America's Children and the Environment, Third Edition

DRAFT Indicators

Health: Adverse Birth Outcomes

EPA is preparing the third edition of *America's Children and the Environment* (ACE3), following the previous editions published in December 2000 and February 2003. ACE is EPA's compilation of children's environmental health indicators and related information, drawing on the best national data sources available for characterizing important aspects of the relationship between environmental contaminants and children's health. ACE includes four sections: Environments and Contaminants, Biomonitoring, Health, and Special Features.

EPA has prepared draft indicator documents for ACE3 representing 23 children's environmental health topics and presenting a total of 42 proposed children's environmental health indicators. This document presents the draft text, indicators, and documentation for the adverse birth outcomes topic in the Health section.

For more information on America's Children and the Environment, please visit www.epa.gov/ace. For instructions on how to submit comments on the draft ACE3 indicators, please visit www.epa.gov/ace/ace3drafts/.

Adverse Birth Outcomes

The period of gestation is a crucial determinant of an infant's health and survival for years to come. Two measures that may be used to understand the quality of an infant's gestation are the length of gestation (pregnancy length) and birth weight. Normal term pregnancies last between 37 and 41 completed weeks, allowing for more complete development of an infant's organs and systems.[1] An infant is considered preterm if he or she is born before 37 completed weeks of gestation.[1] Birth weight is a composite determined by two factors: length of gestation and fetal growth (the rate at which an infant develops and increases in size). Infants may be born with a low birth weight simply because they were born prematurely, or they may be smaller than expected given their gestational age. Low birth weight is considered as less than 2,500 grams (about 5 pounds, 8 ounces).[2] Because birth weight alone does not always indicate whether an infant's fetal growth has been restricted, other measurements such as birth length, head circumference, and abdominal circumference are also used.

Other adverse birth outcomes that are not discussed here include high birth weight, neonatal mortality, and birth defects, a specific group of adverse birth outcomes that include structural and functional abnormalities.

Preterm and low birth weight infants are at greater risk for mortality and a variety of health and developmental problems. Conditions related to preterm birth and low birth weight are the second leading cause of infant death in the United States (after birth defects).[3] The infant mortality rate for low birth weight infants is about 25 times that of the infant mortality rate for normal weight babies. Likewise, the infant mortality rate for late preterm babies (34–36 weeks of gestation) is about three times the infant mortality rate for term babies, and the infant mortality rate for very preterm babies (less than 32 weeks of gestation) is 75 times that of term babies.[3] Low birth weight infants are more likely to have underdeveloped lungs and breathing problems; heart problems (which can lead to heart failure); immature and improperly functioning livers; too many or too few red blood cells (polycythemia or anemia); inadequate body fat, leading to trouble maintaining a normal body temperature; feeding problems; and increased risk of infection.[2] Preterm infants may experience complications such as acute respiratory, gastrointestinal, immunologic, and central nervous system problems. Longer-term motor, cognitive, visual, hearing, behavioral, social-emotional, health, and growth problems may not become apparent for years, and may persist throughout a child's life. The birth of a preterm or low birth weight infant can have significant emotional and economic effects on the infant's family.[4]

For many years, the prevalence of both preterm birth and low birth weight have been increasing;[5] however, starting in 2006 this pattern seems to be partially reversing as the rate of preterm birth is now declining. A number of factors may be contributing to the increases, including increases in maternal age, rates of multiple births (e.g., twins, triplets), use of early Cesarean sections and labor inductions, and use of assisted reproductive technologies (e.g., in vitro fertilization).[4] The rates of multiple births have increased in recent decades. The rate of twin births increased 70% from 1980–2004, but has been essentially stable since that time. The rate of triplet and higher

order births increased 400% from 1980 to 1998, but since that time has been trending downward.[6] Multiple births run a higher risk of preterm birth and low birth weight. Other factors linked to preterm birth and low birth weight include fetal birth defects; chronic maternal health problems (e.g., high blood pressure); maternal use of tobacco, alcohol, and illicit drugs; maternal and fetal infections; placental problems; inadequate maternal weight gain; and socioeconomic factors (e.g., low income and poor education).[7-11]

Rates of low birth weight and preterm birth can vary greatly by maternal race/ethnicity. Black women have consistently had higher rates of preterm and low birth weight babies.[12] While it has been suggested that race is a proxy for differences in socioeconomic status (SES), most studies that have controlled for differences in SES continue to find persistent birth outcomes differences between Black and White women.[12-15] Similarly, studies that have adjusted for other risk factors, such as risky behavior during pregnancy and use of prenatal care, have found these persistent Black-White differences in birth outcomes as well.[3,16,17]

While much of the increasing frequency of preterm birth and low birth weight might be explained by changing maternal characteristics and obstetric practices, other factors—including environmental contaminants—may also play a role in the increasing rates.[18] A growing number of studies have examined the possible role that exposure to environmental contaminants may play in the causation of preterm birth and low birth weight. The evidence is particularly strong for environmental tobacco smoke (ETS) and lead. The U.S. Surgeon General has concluded that the evidence is sufficient to infer a causal relationship between maternal exposure to ETS and reductions in birth weight, and is suggestive of a causal relationship between exposure to ETS and preterm delivery.[19] The Institute of Medicine has that concluded there is sufficient evidence to suggest that maternal exposure to lead results in an increased risk of preterm birth.[4]

The link between common air pollutants and adverse birth outcomes has received more attention in recent years. Particulate matter (PM), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO) exposure have all been linked to decreased fetal growth, low birth weight, and preterm birth in a number of large epidemiological studies (many with 10,000+ participants) in many different countries.[20-34] In such studies, researchers make an effort, when data are available, to adjust for other factors that may also lead to an increased risk of low birth weight or preterm birth, such as mother's age, smoking status, race, and income.[35] Other studies have linked proximity to traffic density during pregnancy to increased risk of preterm birth and low birth weight, although an extensive review study concluded that there is inadequate and insufficient evidence to infer a causal relationship.[36-41]

In addition to air pollutants, several other environmental chemicals are suspected contributors to adverse birth outcomes. There is limited, yet growing evidence that prenatal exposure to phthalates may lead to adverse birth outcomes. A handful of studies find associations between prenatal exposure to some phthalates and preterm birth, shorter gestational length, and low birth weight.[42-45] A limited number of studies suggest that prenatal exposure to another class of chemicals, polychlorinated biphenyls (PCBs), may lead to preterm birth and low birth weight or otherwise restrict fetal growth.[46-49] One study examining women from the Danish National Birth Cohort found that exposure to PCBs from fatty fish consumption was associated with lower birth weight. The study found that infants born to highly exposed women weighed, on average, about

5.5 ounces less than infants born to women with relatively low PCB exposure.[50] Another study looked at a historical cohort of women who were pregnant prior to the 1979 ban of PCBs, and failed to see any relation between PCB exposure and low birth weight or shorter pregnancy length.[51] A growing number of human health studies have found associations between prenatal exposure to perfluorinated compounds (PFCs)—particularly PFOS and PFOA—and a range of adverse birth outcomes, such as low birth weight, decreased head circumference, reduced birth length, and smaller abdominal circumference, although the results of such studies are mixed.[52-56] Studies of disinfection byproducts in drinking water as possible causes of adverse birth outcomes are also conflicting, with recent evidence indicating that there may be no effect on preterm birth.[57-59] Studies of arsenic in drinking water and birth outcomes have produced similarly mixed results.[60-62] For the following environmental contaminants, there is some evidence from animal studies and a limited number of studies in humans of possible associations with adverse birth outcomes, particularly reduced fetal growth: benzene,[63] herbicides,[64] bisphenol A (BPA),[65] dioxins and dioxin-like chemicals,[66] and manganese.[67]

This section presents two indicators of adverse birth outcomes: Indicator Birth1 presents the rate of preterm birth, and Indicator Birth2 presents the rate of term low birth weight. These two indicators were chosen because for each there is a wealth of quality data available.

Indicator Birth1: Percentage of babies born preterm, by race/ethnicity, 1993–2007

Indicator Birth2: Percentage of babies born at term with low birth weight, by race/ethnicity, 1993–2007

Overview

Indicator Birth1 shows the percentage of babies born preterm and Indicator Birth2 shows the percentage of babies who are born at term with low birth weight. Both graphs show separate lines for the different race/ethnicity groups. The data come from a national data system that collects data from birth certificates for virtually every baby born in the United States. Indicators Birth1 and Birth2 show the change in preterm and term low birth weight over time.

The National Vital Statistics System

The data for these indicators of preterm birth and low birth weight come from the National Vital Statistics System (NVSS), operated by the Centers for Disease Control and Prevention (CDC). The NVSS data are provided through contracts between the CDC and vital registration systems operated in each state, which are legally responsible for the registration of vital events including births, deaths, marriages, divorces, and fetal deaths. The collection and publication of this information is mandated by federal law. Together the CDC and the states have developed standard forms and procedures to use for the data collection. The NVSS captures virtually all of the births occurring in the United States.

Birth certificates provide information on characteristics of both the infant and his/her parents, including the weight of the infant and the length of gestation. Length of gestation is recorded in completed weeks, so for example a pregnancy of 36 weeks and 6 days would be recorded as 36 weeks, and would therefore be considered preterm.[4] Pregnancy duration is most often estimated from the date of a woman's last menstrual period. Many factors, including age, levels of physical activity, and body mass, can cause variation in menstrual cycle timing, making this method of estimating gestational length subject to some error.[4]

Data Presented in the Indicators

Indicator Birth1 displays the trend in the percentage of preterm births for all births (singletons, as well as multiples), with a separate line for each maternal race/ethnicity group and a single line for all maternal races and ethnicities combined for the years 1993–2007.

