Perinatal Periods of Risk (PPOR): *Indiana, 2011*

Division of Maternal and Child Health Epidemiology

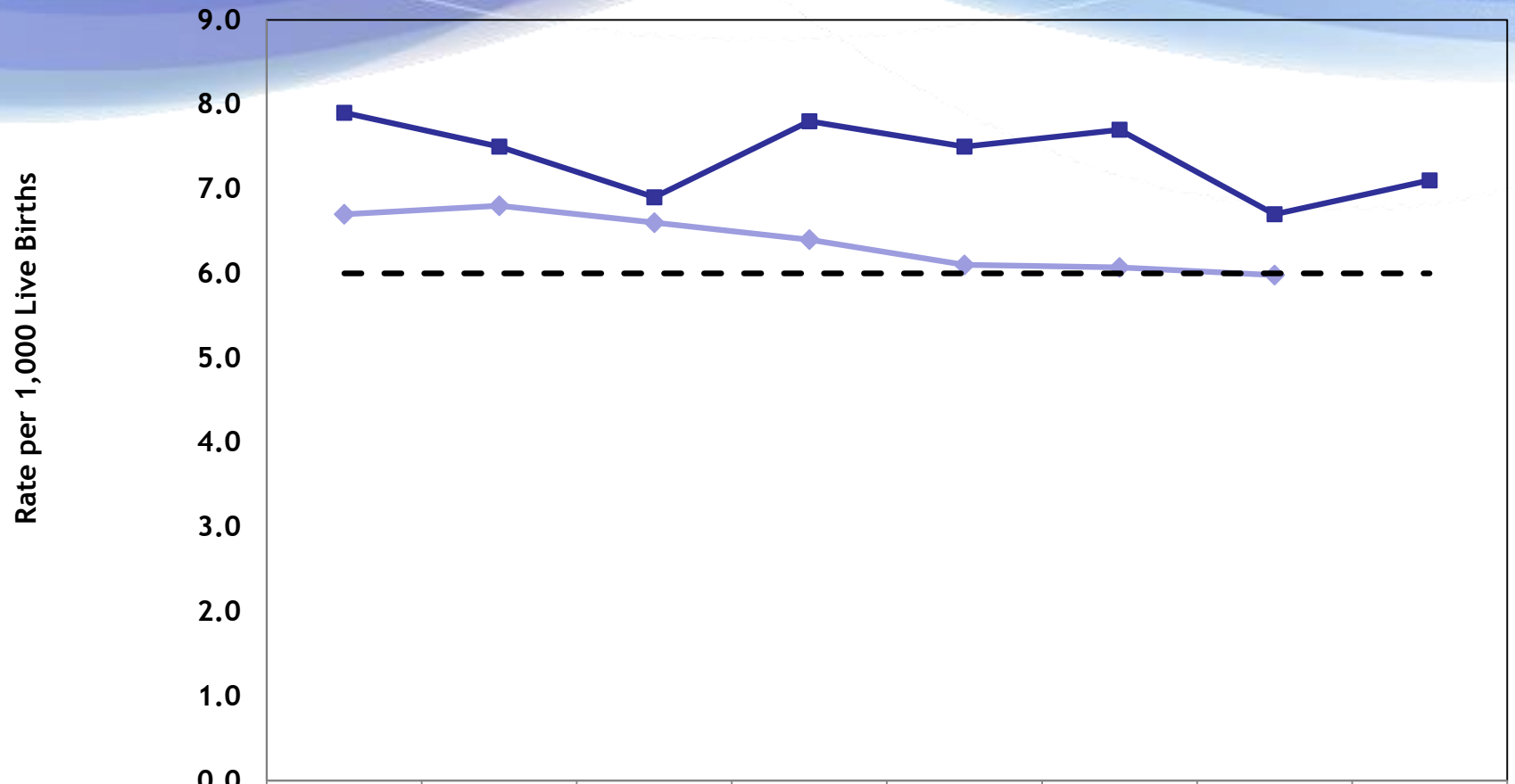
Indiana State Department of Health

The Problem

- Indiana consistently ***worse*** than the U.S. and national goal every year
  - IN - 7.7 per 1,000 (2011); 6.7 (2012); 7.1 (2013)
  - U.S. 6.1 per 1,000 (2011); 5.98 (2012)
  - Healthy People 2020 Goal 6.0 per 1,000
- Black – White infant mortality ratio was 1.8 in 2011, 2.6 in 2012 & 2013
- Hispanic rates have been extremely unstable, true problem is not understood
- Cause-specific infant mortality rates differ among subpopulations making prevention and intervention efforts very complex

Indiana State Department of Health

Infant Mortality Rates, United States & Indiana 2006-2013

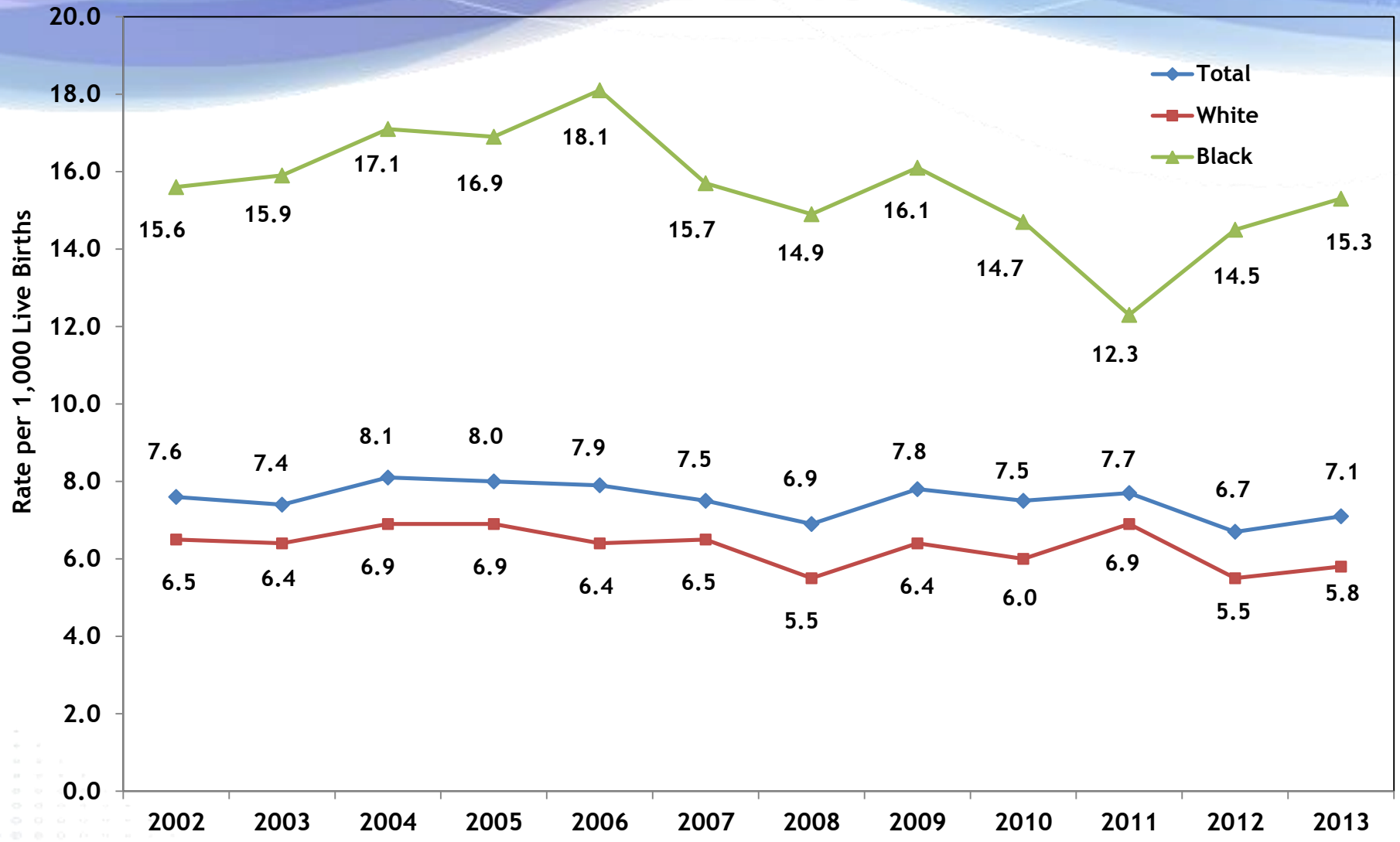


	2006	2007	2008	2009	2010	2011	2012	2013
United States	6.7	6.8	6.6	6.4	6.1	6.07	5.98	***
Indiana	7.9	7.5	6.9	7.8	7.5	7.7	6.7	7.1
Healthy People 2020 Goal	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0

US 2013 IMR pending

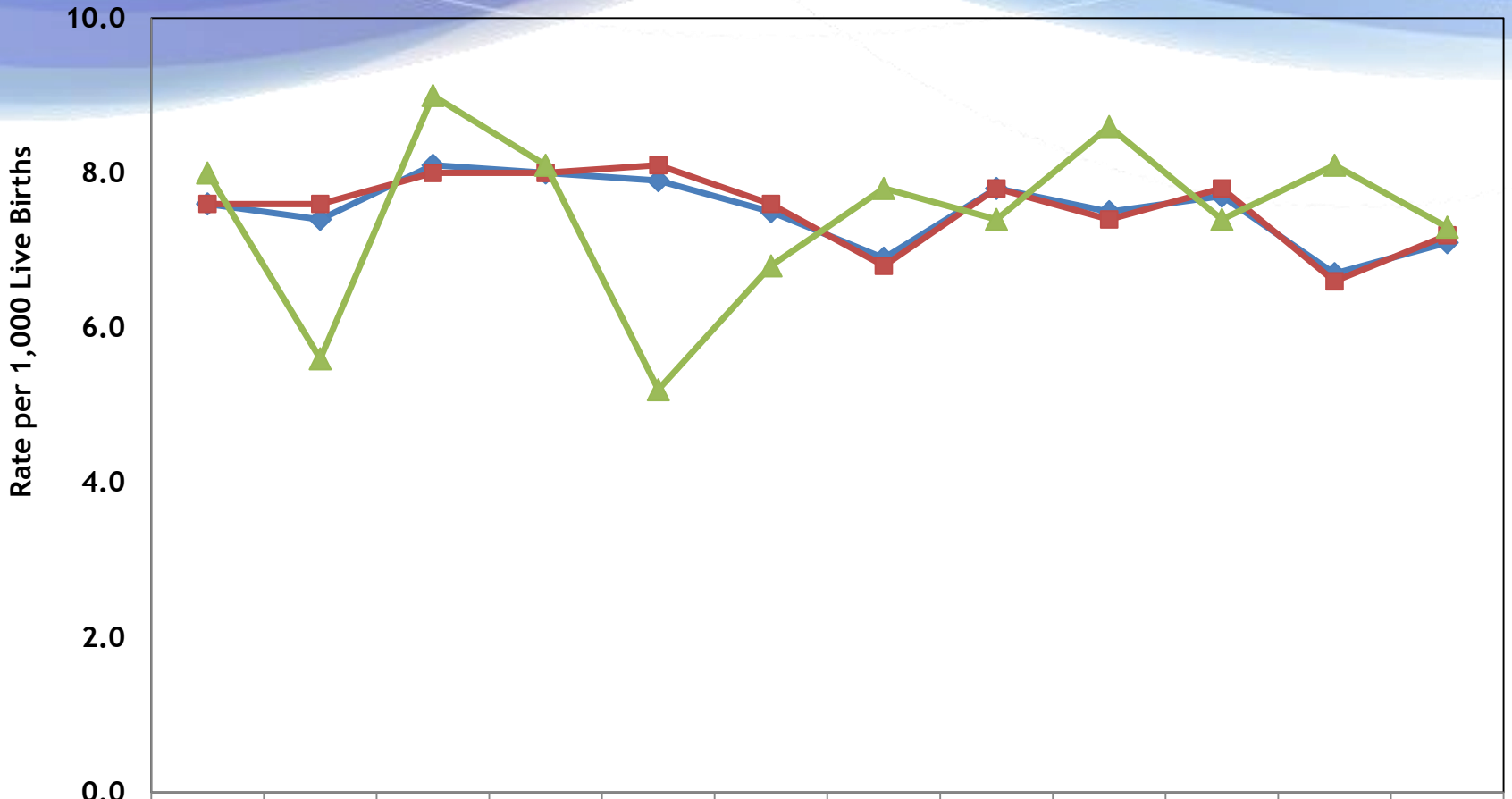
Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [Feb. 11, 2015]
United States Original Source: Centers for Disease Control and Prevention National Center for Health Statistics
Indiana Original Source: Indiana State Department of Health, PHPC, ERC, Data Analysis Team

Indiana Infant Mortality by Race 2002-2013



Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Indiana Infant Mortality Rates by Ethnicity, 2002-2013



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total	7.6	7.4	8.1	8.0	7.9	7.5	6.9	7.8	7.5	7.7	6.7	7.1
Non-Hispanic	7.6	7.6	8.0	8.0	8.1	7.6	6.8	7.8	7.4	7.8	6.6	7.2
Hispanic	8.0	5.6	9.0	8.1	5.2	6.8	7.8	7.4	8.6	7.4	8.1	7.3

Note: Hispanic ethnicity can be of any race.

