4000 – 7999								
8000 - 9999								

Implausible birthweight and gestational age combinations are blacked out.
If plurality is greater than 1, the combinations in blue become plausible.

Imputation is recommended for use if greater than 5% of the birthweight or gestational age values are missing from the records; it is highly recommended if more than 10% are missing values. Fetal deaths for this analysis were found to have nearly 12% missing values and therefore imputation was conducted. Imputation algorithms were developed for PPOR based on the National Center for Health Statistics (NCHS) data for the years 1995-1997, using median birthweight for a given gestational age. Fetal deaths at 32 weeks gestation or more were imputed to have birthweights of 1,500 grams or more. Fetal deaths at gestational ages less than 32 weeks were imputed to weigh less than 1,500 grams (Sappenfield et al., 2010b).

After deleting those that did not meet PPOR criteria, those with missing values and records with implausible birthweight and/or gestation, there were a total of 83,427 live births, 450 infant deaths and 295 fetal deaths eligible for analysis (Table 3). It is important to note that the exclusions falsely lower the mortality rates.

Table 3: Number and percentages of unknowns for live births, fetal deaths and infant deaths ineligible for PPOR analysis, Indiana, 2011

	Live Births		Infant Deaths		Fetal Deaths	
Infant and Maternal Characteristics	Number	%	Number	%	Number	%
Total Deaths	NA	NA	n = 651		NA	NA
Unlinked Deaths			52	8.00		
All Births, Linked Infant Deaths, and Fetal Deaths	n = 83,750		n = 599		n = 764	
Birthweight	65	0.08	8	1.34	89	11.65
Gestational Age	87	0.10	1	0.17	61	7.98
Gestational Age or Birthweight	122	0.15	9	1.5	91	11.91
Age at Death	NA	NA	1	0.17	NA	NA
All PPOR Eligibles*	n = 83,427		n = 450		n = 295	
Age	51	0.06	0	0.00	2	0.68
Education	286	0.34	10	2.22	3	1.02
Hispanic Origin	152	0.18	2	0.44	1	0.34
Race	217	0.26	2	0.44	0	0
Any of the above	674	0.81	14	3.11	5	1.69

NA = Not applicable characteristic for live births and fetal deaths

* = These events meet PPOR study requirement and are not missing values for essential data elements

Adapted from Sappenfield et al., 2010 Table 3

Researchers used an internal reference population for analysis. The underlying assumption is that if one population can experience better feto-infant mortality rates, other populations should also be able to experience similar rates. The internal reference population used for this analysis consisted of Non-Hispanic, White females residing in Indiana, at least 20 years of age with 13 or more years of education. The internal reference population was derived from the study population and consisted of 36,430 live births, 152 infant deaths and 105 fetal deaths after deleting those that did not meet PPOR criteria and those with missing values. It is important to note that the reference population represents nearly 44% of the study population and therefore drives Indiana's mortality rates as a whole and the study population of Non-Hispanic Whites down. For this reason, researchers decided to pull out the characteristics of the reference population from the Non-Hispanic White study population and also conduct analyses on that group of women.

A 2-by-3 table was created with the time of death representing the columns and weight represented by the rows (Figure 1). Time of death is represented by three columns: fetal death, neonatal death (0-27 days), and post-neonatal death (28-264 days). Birthweight is represented by two rows: 500 grams to 1,499 grams and 1,500 grams or greater. All fetal and infant deaths were then assigned to their corresponding category and placed in the proper cell. Those deaths that occurred to individuals weighing less than 1,500 grams were placed in the 'Maternal Health and Prematurity (MH/P)' cell. Those fetal deaths weighing 1,500 grams or greater were placed in the 'Maternal Care (MC)' cell. Neonatal deaths to individuals weighing at least 1,500 grams were placed in the 'Newborn Care (NC)' cell, and post-neonatal deaths of the same weight were placed in the 'Infant Health (IH)' cell. This process was repeated for the internal reference group, for Non-Hispanic Whites, Non-Hispanic Blacks and Hispanics.