Indicator Birth2 displays the trend in the percentage of low birth weight births at term among all births (singletons, as well as multiples), with a separate line for each maternal race/ethnicity group and a single line for all maternal races and ethnicities combined for the years 1993–2007. By highlighting the trend for only term births (babies with a gestational age of 37 completed

weeks or more), the attempt is to focus on babies who are truly small and to exclude babies whose low birth weight is simply a result of being born prematurely. Therefore, this indicator understates the total number of infants with low birth weight. Another effect of this choice is that the indicator will miss preterm babies who would still be of low birth weight even if they had been carried to term.

Five maternal race/ethnicity groups are presented in these indicators: White non-Hispanic, Black non-Hispanic, Hispanic, American Indian/Alaska Native non-Hispanic, and Asian Pacific Islander non-Hispanic. Prior to the year 1993, not all states recorded Hispanic origin on birth certificates; for this reason, both Indicator Birth1 and Birth2 begin with data from the year 1993. Birth certificates do not include information on family or maternal income; therefore it is not possible to examine differences or trends by income level.

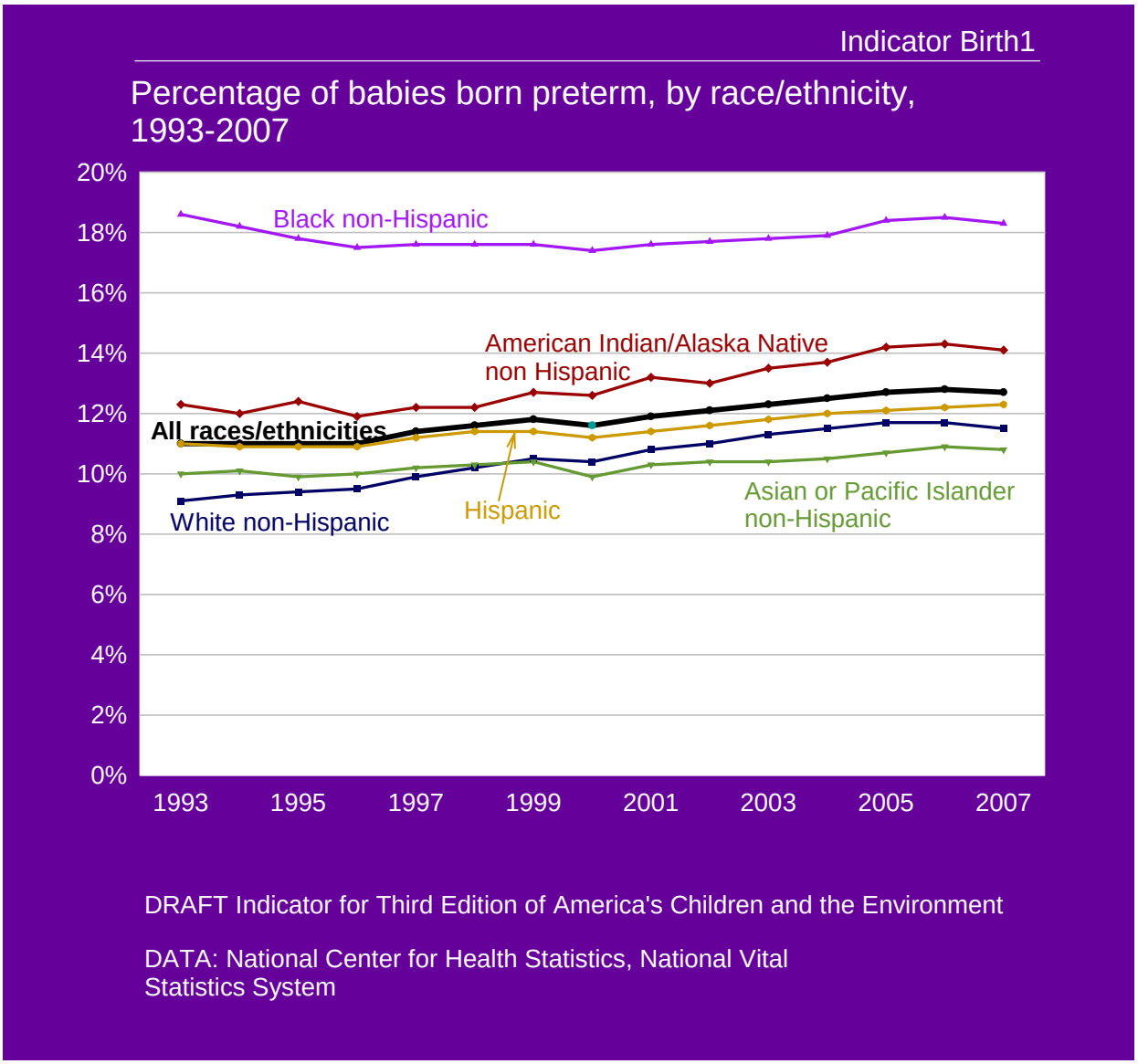
The indicator graphs show data for all births, singletons and multiples combined. The rates for singletons and multiples are provided in supplemental data tables. Additional supplemental tables highlight differences in rates of preterm birth and term low birth weight by age of the mother.

Statistical Testing

Statistical analysis has been applied to the indicators to determine whether any changes in prevalence over time, or any differences in prevalence between demographic groups, are statistically significant. These analyses use a 5% significance level ($p \leq 0.05$), meaning that a conclusion of statistical significance is made only when there is no more than a 5% chance that the observed change over time or difference between demographic groups occurred randomly. It should be noted that when statistical testing is conducted for differences among multiple demographic groups (e.g., considering both race/ethnicity and age), the large number of comparisons involved increases the probability that some differences identified as statistically significant may actually have occurred randomly.

A finding of statistical significance for a health indicator depends not only on the numerical difference in the value of a reported statistic between two groups, but also on the number of observations in the survey and various aspects of the survey design. For example, if the prevalence of a health effect is different between two groups, the statistical test is more likely to detect a difference when data have been obtained from a larger number of people in those groups. A finding that there is or is not a statistically significant difference in prevalence between two groups or in prevalence over time is not the only information that should be considered when determining the public health implications of those differences.

The NVSS records virtually all births in the United States—approximately 4 million per year. Because of this very large sample size, differences in birth outcomes that appear to be small in magnitude may be found to be statistically significant. Extensive research has been conducted with NVSS data to assess the presence of statistically significant trends and demographic differences, including analyses with much more detail than the one conducted here.[18,68,69]



- Between 1993 and 2007, the rate of preterm birth rose from 11.0% of births in 1993 to 12.7% of births in 2007. This increase was statistically significant.

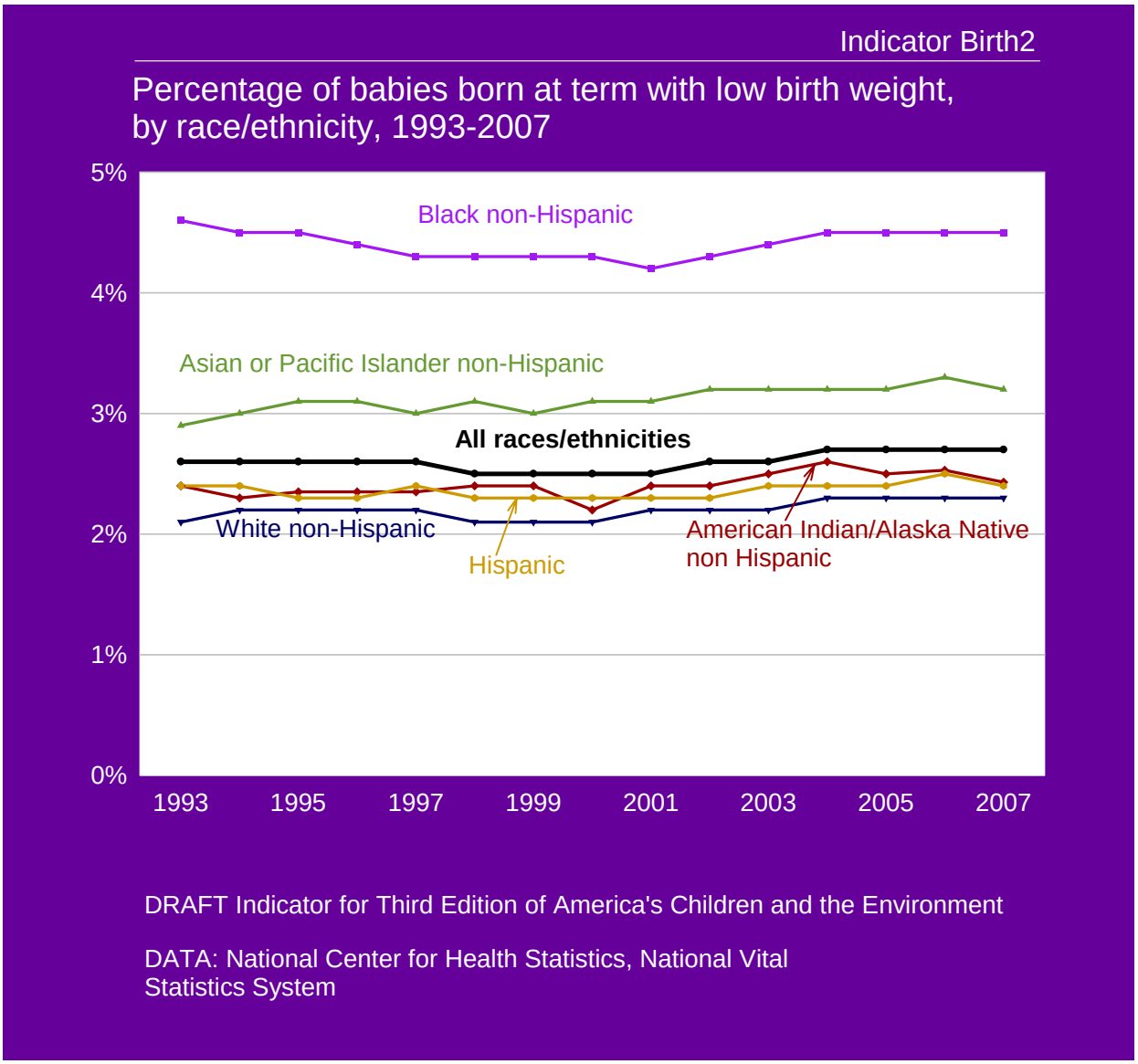
- In 2007, Black non-Hispanic women had the highest rate of preterm birth, compared with women of other races/ethnicities. Almost 1 in 5 infants born to Black non-Hispanic women were born prematurely in that year.
    - Statistical note: The rate of preterm birth for Black non-Hispanic women was statistically significantly higher than for all other race/ethnicity groups.