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

What is PPOR?

- Analytic framework for investigating and preventing feto-infant mortality at a local level
- Widely used by health departments and supported by CDC, March of Dimes, WHO, and CityMatCH
- Six stages:
  - Assure community and analytic readiness
  - ***Conduct analytic phases of PPOR***
  - Develop strategic actions for targeted prevention
  - Launch new prevention initiatives
  - Monitor and evaluate the approach
  - Sustain stakeholder investment and political will
- Used to identify opportunity gaps, guide further investigations, and focus prevention efforts

Indiana State Department of Health

Analytic Phases of PPOR

- **Phase 1**: Identifies populations and periods of risk with excess mortality
    - Feto-infant mortality mapping for Indiana overall
    - Feto-infant mortality mapping for subpopulations of Indiana
    - Compare reference population to study groups to calculate excess mortality and identify opportunity gaps

- **Phase 2**: Explains excess mortality and identifies important risk factors

Indiana State Department of Health

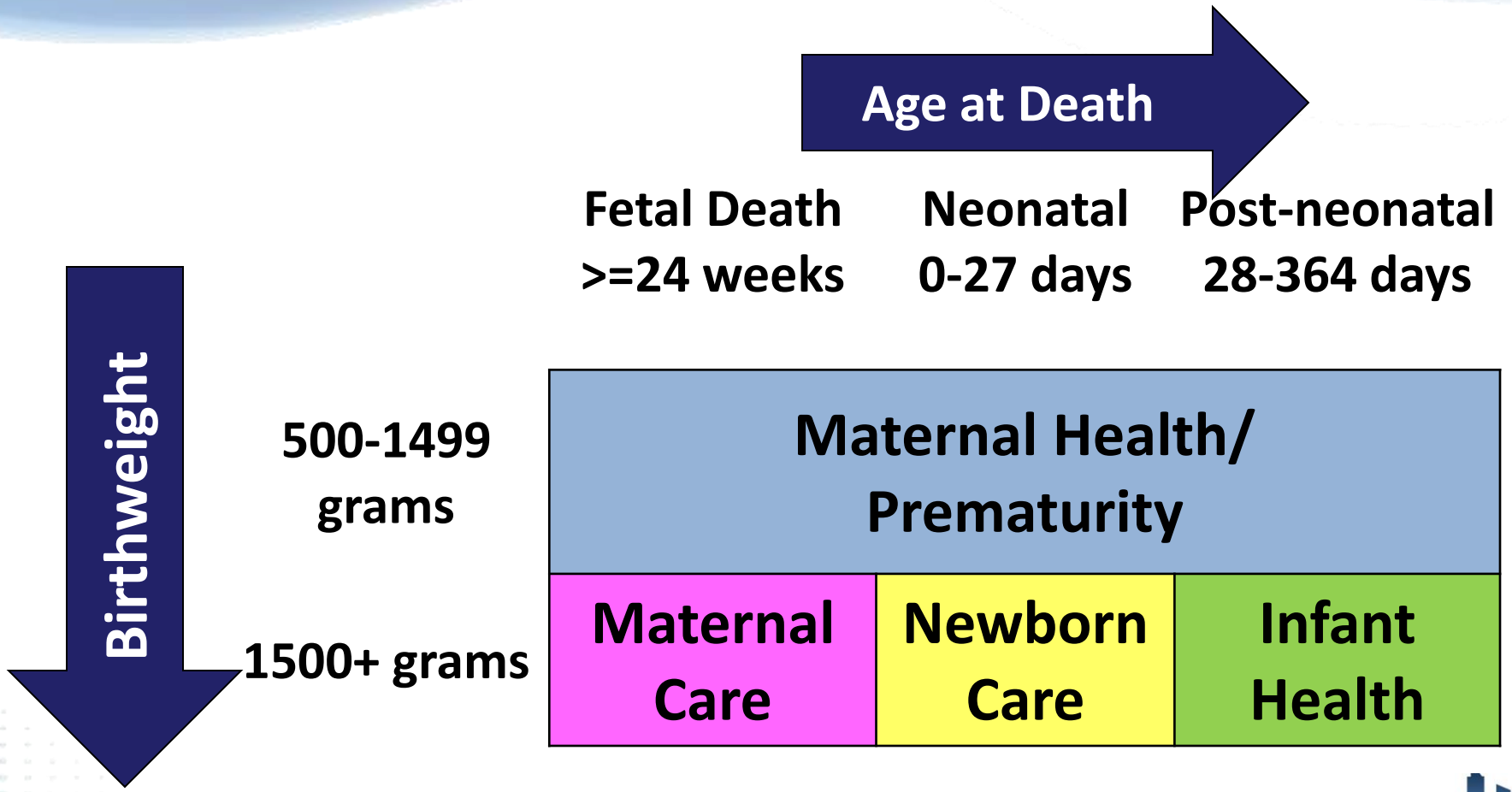
Phase 1 Materials & Methods

- 2011 Data
  - Live birth certificate file
  - Fetal death certificate file
  - Linked birth-infant death file
- Two Dimension Analysis
  - Age at death
  - Birthweight
- Study Exclusions
  - Excluded fetal deaths < 24 weeks
  - Excluded live births, fetal deaths, infant deaths < 500 grams
  - Excluded implausible birthweight/gestation combinations
  - Spontaneous and induced abortions do not receive death certificates and are excluded from PPOR analyses

Indiana State Department of Health

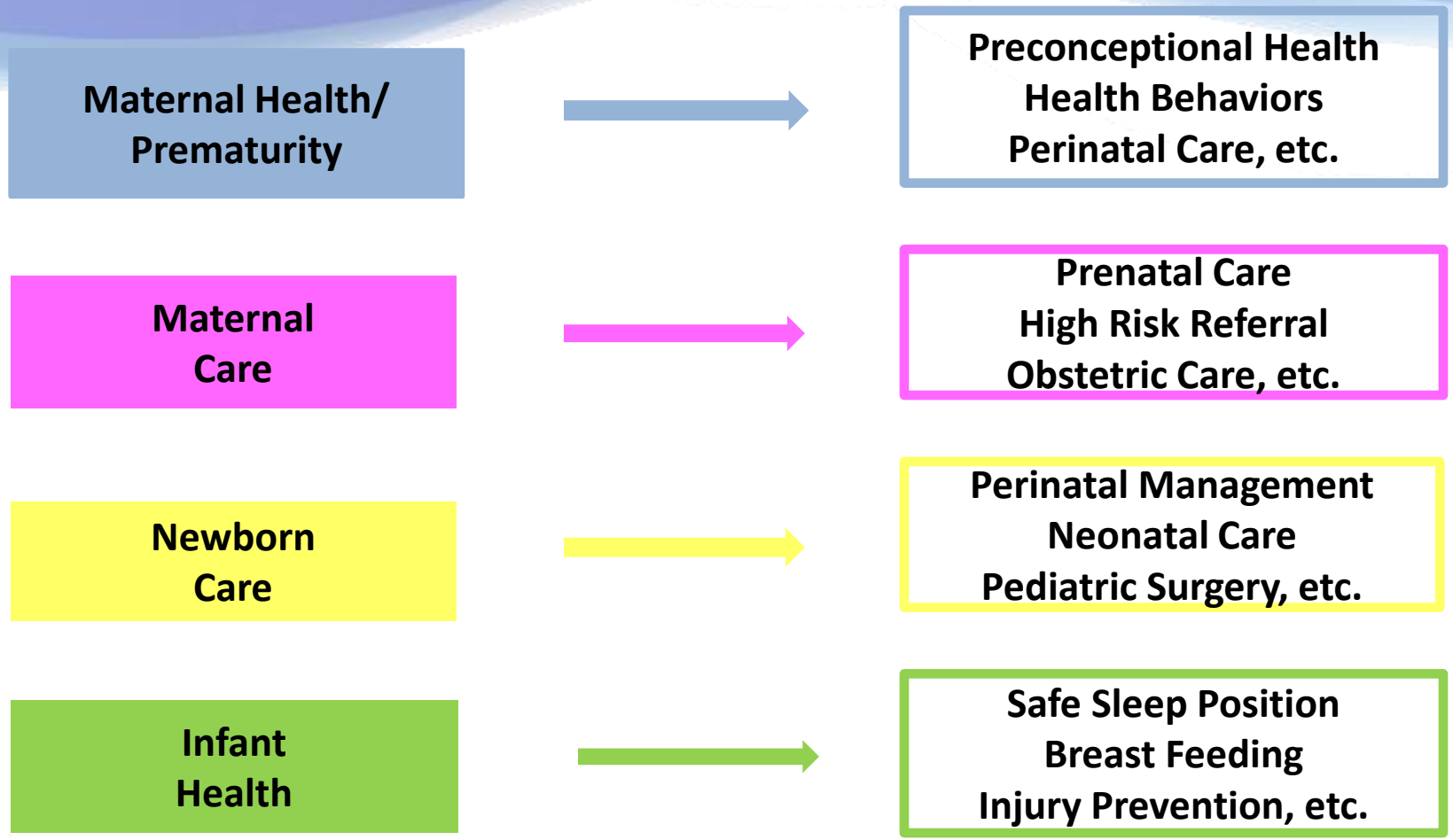
The Perinatal Periods of Risk

Feto-infant Mortality Map



citymatch
The National Organization of Urban MCH Leaders

PPOR Intervention Model



citymatch
The National Organization of Urban MCH Leaders

Study Population

- Indiana Overall
  - Mother IN resident at time of delivery
  - 2011 live births, >= 500 grams
  - 2011 fetal deaths, >= 500 grams and >= 24 weeks gestation
  - Death cohort – All infant deaths that occurred in 2011, regardless of year of birth (2010, 2011), >= 500 grams

- Subpopulations
  - White, Non-Hispanic
  - Black, Non-Hispanic
  - Hispanic

Indiana State Department of Health

Internal Reference Group

- **Purpose:** Underlying assumption is that if the reference group can have low mortality, the study group should also be able to reach that goal

- In general, rates tend to be lower for white, well-educated women between the ages of 20-35

- 2011 Indiana internal reference population, defined by maternal characteristics:
  - **20 years of age or older**
  - **13 or more years of education**
  - **Non-Hispanic, White**
  - **Indiana resident at time of baby's birth**

Indiana State Department of Health

Phase 1 Results

Indiana State Department of Health

Numbers and percents of unknowns/missing for live births, fetal deaths and infant deaths ineligible for PPOR