Mortality rates for each period of risk and population were calculated by dividing the deaths in each risk period by the number of live births and fetal deaths and then multiplying by one thousand. From these values, the reference group rate was subtracted to obtain excess mortality rates for each category and population. Then, the numbers of excess deaths for each risk period were calculated by multiplying the excess death rates by the appropriate total number of fetal deaths and live births divided by one thousand. Last, the percentage contribution of excess deaths by category was calculated.

Next, researchers began Stage 2, Phase 2 analysis. The Kitagawa formula was used to determine the contribution to excess deaths due to higher birthweight-specific mortality rates or due to birthweight distribution rates, specifically within the MH/P category. The Kitagawa formula uses six birthweight categories for birthweights less than 2,500 grams in order to have precise contribution estimates. Kitagawa analysis allows researchers to determine if the excess mortality in the population is due to a larger distribution of babies being born at low birthweights, or if there are higher mortality rates among low birthweight babies. Results from Kitagawa analyses allow program areas to focus efforts on either reducing the prevalence of risk factors associated with a very low birthweight birth or aspects of the perinatal care system that are responsible for higher birthweight-specific mortality rates.

Researchers then followed up the PPOR analyses by examining the black and white experience in the Maternal Health/Prematurity and Infant Health categories. For the MH/P period of risk, after identifying the underlying mechanism in each population with results from Kitagawa analyses, the prevalence of known risk factors associated with very low birthweight births and deaths were estimated for the study and reference populations. Prevalence was estimated for those women having a very low birthweight birth or death and compared to those women who did not.

Within the IH period of risk, cause specific mortality rates were calculated to determine where the largest amounts of excess deaths were occurring. Then, the prevalence of risk factors associated with the cause was estimated for the study and reference populations. Prevalence was estimated for those women experiencing and infant death and compared to those women who did not experience and infant death.

Next, a logistic regression analysis was used to estimate odds ratios within both periods of risk. Finally, researchers calculated population attributable risk percentages to estimate the impact of each risk factor.

RESULTS

PHASE 1

There were a total of 83,427 live births, 450 infant deaths, and 295 fetal deaths in 2011 to Indiana residents that met PPOR criteria and were eligible to be used in analysis. This left a total of 83,722 live births and fetal deaths to use as the denominator for calculations. The overall feto-infant death rate for Indiana was 8.9 per 1,000 live births and fetal deaths (Table 4), compared to 7.03 for the internal reference group (Table 5). An important note, these mortality rates are not comparable to Indiana's standard infant mortality rates that are released each year in Indiana's Mortality Report (ISDH, 2014). PPOR analysis includes fetal deaths in the mortality rate and also excludes infant deaths that do not meet established criteria; Indiana's infant mortality rate, as reported on the annual Mortality Report, only includes infant deaths and does not exclude any records (ISDH, 2014).

As hypothesized, Indiana's largest mortality rate fell in the Maternal Health/Prematurity category with a rate of 3.22 deaths per 1,000 live births and fetal deaths. The Infant Health category had the second largest mortality rate of the four categories with a rate of 2.96 per 1,000 live births and fetal deaths. These rates were followed by the Maternal Care and Newborn Care categories, respectively, with rates of 2.01 and 0.70 per 1,000 live births and fetal deaths.

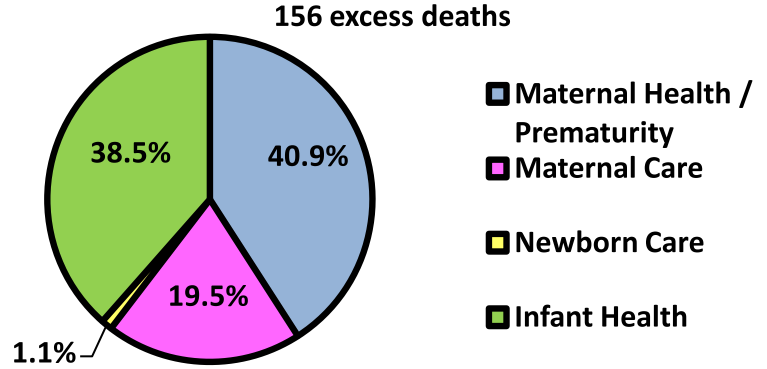
Table 4: Indiana Feto-Infant Mortality Map			
	Fetal Death >= 24 Weeks	**Neonatal Death 0 – 27 Days**	**Post-Neonatal Death 28 – 364 Days**
500 – 1,499 Grams	Maternal Health / Prematurity 270 deaths **3.22**		
1,500 + Grams	Maternal Care 168 deaths **2.01**	Newborn Care 59 deaths **0.70**	Infant Health 248 deaths **2.96**
Feto-Infant Deaths = 745			
Live Births + Fetal Deaths = 83, 722 (Used for denominator)			
Indiana's Overall Feto-Infant Mortality Rate* = 8.90 deaths per 1,000 live births and fetal deaths			
* = The sum of the four periods may not exactly equal the total because of differences due to rounding.			