- The preterm birth rate rose for each race/ethnicity group. The preterm birth rate for Black non-Hispanic women fell slightly between 1993 and 2000, and after that began to rise back to 1993 levels.

  - Statistical note: The increases in the rate of preterm birth for each race/ethnicity group were statistically significant. For Black non-Hispanic women, the decrease from 1993 to 2000 and the increase from 2000 to 2007 were both statistically significant.

- Preterm birth rate trends vary depending on the age of the mother. Women ages 20 to 39 years have the lowest rate of preterm birth, compared with women under 20 years and women 40 years and older. Each age group experienced an increase in the rate of preterm birth between 1993 and 2007; however, the increase for women under 20 years was comparatively smaller. (See Table Birth1a.)
  - Statistical note: The differences between the preterm birth rates for the different age groups are statistically significant. The increases in the rate of preterm birth for all age groups were statistically significant as well.

- Twins, triplets, and other higher-order multiple birth babies are more than 5 times as likely to be born preterm compared to singleton babies (61.6% vs. 11.0% in 2007). The rates for both singletons and multiples have increased from 1993 to 2007. (See Table Birth1b)
  - Statistical note: The increases for both singleton and multiple births are statistically significant.



- Between 1993 and 2007, the rate of term low birth weight stayed relatively constant between 2.5% and 2.7%. The rates of term low birth weight for each race/ethnicity group have also stayed relatively constant over the period of 1993–2007.

- The rate of term low birth weight varies by race/ethnicity. The rate is highest for infants born to Black non-Hispanic mothers and lowest for infants born to White non-Hispanic mothers.
    - Statistical note: The rate of term low birth weight for Black non-Hispanic women was statistically significantly higher than for all other race/ethnicity groups. The rate of term low birth weight for White non-Hispanic women was statistically significantly lower than for all other race/ethnicity groups except for American Indian/Alaska Native non-Hispanic women.

- Term low birth weight rates vary by the age of the mother. Women ages 20 to 39 years have the lowest rate of term low birth weight infants, while women under 20 years have the highest rate of term low birth weight infants. (See Table Birth2a.) These differences are statistically significant.

- The rate of term low birth weight increased for women of all age groups: under 20, 20–39, and 40 and older. Women 40 years and older experienced the largest increase in the rate of term low birth weight, increasing from 2.9% in 1993 to 3.3% in 2007. These increases were statistically significant (See Table Birth2a.)

- Twins, triplets, and other higher-order multiple birth babies are more than 5 times as likely to be born at term with low birth rate compared with singleton babies (12.3% vs. 2.4% in 2007). The rate of term low birth weight for singleton babies has increased slightly over the period of 1993–2007, while the rate of term low birth weight for multiples has decreased over the same time period. (See Table Birth2b)
    - Statistical note: Both the increase in the rate of term low birth weight for singleton babies and the decrease in the rate for multiple babies are statistically significant.

Data Tables

Table Birth1: Percentage of babies born preterm, by race/ethnicity, 1993-2007

1993-2000								
	1993	1994	1995	1996	1997	1998	1999	2000
All races/ethnicities	11.0%	11.0%	11.0%	11.0%	11.4%	11.6%	11.8%	11.6%
White non-Hispanic	9.1%	9.3%	9.4%	9.5%	9.9%	10.2%	10.5%	10.4%
Black or African-American non-Hispanic	18.6%	18.2%	17.8%	17.5%	17.6%	17.6%	17.6%	17.4%
Asian or Pacific Islander non-Hispanic	10.0%	10.1%	9.9%	10.0%	10.2%	10.3%	10.4%	9.9%
American Indian or Alaska Native non-Hispanic	12.3%	12.0%	12.4%	11.9%	12.2%	12.2%	12.7%	12.6%
Hispanic	11.0%	10.9%	10.9%	10.9%	11.2%	11.4%	11.4%	11.2%
Mexican	10.6%	10.6%	10.6%	10.5%	10.8%	11.0%	11.1%	11.0%
Puerto Rican	13.3%	13.4%	13.4%	13.2%	13.7%	13.9%	13.7%	13.5%
Unknown ethnicity	10.1%	11.0%	10.5%	9.8%	10.7%	10.5%	10.5%	10.8%
2001-2007								
	2001	2002	2003	2004	2005	2006	2007	
All races/ethnicities	11.9%	12.1%	12.3%	12.5%	12.7%	12.8%	12.7%	
White non-Hispanic	10.8%	11.0%	11.3%	11.5%	11.7%	11.7%	11.5%	
Black or African-American non-Hispanic	17.6%	17.7%	17.8%	17.9%	18.4%	18.5%	18.3%	
Asian or Pacific Islander non-Hispanic	10.3%	10.4%	10.4%	10.5%	10.7%	10.9%	10.8%	
American Indian or Alaska Native non-Hispanic	13.2%	13.0%	13.5%	13.7%	14.2%	14.3%	14.1%	
Hispanic	11.4%	11.6%	11.8%	12.0%	12.1%	12.2%	12.3%	
Mexican	11.2%	11.4%	11.7%	11.8%	11.8%	11.8%	11.9%	
Puerto Rican	13.7%	14.0%	13.8%	14.0%	14.3%	14.4%	14.5%	
Unknown ethnicity	11.3%	11.2%	12.8%	12.8%	13.2%	13.1%	13.6%	

DATA: National Center for Health Statistics, National Vital Statistics System

Table Birth1a. Percentage of babies born preterm, by mother's age, 1993-2007

1993-2000								
	1993	1994	1995	1996	1997	1998	1999	2000
< 20 years	14.3%	14.2%	13.8%	13.6%	13.8%	14.0%	14.1%	13.9%
20-39 years	10.4%	10.5%	10.5%	10.5%	10.9%	11.2%	11.3%	11.2%
40+ years	13.2%	13.7%	13.7%	13.8%	14.4%	14.9%	15.2%	15.1%
2001-2007								
	2001	2002	2003	2004	2005	2006	2007	
< 20 years	14.1%	14.0%	14.3%	14.5%	14.7%	14.8%	14.6%	
20-39 years	11.6%	11.7%	12.0%	12.1%	12.4%	12.4%	12.3%	
40+ years	15.6%	16.0%	16.3%	16.6%	16.8%	17.0%	17.2%	

DATA: National Center for Health Statistics, National Vital Statistics System

Table Birth1b. Percentage of babies born preterm, by all births, singletons, and multiples, 1993-2007

1993-2000								
	1993	1994	1995	1996	1997	1998	1999	2000
All births	11.0%	11.0%	11.0%	11.0%	11.4%	11.6%	11.8%	11.6%
Singletons	9.9%	9.9%	9.8%	9.7%	10.0%	10.1%	10.3%	10.1%
Multiples	53.1%	54.0%	54.6%	55.6%	57.3%	58.4%	59.4%	58.7%
2001-2007								
	2001	2002	2003	2004	2005	2006	2007	
All births	11.9%	12.1%	12.3%	12.5%	12.7%	12.8%	12.7%	
Singletons	10.4%	10.4%	10.6%	10.8%	11.0%	11.1%	11.0%	
Multiples	59.4%	60.1%	61.2%	61.4%	62.1%	61.9%	61.6%	

DATA: National Center for Health Statistics, National Vital Statistics System

Table Birth2: Percentage of babies born at term with low birth weight, by race/ethnicity, 1993-2007

1993-2000								
	1993	1994	1995	1996	1997	1998	1999	2000
All races/ethnicities	2.6%	2.6%	2.6%	2.6%	2.6%	2.5%	2.5%	2.5%
White non-Hispanic	2.1%	2.2%	2.2%	2.2%	2.2%	2.1%	2.1%	2.1%
Black or African-American non-Hispanic	4.6%	4.5%	4.5%	4.4%	4.3%	4.3%	4.3%	4.3%
Asian or Pacific Islander non-Hispanic	2.9%	3.0%	3.1%	3.1%	3.0%	3.1%	3.0%	3.1%

