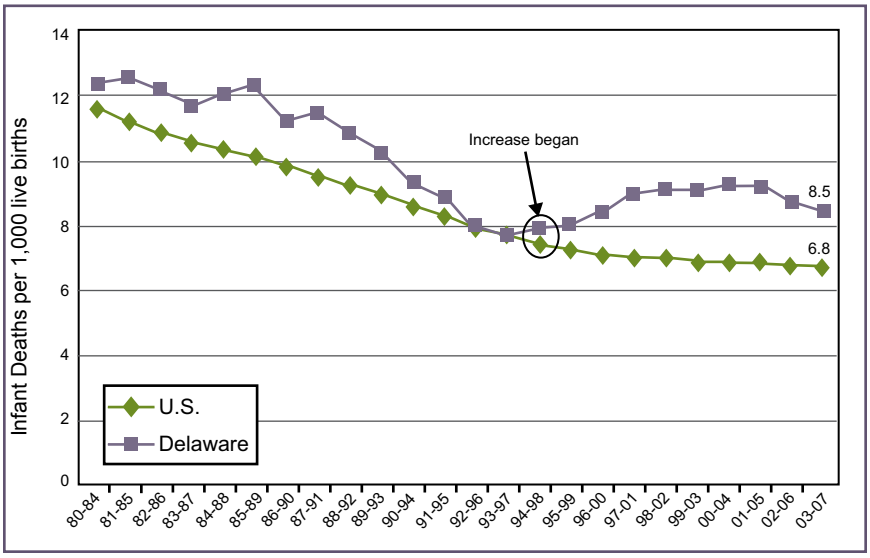
Case Study: Delaware

Background

The Delaware infant mortality rate steadily increased in the mid-1990s and reached a high of 9.3 deaths per 1,000 live births between 2000 through 2004. In 2004, Delaware joined the State Infant Mortality Collaborative to investigate the increasing infant mortality trend and identify interventions for addressing underlying factors.

Rolling Five-Year Average Infant Mortality Rates for Delaware and the United States, 1980-2007



STAGE 1: Establish time period, study population and baseline infant mortality rates

Analysis of infant mortality trends in Delaware mainly focused on two five-year time periods, 1993-1997 and 1998-2002. Five-year infant mortality rates were calculated to provide large enough numbers to generate stable rates. These two time periods were chosen because the time period 1993-1997 represented a time period when the Delaware infant mortality rate was comparable to that of the United States, and the time period 1998-2002 represented a time frame when the Delaware infant mortality rate was among the highest in the nation.

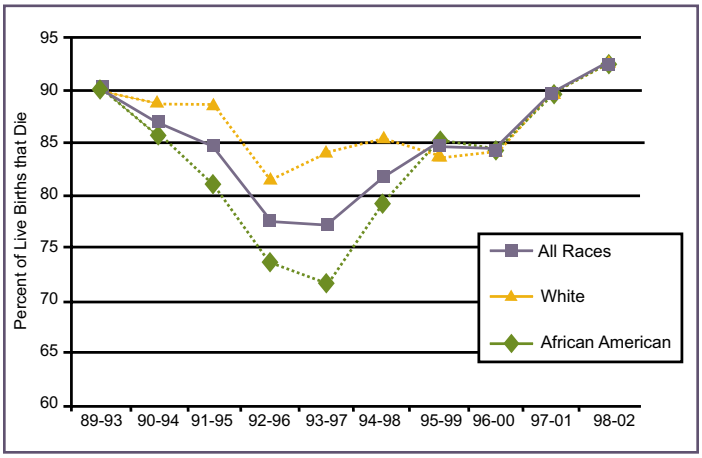
Further analysis revealed striking racial disparities. The infant mortality rate for African American infants was more than twice that of white infants (16.7 versus 6.9 for 1998-2002). Also, the infant mortality rate for African American infants increased more slowly between 1993-1997 and between 1998-2002 than the infant mortality rate for white infants. Infant mortality rates by geography were also examined for all three counties in Delaware: New Castle, Kent and Sussex. While overall rates increased in both Kent and New Castle counties, Kent County had the highest infant mortality rate because of increasing infant mortality among white infants in this county.

Review reporting changes in fetal deaths, live births, infant deaths

Delaware reviewed reporting practices and legislation, including definitions and standard operating procedures. The assessment found that birth certificates with missing or unknown birth weight or with plural birth sibling data were flagged in the electronic system, and staff was now required to confirm birth weight for these flagged certificates. Concurrent to the implementation of these data quality edits, infant mortality rates began to increase, reflecting improvements in infant death reporting.