Table 5: Indiana Internal Reference Group Feto-Infant Mortality Map

	Fetal Death >= 24 Weeks	Neonatal Death 0 – 27 Days	Post-Neonatal Death 28 – 364 Days
500 – 1,499 Grams	Maternal Health / Prematurity 90 deaths **2.46**		
1,500 + Grams	Maternal Care 60 deaths **1.64**	Newborn Care 25 deaths **0.68**	Infant Health 82 deaths **2.24**
Feto-Infant Deaths = 257			
Live Births + Fetal Deaths = 36, 535 (Used for denominator)			
Internal Reference Group Feto-Infant Mortality Rate* = 7.03 deaths per 1,000 live births and fetal deaths			
* = The sum of the four periods may not exactly equal the total because of differences due to rounding.			

Relative to the internal reference group, there were a calculated 156 excess fetal and infant deaths in Indiana during 2011. In other words, if Indiana as a whole would have had the same feto-infant mortality rate as the internal reference population (7.03), 156 additional babies would have survived 2011. Within the PPOR classification groups, 79.4% of excess deaths occurred in two periods of risk: Maternal Health/Prematurity (64 excess deaths, 40.9%) and Infant Health (60 excess deaths, 38.5%) (Figure 3).

Figure 3: Excess feto-infant mortality
Indiana vs. IN Internal Reference Population
156 excess deaths



When looking at sub-populations, Non-Hispanic Blacks experienced the highest feto-infant mortality rates (12.04 per 1,000 live births and fetal deaths). Non-Hispanic Whites and

Hispanics had the next highest rates, respectively, with 8.46 and 8.03 feto-infant deaths per 1,000 live births and fetal deaths (Tables 6, 7, 8). Non-Hispanic Blacks and Hispanics had lower mortality rates in the Newborn Care risk period than the internal reference population. Hispanics also experienced lower mortality rates in the Infant Health risk period when compared to the internal reference population.

As mentioned above, because the internal reference population represented nearly 44% of the study population, researchers studied Non-Hispanic Whites not including the reference population. There were 279 fetal and infant deaths in this group of women, with an overall feto-infant mortality rate of 10.39, which is higher than the rate of all Non-Hispanic White females (8.46). While the overall feto-infant mortality rate was different between the two, the total number of excess deaths did not differ from the overall study population of Non-Hispanic Whites, with 90 excess deaths in each.

While Non-Hispanic Blacks had the highest feto-infant mortality rate overall among the sub-populations when compared to the internal reference population, it was Non-Hispanic Whites who had the largest amount of excess deaths, with 90 excess deaths in 2011. There were 49 excess deaths occurring to Non-Hispanic Blacks and 12 occurring to Hispanics when compared to the internal reference population. Trends were the same as Indiana as a whole when looking at the sub-populations and what categories had the largest percentage of excess deaths. For Non-Hispanic Whites and Blacks the highest percentages occurred in the Maternal Health/Prematurity and Infant Health categories (Figures 4, 5). Hispanics had the largest amount of excess deaths occurring in the Maternal Health and Prematurity risk period (94.0%) (Figure 6).

Table 6: Non-Hispanic Whites Feto-Infant Mortality Map			
	Fetal Death >= 24 Weeks	**Neonatal Death 0 – 27 Days**	**Post-Neonatal Death 28 – 364 Days**
500 – 1,499 Grams	Maternal Health / Prematurity 182 deaths **2.87**		
1,500 + Grams	Maternal Care 123 deaths **1.94**	Newborn Care 49 deaths **0.77**	Infant Health 182 deaths **2.87**
Feto-Infant Deaths = 536			
Live Births + Fetal Deaths = 63, 394 (Used for denominator)			
Internal Reference Group Feto-Infant Mortality Rate* = 8.46 deaths per 1,000 live births and fetal deaths			
* = The sum of the four periods may not exactly equal the total because of differences due to rounding.			

