Matern Child Health J (2009) 13:769–779
DOI 10.1007/s10995-009-0476-z

# One Size Does Not Fit All: An Examination of Low Birthweight Disparities Among a Diverse Set of Racial/Ethnic Groups

**P. Johnelle Sparks**

Published online: 4 June 2009


**Abstract** To examine disparities in low birthweight using a diverse set of racial/ethnic categories and a nationally representative sample. This research explored the degree to which sociodemographic characteristics, health care access, maternal health status, and health behaviors influence birthweight disparities among seven racial/ethnic groups. Binary logistic regression models were estimated using a nationally representative sample of singleton, normal for gestational age births from 2001 using the ECLS-B, which has an approximate sample size of 7,800 infants. The multiple variable models examine disparities in low birthweight (LBW) for seven racial/ethnic groups, including non-Hispanic white, non-Hispanic black, U.S.-born Mexican-origin Hispanic, foreign-born Mexican-origin Hispanic, other Hispanic, Native American, and Asian mothers. Race-stratified logistic regression models were also examined. In the full sample models, only non-Hispanic black mothers have a LBW disadvantage compared to non-Hispanic white mothers. Maternal WIC usage was protective against LBW in the full models. No prenatal care and adequate plus prenatal care increase the odds of LBW. In the race-stratified models, prenatal care adequacy and high maternal health risks are the only variables that influence LBW for all racial/ethnic groups. The race-stratified models highlight the different mechanism important across the racial/ethnic groups in determining LBW. Differences in the distribution of maternal sociodemographic, health care access, health status, and behavior characteristics by race/ethnicity demonstrate that a single empirical framework may distort associations with LBW for certain racial and ethnic groups. More attention must be given to the specific mechanisms linking maternal risk factors to poor birth outcomes for specific racial/ethnic groups.

**Keywords** Low birthweight · Racial/ethnic disparities · ECLS-B · WIC · Prenatal care adequacy

## Introduction

When discussing racial/ethnic disparities in infant health outcomes, it is important to elucidate possible mechanisms that may lead to these disparities based on the unequal distribution of economic and social resources across a diverse set of racial and ethnic groups. One of the most puzzling relationships among racial/ethnic differences in a variety of health outcomes is based on the health advantage noted for Hispanics compared to non-Hispanic whites when their SES profile most closely resembles non-Hispanic blacks. This pattern has been termed the epidemiologic paradox [1]. One potential explanation for healthier birthweights among Hispanics is better health practices during pregnancy, including lower rates of smoking and alcohol consumption compared to non-Hispanic whites [2]. Other potential mechanisms thought to explain the Hispanic birthweight advantage could be healthier dietary patterns [3, 4], social support [5–7], and immigrant status and selectivity [6, 8, 9] among the Hispanic population.

Some of the data used in this analysis are derived from the restricted-use files of the ECLS-B obtained under special contractual arrangements with the National Center for Education Statistics designed to protect the anonymity of the respondents. These data are not available from the author.

P. Johnelle Sparks (✉)
Department of Demography and Organization Studies, The University of Texas at San Antonio, One UTSA Circle, San Antonio, TX 78249, USA
e-mail: johnelle.sparks@utsa.edu

Still there is debate as to the nature of the epidemiologic or Hispanic paradox for immigrant and non-immigrant Hispanics, as well as for different ethnic groups that comprise the Hispanic population [10]. Puerto Ricans tend to have worse infant health outcomes compared to non-Hispanic whites, while Mexicans, Central Americans, and South Americans tend to have health outcomes similar or better than non-Hispanic whites when controlling for various measures of socioeconomic status [9, 11–14]. Pregnancy outcomes are also significantly better among foreign-born Hispanic mothers than native-born Hispanic mothers [15–17]. Two explanations are often given for both the immigrant and Mexican infant health advantage. First, it is argued that immigrant mothers are healthier than those that do not migrate. Second, mothers born in Mexico are thought to have more healthy lifestyles than their U.S.-born counterparts, which could be protective against negative social environments and low SES [18]. However, other research finds little support for a LBW advantage for certain Hispanic ethnic groups compared to non-Hispanic whites once SES, maternal nativity, and immigration status are controlled [5, 19, 20].

On the other hand, non-Hispanic blacks continue to experience an infant health disadvantage compared to non-Hispanic whites for many outcomes. The most common explanations for the non-Hispanic black and non-Hispanic white disparity in infant health outcomes relate to biobehavioral and medical risk factors [21]. However it is not clear why the black-white racial disparity increases for mothers with few of these risk factors present [22]. Other possible explanations for the black-white disparity in infant health outcomes are differential economic benefits for similar educational attainment, institutional racism, residential segregation, and fewer opportunities for gathering wealth [23].