1993-2000								
American Indian or Alaska Native non-Hispanic	2.4%	2.3%	2.3%	2.3%	2.3%	2.4%	2.4%	2.2%
Hispanic	2.4%	2.4%	2.3%	2.3%	2.4%	2.3%	2.3%	2.3%
Mexican	2.3%	2.2%	2.2%	2.2%	2.2%	2.2%	2.1%	2.2%
Puerto Rican	3.4%	3.2%	3.3%	3.3%	3.3%	3.4%	3.1%	3.2%
Unknown ethnicity	2.5%	2.6%	2.4%	2.4%	2.4%	2.2%	2.5%	2.2%
2001-2007								
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	
All races/ethnicities	2.5%	2.6%	2.6%	2.7%	2.7%	2.7%	2.7%	
White non-Hispanic	2.2%	2.2%	2.2%	2.3%	2.3%	2.3%	2.3%	
Black or African-American non-Hispanic	4.2%	4.3%	4.4%	4.5%	4.5%	4.5%	4.5%	
Asian or Pacific Islander non-Hispanic	3.1%	3.2%	3.2%	3.2%	3.2%	3.3%	3.2%	
American Indian or Alaska Native non-Hispanic	2.4%	2.4%	2.5%	2.6%	2.5%	2.5%	2.4%	
Hispanic	2.3%	2.3%	2.4%	2.4%	2.4%	2.5%	2.4%	
Mexican	2.2%	2.2%	2.2%	2.3%	2.3%	2.4%	2.2%	
Puerto Rican	3.2%	3.2%	3.4%	3.2%	3.3%	3.4%	3.4%	
Unknown ethnicity	2.2%	2.3%	2.5%	2.6%	2.3%	2.8%	2.9%	

DATA: National Center for Health Statistics, National Vital Statistics System

Table Birth2a. Percentage of babies born at term with low birth weight, by mother's age, 1993-2007

1993-2000								
	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
< 20 years	3.4%	3.5%	3.5%	3.6%	3.6%	3.5%	3.5%	3.5%
20-39 years	2.5%	2.5%	2.4%	2.5%	2.4%	2.4%	2.4%	2.4%
40+ years	2.9%	3.1%	3.1%	3.1%	3.1%	3.0%	3.1%	3.2%
2001-2007								
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	
< 20 years	3.5%	3.5%	3.6%	3.7%	3.7%	3.7%	3.6%	
20-39 years	2.4%	2.4%	2.5%	2.5%	2.5%	2.6%	2.6%	
40+ years	3.2%	3.2%	3.2%	3.4%	3.4%	3.4%	3.3%	

DATA: National Center for Health Statistics, National Vital Statistics System

Table Birth2b. Percentage of babies born at term with low birth weight, by all births, singletons, and multiples, 1993-2007

1993-2000								
	1993	1994	1995	1996	1997	1998	1999	2000
All births	2.6%	2.6%	2.6%	2.6%	2.6%	2.5%	2.5%	2.5%
Singletons	2.3%	2.3%	2.3%	2.3%	2.3%	2.2%	2.2%	2.2%
Multiples	13.4%	13.0%	13.1%	13.0%	12.3%	12.1%	11.9%	12.0%
2001-2007								
	2001	2002	2003	2004	2005	2006	2007	
All births	2.5%	2.6%	2.6%	2.7%	2.7%	2.7%	2.7%	
Singletons	2.2%	2.3%	2.3%	2.3%	2.3%	2.4%	2.4%	
Multiples	12.2%	12.1%	12.0%	12.0%	12.0%	12.3%	12.3%	

DATA: National Center for Health Statistics, National Vital Statistics System

References

1. Centers for Disease Control and Prevention. 2009. *Maternal and Infant Health Research: Preterm Birth*. CDC. Retrieved October 10, 2010 from http://www.cdc.gov/reproductivehealth/maternalinfanthealth/PBP.htm.

2. JAMA. 2002. JAMA patient page: Low birth weight. *Journal of the American Medical Association* 287 (2):270.

3. Mathews, T.J., and M.F. MacDorman. 2008. Infant mortality statistics from the 2005 period linked birth/infant death data set. *National Vital Statistics Reports* 57 (2).

4. Institute of Medicine. 2007. *Preterm Birth: Causes, Consequences, and Prevention*. Edited by R. E. Behrman and A. S. Butler. Washington, DC: The National Academies Press.

5. Martin, J.A., B.E. Hamilton, P.D. Sutton, S.J. Ventura, P.H. Menacker, S. Kirmeyer, and T.J. Mathews. 2009. Births: Final Data for 2006. *National Vital Statistics Reports* 57 (7).

6. Martin, J.A., B.E. Hamilton, P.D. Sutton, S.J. Ventura, T.J. Mathews, S. Kirmeyer, and M.J.K. Osterman. 2010. Births: Final Data for 2007. *National Vital Statistics Reports* 58 (24).

7. American College of Obstetricians and Gynecologists (ACOG). 2000. Intrauterine growth restriction. ACOG practice bulletin, number 12. *Obstetrics and Gynecology* 95 (1).

8. Berghella, V. 2007. Prevention of recurrent fetal growth restriction. *Obstetrics and Gynecology* 110 (4):904-12.

9. Honein, M.A., R.S. Kirby, R.E. Meyer, J. Xing, N.I. Skerrette, N. Yuskiv, L. Marengo, J.R. Petrini, M.J. Davidoff, C.T. Mai, C.M. Druschel, S. Viner-Brown, and L.E. Sever. 2009. The association between major birth defects and preterm birth. *Maternal and Child Health Journal* 13 (2):164-75.

10. U.S. Department of Health and Human Services. 2004. *The Health Consequences of Smoking: A Report of the Surgeon General*. Atlanta, GA: Centers for Disease Control and Prevention, Office on Smoking and Health.

11. Goldenberg, R.L., and J.F. Culhane. 2007. Low birth weight in the United States. *American Journal of Clinical Nutrition* 85 (2):584S-590S.

12. Lu, M.C., and N. Halfon. 2003. Racial and ethnic disparities in birth outcomes: a life-course perspective. *Maternal and Child Health Journal* 7 (1):13-30.

13. Collins, J.W., Jr., and A.G. Butler. 1997. Racial differences in the prevalence of small-for-dates infants among college-educated women. *Epidemiology* 8 (3):315-7.

14. McGrady, G.A., J.F. Sung, D.L. Rowley, and C.J. Hogue. 1992. Preterm delivery and low birth weight among first-born infants of black and white college graduates. *American Journal of Epidemiology* 136 (3):266-76.

15. Schoendorf, K.C., C.J. Hogue, J.C. Kleinman, and D. Rowley. 1992. Mortality among infants of black as compared with white college-educated parents. *New England Journal of Medicine* 326 (23):1522-6.

16. Goldenberg, R.L., S.P. Cliver, F.X. Mulvihill, C.A. Hickey, H.J. Hoffman, L.V. Klerman, and M.J. Johnson. 1996. Medical, psychosocial, and behavioral risk factors do not explain the increased risk for low birth weight among black women. *American Journal of Obstetrics & Gynecology* 175 (5):1317-24.

17. Singh, G.K., and S.M. Yu. 1995. Infant mortality in the United States: trends, differentials, and projections, 1950 through 2010. *American Journal of Public Health* 85 (7):957-64.

18. Donahue, S.M., K.P. Kleinman, M.W. Gillman, and E. Oken. 2010. Trends in birth weight and gestational length among singleton term births in the United States: 1990-2005. *Obstetrics and Gynecology* 115 (2 Pt 1):357-64.

19. U.S. Department of Health and Human Services. 2006. *The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

20. Bobak, M. 2000. Outdoor air pollution, low birth weight, and prematurity. *Environmental Health Perspectives* 108 (2):173-6.

21. Dugandzic, R., L. Dodds, D. Stieb, and M. Smith-Doiron. 2006. The association between low level exposures to ambient air pollution and term low birth weight: a retrospective cohort study. *Environmental Health* 5:3.

22. Ha, E.H., Y.C. Hong, B.E. Lee, B.H. Woo, J. Schwartz, and D.C. Christiani. 2001. Is air pollution a risk factor for low birth weight in Seoul? *Epidemiology* 12 (6):643-8.

23. Huynh, M., T.J. Woodruff, J.D. Parker, and K.C. Schoendorf. 2006. Relationships between air pollution and preterm birth in California. *Paediatric and Perinatal Epidemiology* 20 (6):454-61.

24. Lin, C.M., C.Y. Li, G.Y. Yang, and I.F. Mao. 2004. Association between maternal exposure to elevated ambient sulfur dioxide during pregnancy and term low birth weight. *Environmental Research* 96 (1):41-50.

25. Liu, S., D. Krewski, Y. Shi, Y. Chen, and R.T. Burnett. 2003. Association between gaseous ambient air pollutants and adverse pregnancy outcomes in Vancouver, Canada. *Environmental Health Perspectives* 111 (14):1773-8.

26. Maisonet, M., T.J. Bush, A. Correa, and J.J. Jaakkola. 2001. Relation between ambient air pollution and low birth weight in the Northeastern United States. *Environmental Health Perspectives* 109 (Suppl 3):351-6.

27. Maroziene, L., and R. Grazuleviciene. 2002. Maternal exposure to low-level air pollution and pregnancy outcomes: a population-based study. *Environmental Health* 1 (1):6.

28. Parker, J.D., T.J. Woodruff, R. Basu, and K.C. Schoendorf. 2005. Air pollution and birth weight among term infants in California. *Pediatrics* 115 (1):121-8.

29. Sagiv, S.K., P. Mendola, D. Loomis, A.H. Herring, L.M. Neas, D.A. Savitz, and C. Poole. 2005. A time-series analysis of air pollution and preterm birth in Pennsylvania, 1997-2001. *Environmental Health Perspectives* 113 (5):602-6.

30. U.S. Environmental Protection Agency. 2009. *Integrated Science Assessment for Particulate Matter (Final Report)*. Washington, DC: U.S. EPA. EPA/600/R-08/139F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546.

31. Wang, X., H. Ding, L. Ryan, and X. Xu. 1997. Association between air pollution and low birth weight: a community-based study. *Environmental Health Perspectives* 105 (5):514-20.

32. Wilhelm, M., and B. Ritz. 2005. Local variations in CO and particulate air pollution and adverse birth outcomes in Los Angeles County, California, USA. *Environmental Health Perspectives* 113 (9):1212-21.