Table 7: Non-Hispanic Blacks Feto-Infant Mortality Map			
	Fetal Death >= 24 Weeks	**Neonatal Death 0 – 27 Days**	**Post-Neonatal Death 28 – 364 Days**
500 – 1,499 Grams	Maternal Health / Prematurity 45 deaths **4.67**		
1,500 + Grams	Maternal Care 25 deaths **2.59**	Newborn Care 6 deaths **0.62**	Infant Health 40 deaths **4.15**
Feto-Infant Deaths = 116			
Live Births + Fetal Deaths = 9, 635 (Used for denominator)			
Internal Reference Group Feto-Infant Mortality Rate* = 12.04 deaths per 1,000 live births and fetal deaths			
* = The sum of the four periods may not exactly equal the total because of differences due to rounding.			

Table 8: Hispanics Feto-Infant Mortality Map			
	Fetal Death >= 24 Weeks	**Neonatal Death 0 – 27 Days**	**Post-Neonatal Death 28 – 364 Days**
500 – 1,499 Grams	Maternal Health / Prematurity 31 deaths **3.83**		
1,500 + Grams	Maternal Care 14 deaths **1.73**	Newborn Care <5 deaths **0.49**	Infant Health 16 deaths **1.98**
Feto-Infant Deaths = 65			
Live Births + Fetal Deaths = 8, 093 (Used for denominator)			
Internal Reference Group Feto-Infant Mortality Rate* = 8.03 deaths per 1,000 live births and fetal deaths			
* = The sum of the four periods may not exactly equal the total because of differences due to rounding.			

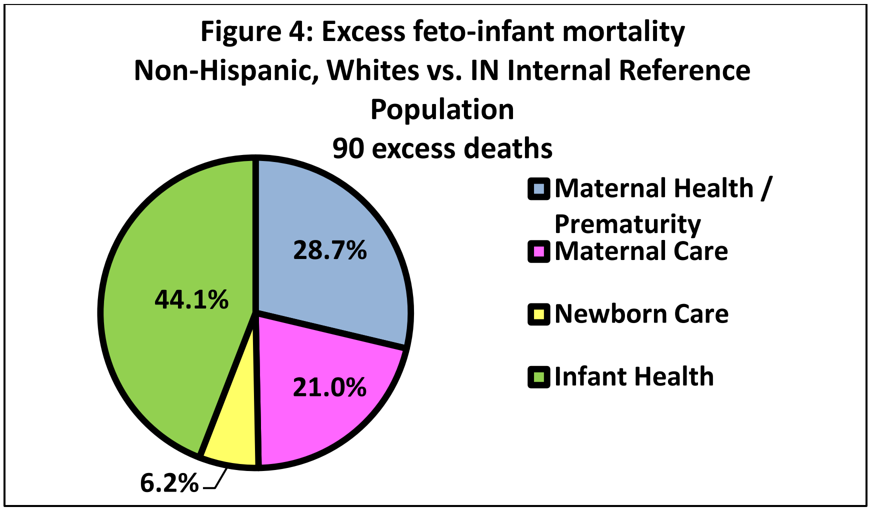


Figure 4: Excess feto-infant mortality
Non-Hispanic, Whites vs. IN Internal Reference Population
90 excess deaths
28.7%
44.1%
21.0%
6.2%
Maternal Health / Prematurity
Maternal Care
Newborn Care
Infant Health