Further evaluation of fetal death and live birth reporting was conducted. An analysis of live birth and fetal death trends in Delaware found that the number of live born infants with birth weights <500 grams steadily increased between 1993 and 2002, coinciding with the increase in the infant mortality rate. Additionally, a review of reporting practices revealed that prior to the increase in the infant mortality rate from 1992 through 1996, many infants born with a birth weight <500 grams were classified as surviving live births rather than infant or fetal deaths. The mortality rate for infants with a birth weight <500 grams is close to 100 percent, and the underreporting of infant deaths accounted in part for the low mortality rate among infants with a birth weight <500 grams.

Rolling Five-Year Average Percent of <500 Gram Live Births that Die by Race in Delaware, 1989-2002 Birth Cohort



Despite the correction of underreporting of infant deaths, the infant mortality rates continued to increase for the time periods 2000-2004 and 2001-2005. Investigators concluded that reporting issues accounted for a small proportion of the infant mortality rate increase in the 1990s and further analyses were required.

Case Study: Delaware *continued*

Consider changes in causes and timing of deaths

Delaware investigated changes in the timing of infant death and found an increase in the proportion of infant deaths occurring in the early neonatal period (0-6 days), from 52 percent in 1994-1996 to 62 percent in 1998-2000. By contrast, there was a decrease in the proportion of infant deaths occurring during the late neonatal (7-27 days) and post neonatal periods (28-364 days). In the early neonatal period, the majority of the increase was during the first day of life, suggesting these infants were born with significant health problems. Cause of death analyses death analyses were undertaken, but did not provide information that helped to further explain the increase in infant mortality.

Examine changes in high-risk outcomes: maturity at birth and maturity-specific mortality

The Kitagawa method was used to quantify the contributions of birth weight-specific mortality and birth weight distribution to the excess infant mortality rates. Analysis revealed that the frequency of births with weights <500 grams (birth weight distribution) was the main contributor (40.5 percent) to the overall excess in infant mortality. Further analysis by race found that the excess in infant mortality among African American infants was largely due to birth weight-specific mortality (73.4 percent), while the excess in infant mortality among white infants was largely due to the frequency of low birth weight births (59.4 percent). For both races, excess infant mortality among <500 gram births contributed to the majority of overall excess. These data formed the hypothesis that the birth of smaller and less healthy infants was driving the overall infant mortality rate increase in Delaware. Subsequently, Delaware staff recommended a review of all infant deaths where the birth weight was <1,500 grams to better understand their contribution to the overall infant mortality rate.

Analysis of birth weight categories <500, 500-749, 750-999, and 1,000-1,499 grams revealed that the African American/white disparity ratio decreased due to an increase in the proportion of white births in each of the birth weight categories and a decrease in African American births in the <500 and 1,000-1,499 gram birth weight categories. The largest African American/white disparity ratio occurred in the <500 gram birth weight category. In addition, the proportion of births occurring at <24 weeks gestation for African American mothers was three times that of white mothers. There was also an increase in births occurring at <24 weeks gestation among white mothers from 1993 through 1997 and from 1998 through 2002. These results indicated that programs should continue to focus their activities on African American women, as they were more likely to deliver smaller and less healthy infants than white women.

Kitagawa Analysis of the Difference between 1993-1997 and 1998-2002 Infant Mortality Rates

Birth Weight in Grams	Birth Weight Frequency (%)	Birth Weight-Specific Mortality (%)	Total Difference
< 500 grams	40.5	27.1	67.6
500–749 grams	0.9	22.5	23.4
750–999 grams	3.2	5.4	8.7
1,000–1,499 grams	2.3	4.1	6.4
1,500 or more grams	-0.4	-5.7	-6.1
TOTAL	**46.6**	**53.4**	**100.0**

PPOR analysis was conducted to examine changes in the birth weight distribution and birth weight-specific mortality, along with underlying contributing factors. Two subpopulations, race and county, were examined using non-Hispanic white women 20 years of age or older with more than high school education as the reference population. Results of the PPOR analyses for race and county indicated excess feto-infant mortality in Maternal Health/Prematurity. Among African American mothers, Maternal and Infant Health also were focus areas for addressing excess mortality. By county, PPOR analysis indicated Infant Health as a focus area in Kent and Sussex counties. Examination of postneonatal deaths in these counties was undertaken, and analyses of maternal risks and behaviors during the preconception period were identified as next steps.