33. Xu, X., H. Ding, and X. Wang. 1995. Acute effects of total suspended particles and sulfur dioxides on preterm delivery: a community-based cohort study. *Archives of Environmental Health* 50 (6):407-15.

34. Liu, S., D. Krewski, Y. Shi, Y. Chen, and R.T. Burnett. 2007. Association between maternal exposure to ambient air pollutants during pregnancy and fetal growth restriction. *Journal of Exposure Science and Environmental Epidemiology* 17 (5):426-32.

35. Stillerman, K.P., D.R. Mattison, L.C. Giudice, and T.J. Woodruff. 2008. Environmental exposures and adverse pregnancy outcomes: a review of the science. *Reproductive Sciences* 15 (7):631-50.

36. Brauer, M., C. Lencar, L. Tamburic, M. Koehoorn, P. Demers, and C. Karr. 2008. A cohort study of traffic-related air pollution impacts on birth outcomes. *Environmental Health Perspectives* 116 (5):680-6.

37. Genereux, M., N. Auger, M. Goneau, and M. Daniel. 2008. Neighbourhood socioeconomic status, maternal education and adverse birth outcomes among mothers living near highways. *Journal of Epidemiology and Community Health* 62 (8):695-700.

38. Health Effects Institute. 2010. *HEI Panel on the Health Effects of Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects*. Boston, MA. HEI Special Report 17. http://pubs.healtheffects.org/view.php?id=334

39. Ponce, N.A., K.J. Hoggatt, M. Wilhelm, and B. Ritz. 2005. Preterm birth: the interaction of traffic-related air pollution with economic hardship in Los Angeles neighborhoods. *American Journal of Epidemiology* 162 (2):140-8.

40. Slama, R., V. Morgenstern, J. Cyrys, A. Zutavern, O. Herbarth, H.E. Wichmann, and J. Heinrich. 2007. Traffic-related atmospheric pollutants levels during pregnancy and offspring's term birth weight: a study relying on a land-use regression exposure model. *Environmental Health Perspectives* 115 (9):1283-92.

41. Wilhelm, M., and B. Ritz. 2003. Residential proximity to traffic and adverse birth outcomes in Los Angeles county, California, 1994-1996. *Environmental Health Perspectives* 111 (2):207-16.

42. Meeker, J.D., H. Hu, D.E. Cantonwine, H. Lamadrid-Figueroa, A.M. Calafat, A.S. Ettinger, M. Hernandez-Avila, R. Loch-Caruso, and M.M. Tellez-Rojo. 2009. Urinary phthalate metabolites in relation to preterm birth in Mexico City. *Environmental Health Perspectives* 117 (10):1587-92.

43. Zhang, Y., L. Lin, Y. Cao, B. Chen, L. Zheng, and R.S. Ge. 2009. Phthalate levels and low birth weight: a nested case-control study of Chinese newborns. *Journal of Pediatrics* 155 (4):500-4.

44. Latini, G., C. De Felice, G. Presta, A. Del Vecchio, I. Paris, F. Ruggieri, and P. Mazzeo. 2003. In utero exposure to di-(2-ethylhexyl)phthalate and duration of human pregnancy. *Environmental Health Perspectives* 111 (14):1783-5.

45. Whyatt, R.M., J.J. Adibi, A.M. Calafat, D.E. Camann, V. Rauh, H.K. Bhat, F.P. Perera, H. Andrews, A.C. Just, L. Hoepner, D. Tang, and R. Hauser. 2009. Prenatal di(2-ethylhexyl)phthalate exposure and length of gestation among an inner-city cohort. *Pediatrics* 124 (6):e1213-20.

46. Murphy, L.E., A.L. Gollenberg, G.M. Buck Louis, P.J. Kostyniak, and R. Sundaram. 2010. Maternal serum preconception polychlorinated biphenyl concentrations and infant birth weight. *Environmental Health Perspectives* 118 (2):297-302.

47. Wigle, D.T., T.E. Arbuckle, M.C. Turner, A. Berube, Q. Yang, S. Liu, and D. Krewski. 2008. Epidemiologic evidence of relationships between reproductive and child health outcomes and environmental chemical contaminants. *Journal of Toxicology and Environmental Health Part B Crit Reviews* 11 (5-6):373-517.

48. Hertz-Picciotto, I., M.J. Charles, R.A. James, J.A. Keller, E. Willman, and S. Teplin. 2005. In utero polychlorinated biphenyl exposures in relation to fetal and early childhood growth. *Epidemiology* 16 (5):648-56.

49. Baibergenova, A., R. Kudyakov, M. Zdeb, and D.O. Carpenter. 2003. Low birth weight and residential proximity to PCB-contaminated waste sites. *Environmental Health Perspectives* 111 (10):1352-7.

50. Halldorsson, T.I., I. Thorsdottir, H.M. Meltzer, F. Nielsen, and S.F. Olsen. 2008. Linking exposure to polychlorinated biphenyls with fatty fish consumption and reduced fetal growth among Danish pregnant women: a cause for concern? *American Journal of Epidemiology* 168 (8):958-65.

51. Longnecker, M.P., M.A. Klebanoff, J.W. Brock, and X. Guo. 2005. Maternal levels of polychlorinated biphenyls in relation to preterm and small-for-gestational-age birth. *Epidemiology* 16 (5):641-7.

52. Apelberg, B.J., F.R. Witter, J.B. Herbstman, A.M. Calafat, R.U. Halden, L.L. Needham, and L.R. Goldman. 2007. Cord serum concentrations of perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) in relation to weight and size at birth. *Environmental Health Perspectives* 115 (11):1670-6.

53. Fei, C., J.K. McLaughlin, R.E. Tarone, and J. Olsen. 2007. Perfluorinated chemicals and fetal growth: a study within the Danish National Birth Cohort. *Environmental Health Perspectives* 115 (11):1677-82.

54. Fei, C., J.K. McLaughlin, R.E. Tarone, and J. Olsen. 2008. Fetal growth indicators and perfluorinated chemicals: a study in the Danish National Birth Cohort. *American Journal of Epidemiology* 168 (1):66-72.

55. Stein, C.R., D.A. Savitz, and M. Dougan. 2009. Serum levels of perfluorooctanoic acid and perfluorooctane sulfonate and pregnancy outcome. *American Journal of Epidemiology* 170 (7):837-46.

56. Washino, N., Y. Saijo, S. Sasaki, S. Kato, S. Ban, K. Konishi, R. Ito, A. Nakata, Y. Iwasaki, K. Saito, H. Nakazawa, and R. Kishi. 2009. Correlations between prenatal exposure to perfluorinated chemicals and reduced fetal growth. *Environmental Health Perspectives* 117 (4):660-7.

57. Bove, F., Y. Shim, and P. Zeitz. 2002. Drinking water contaminants and adverse pregnancy outcomes: a review. *Environmental Health Perspectives* 110 (Suppl 1):61-74.

58. Hoffman, C.S., P. Mendola, D.A. Savitz, A.H. Herring, D. Loomis, K.E. Hartmann, P.C. Singer, H.S. Weinberg, and A.F. Olshan. 2008. Drinking water disinfection by-product exposure and fetal growth. *Epidemiology* 19 (5):729-37.

59. Hoffman, C.S., P. Mendola, D.A. Savitz, A.H. Herring, D. Loomis, K.E. Hartmann, P.C. Singer, H.S. Weinberg, and A.F. Olshan. 2008. Drinking water disinfection by-product exposure and duration of gestation. *Epidemiology* 19 (5):738-46.

60. Myers, S.L., D.T. Lobdell, Z. Liu, Y. Xia, H. Ren, Y. Li, R.K. Kwok, J.L. Mumford, and P. Mendola. 2010. Maternal drinking water arsenic exposure and perinatal outcomes in inner Mongolia, China. *Journal of Epidemiology and Community Health* 64 (4):325-9.

61. Rahman, A., M. Vahter, A.H. Smith, B. Nermell, M. Yunus, S. El Arifeen, L.A. Persson, and E.C. Ekstrom. 2009. Arsenic exposure during pregnancy and size at birth: a prospective cohort study in Bangladesh. *American Journal of Epidemiology* 169 (3):304-12.

62. Smith, A.H., and C.M. Steinmaus. 2009. Health effects of arsenic and chromium in drinking water: recent human findings. *Annual Review of Public Health* 30:107-22.

63. Slama, R., O. Thiebaugeorges, V. Goua, L. Aussel, P. Sacco, A. Bohet, A. Forhan, B. Ducot, I. Annesi-Maesano, J. Heinrich, G. Magnin, M. Schweitzer, M. Kaminski, and M.A. Charles. 2009. Maternal personal exposure to airborne benzene and intrauterine growth. *Environmental Health Perspectives* 117 (8):1313-21.

64. Ochoa-Acuna, H., J. Frankenberger, L. Hahn, and C. Carbajo. 2009. Drinking-water herbicide exposure in Indiana and prevalence of small-for-gestational-age and preterm delivery. *Environmental Health Perspectives* 117 (10):1619-24.

65. Ranjit, N., K. Siefert, and V. Padmanabhan. 2010. Bisphenol-A and disparities in birth outcomes: a review and directions for future research. *Journal of Perinatology* 30 (1):2-9.

66. Konishi, K., S. Sasaki, S. Kato, S. Ban, N. Washino, J. Kajiwara, T. Todaka, H. Hirakawa, T. Hori, D. Yasutake, and R. Kishi. 2009. Prenatal exposure to PCDDs/PCDFs and dioxin-like PCBs in relation to birth weight. *Environmental Research* 109 (7):906-13.