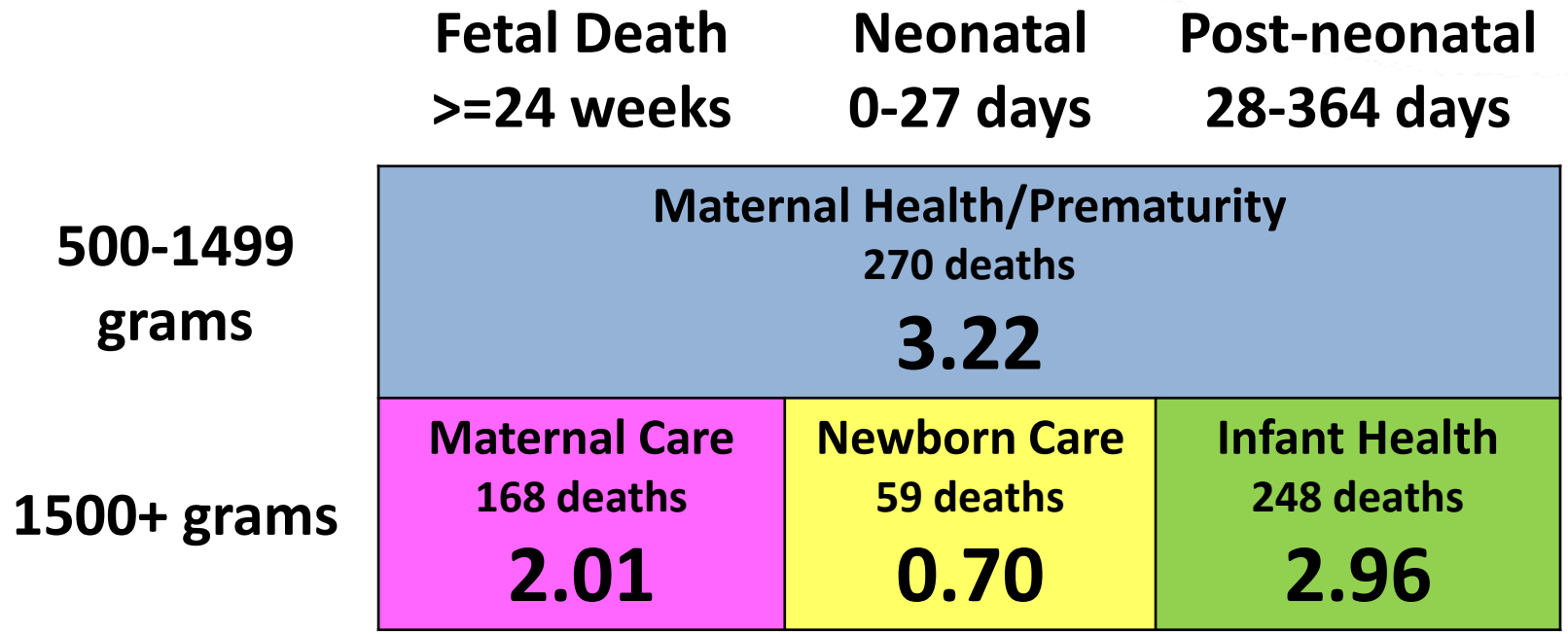
Infant and Maternal Characteristics	Live Births		Infant Deaths		Fetal Deaths	
	Number	%	Number	%	Number	%
Total Deaths	NA	NA	n = 651		NA	NA
Unlinked Deaths			52	8.00		
All Births, Linked Infant Deaths, and Fetal Deaths	n = 83,750		n = 599		n = 764	
Birthweight	65	0.08	8	1.34	89	11.65
Gestational Age	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	0.00
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**

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [2014]

2011 Indiana Feto-Infant Mortality



Feto-Infant Deaths = 745
Live Births + Fetal Deaths = 83,722

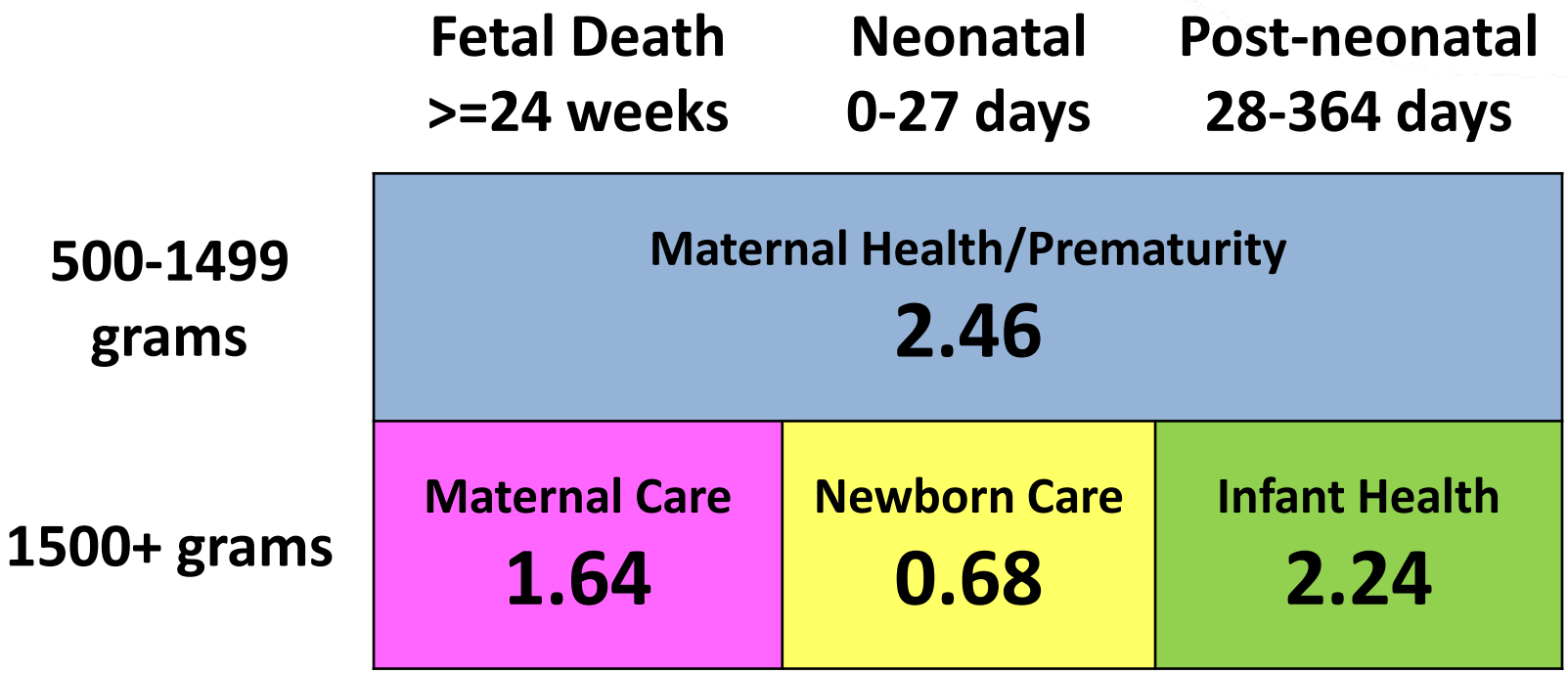
Overall rate*: 8.90 **per 1,000 live births and fetal deaths**

***The sum of the four periods may not exactly equal the total because of differences due to rounding**

Indiana State Department of Health

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [2014]

2011 Internal Reference Group



Overall rate*: 7.03 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

Indiana State Department of Health

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [2014]

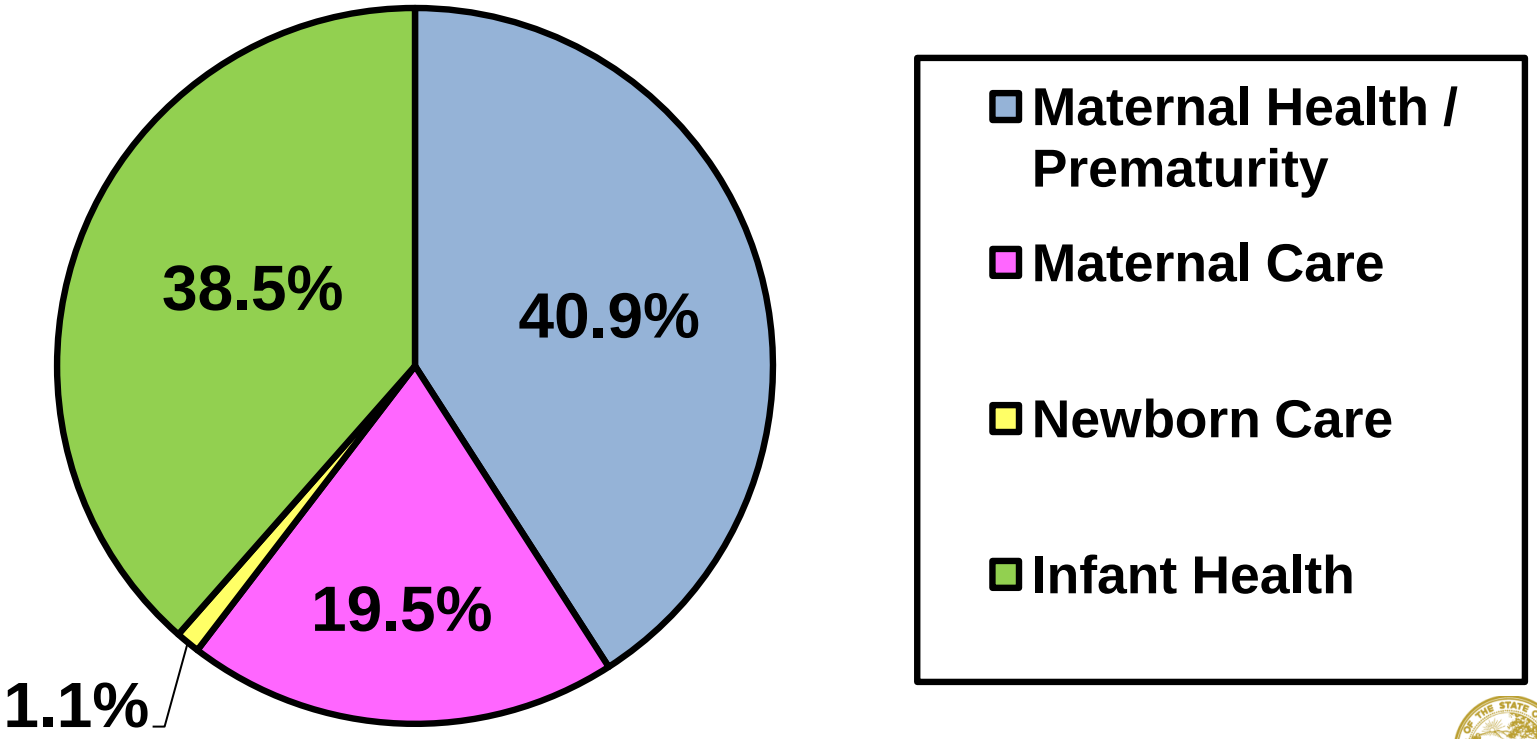
2011 Excess Mortality IN vs. Reference Group

	Maternal Health/ Prematurity	Maternal Care	Newborn Care	Infant Health	Total*
Indiana Overall	3.22	2.01	0.70	2.96	8.90
Reference Group	2.46	1.64	0.68	2.24	7.03
Excess Rate [A]	0.76	0.36	0.02	0.72	1.86
Estimated Preventable Deaths [B]	64	31	2	60	156

*** The sum of the four periods may not exactly equal the total because of differences due to rounding.**
A = For each period and total, excess rates are the rates for the study population group minus the rates for the internal reference group.
B = Number of excess deaths is the excess rate multiplied by the number of fetal deaths and live births divided by 1,000.

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [2014]

% Distribution of Overall Excess Mortality IN vs. Reference Group, 2011



Indiana State Department of Health

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [2014]

2011 Feto-Infant Mortality by Race/Ethnicity

Non-Hispanic Whites

Maternal Health/Prematurity		
2.87		
Maternal Care	Newborn Care	Infant Health
1.94	0.77	2.87

Feto-Infant Deaths = 536
Live Births + Fetal Deaths = 63,394
Overall rate: 8.46

Non-Hispanic Blacks

Maternal Health/Prematurity		
4.67		
Maternal Care	Newborn Care	Infant Health
2.59	0.62	4.15

Feto-Infant Deaths = 116
Live Births + Fetal Deaths = 9,635
Overall rate: 12.04

Hispanic

Maternal Health/Prematurity		
3.83		
Maternal Care	Newborn Care	Infant Health
1.73	0.49	1.98

Feto-Infant Deaths = 65
Live Births + Fetal Deaths = 8,093
Overall rate: 8.03

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [2014]

Indiana State Department of Health

2011 Excess Mortality Subpopulations vs. Reference Group

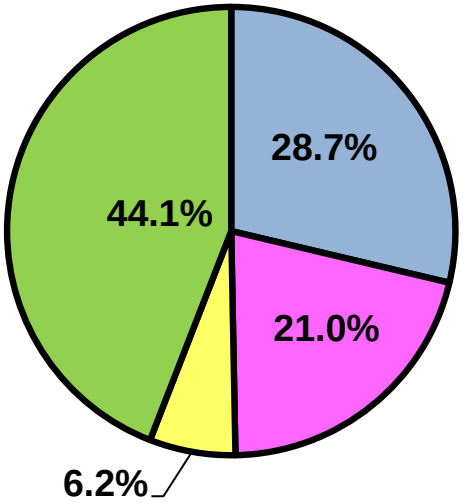
		Maternal Health/ Prematurity	Maternal Care	Newborn Care	Infant Health	Total*
Non-Hispanic Whites	Excess Rate [A]	0.41	0.30	0.09	0.63	1.42
	Estimated Preventable Deaths [B]	26	19	6	40	90
Non-Hispanic Blacks	Excess Rate [A]	2.21	0.95	-0.06	1.91	5.01
	Estimated Preventable Deaths [B]	21	9	-1	18	48
Hispanic	Excess Rate [A]	1.37	0.09	-0.19	-0.27	1.00
	Estimated Preventable Deaths [B]	11	1	-2	-2	8

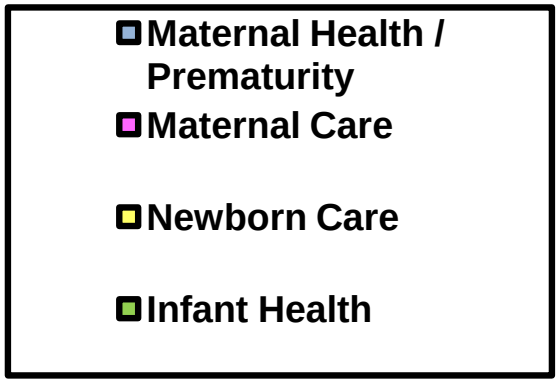
*** The sum of the four periods may not exactly equal the total because of differences due to rounding.**
A = For each period and total, excess rates are the rates for the study population group minus the rates for the internal reference group.
B = Number of excess deaths is the excess rate multiplied by the number of fetal deaths and live births divided by 1,000.