PPOR Analysis Map, Delaware, 2001-2005

Birth Weight	Fetal	Neonatal	Postneonatal
500–1,499 grams	Maternal Health / Prematurity		
1,500 or more grams	Maternal Care	Newborn Care	Infant Health

PPOR Analysis by Race, Delaware, 2001-2005

White Rates, All Counties					Black Rates, All Counties				
3.3					6.7				
1.6	1.0	1.5	7.4		2.5	1.7	2.9	13.8	
Control Population Rates					Control Population Rates				
2.4					2.4				
1.1	1.0	0.9	5.5		1.1	1.0	0.9	5.5	
Excess in Rates					Excess in Rates				
0.9					4.3				
0.4	-0.1	0.6	1.9		1.4	0.7	1.9	8.3	

PPOR Analysis by County, Delaware, 2001-2005

New Castle, All Races					Kent, All Races					Sussex, All Races				
4.0					4.2					4.0				
1.8	1.0	1.7	8.6		1.9	1.0	2.3	9.4		1.8	1.0	1.7	9.3	
Control Population Rates					Control Population Rates					Control Population Rates				
2.4					2.4					2.4				
1.1	1.0	0.9	5.5		1.1	1.0	0.9	5.5		1.1	1.0	0.9	5.5	
Excess in Rates					Excess in Rates					Excess in Rates				
1.6					1.8					1.6				
0.7	0.0	0.8	3.2		0.8	0.0	1.4	3.9		0.5	0.8	1.0	3.8	

Evidence-Based Interventions

The findings of this analysis were used to establish new surveillance systems in Delaware. These also were used to design and implement new interventions in preconception, prenatal and postpartum health; health care; statewide education campaigns; and proposed modification to standards of care.

STAGE 2: Investigate changes in high-risk precursors to infant mortality

To fully evaluate the impact of multiple poor birth outcomes on women residing in Delaware, the Division of Public Health developed a longitudinal maternally linked birth file. The file was used to monitor trends in birth outcomes for women with a prior adverse outcome, such as preterm birth, low birth weight deliveries or infant death and included all live births beginning in 1989.

Analyses of these data revealed that women who experienced a second infant death were more than two times as likely to have waited less than one year between pregnancies compared with women who did not experience a second infant death. Similarly, women who experienced a second infant death were more likely to have gained too little or too much weight during pregnancy than women who did not experience a second infant death. Findings were similar for women with low birth weight infants in successive pregnancies, but with smoking emerging as an additional risk factor.

The findings were adjusted for county of residence, maternal age, marital status, education, plurality, number of prenatal care visits, method of delivery and race. The trends observed led to more targeted interventions for addressing infant mortality throughout the state, including the development of reproductive life plans (i.e., planned birth spacing), smoking cessation programs, drug abuse and alcohol use counseling wrapped into a preconception care program for women who were not pregnant, and existing prenatal services for pregnant women.

Case Study: Louisiana

Background

The Louisiana population averaged 4.5 million, with about 65,000 births per year during the late 1990s and early 2000s. With 63 percent of births covered by Medicaid, Louisiana has relied heavily on its regional, state-supported hospital system and large network of publicly funded clinics to provide preventive and primary health care.

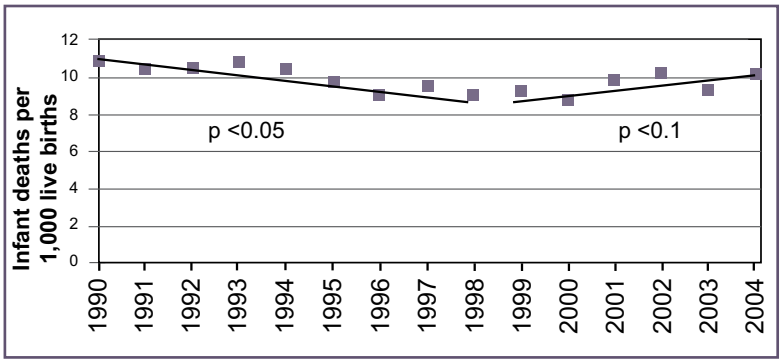
Each year from 1998 through 2002, Louisiana reported one of the five highest infant mortality rates (IMRs) in the United States and ranked 49th in infant mortality. The rate of preterm birth in 2004 was 15.6 percent, surpassed only by Mississippi and Alabama. In 2004, Louisiana joined the State Infant Mortality Collaborative to investigate trends and potential reasons for infant mortality rates that were consistently higher than other U.S. states.