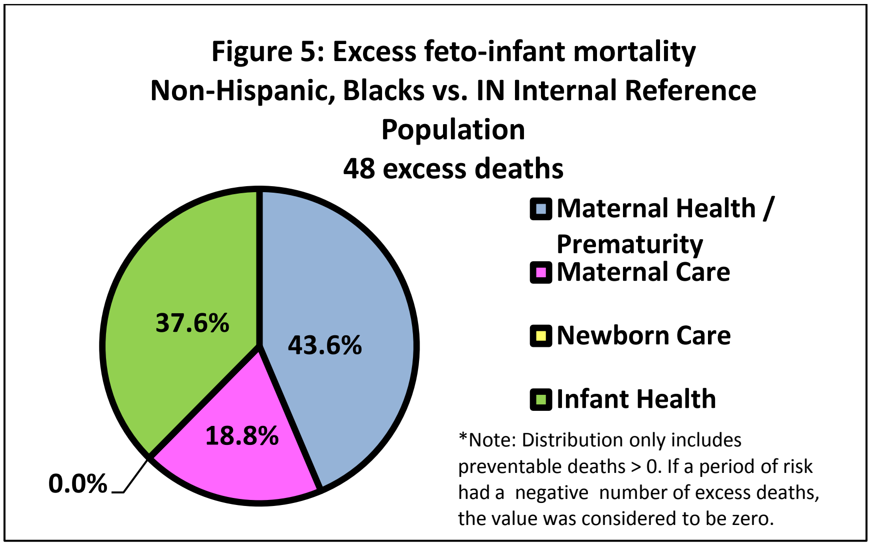


Figure 5: Excess feto-infant mortality
Non-Hispanic, Blacks vs. IN Internal Reference Population
48 excess deaths
37.6%
43.6%
18.8%
0.0%
Maternal Health / Prematurity
Maternal Care
Newborn Care
Infant Health
*Note: Distribution only includes preventable deaths > 0. If a period of risk had a negative number of excess deaths, the value was considered to be zero.

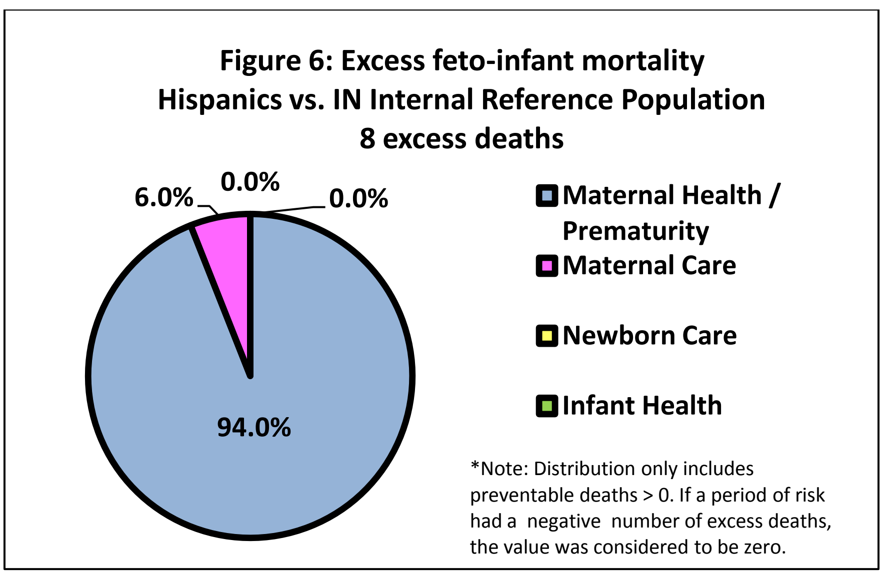


Figure 6: Excess feto-infant mortality
Hispanics vs. IN Internal Reference Population
8 excess deaths
6.0%
0.0%
0.0%
94.0%
Maternal Health / Prematurity
Maternal Care
Newborn Care
Infant Health
*Note: Distribution only includes preventable deaths > 0. If a period of risk had a negative number of excess deaths, the value was considered to be zero.

PHASE 2

Results of Kitagawa analysis are shown in Table 9. Overall, Non-Hispanic Blacks and Non-Hispanic Whites excess mortality is being caused by two difference mechanisms. For excess deaths among Non-Hispanic Blacks in the MH/P category, 62.9% can be attributed to a higher distribution of very low birthweight births. Among Non-Hispanic Whites, excess mortality is evenly distributed among both mechanisms, with 14.7% of excess mortality attributed to a higher distribution of very low birthweight births and 14.1% of excess mortality attributed to higher infant mortality rates among very low birthweight births. Among all birthweights, each population had a different cause for excess mortality. Non-Hispanic Blacks had a higher distribution of low birthweight births, attributable to 84.2% of excess mortality. Non-Hispanic Whites had higher birthweight specific mortality rates, attributable to 69.3% of excess mortality among low birthweight births.