Less work has examined the existence of racial/ethnic differentials in LBW for Asian and Native American mothers compared to other racial/ethnic groups. Of the empirical evidence that examines these racial groups, a LBW disadvantage is observed for Asian [24, 25] and Native American [26] infants compared to non-Hispanic white infants. However, the heterogeneity present in these two racial groups often leads to difficulties in determining specific mechanisms leading to LBW differentials. Research focusing on more diverse racial/ethnic groups and low birthweight is necessary because the most common explanation for these differentials, which is framed in differences based on SES, does not account for the persistent disparity in this outcome for different racial/ethnic groups. This study fills this gap by examining differences in LBW status among seven racial/ethnic groups and uses more refined measures of poverty status and maternal health care access and behaviors to capture differences among these racial/ethnic categories.

## Methods

### Sample

The Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) is an ideal data source to analyze racial/ethnic differentials in LBW. The ECLS-B follows a nationally representative probability sample of children born between January and December 2001, with specific sampling strategies to ensure that a broad range of socioeconomic characteristics of the population, minorities, and LBW infants are included [27]. Data for this analysis were taken from the nine-month wave of the data collection and include information contained on the child's birth certificate and information obtained during the parental interview.[1] This analysis was restricted to singleton births and infants with birthweights that did not fall below the 10th percentile for infants of the same gestational age, also known as small for gestational age (SGA). These exclusions were made so that associations could be assessed among the covariates detailed below and LBW without bias introduced by infants most at risk of LBW, including multiple birth infants or infants experiencing fetal growth problems. This gives an approximate sample size of 7,800 infants. The ECLS-B provides a comprehensive assessment of childhood health and developmental measures, as well as detailed sociodemographic and health profiles of each child's family.

### Exposure/Dependent Variable Definitions

In order to examine racial/ethnic differences in LBW, the race/ethnicity of the mother reported on the infant's birth certificate was used to construct the separate race/ethnicity categories. Three separate variables taken from the birth certificate were used in order to specify if the mother was Hispanic, to determine if the mother was U.S.- or foreign-born, and to identify the mother's race. This classification scheme allowed for seven categories of race/ethnicity. These included non-Hispanic whites (NHW), foreign-born Mexican-origin Hispanics (FBMO), U.S.-born Mexican-origin Hispanics (USMO), non-Hispanic blacks (NHB),

[1] Data for this analysis were obtained by permission and approval of the Institute of Education Sciences (IES) Data Security Office of the U.S. Department of Education, National Center for Education Statistics. Due to the sensitive nature of the information contained in this data, the author has obtained a restricted data license allowing the use of this data source for the above research purpose. All protocols specified in the restricted data license agreement were followed in order to protect the confidentiality of respondents. Copies of the data are not available from the author. Interested parties should contact the IES Data Security Office at IESData.Security@ed.gov if interested in obtaining their own restricted data license for the ECLS-B.

Native Americans, Asians (all ethnicities), and other Hispanics (all ethnicities except Mexican).

LBW status, measured as a dichotomous variable to indicate if the child weighed less than 2,500 grams at birth, was the dependent variable in this analysis. A categorical variable contained in the data indicating if the child was normal, low, or very low birthweight was used to construct a dichotomous measure of whether the child was born LBW (either the low or very low birthweight categories). Additional analyses were performed to test for differences in actual birthweights by race/ethnicity, and the birth weight recorded on the infant's birth certificate in grams was used.

### Independent Variable Definitions

To capture maternal age at the time of the infant's birth, three age categories were constructed based on the mother's age reported on the infant's birth certificate: less than 20 years of age, between the ages of 20 and 34 years, and older than 34 years of age. These categories were selected due to nonlinear association noted between maternal age and LBW [24, 28–31]. Maternal education was operationalized with three categories: less than a high school education, a high school diploma, and some college education or more. Poverty status was determined based on parental responses to questions about family income and size. A constructed variable was available in the ECLS-B that indicates if the family lives below the federally designated poverty threshold, 130% of poverty, 185% of poverty, or lives above the poverty threshold. Dummy variables were created for each of these relative poverty categories. A dichotomous measure of marital status at the time of birth was taken from the infant's birth certificate. A final measure of family socioeconomic status was operationalized as a dichotomous variable based on responses to the parental interview that asked the mother if she had used WIC benefits in the past 12 months for herself.