STAGE 1: Establish time period, study population and baseline infant mortality rates

Identify time period, study population and baseline infant mortality rates

Louisiana resident IMR trends were evaluated from 1990-2004 (Figure A), while in-depth analyses focused on the time period from 1997 through 2004.

Figure A. Louisiana Infant Mortality Rate Trends, 1990-2004



Baseline (1990) IMR was 11.0 per 1,000 live births, falling to a low of around 9.0 per 1,000 live births from 1998 through 2000, and returning to 10.4 per 1,000 by 2004. Statistically significant decreases were noted in the 1990s, while non-statistically significant increases were seen from about 1999-2004.

The study population included all Louisiana resident women delivering a live-born infant. Analyses were completed for the state overall, with additional investigation by race (white and African American/black), plurality, birth weight, hospital level of care, geographic region, cause of death, age at death, PPOR and vital event underreporting.

Review reporting changes in fetal deaths, live births, infant deaths

There were no changes in vital event definitions or reporting requirements during the study period. Reporting procedures remained consistent and there was no reason to expect any changes in reporting practice.

Although no changes were identified in definitions or reporting requirements, analyses were completed to evaluate the likelihood of complete death reporting among live-born infants weighing <500 grams at delivery. Results of this underreporting analysis indicated that the annual percentage of live births <500 grams was stable at 0.3 percent from 1998 to 2004. Factors contributing to underreporting included: some birth records with the "died in facility" check box checked that had no corresponding death certificates; some live births had corresponding fetal death certificates instead of live-born death certificates; and some records had no indication that a death event occurred at all. Among the certificates with no indication of the outcome, it is possible that certificates were in fact filed, but the final data files used for the linkage did not contain late filed certificates. It is also possible that movement into or out of state might have masked true reporting, as only Louisiana certificates were evaluated. Annual reported and adjusted (accounting for underreporting) IMRs are shown in Table A.

Table A. Adjusted IMR Assuming <500 Gram 'Real' IMR is 900.0 per 1,000 Live Births

Year	1998	1999	2000	2001	2002	2003	2004
LA reported IMR <500 g	732.5	700.7	538.9	711.0	820.3	780.3	734.4
Total IMR underreported	0.5	0.6	1.1	0.6	0.2	0.4	0.5
LA total reported IMR	9.1	9.2	8.9	9.8	10.2	9.3	10.4
LA total adjusted IMR	9.6	9.8	10.0	10.4	10.4	9.7	10.9

Results underscored the need to periodically evaluate underreporting to better understand the occurrence of reported compared to expected infant deaths in Louisiana. The lowest reported IMR from from 1990 through 2004 occurred in 2000, which is the same year that the worst underreporting occurred (Figure B).

Figure B. Reported and Adjusted IMR, Louisiana, 1997-2004

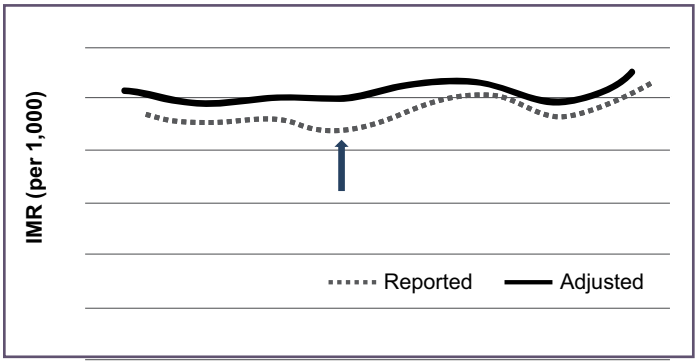
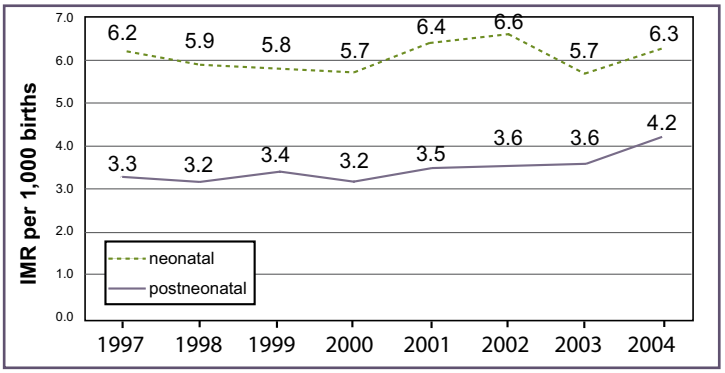