Table 9: Kitagawa analysis results for Non-Hispanic Whites and Non-Hispanic Blacks compared to Indiana internal reference population

Birthweight (grams)	Non-Hispanic Whites		Non-Hispanic Blacks	
	% Attributable to birthweight distribution	% Attributable to birthweight-specific mortality	% Attributable to birthweight distribution	% Attributable to birthweight-specific mortality
500-749	10.33	1.27	36.40	-14.41
750-999	0.96	1.82	10.72	-1.35
1,000 – 1,249	1.82	5.57	5.34	-2.52
1,250 – 1,499	1.55	5.37	10.54	-0.63
Total < 1,500	**14.7**	**14.1**	**62.9**	**-18.9**
1,500 – 1,999	9.18	-5.91	15.52	-9.12
2,000 – 2,499	9.13	6.35	11.73	-9.48
2,500 +	-2.25	54.81	-6.04	53.28
Total*	**30.7**	**69.3**	**84.2**	**15.8**
* = The sum may not exactly equal the total due to differences in rounding				

Logistic regression analysis was used to identify, in the MH/P period of risk, maternal characteristics associated with a very low birthweight birth for both Non-Hispanic Whites and

Non-Hispanic Blacks. Of the factors considered, there were several shown to be statistically significant, which can be seen in Table 10.

Table 10: Multivariate analysis of maternal characteristics for very low birthweight births

Risk Factor	Adjusted Odds Ratio	95% Confidence Interval	Population Attributable Risk %
Plurality > 1	12.95	11.10, 15.10	28.68
Weight Gain, < 15 lbs.	3.45	2.99, 3.98	24.71
Prior Preterm Birth, Yes	2.56	2.00, 3.23	3.87
Race, Black	1.88	1.61, 2.20	9.40
Mother's Age, < 20 Years	1.64	1.34, 2.00	5.76
Smoked, Yes	1.37	1.17, 1.60	5.80
Medicaid Recipient	1.20	1.04, 1.38	1.01
Mother's Age, >= 35 Years	1.16	0.96, 1.40	1.66
Prenatal Care, Inadequate	0.93	0.80, 1.10	-1.14
STD Present	0.90	0.61, 1.32	-0.25
Mother's Education, 13+ Years	0.87	0.75, 0.99	-6.56
Pre-pregnancy obesity, BMI 30+	0.72	0.63, 0.84	-7.37
Weight Gain, > 40 lbs.	0.34	0.27, 0.42	-18.23

Because Non-Hispanic Whites also experienced a portion of excess mortality due to birthweight specific mortality rates; logistic regression analysis was performed, specifically for Non-Hispanic Whites, to determine risk factors associated with a very low birthweight infant death. Researchers found that delivery at a self-declared Perinatal Level of Care I was significantly associated with an increased risk of infant death. Non-Hispanic White mothers in Indiana who deliver at a self-declared Perinatal Level of Care I are over four times the odds of experiencing a very low birthweight infant death compared to women who delivered at a self-declared Perinatal Level of Care III.

Within the IH period of risk, researchers grouped causes of death into six distinct categories: perinatal conditions, congenital anomalies, infections, SIDS/SUIDs, injuries and all other causes. Next, researchers calculated cause specific mortality rates for Indiana, Non-Hispanic Whites and Non-Hispanic Blacks and compared those rates to the internal reference population. Approximately 43% of Non-Hispanic White and 63% of Non-Hispanic Black excess infant deaths within the IH category were due to SIDS/SUIDS. Logistic regression analysis found that two risk factors were associated with an increased risk in a SIDS/SUIDS death: being a black mother and smoking prior to or during pregnancy (Table 11).