A dichotomous measure of insurance status was included in this analysis and indicates if the mother had access to private or public health insurance from any source at the time of her infant's birth. To capture prenatal care adequacy, a constructed variable contained in the ECLS-B that uses the Kessner/Institute of Medicine (IOM) Adequacy of Prenatal Care Index [32, 33] was used. Responses to this constructed variable were recoded as dummy variables and indicate if the mother received no care, inadequate care, intermediate care, adequate care, or adequate plus care. Pregnancy weight gain was included as a measure of maternal nutrition prior to and during the pregnancy and was taken from the infant's birth certificate. Three dummy variables were created to indicate if the mother had low weight gain (0–15 pounds), normal weight gain (16–40 pounds), or high weight gain (41 or more pounds).

Two subjective maternal health measures were used in this analysis, including a self-rating of mental and physical health. If mothers responded that their mental health status was fair or poor they were identified as having poor self-rated mental health. Mothers reporting their physical health as fair or poor were assigned to the variable poor self-rated health status. Additional maternal health conditions taken from the infant's birth certificate were used to construct variables indicating the mother's health risks during pregnancy. These health conditions included: anemia, cardiac disease, acute/chronic lung disease, diabetes, genital herpes, (oligo)hydramnios, hemoglobinopathy, chronic hypertension, hypertension during pregnancy, eclampsia, incompetent cervix, previous birth weighing 4,000 or more grams, previous preterm or small birth, renal disease, rh sensitization, uterine bleeding, and other medical risk factors. Three dummy variables were created to indicate if the mother experienced no health risks, low risk (one health condition present), or high risk (between two and six (maximum value) health conditions present) [34, 35]. Finally a measure was taken from the infant's birth certificate to indicate if the mother smoked cigarettes during her pregnancy [36]. To deal with item missing issues with these last two variables, missing cases were assigned a value of 0 to indicate the health risk was not present and that the mother did not smoke. Variables were included in preliminary analyses to assess if this imputation strategy biased associations with these or other variables, and the significance levels for these variables indicated the imputation did not bias the results. Additionally this type of imputation method leads to more conservative estimates of the associations with these variables and LBW in the models presented.

## Analysis

First, the distribution of characteristics of mothers just described was examined based on the seven maternal race/ethnicity categories. Chi-square tests for equal distributions were conducted for each variable based on maternal race/ethnicity. Due to the complex sample design of the ECLS-B, the SURVEYFREQ procedure in SAS 9.2 [37] was used to allow adjustments for standard errors when estimating the chi-square statistic. This leads to more robust estimates of the actual differences between groups. All unweighted sample sizes included in this analysis are rounded to the nearest 50 value in order to protect the confidentiality of respondents in the ECLS-B, as specified in the restricted data license agreement held by the researcher.

Next logistic regression models were estimated to approximate the associations between LBW, race/ethnicity, and the covariates detailed above. The SURVEYLOGISTIC

procedure in SAS 9.2 [37] was used to estimate all of the multiple logistic regression models in order to adjust standard errors due to the complex sample design of the data. Variance estimates in the models are adjusted using the Taylor series expansion approximation method. This method incorporates sample design information, including stratification based on key individual characteristics, clustering of individual sample units, and unequal weighting probabilities of selection [38] and allows the results to be generalizable to all singleton, non-SGA births occurring in the U.S. in 2001. In addition to the full sample analysis, race-stratified logistic regression models were estimated using the same procedures detailed above to adjust for the sample design of the data. Finally the SURVEYREG and GLM procedures were used to estimate the mean birthweight in grams for each racial/ethnic group once all variables in the full logistic regression models are controlled for in the regression based model with design effects.

## Results

LBW among singleton and non-SGA infants is quite variable across the seven racial/ethnic groups, and the differences are statistically significant. LBW is lowest among USMO (2.24%), Native American (2.61%), NHW (3.02%), and FBMO (3.07%) infants. NHB infants have the highest rate of LBW (6.08%). From examining this bivariate association, USMO and Native American infants have lower rates of LBW than NHW infants, while all other racial/ethnic groups have higher rates of LBW compared to NHW infants.

Statistically significant differences are found across the seven racial/ethnic groups for all independent variables used in this analysis. When examining the risk factors for LBW across the racial/ethnic groups (Table 1), the most advantaged groups sociodemographically appear to be NHW and Asian mothers, while FBMO, USMO, NHB, Native American, and other Hispanic mothers fare poorly compared to these two racial groups. In most instances FBMO mothers have a less favorable sociodemographic profile than USMO mothers.