Figure C. Neonatal and Postneonatal Mortality Rates, Louisiana, 1997-2004



Consider Changes in Causes and Timing of Teaths

The leading causes of infant death in Louisiana from 2002 through 2004 were length of gestation or fetal growth, followed by congenital malformations/deformations/ chromosomal anomalies, and SIDS. Race-specific rates indicated that black women were almost four times as likely to experience an infant death due to length of gestation or fetal growth compared to white women. The racial disparity was less severe for the second and third leading causes, although black infants continued to experience higher rates than whites (Table B).

Table B. Mortality Rates* for Leading Causes of Infant Deaths, Louisiana, 2002-2004

Cause of Death	Crude	African American	White	Race Ratio
Length of gestation/ fetal growth	1.96 (381)	3.46 (274)	0.95 (105)	3.6
Congenital malformations	1.87 (363)	2.02 (196)	1.77 (160)	1.1
SIDS	1.02 (199)	1.21 (96)	0.91 (101)	1.3

*Rate expressed per 1,000 live births; Number of deaths shown in parentheses (N)

The neonatal mortality rate (birth to <28 days) exceeded the postneonatal mortality rate (28 days to one year of age) by nearly two-fold in the late 1990s. Neonatal mortality remained relatively stable from 1997-2004, while postneonatal mortality increased from 3.3 per 1,000 births in 1997 to 3.6 in 2003 (9 percent increase) and 4.2 in 2004 (27 percent increase from 1997). Roughly 65 percent of infant deaths in Louisiana from 1998 through 2002 occurred during the neonatal period, with little fluctuation from year to year (Figure C).

The leading cause of neonatal death from 2000 through 2002 was conditions originating in the perinatal period, accounting for 72 percent of neonatal deaths. Conditions originating in the perinatal period are primarily related to low birth weight and preterm birth; complications of pregnancy, labor and delivery; and respiratory distress and other respiratory conditions. Congenital malformations, deformations and chromosomal abnormalities accounted for 22 percent of neonatal deaths. The leading causes of death in the postneonatal period from 2002 through 2004 were SIDS and injury, accounting for 0.7 and 0.4 deaths per 1,000 births, respectively.

STAGE 2: Investigate changes in high-risk precursors to infant mortality

Multiples

The proportion of births that were multiples remained low from 1997 through 2004, and accounted for less than 3.4 percent of all Louisiana resident births. Triplets and higher order multiples accounted for less than 0.2 percent of all births each year. There was no meaningful difference by race in the percent of births that were multiples. Infant mortality rates and related risk factors also remained essentially unchanged when multiples were excluded from analyses.

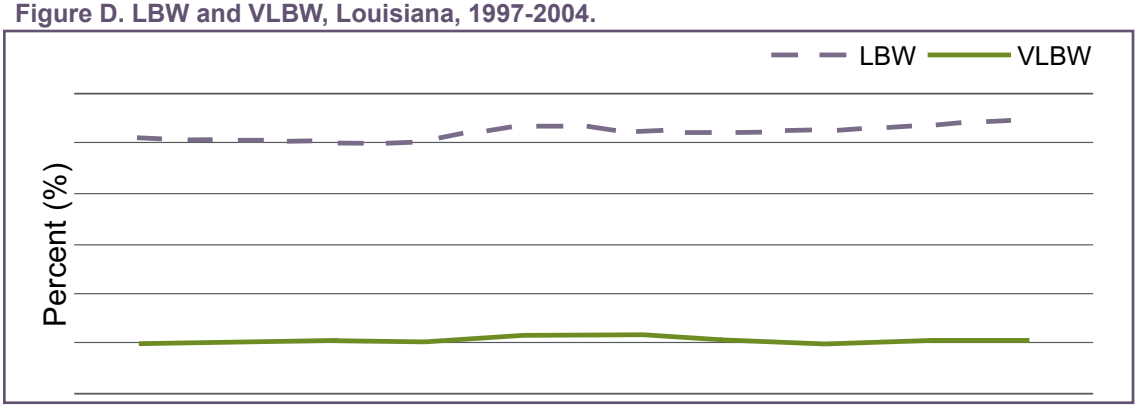
Birth Weight

In Louisiana, low birth weight (LBW, <2,500 grams) births have exceeded 10 percent of all live births since 1997, and reached nearly 11 percent in 2004 (Figure D). There is a wide racial disparity noted, with 8-9 percent of white birth LBW compared to 14-15 percent of African American births. As a major risk factor for infant death, LBW is of great importance to Louisiana efforts to improve birth outcomes.