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [2014]

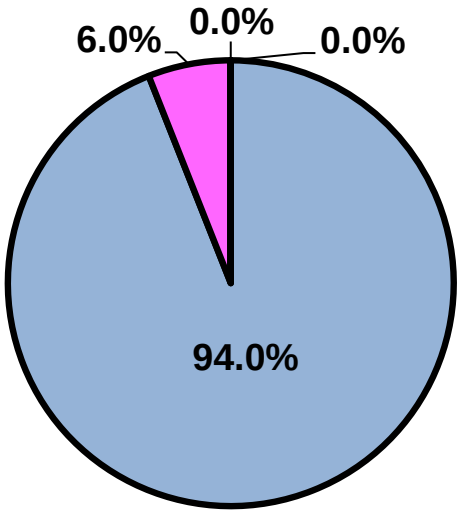
% Distribution of Excess Mortality for IN Subpopulations vs. Reference Group, 2011

Non-Hispanic, Whites
90 excess deaths

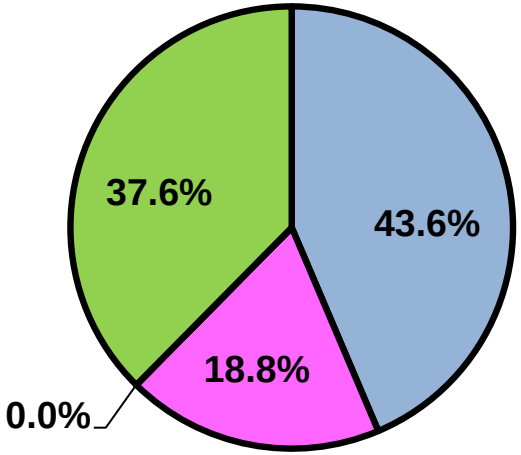




Hispanics
8 excess deaths



Non-Hispanic, Blacks
48 excess deaths



*Each distribution only includes preventable deaths >0; If a period of risk had a negative number for preventable deaths, the value was considered zero.

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [2014]

Indiana State Department of Health

Phase 1 Conclusions

- ***156 preventable deaths in 2011*** when compared to the internal reference population

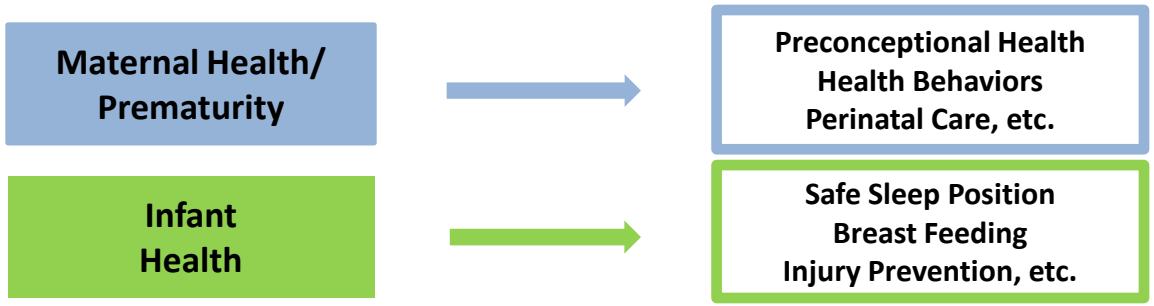
- *Highest excess rate found in* ***Non-Hispanic Black*** population, but larger impact *(more preventable deaths) occurring in* ***Non-Hispanic White*** population

- ***Maternal Health / Prematurity*** *and* ***Infant Health*** are the two periods of risk to investigate further for Non-Hispanic Whites and Blacks

Indiana State Department of Health

Phase 2 Analysis

- Investigating the opportunity gaps
  - In phase 2, the population(s) with the largest excess mortality become the study population(s) and the focus
    - Non-Hispanic, Whites
    - Non-Hispanic, Blacks



- Phase 2 analyses will unlikely discover new causes of feto-infant mortality, but will help verify which known causes are of local importance

Indiana State Department of Health

Phase 2 Materials and Methods

- Phase 1 datasets

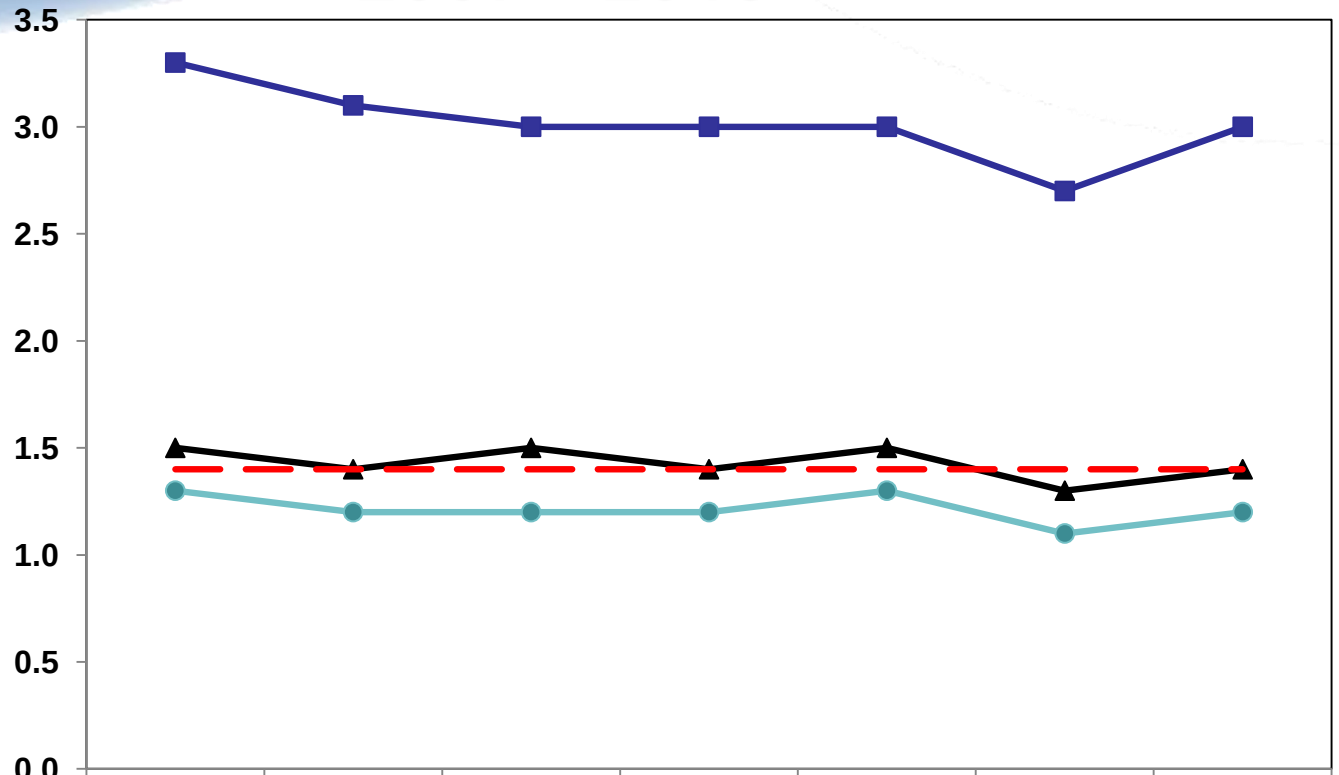
- Three primary steps for each risk period investigation:
  1. Identify causal pathways or biologic mechanisms for excess mortality
     - KITAGAWA ANALYSIS/CAUSE-SPECIFIC MORTALITY RATES
  2. Estimate prevalence of risk and preventive factors by type of mechanism
     - COMPARE PREVALENCE OF RISK FACTORS IN THE STUDY POPULATIONS AT RISK TO THE REFERENCE POPULATION
  3. Estimate the impact of the risk and preventive factors
     - COMPARE PREVALENCE OF RISK FACTORS AMONG STUDY POPULATIONS WITH AND WITHOUT OUTCOME OF INTEREST (VLBW, DEATH)
     - MEASURE THE ASSOCIATION BETWEEN OUTCOME AND RISK FACTORS
     - CALCULATE POPULATION ATTRIBUTABLE RISK%

MATERNAL HEALTH / PREMATURITY PERIOD OF RISK

	Fetal Deaths < 24 Weeks Neonatal Deaths Post-Neonatal Deaths		
500 – 1,499 Grams	Non-Hispanic, Whites N = 182	Non-Hispanic, Blacks N = 45	Reference Population N = 90
	2.87	4.67	2.46

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Maternal Health / Prematurity Phase 2
Prevalence of VLBW Births in Indiana
2007 - 2013



	2007	2008	2009	2010	2011	2012	2013
Whites	1.3	1.2	1.2	1.2	1.3	1.1	1.2
Blacks	3.3	3.1	3.0	3.0	3.0	2.7	3.0
Indiana	1.5	1.4	1.5	1.4	1.5	1.3	1.4
HP 2020 Goal	1.4	1.4	1.4	1.4	1.4	1.4	1.4

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 2, 2015]
Indiana Original Source: Indiana State Department of Health, PHPC, ERC, Data Analysis Team

Maternal Health / Prematurity

STEP ONE: Identify Causal Pathways or Biologic Mechanisms for Excess Mortality

- Cause of VLBW fetal and infant deaths is:
  - Multifactorial
  - Complex
  - Inconsistent
  - Varies by training

- ICD-10 Cause of Death Codes are not very helpful

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 2, 2015]
Original Source: Sappenfield, W.M., Peck, M.G., Gilbert, C.S., Haynatzka, V.R., Bryant III, T. (2010). Perinatal periods of risk: Phase 2 analytic methods for further investigating feto-infant mortality. Maternal and Child Health Journal, 14, 838-850.

Maternal Health / Prematurity

STEP ONE: Identify Causal Pathways or Biologic Mechanisms for Excess Mortality

- Kitagawa Analysis
  - Partitions excess mortality into two parts:
    - ***Birthweight Distribution*** = the percentage of infants born into each birthweight category
    - ***Birthweight-Specific Mortality*** = mortality rate for each birthweight category

- Different sets of risk factors and interventions affect the two mechanisms.

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 2, 2015]
Original Source: Sappenfield, W.M., Peck, M.G., Gilbert, C.S., Haynatzka, V.R., Bryant III, T. (2010). Perinatal periods of risk: Phase 2 analytic methods for further investigating feto-infant mortality. Maternal and Child Health Journal, 14, 838-850.