NHWs and Asians have the lowest percentage of mothers giving birth before the age of 20. USMO, NHB, and Native American mothers have the highest percentages of births to mothers less than 20 years of age. The majority of infants of all racial/ethnic groups are born to mothers between the ages of 20 and 34. FBMO mothers have the lowest levels of education of all the racial/ethnic groups, while NHW and Asian mothers have the highest levels of education. Strong racial/ethnic differences in relative family poverty status were observed. NHW and Asian mothers are least likely to live in families that are poor. Relative poverty, meaning living below, at 130%, or 180% of the poverty threshold, is highest among FBMO and NHB mothers. NHB (34.31%) and Native American (36.37%) mothers are the least likely to be married at the time of the infant's birth. Of the Hispanic ethnic groups in this analysis, FBMO mothers (63.19%) are most likely to be married at the time of their infant's birth.

Access to both private and public forms of health insurance differs significantly based on race/ethnicity. FBMO, NHB, Native American, and other Hispanic mothers are least likely to have any form of health insurance. USMO mothers appear to have a slight advantage in having access to health insurance compared to the two other Hispanic ethnic groups. Prenatal care adequacy varies significantly based on race/ethnicity. No prenatal care is most common among Native American mothers (15.68%). Inadequate prenatal care is highest among NHB (19.01%), Native American (18.39%), and FBMO (17.44%) mothers. The vast majority of mothers experience normal weight gain during pregnancy. However, statistically significant differences exist in pregnancy weight gain based on maternal race/ethnicity. Rates of poor self-rated mental health vary marginally among the different racial/ethnic groups, while strong significant differences are noted in poor self-rated physical health among the different racial/ethnic groups. Native American mothers are most likely to report their mental health as poor, while FBMO mothers are most likely to report their physical health as poor. Native American (7.04%), NHB (6.70%), and NHW (5.74%) mothers have the highest rates of high pregnancy health risks. Smoking during pregnancy also varies based on maternal race/ethnicity, with Native American mothers most likely to smoke (15.60%) and FBMO mothers (0.23%) least likely to smoke.

### Logistic Regression Results

With only maternal race/ethnicity variables included in the logistic regression model (Model 1, Table 2), the odds of being LBW are 2.09 times higher (95% CI = 1.74–2.51) among NHB infants compared to NHW infants. No other significant differences in LBW among the other racial/ethnic groups and NHW infants were observed in this model.

Mothers less than 20 years of age at the time of birth have 42% higher odds (95% CI = 1.05–1.93) of having a LBW infant compared to mothers between the ages of 20 and 34 (Model 2, Table 2). Mothers over the age of 34 have 55% higher odds (95% CI = 1.28–1.98) of having a LBW infant compared to mothers between the ages of 20 and 34. While living below the poverty threshold does not have a significant association with LBW status, mothers living in families at 130% of poverty have 30% higher odds (95% CI = 1.01–1.67) of having a LBW infant while

**Table 1** Weighted percentage of singleton, normal for gestational age, low birthweight infants, sociodemographic characteristics, health risk factors and behaviors by mother's race/ethnicity with design effects, Early Childhood Longitudinal Study-Birth Cohort, $n \sim 7{,}800$