Each year, about 50 percent of Louisiana infant deaths occur among those born very low birth weight (VLBW, <1,500 grams). The percent of VLBW births has remained stable at just above 2 percent of all live births from 1997 through 2004. The racial disparity seen among VLBW births indicates a stable two-fold increase for African Americans compared to whites (2004 VLBW: African American = 3.5 percent, white = 1.2 percent). This disparity among VLBW births is likely a major contributor to the racial disparity seen in Louisiana race-specific IMRs.

Case Study: Louisiana *continued*

Figure D. LBW and VLBW, Louisiana, 1997-2004.

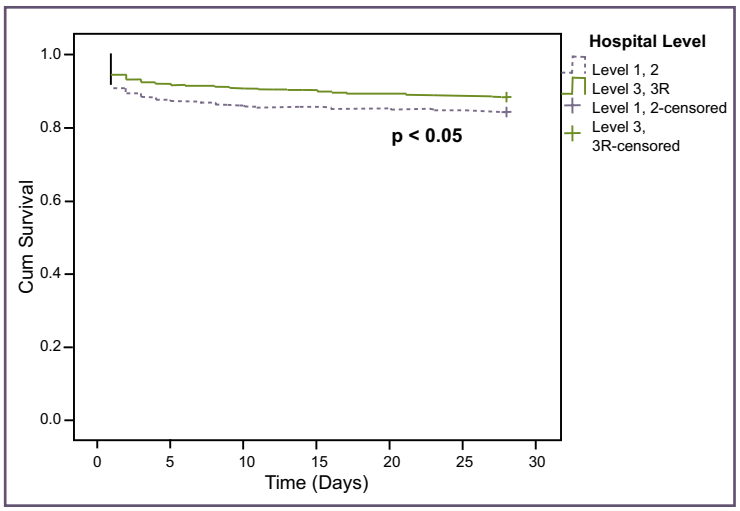


PRAMS data indicated that smoking during pregnancy, inadequate weight gain during pregnancy, lack of counseling during prenatal care and low income status were associated with LBW in Louisiana. A separate study, using the 1998-2002 Louisiana linked live birth-infant death files, examined variations in maternal and newborn characteristics with respect to infant deaths. Low education, unmarried status, preterm birth and LBW/VLBW births were significantly associated with increased infant mortality for both whites and African Americans.

Hospital level of neonatal care

The 1998-2002 infant mortality study also reported higher neonatal mortality in Level I and Level II hospitals (181.8 per 1,000) compared to Level III and Level III-Regional hospitals (111.5 per 1,000). Furthermore, 1997-2003 data indicated that the survival rate of VLBW infants up to 28 days old was 88.3 percent in Level III facilities compared to 84.4 percent in lower-level facilities ($p<0.0001$). From 2002 through 2004, Louisiana reported that 86-89 percent of VLBW infants were born in Level III or higher facilities, approaching the *Healthy People 2010* goal of 90 percent.

Figure E. Survival Time Distributions of VLBW Live Births in the Neonatal Period by Hospital Level, Louisiana, 1997-2003



Geographic Region

The nine public health regions in Louisiana offer additional opportunities to identify geographic areas with uniquely low or high IMRs (Figure F and Table C).