Maternal Health / Prematurity

STEP ONE: Identify Causal Pathways or Biologic Mechanisms for Excess Mortality

- Kitagawa's Formula

$$\sum_{1}^{n}\left(\left(\frac{(P_{1n}+P_{2n})}{2}\times(M_{1n}-M_{2n})\right)+\left(\frac{(M_{1n}+M_{2n})}{2}\times(P_{1n}-P_{2n})\right)\right)$$

- Where "P" stands for birthweight distribution (proportion of births in stratum n)
- And "M" stands for specific mortality (the mortality rate in stratum n)

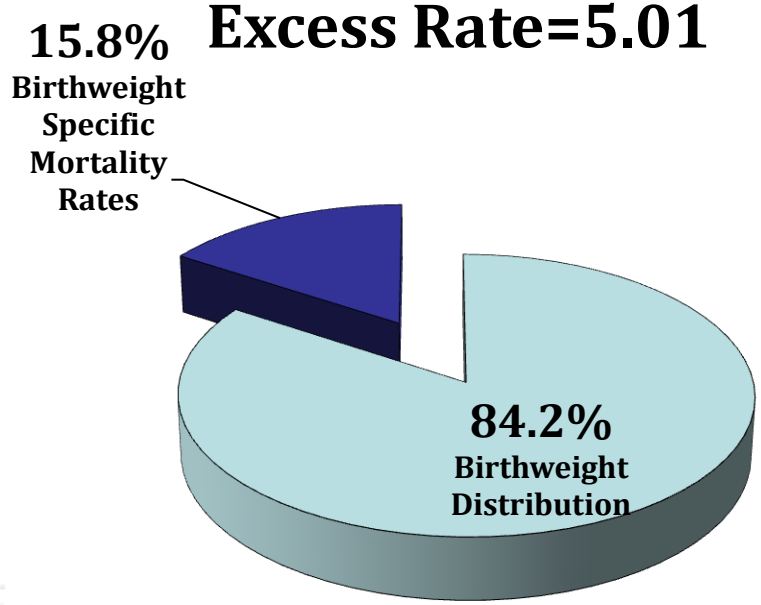
Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 2, 2015]
Original Source: Sappenfield, W.M., Peck, M.G., Gilbert, C.S., Haynatzka, V.R., Bryant III, T. (2010). Perinatal periods of risk: Phase 2 analytic methods for further investigating feto-infant mortality. Maternal and Child Health Journal, 14, 838-850.

Kitagawa Analysis

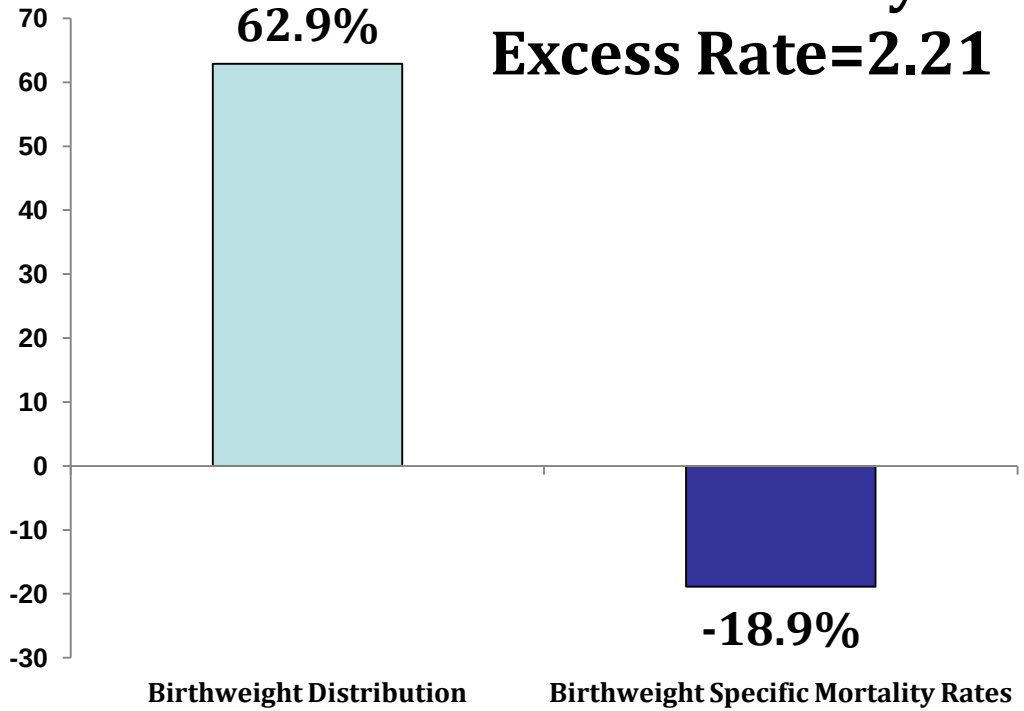
Maternal Health/Prematurity Investigation

Non-Hispanic Blacks

Overall
Excess Rate=5.01



Maternal Health / Prematurity
Excess Rate=2.21



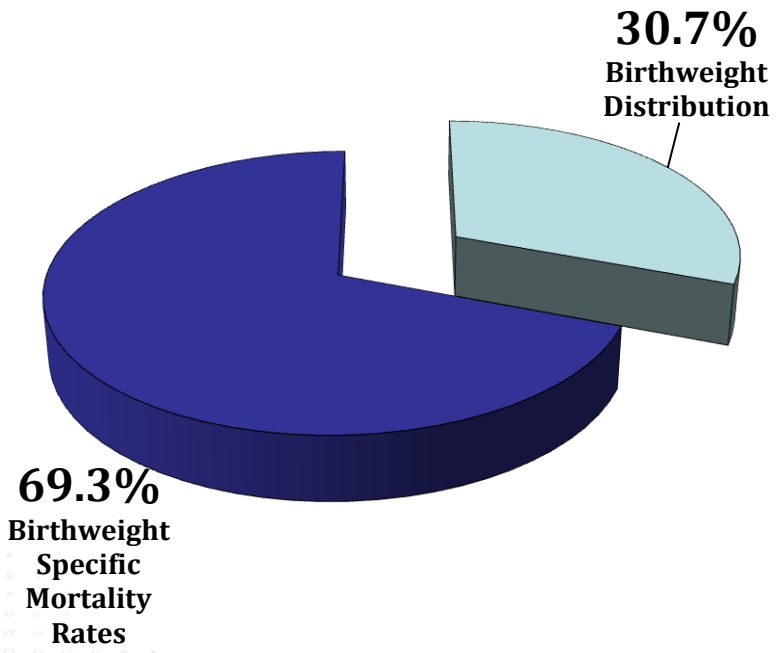
Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Kitagawa Analysis

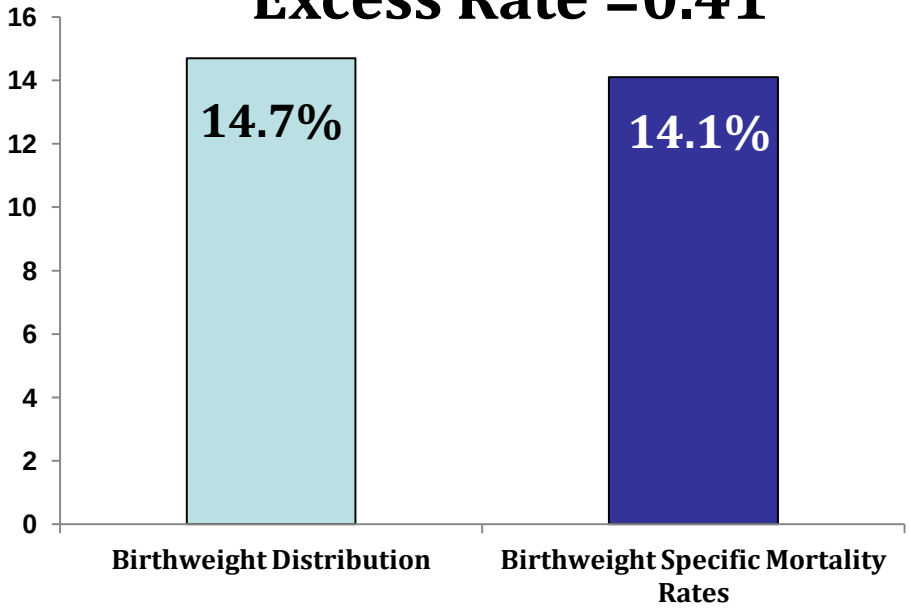
Maternal Health/Prematurity Investigation

Non-Hispanic Whites

Overall
Excess Rate=1.42



Maternal Health / Prematurity
Excess Rate =0.41



Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Maternal Health / Prematurity

STEP ONE: Identify Causal Pathways or Biologic Mechanisms for Excess Mortality

Mechanism	Pathway	Outcome	Study Population	At Risk
Birthweight Distribution	Prematurity	Very Low Birthweight	Non-Hispanic Whites, Non-Hispanic Blacks	All Births and Fetal Deaths*
Birthweight-Specific Mortality Rates	Perinatal Care	Mortality	Non-Hispanic Whites	VLBW Births and Fetal Deaths*

*fetal deaths if variables available

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 2, 2015]
Original Source: Sappenfield, W.M., Peck, M.G., Gilbert, C.S., Haynatzka, V.R., Bryant III, T. (2010). Perinatal periods of risk: Phase 2 analytic methods for further investigating feto-infant mortality. Maternal and Child Health Journal, 14, 838-850.

Maternal Health / Prematurity

STEP TWO: Estimate prevalence of risk & preventive factors by type of mechanism

Prematurity Pathway

Obtained/Used	Not Obtained/Not Used
Maternal Age (<20, ≥35 Years) **Maternal Education (13+ years education)** **Maternal Race** **Plurality (>1)** **(The number of babies resulting from a single pregnancy)** **Pregnancy Weight Gain** **Weight gain low = < 15 pounds** **Weight gain medium = 15 – 40 pounds** **Weight gain high = > 40 pounds** **Pre-Pregnancy Weight (BMI 30+)** **Prenatal Care (Inadequate)** **Prior Preterm Birth** **Sexually Transmitted Diseases** **Gonorrhea, Syphilis, Chlamydia** **Smoking during Pregnancy** **Pay Source (Medicaid)**	Alcohol Use Anemia Domestic Violence Drug Abuse Household Income Unintended Pregnancies

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 2, 2015]
Original Source: Sappenfield, W.M., Peck, M.G., Gilbert, C.S., Haynatzka, V.R., Bryant III, T. (2010). Perinatal periods of risk: Phase 2 analytic methods for further investigating feto-infant mortality. Maternal and Child Health Journal, 14, 838-850.

Maternal Health / Prematurity

STEP TWO: Estimate prevalence of risk & preventive factors by type of mechanism

Prematurity Pathway

% RISK FACTORS IN THE TOTAL STUDY POPULATIONS COMPARED TO REFERENCE

Risk Factor	Non-Hispanic Whites** (%) N = 26,856	Non-Hispanic Blacks (%) N = 9,656	Reference Population* (%) N = 36,514	p-value
Plurality > 1 (The number of babies resulting from a single pregnancy)	2.8	3.6	4.0	***0.0466***
Weight Gain, < 15 lbs.	10.3	***19.6***	14.9	***<0.0001***
Weight Gain, > 40 lbs.	25.2	22.5	23.4	***0.0250***
Prior Preterm Birth, Yes	2.8	3.7	2.3	***<0.0001***
Smoked During Pregnancy, Yes	***32.7***	13.3	9.2	***<0.0001***
Mother's Age, < 20 Years	20.4	15.7	-	***<0.0001***
Mother's Age, >= 35 Years	6.0	8.2	13.5	***<0.0001***
Mother's Education, 13+ Years	2.0	44.0	-	***<0.0001***
STD Present	3.1	6.9	0.9	***<0.0001***
Medicaid Recipient	***61.4***	***76.2***	21.4	***<0.0001***
Inadequate PNC	***22.3***	***26.8***	8.6	***<0.0001***
Pre-pregnancy Obesity, BMI 30+	25.1	***33.1***	24.0	***<0.0001***

**Non-Hispanic Whites not included in the Reference

*Reference Population includes all NH-White women who are 20+ years of age and have 13+ years education

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Maternal Health / Prematurity

STEP THREE: Estimate the impact of the risk and preventive factors on VLBW births

Prematurity Pathway

% RISK FACTORS IN VLBW BIRTHS VS. ALL OTHER BIRTHS

Risk Factors	NON-HISPANIC WHITES		NON-HISPANIC BLACKS	
	VLBW (%) N = 718	Live Births ≥1500 Grams (%) N = 62, 567	VLBW (%) N = 244	Live Births ≥1500 Grams (%) N = 9, 373
Plurality > 1 (The number of babies resulting from a single pregnancy)	***28.8***	***3.2***	***11.9***	***3.3***
Weight Gain, < 15 lbs.	***31.8***	***11.2***	***40.2***	***17.8***
Weight Gain, > 40 lbs.	***11.0***	***25.0***	***7.8***	***23.6***
Prior Preterm Birth, Yes	***5.8***	***2.5***	***11.9***	***3.5***
Smoked During Pregnancy, Yes	***24.7***	***19.1***	16.8	13.3
Mother's Age, < 20 Years	***11.8***	***8.7***	13.1	15.8
Mother's Age, >= 35 Years	11.3	10.3	***12.7***	***8.1***
Mother's Education, 13+ Years	55.2	58.5	49.2	44.0
STD Present	1.4	1.8	4.5	7.0
Medicaid Recipient	***44.7***	***38.2***	85.7	75.6
Inadequate PNC	***17.1***	***14.3***	23.8	26.8
Pre-pregnancy Obesity, BMI 30+	***27.2***	***24.2***	34.4	32.3

Significant at p<.05

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Maternal Health / Prematurity

STEP THREE: Estimate the impact of the risk and preventive factors on VLBW births

Prematurity Pathway

MULTIVARIATE ANALYSIS AND POPULATION ATTRIBUTABLE RISK %

Risk Factor	Adj. Odds Ratio	95% Confidence Interval	Population Attributable Risk %
Plurality > 1 (The number of babies resulting from a single pregnancy)	***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
Inadequate PNC	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***

Significant at p<.05

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Maternal Health / Prematurity

STEP TWO: Estimate prevalence of risk & preventive factors by type of mechanism

Perinatal Care Pathway

Obtained/Used	Not Obtained/Not Used
Cesarean Delivery **Perinatal Levels of Care** ***(SELF-REPORTED)*** **Infant Transfer** **Maternal Transfer** **Hypertension** **Gestational, Chronic, Eclampsia** **Diabetes** **Gestational, Chronic** **Congenital Anomalies** ***(Death data only)*** **Fetal Death During Labor** **Medicaid Recipient** **Infant age at death** **Gestational Age by birthweight** **Prenatal Care**	Follow Up Health Care Medical Home Respirator Care Maternal Referrals Congenital Anomalies (Birth data) Prenatal Steroids Screen for Group B strep

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 12, 2015]
Original Source: Sappenfield, W.M., Peck, M.G., Gilbert, C.S., Haynatzka, V.R., Bryant III, T. (2010). Perinatal periods of risk: Phase 2 analytic methods for further investigating feto-infant mortality. Maternal and Child Health Journal, 14, 838-850.