| | Non-Hispanic whites ($n \sim 3{,}400$) | Foreign-born Mexican origin ($n \sim 550$) | U.S.-born Mexican origin ($n \sim 350$) | Non-Hispanic black ($n \sim 1{,}250$) | Native American ($n \sim 500$) | Asian ($n \sim 1{,}350$) | Other Hispanics ($n \sim 400$) |
|---|---|---|---|---|---|---|---|
| Low Birthweight*** | 3.02 | 3.07 | 2.24 | 6.08 | 2.61 | 3.26 | 3.82 |
| *Sociodemographic characteristics* | | | | | | | |
| Mother's age*** | | | | | | | |
| Less than 20 | 5.17 | 7.83 | 14.57 | 12.66 | 11.80 | 3.22 | 8.99 |
| 20-34 | 74.84 | 78.74 | 76.43 | 74.14 | 79.85 | 73.74 | 77.39 |
| More than 34 | 19.99 | 13.43 | 9.00 | 13.20 | 8.35 | 23.04 | 13.62 |
| Mother's education*** | | | | | | | |
| Less than high school | 12.62 | 68.68 | 35.67 | 30.52 | 41.02 | 13.36 | 36.89 |
| High school diploma | 28.09 | 18.19 | 32.07 | 38.11 | 32.06 | 21.50 | 30.69 |
| Some college or more | 59.29 | 13.13 | 32.26 | 31.37 | 26.92 | 65.14 | 32.42 |
| Family Poverty Status Scale*** | | | | | | | |
| Lives below poverty threshold | 13.22 | 47.62 | 32.63 | 47.14 | 41.94 | 13.01 | 28.65 |
| At 130% of poverty | 9.29 | 22.11 | 12.64 | 12.02 | 11.03 | 9.22 | 13.67 |
| At 185% of poverty | 11.25 | 14.33 | 14.84 | 12.42 | 15.62 | 12.31 | 17.86 |
| Not in poverty | 66.24 | 15.94 | 39.89 | 28.42 | 31.41 | 65.46 | 39.82 |
| Marital status at birth*** | | | | | | | |
| Married | 78.60 | 63.19 | 53.95 | 34.31 | 36.37 | 85.62 | 53.19 |
| Not married | 21.40 | 36.81 | 46.05 | 65.69 | 63.63 | 14.38 | 46.81 |
| Mother used WIC in past 12 months*** | 27.23 | 69.26 | 57.11 | 64.57 | 62.27 | 23.83 | 48.30 |
| *Health care access and health status* | | | | | | | |
| Health insurance*** | | | | | | | |
| Any form of insurance | 64.36 | 33.51 | 47.10 | 26.44 | 32.45 | 63.16 | 38.77 |
| No coverage | 35.64 | 66.49 | 52.90 | 73.56 | 67.55 | 36.84 | 61.23 |
| Prenatal care adequacy*** | | | | | | | |
| No care | 2.24 | 7.94 | 7.04 | 4.31 | 15.68 | 4.55 | 7.17 |
| Inadequate care | 6.28 | 17.44 | 15.77 | 19.01 | 18.39 | 8.28 | 13.19 |
| Intermediate care | 14.85 | 14.32 | 13.50 | 10.77 | 13.43 | 15.85 | 14.18 |
| Adequate care | 45.70 | 34.00 | 34.95 | 35.30 | 31.49 | 43.81 | 40.33 |
| Adequate plus care | 30.93 | 26.30 | 28.74 | 30.61 | 21.01 | 27.51 | 25.13 |
| Pregnancy weight gain*** | | | | | | | |
| Weight gain low | 8.19 | 5.74 | 4.99 | 16.19 | 10.21 | 6.03 | 7.47 |
| Weight gain normal | 72.69 | 87.48 | 83.13 | 67.99 | 75.15 | 85.00 | 76.90 |
| Weight gain high | 19.12 | 6.78 | 11.88 | 15.82 | 14.64 | 8.97 | 15.63 |
| Poor self rated mental health* | 3.98 | 1.51 | 4.11 | 2.83 | 6.69 | 1.17 | 1.66 |
| Poor self rated health status *** | 5.34 | 13.07 | 9.87 | 8.17 | 12.61 | 5.26 | 8.67 |
| Maternal health complications*** | | | | | | | |
| No health risks | 71.19 | 80.62 | 82.33 | 68.24 | 67.91 | 78.15 | 73.09 |
| Low health risk | 23.07 | 16.81 | 15.09 | 25.06 | 25.05 | 18.37 | 24.71 |
| High health risk | 5.74 | 2.57 | 2.58 | 6.70 | 7.04 | 3.48 | 2.20 |
| *Health behaviors* | | | | | | | |
| Smoking during pregnancy*** | 13.78 | 0.23 | 2.46 | 6.66 | 15.60 | 1.93 | 3.58 |

*Weight* W1R0; * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$

**Table 2** Logistic regression models of race/ethnicity and low birthweight among singleton and normal for gestational age infants and other maternal covariates using Taylor series estimation with design effects, Early Childhood Longitudinal Study-Birth Cohort, $n \sim 7{,}800$ (OR = odds ratios; CI = confidence intervals)