Table 11: Multivariate analysis of maternal characteristics for SIDS/SUIDS infant deaths

Risk Factor	Adjusted Odds Ratio	95% Confidence Interval	Population Attributable Risk %
Race, Black	2.03	1.16, 3.55	10.71
Smoked Prior to or During Pregnancy	1.88	1.14, 3.10	15.13
Prenatal Care, Inadequate	1.50	0.90, 2.49	7.82
Marital Status, Not Married	1.25	0.71, 2.19	9.22
Maternal Age < 20 Years	1.15	0.58, 2.27	1.39
Breastfeeding at Hospital Discharge, No	1.10	0.67, 1.79	2.38
Medicaid Recipient	1.07	0.62, 1.85	2.89
Maternal Education < 13 Years	1.03	0.62, 1.71	1.40

DISCUSSION

STRENGTHS AND LIMITATIONS

There are several strengths to conducting PPOR analyses. First, all vital records needed to conduct analyses are available electronically and linkage is possible between birth and death records (CityMatCH, 2014a). Indiana had a 92% match rate when linking records for this study. PPOR offers a framework and simple analytic approach that can be used by communities with limited resources and skills. The analysis allows researchers to gain as much information as possible from a small amount of mortality events. PPOR also provides a visual tool that allows communities to easily facilitate communication about the burden of feto-infant mortality in their area. An additional strength to conducting PPOR analyses is its ability to identify and describe racial and ethnic disparities in terms of excess mortality rates and preventable deaths (Sappenfield et al., 2010b).

While PPOR is a great tool, it does have several limitations. It is important to note that PPOR analysis must have maternal residence, gestational age, weight at birth and age at death. If any of these data elements are missing from the birth certificate, death certificate or fetal death certificate it cannot be used in the numerator or denominator. An infant death that has not been linked to its corresponding birth certificate cannot be used. Often, higher percentages of required variables are missing among fetal and infant deaths than among the births that survived. All of the above mentioned factors will artificially lower the mortality rates (CityMatCH, 2014a). The quality and content of vital records was shown to also be a limitation. While Phase 1 Analysis provides results quickly, the answers are only as good as the data sources (Sappenfield et al., 2010b). The quality of vital records in many communities is proven to be poor due the high number of unreported fetal and/or infant deaths, unlinked infant deaths, or records with incomplete or accurate reporting (Sappenfied et al., 2010b).

Under-reporting is also an issue that is important to consider when looking at PPOR analyses. Under-reporting is a large source of bias, especially for fetal deaths. It is often difficult to detect and can falsely lower mortality rates (CityMatCH, 2014a). Residual confounding is a bias present during Phase 2 Analyses for variables that cannot be collected, such as drug or alcohol use.

Last, one of the biggest limitations of PPOR is the fact that most communities do not follow through after they complete Stage 2, Phase 1 and 2 Analyses. While Stage 2 is very helpful, it does not provide sufficient information for community efforts (Sappenfield et al., 2010b).

CONCLUSION

Phase 1 PPOR analysis for the state of Indiana found high feto-infant mortality rates across the state and sub-populations when compared to the internal reference population. Researchers also discovered clear racial and ethnic disparities across the state. Excess mortality occurred in all four PPOR categories for Indiana as a whole and White, Non-Hispanics when compared to the internal reference population. It was expected that Black, Non-Hispanics would have the highest excess feto-infant mortality rate, as blacks experience the highest infant mortality rates in Indiana.

In summary, Indiana found two high risk periods in the state: Maternal Health/Prematurity and Infant Health. Within the state, there were 156 estimated preventable deaths during 2011. Non-Hispanic Blacks had the overall highest feto-infant mortality and excess rates, Non-Hispanic Whites had the most estimated preventable deaths. Specifically within the MH/P period of risk, Non-Hispanic Blacks excess deaths can be attributed to a higher distribution of very low birthweight babies. Non-Hispanic Whites excess mortality can be equally attributed to both a larger distribution of very low birthweight births and higher infant mortality rates among very low birthweight babies. Within the Infant Health period of risk, researchers determined SIDS/SUIDs to be the major contributor to excess deaths among both Non-Hispanic Whites and Non-Hispanic Blacks. Smoking and being a black mother were two risk factors significantly associated with a SIDS/SUIDs infant death. Prevention efforts to reduce feto-infant mortality across Indiana would best be geared towards evidence-based strategies to reduce the number of very low birthweight births and SIDS/SUIDs deaths.

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