67. Zota, A.R., A.S. Ettinger, M. Bouchard, C.J. Amarasiriwardena, J. Schwartz, H. Hu, and R.O. Wright. 2009. Maternal blood manganese levels and infant birth weight. *Epidemiology* 20 (3):367-73.

68. Davidoff, M.J., T. Dias, K. Damus, R. Russell, V.R. Bettegowda, S. Dolan, R.H. Schwarz, N.S. Green, and J. Petrini. 2006. Changes in the gestational age distribution among U.S. singleton births: impact on rates of late preterm birth, 1992 to 2002. *Seminars in Perinatology* 30 (1):8-15.

69. Heron, M., P.D. Sutton, J. Xu, S.J. Ventura, D.M. Strobino, and B. Guyer. 2010. Annual summary of vital statistics: 2007. *Pediatrics* 125 (1):4-15.

Metadata

Metadata for	National Vital Statistics System (NVSS)
Brief description of the data set	The National Vital Statistics System (NVSS) collects and disseminates data on births, deaths, marriages, divorces, and fetal deaths from vital event registration systems. The results of NVSS provide nearly complete data to track these vital statistics nationwide.
Who provides the data set?	Centers for Disease Control and Prevention, National Center for Health Statistics.
How are the data gathered?	Data are obtained from birth, death, marriage and divorce certificates collected by the various jurisdictions legally responsible for registration of these events.
What documentation is available describing data collection procedures?	See http://www.cdc.gov/nchs/data_access/Vitalstatsonline.htm for user's guides by calendar year.
What types of data relevant for children's environmental health indicators are available from this database?	Births, deaths, marriages, and divorces. Demographic information. Cause of mortality. State and county (data prior to 2004 only). Births: birth order, period of gestation, method of delivery, birth weight, abnormal conditions of the newborn, congenital abnormalities.
What is the spatial representation of the database (national or other)?	Nearly complete national registration data have been collected since 1985. State and county locations are recorded until 2004.
Are raw data (individual measurements or survey responses) available?	Data for each calendar year are available for download and analysis from (http://www.cdc.gov/nchs/data_access/Vitalstatsonline.htm) with records for each birth, death, marriage, or divorce certificate. Annual and monthly reports from the NVSS are available (http://www.cdc.gov/nchs/nvss/nvss_products.htm). Raw NVSS data are also available from the National Bureau of Economic Research at http://www.nber.org/data/#demographic Personal identification data (e.g., names) is not available.
How are database files obtained?	Raw data: http://www.cdc.gov/nchs/data_access/Vitalstatsonline.htm and http://www.nber.org/data/#demographic. Queriable, less detailed data set including births, deaths, and fetal deaths, with broad response categories: CDC WONDER at http://wonder.cdc.gov Prebuilt or user-built birth data tables are available at http://www.cdc.gov/nchs/VitalStats.htm.
Are there any known data quality or data analysis concerns?	For approximately 0.5% of the birth records, the mother's race was not stated and in those cases the mother's race was statistically imputed. From 2003, some states allowed reporting of multiple races, and in those cases the multiple race was bridged to a primary race using statistical methods.
What documentation is available describing QA procedures?	See http://www.cdc.gov/nchs/data_access/Vitalstatsonline.htm for user's guides by calendar year.
For what years are data	Online data: Births 1968-2007. Mortality multiple cause 1968-2007.

Metadata for	**National Vital Statistics System (NVSS)**
available?	Fetal death 1982-2005.
What is the frequency of data collection?	Continuous.
What is the frequency of data release?	Annually.
Are the data comparable across time and space?	Some response variables have response categories that have changed over time. Cause of mortality International Classification of Diseases coding systems have changed over time. Birth certificate categories changed between the 1989 and 2003 versions of the birth certificates.
Can the data be stratified by race/ethnicity, income, and location (region, state, county or other geographic unit)?	Race, ethnicity, State and county data are complete prior to 1989, contain county and city information only for counties with populations above 100,000 for 1989 to 2004, and contain no location information from 2005 forward. No income data.

1

Methods

Indicator

Birth1. Percentage of babies born preterm, by race/ethnicity, 1993-2007.
Birth2. Percentage of babies born at term with low birth weight, by race/ethnicity, 1993-2007.

Summary

Since 1960, the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention, has compiled birth certificate registration data from states and other U.S. jurisdictions. The National Vital Statistics System (NVSS) online database includes birth certificate data for virtually all U.S. births from 1968 to 2007. Indicator Birth1 uses the NVSS data from 1993 to 2007 to calculate the percentages of babies that are born preterm, defined as a period of gestation less than 37 completed weeks. Indicator Birth2 uses the NVSS data from 1993 to 2007 to calculate the percentages of babies that are both born at term, defined as a period of gestation of at least 37 completed weeks, and have low birth weight, defined as a weight less than 2,500 grams (5 pounds, 8 ounces). Tabulated results give the percentages of preterm and term low birth weight babies by calendar year and maternal race/ethnicity. The supplementary tables Birth1a and Birth2a give the percentages of preterm and term low birth weight babies by calendar year and maternal age group (< 20, 20-39, and 40+). The supplementary tables Birth1b and Birth2b give the percentages of preterm and term low birth weight babies by calendar year and plurality (all, singleton, multiple).

Data Summary

Indicator	Birth1. Percentage of babies born preterm, by race/ethnicity, 1993-2007. Birth2. Percentage of babies born at term with low birth weight, by race/ethnicity, 1993-2007.					
Time Period	1993-2007					
Data	U.S. birth certificates.					
Years (1993-1998)	1993	1994	1995	1996	1997	1998
Birth certificates	4,004,523	3,956,925	3,903,012	3,894,874	3,884,329	3,945,192
Missing gestation period	35,888	35,124	36,501	40,687	38,503	40,433
Missing gestation period and/or birth weight	39,074	38,026	38,897	43,321	40,810	43,045

Indicator	Birth1. Percentage of babies born preterm, by race/ethnicity, 1993-2007. Birth2. Percentage of babies born at term with low birth weight, by race/ethnicity, 1993-2007.					
Years (1999-2004)	1999	2000	2001	2002	2003	2004
Birth certificates	3,963,465	4,063,823	4,031,531	4,027,376	4,096,092	4,118,907
Missing gestation period	42,987	43,392	39,874	41,295	43,883	43,047
Missing gestation period and/or birth weight	45,258	45,500	41,784	43,099	46,887	46,285
Years (2005-2006)	2005	2006	2007			
Birth certificates	4,145,619	4,273,225	4,324,008			
Missing gestation period	29,585	25,729	6,856			
Missing gestation period and/or birth weight	33,027	29,358	10,904			

Overview of Data Files

The following files are needed to calculate this indicator.

Birth data:

- NATLXXXX.DAT.Z, where XXXX denotes the four-digit year for years 1996 - 2006. Each file is a compressed file that when decompressed gives the national birth certificate data for a calendar year for births in the 50 U.S. states or Washington DC. The companion files with birth certificate data for U.S. territories were not used for these analyses. These files together with SAS code to extract and read these data files and convert them into SAS format were obtained from the National Bureau of Economic Research (NBER) at the url:

  http://www.nber.org/data/vital-statistics-natality-data.html

- Natl2007us.zip. This file is a compressed file that when decompressed gives the national birth certificate data for the calendar year 2007 for births in 50 U.S. states and

Washington D.C. The SAS code to process 2006 year data was downloaded from NBER as described above and modified to process the 2007 year data contained in this file. This file was obtained from vital statistics data maintained online by the Centers for Disease Control and Prevention and available at the url:

http://www.cdc.gov/nchs/data_access/Vitalstatsonline.htm

The variables needed for this indicator are the calendar year, mother's age, mother's race, mother's ethnicity, length of gestation, plurality, and birth weight. The variable names and formats vary by year and are detailed below.

National Vital Statistics System (NVSS) Natality Data

The National Vital Statistics System (NVSS) is maintained by the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention. The NVSS compiles national registration certificate data for births, deaths, marriages, divorces, and fetal deaths provided by various jurisdictions, including states. This indicator uses NVSS birth data to determine preterm and term low birth weight births.

The Indicator Birth1 uses the gestation period variable GESTAT3 (GESTREC3 from 2003 to 2007) coded as follows:

- 1 = Under 37 weeks
- 2 = 37 weeks and over
- 3 = Not stated

This variable is a recode of the variable DGESTAT (COMBGEST from 2003 to 2007) that ranges from 17 to 47 and provides the number of completed weeks of gestation of the mother. A preterm birth is defined as a birth with GESTAT3 = 1. Birth certificates with an unknown gestation period (GESTAT3 = 3) were excluded from the calculation of the Indicator Birth1.

The Indicator Birth2 uses the gestation period variable GESTAT3 (GESTREC3 from 2003 to 2007) and the birth weight variable BIRWT4 (BWTR4 for 2003 to 2007) coded as follows:

- 1 = 1499 grams or less
- 2 = 1500 – 2499 grams
- 3 = 2500 grams or more
- 4 = Unknown or not stated

This variable is a recode of the variable DBIRWT (DBWT for 2004 to 2007) that ranges from 0227 to 8165 and gives the birth weight in grams. A term low birth weight birth has a gestation period of 37 or more completed weeks and a birth weight of less than 2,500 grams. Thus a term low birth weight birth is defined by GESTAT3 = 2 and BIRWT4 = 1 or 2 . Birth certificates with

an unknown gestation period (GESTAT3 = 3) and/or an unknown birth weight (BIRWT4 = 4) were excluded from the calculation of the Indicator Birth2.