| | Model 1 OR (95% CI) | Model 2 OR (95% CI) | Model 3 OR (95% CI) |
|---|---|---|---|
| *Race/ethnicity (ref = Non-Hispanic white)* | | | |
| Foreign-born Mexican-origin Hispanic | 1.02 (0.73–1.42) | 0.90 (0.63–1.27) | 1.04 (0.71–1.54) |
| U.S.-born Mexican-origin Hispanic | 0.74 (0.53–1.03) | 0.66 (0.47–0.92)** | 0.80 (0.56–1.12) |
| Non-Hispanic black | 2.09 (1.74–2.51)*** | 1.71 (1.35–2.16)*** | 1.58 (1.23–2.04)** |
| Native American | 0.85 (0.54–1.33) | 0.71 (0.45–1.13) | 0.67 (0.39–1.12) |
| Asian | 1.08 (0.80–1.47) | 1.10 (0.82–1.50) | 1.25 (0.88–1.80) |
| Other Hispanics | 1.27 (0.92–1.76) | 1.10 (0.78–1.55) | 1.34 (0.91–1.95) |
| *Sociodemographic characteristics* | | | |
| Mother's age (ref = 20–34 years) | | | |
| Less than 20 | | 1.42 (1.05–1.93)* | 1.70 (1.19–2.42)** |
| More than 34 | | 1.55 (1.21–1.98)** | 1.56 (1.20–2.04)** |
| Mother's education (ref = some college or more) | | | |
| Less than high school | | 1.20 (0.89–1.63) | 1.06 (0.78–1.46) |
| High school diploma | | 1.20 (0.94–1.54) | 1.11 (0.84–1.45) |
| Family poverty status (ref = not in poverty) | | | |
| Lives below poverty threshold | | 1.20 (0.94–1.52) | 1.00 (0.76–1.30) |
| At 130% of poverty | | 1.30 (1.01–1.67)* | 1.09 (0.80–1.49) |
| At 185% of poverty | | 1.37 (1.04–1.81)* | 1.25 (0.93–1.68) |
| Married at child's birth | | 0.69 (0.56–0.85)** | 0.74 (0.60–0.91)** |
| Mother used WIC in past 12 months | | 0.80 (0.65–0.99)* | 0.68 (0.53–0.86)** |
| *Health care access, health status & behaviors* | | | |
| Private or public health insurance coverage | | | 0.80 (0.64–1.01) |
| Prenatal care adequacy (ref = adequate care) | | | |
| No care | | | 3.99 (2.52–6.31)*** |
| Inadequate care | | | 2.43 (1.75–3.37)*** |
| Intermediate care | | | 0.86 (0.56–1.32) |
| Adequate plus care | | | 5.74 (4.49–7.34)*** |
| Pregnancy weight gain (ref = normal) | | | |
| Weight gain low | | | 2.32 (1.82–2.96)*** |
| Weight gain high | | | 0.39 (0.29–0.55)*** |
| Poor self rated mental health | | | 1.30 (0.79–2.14) |
| Poor self rated health status | | | 1.81 (1.39–2.37)*** |
| Maternal health complications (ref = no risk) | | | |
| Low health risk | | | 2.02 (1.62–2.52)*** |
| High health risk | | | 2.96 (2.14–4.09)*** |
| Smoking during pregnancy | | | 1.68 (1.30–2.17)*** |
| −2 log likelihood | 1045491.30 | 1034754.20 | 914196.93 |
| Degrees of freedom | 6 | 15 | 27 |

*Weight* W1R0; * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$

mothers at 185% of poverty have 37% higher odds (95% CI = 1.04–1.81) of LBW compared to non-poor mothers. Mothers married at the time of the infant's birth and using WIC for themselves in the past 12 months have lower odds of having a LBW infant. With the inclusion of all sociodemographic variables in Model 2, Table 2, two significant associations are noted between the racial/ethnic groups and LBW. USMO mothers have 34% lower odds (95% CI = 0.47–0.92) of having a LBW infant compared to NHW mothers, while NHB mothers have 71% higher odds (95% CI = 1.35–2.16) of having a LBW infant compared to NHW mothers.

With all covariates included in Model 3 in Table 2, relative poverty status does not have a significant association with LBW status. Mothers receiving no prenatal care, inadequate care or adequate plus care have much higher odds of having a LBW infant compared to mothers receiving adequate prenatal care. Low pregnancy weight gain increases the odds that an infant will be born LBW, while high pregnancy weight gain is protective against LBW, compared to mothers with normal weight gain during pregnancy. Poor maternal self-rated physical health increases the odds that an infant will be LBW by 81% (95% CI = 1.39–2.37). Additionally, low and high health risks measured by maternal heath complications during pregnancy increase the odds that an infant will be LBW compared to mothers experiencing no health risks. Smoking increases the odds of having a LBW infant by 68% (95% CI = 1.30–2.17) compared to mothers that do not smoke. Maternal WIC usage in the past 12 months continues to be protective against LBW in Model 3, Table 2. Only NHB mothers have higher odds of LBW compared to NHW mothers with all covariates included in the full model (Model 3, Table 2).