Maternal Health / Prematurity

STEP TWO: Estimate prevalence of risk & preventive factors by type of mechanism

PERINATAL CARE PATHWAY

% RISK FACTORS FOR VLBW BIRTHS IN STUDY POPULATION COMPARED TO REFERENCE

Risk Factor	Non-Hispanic White** (%) N = 26, 856	Reference Population* (%) N = 36, 514	P-Value
Perinatal LOC I^	***8.8***	2.7	***0.0006***
Perinatal LOC II^	19.2	15.8	0.2374
Perinatal LOC III^	***69.1***	78.0	***0.0085***
Chronic Diabetes	0.7	2.0	0.1513
Gestational Diabetes	***4.0***	9.0	***0.0103***
Chronic Hypertension	4.3	4.2	0.9540
Gestational Hypertension	***12.9***	22.5	***0.0015***
Eclampsia	2.0	1.7	0.7734
Infant Transfer	***19.8***	13.3	***0.0217***
Cesarean Delivery	***68.9***	77.5	***0.0121***
Maternal Transfer	15.0	12.8	0.4064
PNC First Trimester	***66.1***	85.6	***<0.0001***
Adequate PNC	***70.0***	87.8	***<0.0001***
Medicaid Recipient	***70.4***	22.8	***<0.0001***

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

^Self-Reported Perinatal Level of Care
**Non-Hispanic Whites not included in the Reference
*Reference Population includes all NH-White women who are 20+ years of age and have 13+ years education

Maternal Health / Prematurity

STEP THREE: Estimate the impact of the risk and preventive factors on VLBW deaths

PERINATAL CARE PATHWAY: NON-HISPANIC WHITES

% RISK FACTORS FOR VLBW DEATHS COMPARED TO BIRTHS

Risk Factor	VLBW Fetal Deaths (%) N = 105	VLBW Infant Deaths (%) N = 94	VLBW Births (%) N = 580	P-Value
Perinatal LOC I^	*	***16.0***	***3.8***	***<0.0001***
Perinatal LOC,II^	*	18.1	17.2	0.8412
Perinatal LOC III^	*	66.0	75.3	0.0541
Chronic Diabetes	1.0	1.1	1.4	0.6576
Gestational Diabetes	1.0	6.4	6.8	0.0964
Chronic Hypertension	1.9	5.3	4.1	0.7234
Gestational Hypertension	***2.9***	***8.5***	***19.7***	***<0.0001***
Eclampsia	0.0	2.1	1.8	0.4526
Infant Transfer	Not Applicable	***24.5***	***14.8***	***0.0185***
Cesarean Delivery	***15.2***	***54.3***	***76.9***	***<0.0001***
Congenital Anomalies	Not Applicable	17.0	Not Applicable	-
Maternal Transfer	13.3	12.8	13.8	0.7961
Fetal Death During Labor	7.6	Not Applicable	Not Applicable	-
PNC First Trimester	78.1	75.5	68.4	0.3011
Medicaid Recipient	*	44.7	44.3	0.9465
Adequate PNC	*	66.0	72.6	0.1858

^Self-Reported Perinatal Level of Care

* Not included on fetal death certificate.

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Maternal Health / Prematurity

STEP THREE: Estimate the impact of the risk and preventive factors on VLBW deaths

PERINATAL CARE PATHWAY: NON-HISPANIC WHITES

MULTIVARIATE ANALYSIS AND POPULATION ATTRIBUTABLE RISK%

Risk Factor	Adjusted Odds Ratio	Confidence Interval	Population Attributable Risk %
Perinatal LOC I^	***4.30***	***1.83, 10.12***	**15.02**
Chronic Hypertension	1.52	0.52, 4.43	2.31
Eclampsia	1.34	0.28, 6.49	0.53
Perinata LOC II^	1.20	0.65, 2.21	2.85
Maternal Transfer	1.17	0.59, 2.31	2.06
Gestational Diabetes	1.12	0.44, 2.81	0.51
Infant Transfer	0.99	0.53, 1.88	0.27
Medicaid Recipient	0.81	0.51, 1.29	-8.57
Adequate PNC	0.79	0.47, 1.33	-17.51
Chronic Diabetes	0.56	0.06, 5.47	-0.62
Gestational Hypertension	0.55	0.25, 1.21	-8.64
Cesarean Delivery	***0.39***	**0.23, 0.63**	**-82.34**

Significant at p<.05

^Self-Reported Perinatal Level of Care

*Multivariate analysis excluded fetal death data

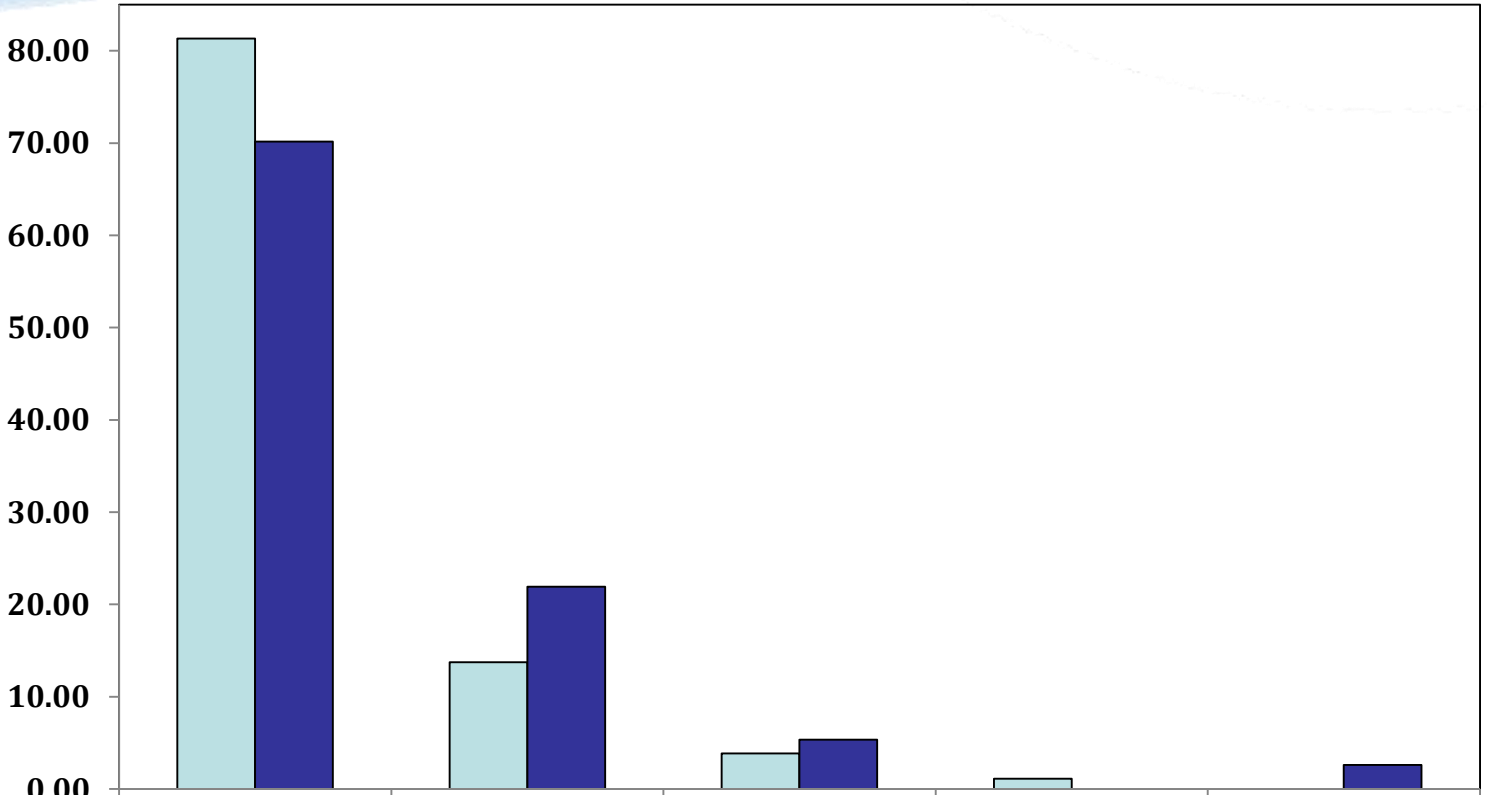
Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Maternal Health / Prematurity

STEP THREE: Estimate the impact of the risk and preventive factors on VLBW deaths

PERINATAL CARE PATHWAY: NON-HISPANIC WHITES

% VLBW Births and VLBW Feto-Infant Deaths by Gestation



	<= 30 Weeks	31 - 33 Weeks	34 - 36 Weeks	37 Weeks	>= 38 Weeks
Feto-Infant Deaths	81.32	13.74	3.85	1.10	0.00
VLBW Births	70.17	21.90	5.35	0.00	2.59

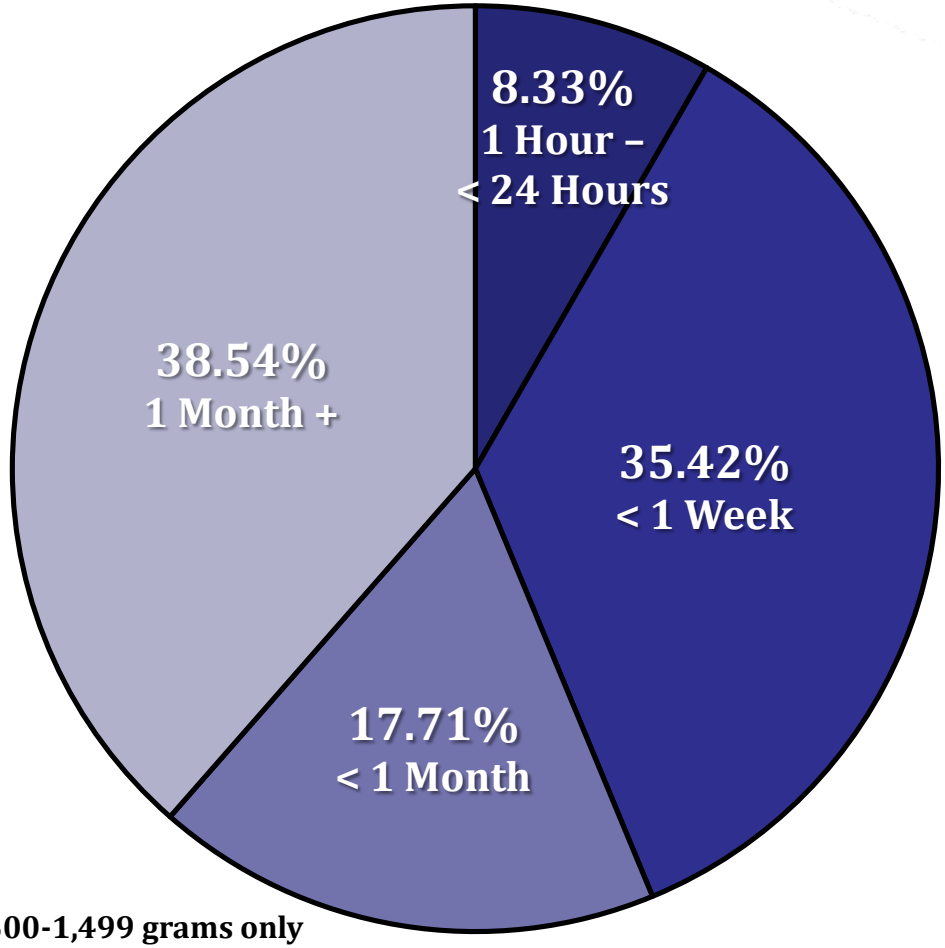
Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Maternal Health / Prematurity

STEP THREE: Estimate the impact of the risk and preventive factors on VLBW deaths

PERINATAL CARE PATHWAY: NON-HISPANIC WHITES

% VLBW Infant Deaths by Age of Death



Includes Infant Deaths 500-1,499 grams only
1 month = 30 Days +

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Maternal Health / Prematurity

STEP THREE: Estimate the impact of the risk and preventive factors on VLBW deaths

PERINATAL CARE PATHWAY: NON-HISPANIC WHITES

Leading Cause of VLBW Congenital Anomaly Infant Deaths

ICD – 10 Code	N = 16
Q91.0-91.3 Edward's Syndrome / Trisomy 18	31.25%
Q000 Anencephaly and similar malformations	18.75%
Q30-Q34 Congenital malformations of respiratory system	12.50%
Q92-Q99 Other chromosomal abnormalities, not elsewhere classified	12.50%

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Maternal Health / Prematurity

Where are VLBW Feto-Infant Deaths Occurring?