The birth plurality used the variable DPLURAL, coded as follows:

- 1 = Single
- 2 = Twin
- 3 = Triplet
- 4 = Quadruplet
- 5 = Quintuplet or higher

Singleton births are defined as births with DPLURAL = 1. Multiple births are defined as births with DPLURAL ≥ 2. In rare cases (e.g., 0.004 % of births in 2007) the plurality was not reported on the birth certificate and the value of DPLURAL was imputed to be 1 (singleton birth).

Age, Race and Ethnicity

The mother's age, race, and ethnicity were obtained from each of the natality files and regrouped into categories, as follows:

Years 1993–2002

- Mother's Age: The mother's age for 1993 to 2002 is characterized by the variable DMAGE. This variable ranges from 10 to 54 and gives the age of mother in single years. For these analysis, the following age groups for the mother were defined:

  - Mother's age less than 20 years (DMAGE < 20);
  - Mother's age between 20 and 39 (20 ≤ DMAGE < 40); and
  - Mother's age is 40 or greater (DMAGE ≥ 40).

- Mother's Race and Hispanic origin: The mother's race for 1993 to 2002 is characterized by the variable MRACE. MRACE is given the following values for the U.S. state and Washington DC data used for these analyses. For the years 1993 to 2002, multiple race responses were not available.

MRACE

01 ... White
02 ... Black
03 ... American Indian (includes Aleuts and Eskimos)
04 ... Chinese
05 ... Japanese
06 ... Hawaiian (includes part-Hawaiian)
07 ... Filipino
18 ... Asian Indian

28 ... Korean
38 ... Samoan
48 ... Vietnamese
58 ... Guamanian
68 ... Other Asian or Pacific Islander in areas reporting codes 18-58
78 ... Combined other Asian or Pacific Islander, includes codes 18-68 for areas that do not report them separately

The mother's Hispanic origin for 1993 to 2002 is characterized by the variable ORMOTH. ORMOTH assumes the following values:

ORMOTH

0 ... Non-Hispanic
1 ... Mexican
2 ... Puerto Rican
3 ... Cuban
4 ... Central or South American
5 ... Other and unknown Hispanic
9 ... Origin unknown or not stated

Based on the above data, the following categories of the mother's race/ethnicity were defined:

- White non-Hispanic (MRACE = 1 and ORMOTH = 0);
- Black non-Hispanic (MRACE = 2 and ORMOTH = 0);
- American Indian/Alaskan Native (AIAN) non-Hispanic (MRACE = 3 and ORMOTH =0);
- Asian or Pacific Islander (API) non-Hispanic (MRACE is 4, 5, 6, 7, 18, 28, 38, 48, 58, 68, or 78 and ORMOTH = 0);
- Hispanic Mexican American (ORMOTH = 1);
- Hispanic Puerto Rican (ORMOTH = 2);
- All Hispanic (ORMOTH = 1, 2, 3, 4, or 5); and
- Unknown ethnicity – (ORMOTH = 9).

In approximately 0.5% of the birth certificate records, the mother's race was not stated. In those cases, if the father's race was stated, then the father's race was used to impute the mother's race. Otherwise, the mother's race was imputed from the mother's race on the preceding record with a known mother's race. Thus a mother's race was assigned to all the records.

Year 2003

- Mother's Age: The mother's age for the year 2003 is characterized by the variable MAGER41. This variable is encoded as follows:

MAGER41

01 = Under 15 years
02 = 15 years
03 = 16 years
04 = 17 years
… …
… …
39 = 52 years
40 = 53 years
41 = 54 years

- For these analyses, the following age groups for the mother were defined:

  - Mother's age less than 20 years (MAGER41 < 7);
  - Mother's age between 20 and 39 (7 ≤ MAGER41 < 27); and
  - Mother's age is 40 or greater (MAGER41 ≥ 27).

- Mother's Race and Hispanic origin: The mother's race for the year 2003 is characterized by two variables MRACE and MBRACE for the U.S. state and Washington DC data used for these analyses. MRACE is used for states and years where multiple race responses are not available, and MBRACE is used for states and years where multiple race responses are available.

MRACE

01 ... White
02 ... Black
03 ... American Indian (includes Aleuts and Eskimos)
04 ... Chinese
05 ... Japanese
06 ... Hawaiian (includes part-Hawaiian)
07 ... Filipino
18 ... Asian Indian
28 ... Korean
38 ... Samoan
48 ... Vietnamese
58 ... Guamanian
68 ... Other Asian or Pacific Islander in areas reporting codes 18-58
78 ... Combined other Asian or Pacific Islander, includes codes 18-68 for areas that do not report them separately
Blank --- Not reported.

Beginning in 2003, some states started allowing multiple race responses for birth records. For example, In 2007, multiple race was reported by California, Colorado, Delaware, Florida, Georgia (for births based on the revised certificate only, which was implemented after January 1), Idaho, Indiana, Iowa, Kansas, Kentucky, Michigan (for births at most facilities), Nebraska, New Hampshire, New York state (excluding New York City), North Dakota, Ohio, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Vermont, Washington, and Wyoming, which used the 2003 revision of the U.S. Standard Certificate of Live Birth, as well as Hawaii, Minnesota and Utah, which used the 1989 revision of the U.S. Standard Certificate of Live Birth. These 27 states accounted for 57% of U.S. births in 2007 and reported 1.7% of mothers as multiracial, with levels varying from 1% (Texas) to 35% (Hawaii). In order to provide uniformity and comparability of data across the years, NVSS bridged the multiple-race data according to the combination of races, Hispanic origin, sex, and age indicated on the birth certificate of the mother or father to obtain a single race for each birth record reporting multiple races in the NVSS datasets. For such records, the single race or bridged multiple race was given by the variable MBRACE. MBRACE is given the following values:

MBRACE

01 White – single race
02 Black – single race
03 American Indian / Alaskan Native – single race
04 Asian Indian – single race
05 Chinese – single race
06 Filipino – single race
07 Japanese – single race
08 Korean – single race
09 Vietnamese – single race
10 Other Asian – single race
11 Hawaiian – single race
12 Guamanian – single race
13 Samoan – single race
14 Other Pacific Islander – single race
21 White – bridged multiple race
22 Black – bridged multiple race
23 American Indian / Alaskan Native – bridged multiple race
24 Asian / Pacific Islander – bridged multiple race
Blank Not on certificate

A new variable CRACE was created by combining the data from MRACE and MBRACE using the following logic. CRACE is equal to MRACE if MRACE is not a missing value. Otherwise, CRACE is equal to MBRACE.

The mother's Hispanic origin for 2003 is characterized by the variable UMHISP. UMHISP assumes the following values:

UMHISP

0 ... Non-Hispanic
1 ... Mexican
2 ... Puerto Rican
3 ... Cuban
4 ... Central or South American
5 ... Other and unknown Hispanic
9 ... Origin unknown or not stated

Based on the above data, following categories of the mother's race/ethnicity were defined:

- White non-Hispanic (CRACE = 1 or 21 and UMHISP = 0);
- Black non-Hispanic (CRACE = 2 or 22 and UMHISP = 0);
- American Indian/Alaskan Native (AIAN) non-Hispanic (CRACE = 3 or 23 and UMHISP =0);
- Asian or Pacific Islander (API) non-Hispanic (CRACE is 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 18, 24, 28, 38, 48, 58, 68, or 78 and UMHISP = 0);
- Hispanic Mexican American (UMHISP = 1);
- Hispanic Puerto Rican (UMHISP = 2);
- All Hispanic (UMHISP = 1, 2, 3, 4, or 5); and
- Unknown ethnicity (UMHISP = 9).

In approximately 0.5% of the birth certificate records, the mother's race was not stated. In those cases, if the father's race was stated, then the father's race was used to impute the mother's race. Otherwise, the mother's race was imputed from the mother's race on the preceding record with a known mother's race. Thus a mother's race was assigned to all the records.

Years 2004 – 2007

- Mother's Age: The mother's age for 2004 to 2007 is characterized by the variable MAGER. This variable ranges from 10 – 54 and gives the age of mother in single years. For these analysis, the following age groups for the mother were defined:
  - Mother's age less than 20 years (MAGER < 20);
  - Mother's age between 20 and 39 (20 ≤ MAGER < 40); and
  - Mother's age is 40 or greater (MAGER ≥ 40).
- Mother's Race and Hispanic Origin: Just as for 2003, the mother's race and Hispanic origin category are given by the variables MRACE or MBRACE, and UMHISP respectively. The categories of the mother's race/ethnicity were defined exactly as for the year 2003.

Calculation of Indicator

For each demographic group, the percentage of preterm births was calculated as the number of preterm births divided by the total number of births:

> Percentage of preterm births =
> Number of preterm births for mothers in group / Number of births with a stated gestation period for mothers in group × 100%

For each demographic group, the percentage of term low birth weight births was calculated as the number of term low birth weight births divided by the total number of births:

> Percentage of term low birth weight births =
> Number of low birth weight births at term for mothers in group / Number of births with a stated gestation period and a stated birth weight for mothers in group × 100%

Questions and Comments

Questions regarding these methods, and suggestions to improve the description of the methods, are welcome. Please use the "Contact Us" link at the bottom of any page in the America's Children and the Environment website.

Statistical Comparisons

Statistical analyses of the percentages of preterm or term low birth weight babies were used to determine whether the differences between percentages for different demographic groups were statistically significant. Using a logistic regression model, the logarithm of the odds that a given baby is preterm or term low birth weight is assumed to be the sum of explanatory terms for the mother's age group and/or race/ethnicity. The odds that a given baby is preterm is the probability that the baby is preterm divided by the probability that the baby is not preterm (similarly for term low birth weight). Thus if two demographic groups have similar (or equal) percentages of preterm or term low birth weight births, then they will also have similar (or equal) values for the logarithm of the odds. Using this model, the difference in the percentage between different demographic groups is statistically significant if the difference between the corresponding sums of explanatory terms is statistically significantly different from zero. The uncertainties of the regression coefficients were calculated using the SAS® (SAS Institute, Cary, North Carolina) statistical software GENMOD procedure and a binomial logistic model, treating the births for each demographic subgroup as a random sample of births. A p-value at or below 0.05 implies that the difference is statistically significant at the 5% significance level. No adjustment is made for multiple comparisons.