When the full set of covariates are used to estimate mean birthweights in grams based on maternal race/ethnicity using a general linear modeling approach (see Table 3), significant variation in actual birthweights were found among the racial/ethnic groups ($F$ value = 42.33, $P$ = <0.001). However, the minimum and maximum values for the predicted means do not indicate that any racial/ethnic group would be expected to have LBW infants with the controls for the sociodemographic, health care access, health status, and health behavior covariates included in the model.

Lastly, results from race-stratified logistic regression models indicate that different characteristics of mothers are associated with LBW status across the seven racial/ethnic groups (see Table 4). Advanced maternal age increases the odds of LBW among FBMO, USMO, and NHB mothers. Infants born to USMO mothers living in any of the three levels of relative poverty have higher odds of LBW compared to non-poor USMO mothers. Poverty does not influence the odds of LBW for any of the other racial/ethnic groups.

Maternal WIC usage in the past 12 months is protective against LBW for infants born to NHW, USMO, NHB, and Native American mothers. Among all of the covariates included in these models, each racial/ethnic group has statistically significant associations between prenatal care adequacy and LBW. Mothers of all races/ethnicities receiving adequate plus care have higher odds of LBW compared to mothers receiving adequate care. Additionally, NHW, FBMO, NHB, and Native American mothers receiving no prenatal care have higher odds of LBW compared to mothers of these races/ethnicities receiving adequate care. High maternal pregnancy health risks also increase the odds that an infant will be LBW for NHW, FBMO, USMO, NHB, Asian, and other Hispanic mothers compared to mothers in those racial/ethnic groups with no pregnancy health risks.

## Conclusions

Results from this analysis contribute to our understanding of racial/ethnic disparities in LBW for several reasons. First the data used for this analysis, the ECLS-B, are based on a nationally representative sample of births in the United States. Due to the complex sampling strategy employed in this data set, there are a rich set of biological, sociodemographic, health status and health behaviors, and psychosocial measures that can be used to more fully explore potential mechanisms that lead to infant health disparities. Second, this analysis used a diverse set of maternal racial/ethnic categories to assess differences in LBW outcomes in singleton, non-SGA infants. Based on information provided on the infant's birth certificate about

**Table 3** Predicted birthweight in grams by maternal race/ethnicity using general linear modeling and Taylor series estimation with design effects to test for significant differences in means[a] Early Childhood Longitudinal Study-Birth Cohort, $n \sim 7{,}800$

| Maternal race/ethnicity | Mean predicted birthweight (grams) | Standard deviation | Minimum–Maximum |
|---|---|---|---|
| Non-Hispanic white | 3389.79 | 155.58 | 2869.34–3725.07 |
| Foreign-born Mexican-origin Hispanic | 3344.20 | 122.61 | 3050.10–3715.02 |
| U.S.-born Mexican-origin Hispanic | 3355.13 | 136.27 | 3022.58–3734.58 |
| Non-Hispanic black | 3300.76 | 151.06 | 2906.99–3715.02 |
| Native American | 3333.46 | 139.46 | 2816.37–3708.25 |
| Asian | 3425.35 | 125.57 | 3000.07–3719.67 |
| Other Hispanics | 3365.36 | 139.22 | 2991.55–3725.07 |
| Grand mean = 3130.91 $F$ value = 42.33, $P$ = <.0001 | | | |

[a] Predicted means once all covariates included in Model 3, Table 2 are controlled for in the model

**Table 4** Race-specific logistic regression models of race/ethnicity and low birthweight among singleton and normal for gestational age infants and other maternal covariates using Taylor series estimation with design effects, Early Childhood Longitudinal Study-Birth Cohort (OR = odds ratios; CI = confidence intervals)