County	Feto-Infant Deaths	% Total (N = 270)
Allen	17	6.3
Elkhart	9	3.3
Hamilton	10	3.7
Lake	21	7.8
Madison	9	3.3
Marion	66	24.4
St. Joseph	12	4.4

These counties make up > 50% of all VLBW feto-infant deaths.

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

MH/P SUMMARY

RISK FACTORS ASSOCIATED WITH VLBW BIRTH

- **BLACK RACE (AOR = 1.88)**
  - **BLACK MOTHERS AT NEARLY A 90% INCREASED ODDS OF HAVING A VLBW BIRTH**

MH/P SUMMARY

RISK FACTORS ASSOCIATED WITH VLBW BIRTH

- **SIGNIFICANT RISK FACTORS THAT ARE MORE PREVALENT AMONG *NON-HISPANIC, BLACK MOTHERS***
  - **LOW WEIGHT GAIN (AOR = 3.45)**
  - **PRIOR PRETERM BIRTH (AOR = 2.56)**
  - **TEEN MOTHER (AOR = 1.64)**
  - **MEDICAID RECEPIENT (AOR = 1.20)**

MH/P SUMMARY

RISK FACTORS ASSOCIATED WITH VLBW BIRTH

- **SIGNIFICANT RISK FACTORS THAT ARE MORE PREVALENT AMONG *NON-HISPANIC, WHITE MOTHERS***
  - **PLURALITY > 1 (AOR = 12.95)**
  - **SMOKING DURING PREGNANCY (AOR = 1.37)**

MH/P SUMMARY

RISK FACTORS ASSOCIATED WITH VLBW BIRTH

- **INADEQUATE PNC HAD A HIGH PREVALENCE AMONG ALL POPULATIONS**
  - **22.3% NON-HISPANIC, WHITES**
  - **26.8% NON-HISPANIC, BLACKS**
  - **VS. 8.6% REFERENCE GROUP**

MH/P SUMMARY
RISK FACTORS ASSOCIATED WITH VLBW INFANT DEATH

- **NON-HISPANIC WHITES**
- **DELIVERY AT A SELF-REPORTED LOC I (AOR = 4.3)**
  - **NON-HISPANIC, WHITE WOMEN DELIVERING A VLBW BIRTH AT A SELF-REPORTED LOC I ARE 4.3X THE ODDS OF EXPERIENCING AN INFANT DEATH COMPARED TO WOMEN DELIVERING AT A LOC III**

INFANT HEALTH PERIOD OF RISK

	Post-Neonatal Deaths, 28-364 days		
>= 1,500 Grams	Non-Hispanic, Whites N = 182	Non-Hispanic, Blacks N = 40	Reference Population N = 82
	2.87	4.15	2.24

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Infant Health

Step One: Identify Causal Pathways or Biologic Mechanisms for Excess Mortality

- Use Underlying Cause of Death from Death Certificate (ICD-10 Codes)

- Infant Death Groupings (using ICD-10 codes)
  - Perinatal Conditions
  - Congenital Anomalies
  - Infections
  - SIDS/SUIDs
  - Injuries (not included in SUIDs)

Infant Health

Step One: Identify Causal Pathways or Biologic Mechanisms for Excess Mortality

Cause-Specific Mortality Rates

	TOTAL	Reference Population	Excess CSMR	Excess Deaths	
Perinatal Conditions	0.33	0.33	-0.005	0	
Congenital Anomalies	0.82	0.67	0.159	13	
Infections	0.24	0.14	0.104	9	
SIDS/SUIDs	**0.97**	**0.64**	**0.333**	**27**	← 44% of excess
Injuries	0.19	0.08	0.111	9	
Other	0.45	0.42	0.033	3	

	NON-HISPANIC WHITES	Reference Population	Excess CSMR	Excess Deaths	
Perinatal Conditions	0.34	0.33	0.003	0	
Congenital Anomalies	0.85	0.67	0.182	11	
Infections	0.18	0.14	0.037	2	
SIDS/SUIDs	**0.91**	**0.64**	**0.274**	**17**	← 43% of excess
Injuries	0.21	0.08	0.125	8	
Other	0.43	0.42	0.016	1	

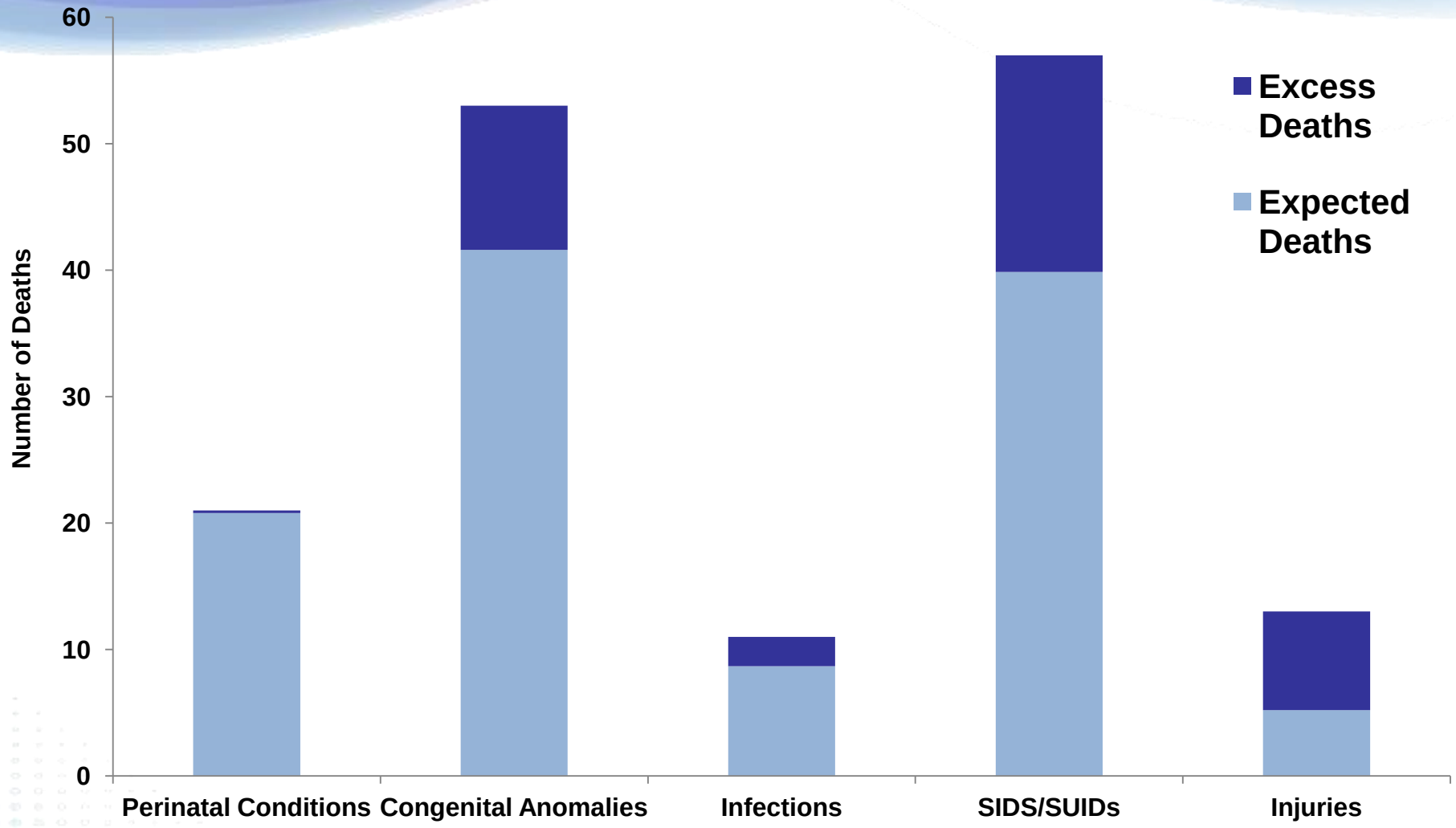
	NON-HISPANIC BLACKS	Reference Population	Excess CSMR	Excess Deaths	
Perinatal Conditions	0.21	0.33	-0.119	-1	
Congenital Anomalies	0.43	0.67	-0.238	-2	
Infections	0.85	0.14	0.716	7	
SIDS/SUIDs	**1.92**	**0.64**	**1.285**	**12**	← 63% of excess
Injuries	0.11	0.08	0.024	0	
Other	0.75	0.42	0.332	3	

CSMR: Cause-Specific Mortality Rate per 1,000 Live Births ≥ 1500 grams

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Excess Deaths - Infant Health

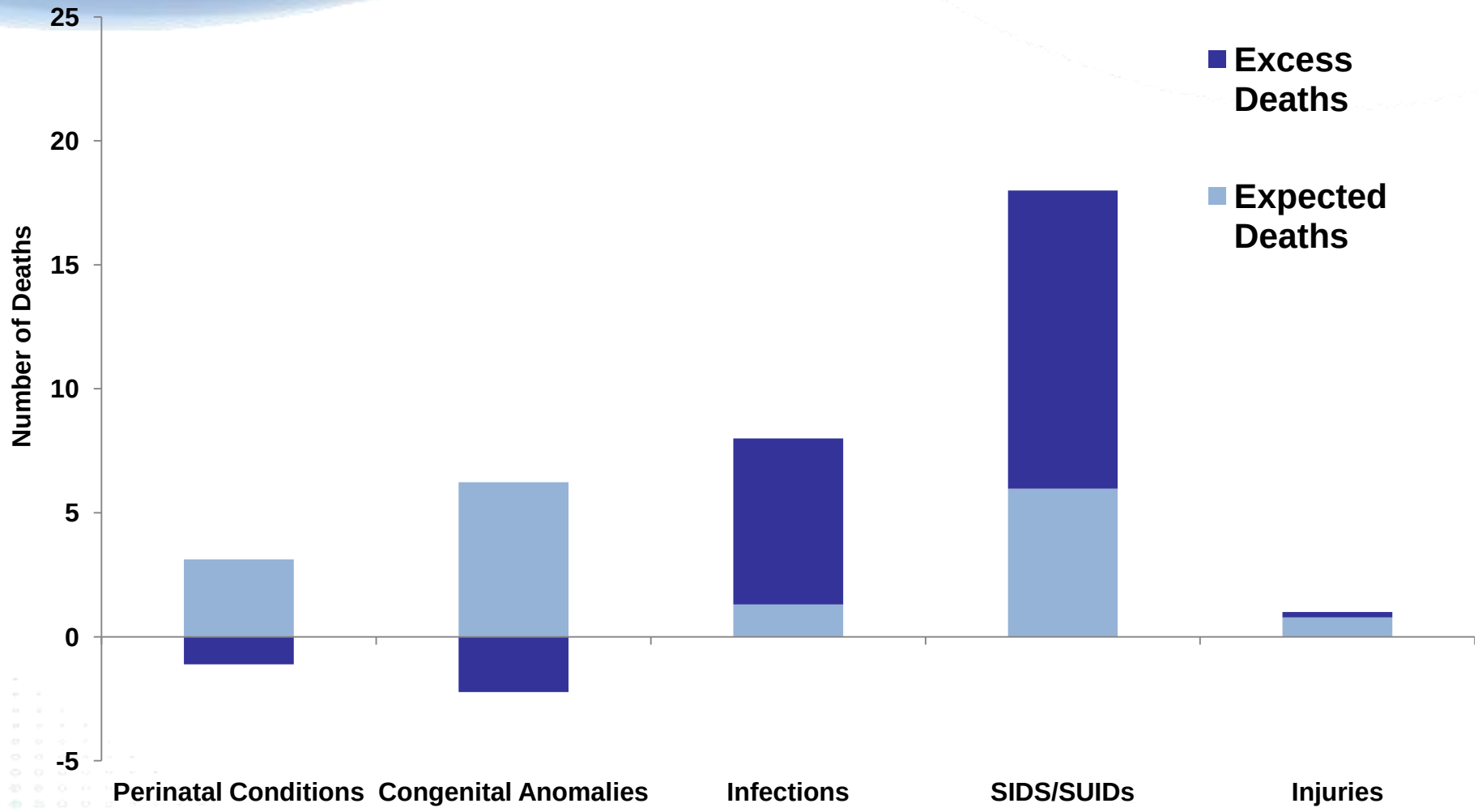
Non-Hispanic Whites: Total Deaths=182, Excess Deaths=40



Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Excess Deaths - Infant Health

Non-Hispanic Blacks: Total Deaths=40, Excess Deaths=19



Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Infant Health

STEP TWO: Estimate prevalence of risk & preventive factors for SIDS/SUIDs

	Risk Factors/Interventions
Obtained/Used	***Smoking among pregnant women*** **(prior, during, 3rd trimester)** ***Maternal Age*** **(<20 years)** ***Maternal Education*** **(<13 years)** ***Breastfeeding at hospital discharge*** ***Pay Source*** **(Medicaid)** ***Prenatal Care*** **(Adequacy, First Trimester)** ***Marital Status*** **(Not Married)** ***Co-sleeping/Bed Sharing/Sleep Position*** **(Death Cert.)**
Not Obtained/Not Used	Co-sleeping/Bed Sharing/Sleep Position (among births) Death Scene Investigation/Autopsy Pacifier Use Household Income

Infant Health

STEP TWO: Estimate prevalence of risk & preventive factors for SIDS/SUIDs

% RISK FACTORS IN THE TOTAL STUDY POPULATIONS COMPARED TO REFERENCE

Risk Factors	Reference (%) N=36,514	Non-Hispanic Whites**(%) N=26,856	Non-Hispanic Blacks (%) N=9,656	p-value
Smoked Prior to Pregnancy	10.7	***31.6***	***15.4***	***<.0001***
Smoked During Pregnancy	9.2	***32.7***	***13.4***	***<.0001***
Smoked in the 3rd Trimester	7.4	***28.4***	***10.8***	***<.0001***
Maternal Age <20 years	-	20.4	15.7	***<.0001***
Maternal Education <13 years	-	98.0	56.0	***<.0001***
Not Breastfeeding at Hospital Discharge	15.1	***37.4***	***42.2***	***<.0001***
Medicaid Recipient	21.6	***61.4***	***76.2***	***<.0001***
No Prenatal Care, First Trimester	19.5	***38.9***	***41.7***	***<.0001***
Prenatal Care, Inadequate	8.6	***22.3***	***26.8***	***<.0001***
Marital Status, Not Married	20.9	***57.4***	***79.7***	***<.0001***

**Non-Hispanic Whites Not Included in the Reference Group
Denominator is all live births in each racial/ethnic group

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Infant Health

STEP THREE: Estimate the impact of the risk and preventive factors on SIDS/SUIDs deaths

% RISK FACTORS FOR SUIDS DEATHS VS. LIVE BIRTHS

Risk Factors	NON-HISPANIC WHITES		NON-HISPANIC BLACKS	
	SIDS/SUIDs Deaths (%) N=57	Live Births ≥1500 Grams (%) N=62566	SIDS/SUIDs Deaths (%) N=18	Live Births ≥1500 Grams (%) N=9376
Smoking Prior to Pregnancy	***36.8***	***19.5***	16.7	15.3
Smoking During Pregnancy	***36.8***	***19.1***	16.7	13.3
Smoking Third Trimester	***33.9***	***16.3***	16.7	10.8
Maternal Age <20 years	15.8	8.6	11.1	15.7
Maternal Education <13 years	54.4	41.5	55.6	56.0
Breastfeeding at Hospital Discharge, No	28.1	24.3	44.4	41.9
Prenatal Care, Inadequate	15.8	14.3	***66.7***	***26.8***
Medicaid Recipient	***63.2***	***38.4***	***55.6***	***76.2***
Marital Status, Not Married	***61.4***	***36.3***	***55.6***	***79.7***

Significant at p<.05

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Infant Health

STEP THREE: Estimate the impact of the risk factors on SIDS/SUIDs deaths

MULTIVARIATE ANALYSIS AND POPULATION ATTRIBUTALE RISK%

Risk Factor	Adj. Odds Ratio	95% Confidence Interval	PAR %
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

Significant at p<.05

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Infant Health

STEP THREE: Estimate the impact of the risk and preventive factors on SIDS/SUIDs deaths

NUMBER OF DEATHS WITHIN THE SUIDS GROUPING

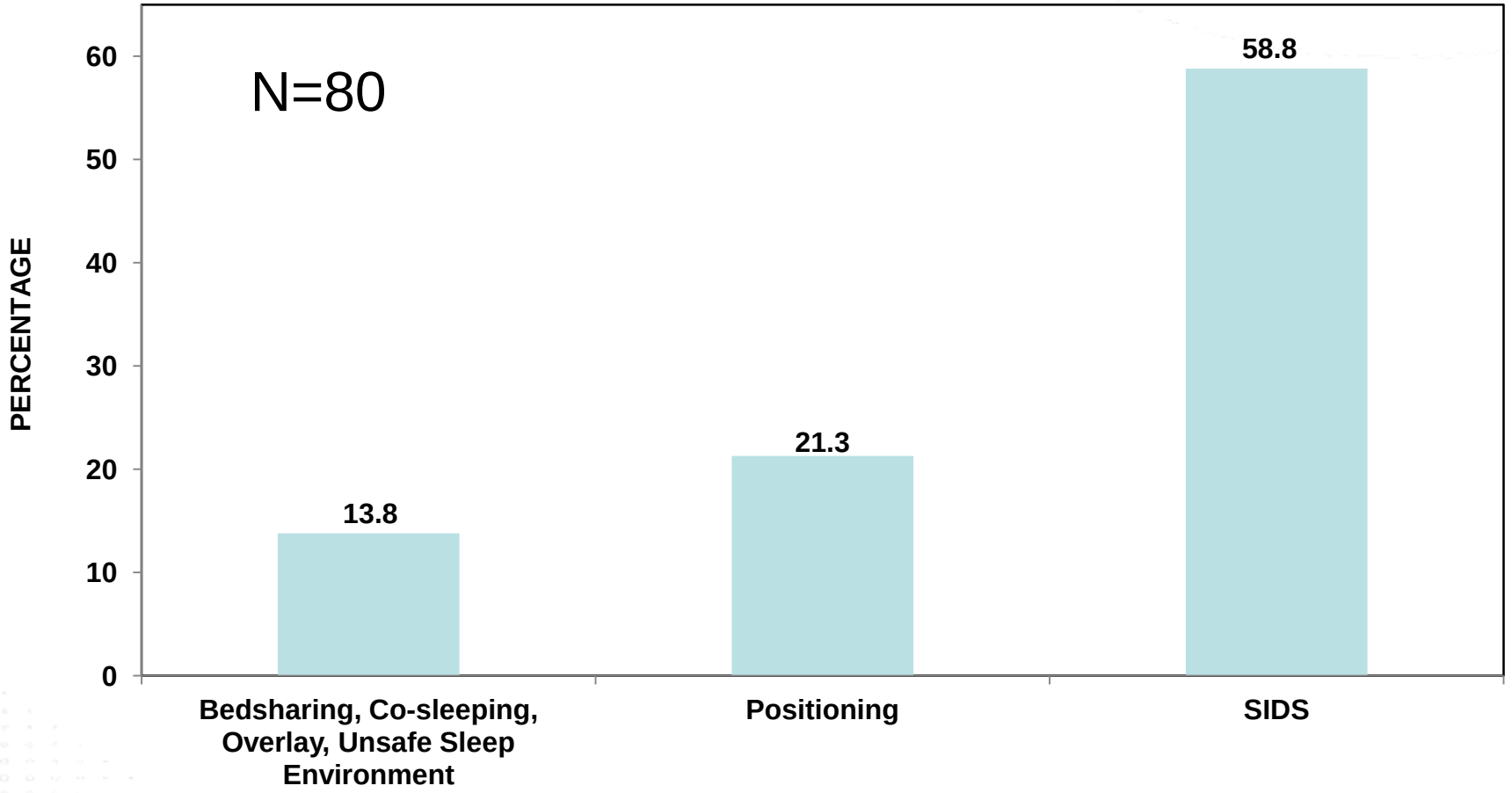
ICD-10 Codes and Descriptions	Total	Non-Hispanic White	Non-Hispanic Black
Sudden Infant Death Syndrome (R95)	**48**	**33**	**12**
Accidental suffocation and strangulation in bed (W75)	**20**	**14**	**5**
Other accidental suffocation and strangulation (W76-77, W81-W84)	8	6	<5
Neglect, abandonment and other maltreatment syndromes (Y06-Y07)	<5	<5	0
Other external causes (Y20)	<5	<5	0

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Infant Health

STEP THREE: Estimate the impact of the risk and preventive factors on SIDS/SUIDs deaths

PERCENTAGE OF SUIDS DEATHS BY KEY WORD CAUSES



Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

Infant Health
Where are SUIDs Deaths Occurring?

County	Infant Health Deaths	% Infant Health Deaths = SUIDS
Allen	10	40.0
Elkhart	8	62.5
Lake	22	36.4
Marion	47	21.3
St. Joseph	9	56.0

These counties make up 40% of the total SUIDs deaths (N = 32).

Source: Indiana State Department of Health, Maternal & Child Health Epidemiology Division [February 11, 2015]

IH Summary

- SIDS/SUIDs deaths account for just under half of all category deaths
- SIDS (R95) and suffocation (in bed) deaths (W75) make up the majority of SUIDs deaths.
- Sleep environment and positioning play an important preventable role in the number of SUIDs deaths each year

IH Summary

- Black mothers have double the odds of having an infant die from SIDS/SUIDs
  - (aOR=2.03, PAR%=10.7%)

- Mothers that smoke prior to or during pregnancy have 1.8x the odds of having an infant die from SIDS/SUIDs (aOR=1.88, PAR%=15.1%)
  - Non-Hispanic Whites

IH Summary

- Although not statistically significant, inadequate prenatal care also plays a role as a predictor as shown in other studies, especially among Non-Hispanic Blacks
  - (aOR=1.50, PAR%=7.82)

Limitations

- Possible reporting inaccuracies on the birth, death, and fetal death certificates (e.g. weight, height)
- Self-reporting bias
- Residual confounding could be possible due to the lack of data for certain covariates (e.g. substance abuse)
- Results from a statewide PPOR are not as strong as community level studies
- Observational studies do not generally show causal link, so PPOR is unlikely to identify previously unknown causes.

Potential Targeted Interventions

- Improving the health of women before, during, and after conception
- Smoking cessation, especially among white mothers
- Improving access to Medicaid for pregnant women
- Access to quality prenatal care, especially for black mothers
- Education for safe sleep practices
- Progesterone access for women with a prior preterm birth
- Ensure pregnant women are receiving risk-appropriate care

Conclusions

- 156 preventable deaths in 2011 with the most preventable deaths occurring in Non-Hispanic White population, but the highest excess rate occurring among Non-Hispanic Blacks

- Prevention efforts would be best geared toward evidence–based methods that help reduce the number of VLBW births and SIDS/suffocation deaths
  - Results further justify the current and planned state infant mortality initiatives

- Future Implications of PPOR
  - PPOR conducted at state-level annually – approximately 6 month time frame, aggregate future years (2012-2013)
  - Fetal Infant Mortality Reviews (FIMR)

Questions?

- MCH Epidemiologists
  - Kelsey Gurganus – kgurganus@isdh.in.gov
  - Kendra Ham – kham@isdh.in.gov

- MCH Division Director
  - Bob Bowman – bobbowman@isdh.in.gov