Figure F. Louisiana Public Health Regions

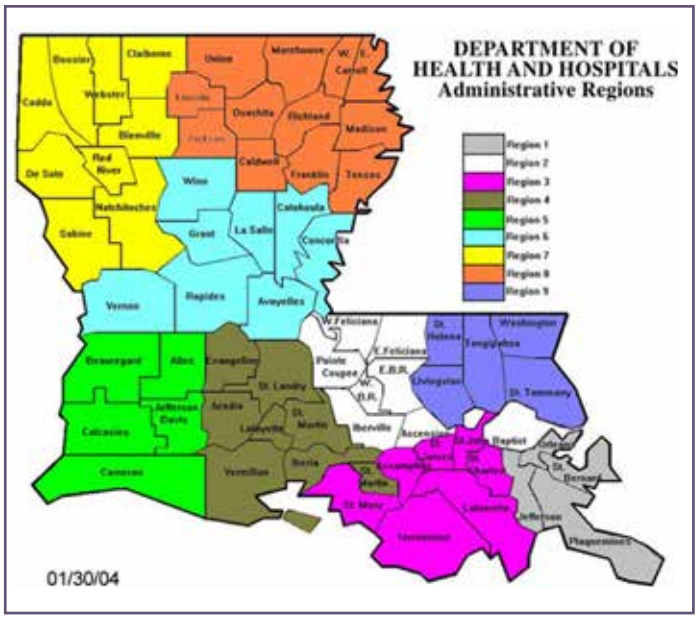


Table C. Region-Specific Infant Mortality Rates Overall and by Race, Louisiana, 2000-2004

OVERALL:

Region	2000	2001	2002	2003	2004
1 (New Orleans)	7.0	9.6	10.5	10.3	10.1
2 (Baton Rouge)	8.7	10.3	9.5	8.0	10.6
3 (Houma)	10.6	10.1	10.1	7.9	10.0
4 (Lafayette)	8.5	10.1	10.3	10.2	9.6
5 (Lake Charles)	8.9	9.7	9.8	7.1	7.1
6 (Alexandria)	9.3	9.9	9.8	8.6	11.3
7 (Shreveport)	11.7	11.2	12.7	9.9	12.0
8 (Monroe)	12.3	10.1	12.2	11.9	11.4
9 (Northshore)	5.9	7.5	6.8	8.3	11.2
Louisiana	**8.9**	**9.8**	**10.2**	**9.3**	**10.4**

WHITE:

Region	2000	2001	2002	2003	2004
1 (New Orleans)	3.4	5.1	7.4	6.1	8.1
2 (Baton Rouge)	5.8	7.3	5.3	4.7	7.6
3 (Houma)	8.7	8.3	5.8	6.9	7.2
4 (Lafayette)	5.0	6.4	5.6	9.1	7.2
5 (Lake Charles)	7.2	8.3	7.9	5.4	6.8
6 (Alexandria)	6.2	4.4	6.8	7.7	8.4
7 (Shreveport)	7.2	5.7	7.4	4.9	6.5
8 (Monroe)	9.2	7.5	11.1	5.4	8.7
9 (Northshore)	3.7	6.4	6.3	6.4	8.4
Louisiana	**5.9**	**6.5**	**6.9**	**6.4**	**7.7**

AFRICAN AMERICAN:

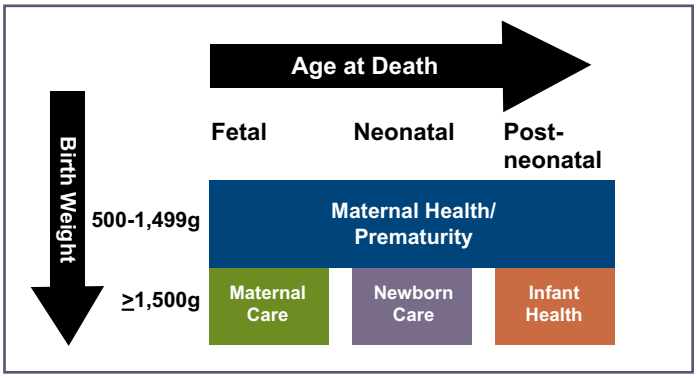
Region	2000	2001	2002	2003	2004
1 (New Orleans)	9.8	12.5	12.9	13.4	12.1
2 (Baton Rouge)	12.1	13.6	13.9	12.0	14.0
3 (Houma)	14.8	13.8	18.3	10.6	16.6
4 (Lafayette)	14.9	16.7	19.6	12.8	14.4
5 (Lake Charles)	14.1	14.1	15.8	11.6	8.7
6 (Alexandria)	16.0	20.3	15.9	11.1	17.5
7 (Shreveport)	16.8	17.8	19.0	16.1	18.7
8 (Monroe)	15.8	13.2	13.2	19.8	14.6
9 (Northshore)	13.6	11.8	7.3	15.8	21.0
Louisiana	**13.2**	**14.4**	**15.0**	**13.8**	**14.7**

Race-specific Louisiana state-level IMRs IMRs showed an African American:white rate ratio of 2.2 in 2000 compared to 1.9 in 2004, although the reduced racial disparity in 2004 actually reflected higher IMRs for both whites and African Americans compared to 2000. At the regional level, wide variations existed for both white and African American rates, although trends over time were more difficult to evaluate due to smaller numbers of events producing less stable rates at the regional level compared with the state.