For these statistical analyses we used six race/ethnicity groups: White non-Hispanic; Black non-Hispanic; Asian or Pacific Islander non-Hispanic; American Indian or Alaska Native non-Hispanic; Hispanic; Unknown ethnicity. In addition, for specific comparisons between the Mexican and Puerto Rican subgroups, we applied a similar statistical analysis to only the data from Mexican or Puerto Rican using two ethnicity groups: Mexican; Puerto Rican. We also used three age groups: < 20, 20-39, and 40+.

For each type of comparison, we present unadjusted and adjusted analyses. The unadjusted analyses directly compare a percentage between different demographic groups. The adjusted analyses add other explanatory variables to the statistical model and use the statistical model to account for the possible confounding effects of these other variables. For example, the unadjusted race/ethnicity comparisons use and compare the percentages between different race/ethnicity pairs. The adjusted analyses add age terms to the statistical model and compare the percentages between different race/ethnicity pairs after accounting for the effects of the age group. For example, if White non-Hispanics tend to be older when they have babies compared to Black non-Hispanics, and if the probability of preterm births strongly depends on the mother's age only, then the unadjusted differences between these two race/ethnicity groups would be significant but the adjusted difference (taking into account age) would not be significant.

Comparisons of the percentages of preterm and term low birth weight births between pairs of race/ethnicity groups in the year 2007 are shown in Table 1. For the unadjusted comparisons, the only explanatory variables are terms for each race/ethnicity group. For these unadjusted comparisons, the statistical tests compare the percentage for each pair of race/ethnicity groups. For the adjusted comparisons ("Adjusted for age"), the explanatory variables are terms for each race/ethnicity group together with terms for each age group. For these adjusted comparisons, the statistical test compares the pair of race/ethnicity groups after accounting for any differences in the age distributions between the race/ethnicity groups.

Additional comparisons of the percentages of preterm and term low birth weight births are shown in Table 2. The AGAINST = "age" unadjusted p-value compares the percentages for different age groups in the year 2007. The adjusted p-value includes adjustment terms for race/ethnicity in the model. The AGAINST = "year" p-value examines whether the linear trend in the percentages is statistically significant; the adjusted model for trend adjusts for demographic changes in the populations from year to year by including terms for age and race/ethnicity. The p-values for AGAINST = "year" and specific values of SUBSET examine whether the trend for that race/ethnicity or age group demographic subset is statistically significant. The trend analyses are presented for the trend from 1993 to 2007. Overall trend analyses are presented for all births, singleton births, and multiple births. To address an issue of particular interest in the indicator, results of trend analysis for preterm births to Black non-Hispanic mothers are also presented for 1993-2000 and 2000-2007.

For more details on these statistical analyses, see the memorandum by Cohen (2010).[1]

Table 1. Statistical significance tests comparing the percentages of preterm or term low birth weight births between pairs of race/ethnicity groups for the year 2007.

		P-VALUES		
Variable	**RACE1**	**RACE2**	**Unadjusted**	**Adjusted for age**
Preterm	White non-Hispanic	Black non-Hispanic	< 0.0005	< 0.0005
Preterm	White non-Hispanic	AIAN non-Hispanic	< 0.0005	< 0.0005

[1] Cohen, J. 2010. *Selected statistical methods for testing for trends and comparing years or demographic groups in other ACE health-based indicators.* Memorandum submitted to Dan Axelrad, EPA, 5 November, 2010.

			P-VALUES	
Variable	**RACE1**	**RACE2**	**Unadjusted**	**Adjusted for age**
Preterm	White non-Hispanic	API non-Hispanic	< 0.0005	< 0.0005
Preterm	White non-Hispanic	Hispanic	< 0.0005	< 0.0005
Preterm	White non-Hispanic	Unknown ethnicity	< 0.0005	< 0.0005
Preterm	Black non-Hispanic	AIAN non-Hispanic	< 0.0005	< 0.0005
Preterm	Black non-Hispanic	API non-Hispanic	< 0.0005	< 0.0005
Preterm	Black non-Hispanic	Hispanic	< 0.0005	< 0.0005
Preterm	Black non-Hispanic	Unknown ethnicity	< 0.0005	< 0.0005
Preterm	AIAN non-Hispanic	API non-Hispanic	< 0.0005	< 0.0005
Preterm	AIAN non-Hispanic	Hispanic	< 0.0005	< 0.0005
Preterm	AIAN non-Hispanic	Unknown ethnicity	0.059	0.048
Preterm	API non-Hispanic	Hispanic	< 0.0005	< 0.0005
Preterm	API non-Hispanic	Unknown ethnicity	< 0.0005	< 0.0005
Preterm	Hispanic	Unknown ethnicity	< 0.0005	< 0.0005
Preterm	Mexican	Puerto Rican	< 0.0005	< 0.0005
Term low birth weight	White non-Hispanic	Black non-Hispanic	< 0.0005	< 0.0005
Term low birth weight	White non-Hispanic	AIAN non-Hispanic	0.250	0.746
Term low birth weight	White non-Hispanic	API non-Hispanic	< 0.0005	< 0.0005
Term low birth weight	White non-Hispanic	Hispanic	0.001	0.270
Term low birth weight	White non-Hispanic	Unknown ethnicity	< 0.0005	< 0.0005
Term low birth weight	Black non-Hispanic	AIAN non-Hispanic	< 0.0005	< 0.0005
Term low birth weight	Black non-Hispanic	API non-Hispanic	< 0.0005	< 0.0005
Term low birth weight	Black non-Hispanic	Hispanic	< 0.0005	< 0.0005
Term low birth weight	Black non-Hispanic	Unknown ethnicity	< 0.0005	< 0.0005
Term low birth weight	AIAN non-Hispanic	API non-Hispanic	< 0.0005	< 0.0005
Term low birth weight	AIAN non-Hispanic	Hispanic	0.713	0.955
Term low birth weight	AIAN non-Hispanic	Unknown ethnicity	< 0.0005	< 0.0005
Term low birth weight	API non-Hispanic	Hispanic	< 0.0005	< 0.0005
Term low birth weight	API non-Hispanic	Unknown ethnicity	0.012	0.002
Term low birth weight	Hispanic	Unknown ethnicity	< 0.0005	< 0.0005
Term low birth weight	Mexican	Puerto Rican	< 0.0005	< 0.0005

Table 2. Other statistical significance tests comparing the percentage of preterm and term low birth weight births.

					P-VALUES	
Variable	**From**	**To**	**Against**	**Subset**	**Unadjusted**	**Adjusted***
Preterm	2007	2007	age		< 0.0005	< 0.0005
Preterm	2007	2007	race		< 0.0005	< 0.0005
Preterm	1993	2007	year		< 0.0005	< 0.0005
Preterm	1993	2007	year	White non-Hispanic	< 0.0005	< 0.0005
Preterm	1993	2007	year	Black non-Hispanic	< 0.0005	< 0.0005
Preterm	1993	2007	year	AIAN non-Hispanic	< 0.0005	< 0.0005
Preterm	1993	2007	year	API non-Hispanic	< 0.0005	< 0.0005
Preterm	1993	2007	year	Hispanic	< 0.0005	< 0.0005
Preterm	1993	2007	year	Unknown ethnicity	< 0.0005	< 0.0005

					P-VALUES	
Variable	**From**	**To**	**Against**	**Subset**	**Unadjusted**	**Adjusted***
Preterm	1993	2007	year	< 20	< 0.0005	< 0.0005
Preterm	1993	2007	year	20-39	< 0.0005	< 0.0005
Preterm	1993	2007	year	40+	< 0.0005	< 0.0005
Preterm	1993	2000	year	Black non-Hispanic	< 0.0005	< 0.0005
Preterm	2000	2007	year	Black non-Hispanic	< 0.0005	< 0.0005
Preterm	1993	2007	year	Singleton	< 0.0005	< 0.0005
Preterm	1993	2007	year	Multiple	< 0.0005	< 0.0005
Term low birth weight	2007	2007	age		< 0.0005	< 0.0005
Term low birth weight	2007	2007	race		< 0.0005	< 0.0005
Term low birth weight	1993	2007	year		< 0.0005	< 0.0005
Term low birth weight	1993	2007	year	White non-Hispanic	< 0.0005	< 0.0005
Term low birth weight	1993	2007	year	Black non-Hispanic	0.505	0.019
Term low birth weight	1993	2007	year	AIAN non-Hispanic	0.002	0.003
Term low birth weight	1993	2007	year	API non-Hispanic	< 0.0005	< 0.0005
Term low birth weight	1993	2007	year	Hispanic	< 0.0005	< 0.0005
Term low birth weight	1993	2007	year	Unknown ethnicity	0.016	0.028
Term low birth weight	1993	2007	year	< 20	< 0.0005	< 0.0005
Term low birth weight	1993	2007	year	20-39	< 0.0005	< 0.0005
Term low birth weight	1993	2007	year	40+	< 0.0005	< 0.0005
Term low birth weight	1993	2007	year	Singleton	< 0.0005	< 0.0005
Term low birth weight	1993	2007	year	Multiple	< 0.0005	< 0.0005

*For AGAINST = "age," the p-values are adjusted for race/ethnicity.
For AGAINST = "year," the p-values are adjusted for age and race/ethnicity.