Perinatal Periods of Risk

PPOR methodology was used to investigate feto-infant mortality according to birth weight and age at death simultaneously, as shown in the figure below.

Figure G. PPOR Data Map



Louisiana IMR was nearly the lowest it had ever been from 1997 through 1999, so this period was used as a baseline. Alternately, 2003-2004 was used to represent the consistently high rates recorded in the early 2000s.

In addition to calculating overall feto-infant mortality and rates for each respective PPOR cell, an internal comparison population representing the lowest infant mortality group in Louisiana (resident, white women at least 20 years old with at least 13 years of education) during each respective time period was used to calculate excess feto-infant mortality.

Feto-infant mortality remained highest in the maternal health and prematurity period, followed by the infant health period. Excess mortality followed the same relative rank as the rates. Both maternal health and prematurity and infant health indicated increased rates and higher excess in 2003-2004 compared to 1997-1999.

Figure H. PPOR Rates and Excess Mortality, Louisiana, 1997-1999

	Maternal Heath/ Prematurity	Maternal Care	Newborn Care	Infant Health	Feto-Infant Mortality
Louisiana	4.5	2.4	1.7	2.5	11.1
Reference	2.3	1.8	1.3	1.1	6.5
Excess	2.2	0.6	0.4	1.5	4.6

Figure I. PPOR Rates and Excess Mortality, Louisiana, 2003-2004

	Maternal Heath/ Prematurity	Maternal Care	Newborn Care	Infant Health	Feto-Infant Mortality
Louisiana	4.8	2.1	1.6	2.9	11.4
Reference	1.5	0.8	0.9	1.1	4.3
Excess	3.3	1.1	0.7	1.8	7.1

Case Study: Louisiana *continued*

PPOR recommends specific sets of possible interventions for each respective cell. For maternal health and prematurity, leading intervention recommendations include focusing on preconception health and family planning, pregnancy intention, and maternal risk factors. For infant health, recommendations include focusing on breastfeeding, injury prevention and medical homes.

Infant Mortality Prevention Programs

Prior to the SIM Collaborative, the Louisiana MCH program implemented a maternal weight gain campaign, a SIDS reduction program, and the Fetal and Infant Mortality Reduction Initiative (FIMRI). A major component of the FIMRI was the nine regional FIMR teams. Although initiated in 2003, it took nearly five years to have all nine regional FIMR teams active in Louisiana, thereby creating one of the first state-wide FIMR initiatives in the United States.

As these FIMR teams developed, substance-use screening and treatment, as well as family planning services, were two recommendations that emerged in multiple regions. In 2005, a Screening, Brief Intervention, Referral, and Treatment (SBIRT) program was implemented to address rates of alcohol, tobacco, and illicit drug use during pregnancy. Data were collected using the 4Ps Plus screening tool over a one year period (2006-2007) in Baton Rouge area private obstetrical provider offices and WIC clinics. WIC clinics reported that 31 percent of children born to WIC clients were exposed to alcohol, tobacco or illicit drugs. Positive screening rates among pregnant women were 17 percent for depression and 5.5 percent for domestic violence. The second implemented intervention (Take Charge) expanded Medicaid coverage for family planning services to 200 percent of the federal poverty level.

In addition, the hospital levels of care data were reviewed by the Louisiana Commission on Perinatal Care and Prevention of Infant Mortality. This commission championed a regulatory mandate published in the February 2007 register that required facilities offering Level III neonatal care to also offer Level III obstetrical care, thus aligning high-level services for women and children.

Finally, PPOR analyses are completed every three years and help guide program resources. Both maternal health/prematurity and infant health cells are closely monitored for changes in absolute rates and excess mortality.

As with all programs, evaluation components should be implemented and maintained to ensure appropriate and data-driven allocation of scarce resources. Additional information is available through the Louisiana Maternal and Child Health Program website (http://new.dhh.louisiana.gov/index.cfm/page/936) and the Partners for Healthy Babies website (www.1800251BABY.org).