| | Non-Hispanic whites | Foreign-born Mexican-origin Hispanics | U.S.-born Mexican-origin Hispanics | Non-Hispanic black |
|---|---|---|---|---|
| *Sociodemographic characteristics* | | | | |
| Mother's age (ref = 20–34 years) | | | | |
| Less than 20 | 1.59 (0.86–2.95) | 2.20 (0.73–6.64) | 3.29 (0.95–11.32) | 1.46 (0.83–2.57) |
| More than 34 | 1.44 (0.99–2.11) | 2.91 (1.23–6.85)* | 15.89 (3.58–70.44)** | 1.69 (1.07–2.69)* |
| Mother's education (ref = some college or more) | | | | |
| Less than high school | 1.38 (0.83–2.31) | 0.61 (0.23–1.63) | 0.24 (0.07–0.81)* | 1.12 (0.62–2.35) |
| High school diploma | 1.31 (0.91–1.88) | 1.71 (0.47–6.30) | 0.59 (0.12–2.83) | 0.82 (0.52–1.28) |
| Family poverty status (ref = not in poverty) | | | | |
| Lives below poverty threshold | 0.93 (0.61–1.41) | 1.62 (0.55–4.81) | 5.90 (1.01–34.47)* | 0.92 (0.55–1.52) |
| At 130% of poverty | 1.01 (0.64–1.59) | 1.08 (0.28–4.17) | 35.83 (8.69–147.71)*** | 1.04 (0.55—1.97) |
| At 185% of poverty | 0.94 (0.62–1.45) | 2.08 (0.52–8.27) | 42.56 (13.00–139.35)*** | 1.61 (0.96–2.72) |
| Married at child's birth | 0.61 (0.43–0.89)** | 0.99 (0.49–1.98) | 1.04 (0.63–2.96) | 0.69 (0.43–1.11) |
| Mother used WIC in past 12 months | 0.67 (0.50–0.90)** | 1.69 (0.68–4.19) | 0.18 (0.05–0.73)* | 0.48 (0.33–0.71)** |
| *Health care access, health status & behaviors* | | | | |
| Any form of insurance (ref = no insurance) | 0.74 (0.55–0.99)* | 0.99 (0.38–2.58) | 0.28 (0.07–1.22) | 1.12 (0.72–1.74) |
| Prenatal care adequacy (ref = adequate care) | | | | |
| No care | 5.79 (2.89–11.49)*** | 7.62 (1.21–47.99)* | 7.22 (0.65–79.96) | 2.88 (1.14–7.27)* |
| Inadequate care | 4.13 (2.11–8.08)*** | 3.80 (0.93–15.45) | 8.14 (1.36–48.82)* | 1.04 (0.59–1.82) |
| Intermediate care | 0.80 (0.40–1.58) | 3.55 (0.67–18.84)** | 3.96 (1.52–10.27)** | 0.70 (0.32–1.57) |
| Adequate plus care | 6.55 (4.46–9.62)*** | 10.48 (2.89–37.99)** | 8.06 (3.01–21.59)*** | 3.90 (2.55–5.95)*** |
| Pregnancy weight gain (ref = normal) | | | | |
| Weight gain low | 1.99 (1.40–2.84)*** | 6.98 (2.43–20.54)** | 5.29 (2.46–11.37)*** | 2.46 (1.56–3.89)*** |
| Weight gain high | 0.36 (0.24–0.53)*** | 0.19 (0.03–1.14) | 0.16 (0.02–1.12) | 0.54 (0.27–1.08) |
| Poor self rated mental health | 1.22 (0.62–2.40) | 0.01 (0.00–0.01) | 2.46 (0.78–7.78) | 2.36 (1.03–5.40)* |
| Poor self rated health status | 1.64 (1.05–2.60)* | 1.55 (0.73–3.28) | 0.22 (0.02–2.39) | 2.50 (1.57–3.97)** |
| Maternal health complications (ref = no risk) | | | | |
| Low health risk | 2.11 (1.60–2.78)*** | 1.44 (0.58–3.54) | 5.05 (1.65–15.60)** | 2.03 (1.23–3.35)* |
| High health risk | 3.04 (2.09–4.42)*** | 4.08 (1.35–12.32)** | 33.38 (5.85–190.49)*** | 1.83 (1.04–3.21)* |
| Smoking during pregnancy | 1.34 (0.98–1.84) | 0.01 (0.00–0.01) | 49.73 (12.31–200.85)*** | 1.93 (0.96–3.89) |
| *n* (rounded to the nearest 50) | 3,400 | 550 | 350 | 1,250 |
| −2 log likelihood | 482501.84 | 75731.36 | 26392.85 | 199197.136 |
| Degrees of freedom | 21 | 21 | 21 | 21 |

| | Native Americans | Asians | Other Hispanics |
|---|---|---|---|
| *Sociodemographic characteristics* | | | |
| Mother's age (ref = 20-34 years) | | | |
| Less than 20 | 1.89 (0.50–6.80) | 2.44 (0.61–9.85) | 1.31 (0.59–2.17) |
| More than 34 | 0.35 (0.09–1.27) | 1.68 (0.87–3.26) | 0.96 (0.28–3.36) |
| Mother's education (ref = some college or more) | | | |
| Less than high school | 1.19 (0.32–4.40) | 1.46 (0.43–4.90) | 0.91 (0.27–3.13) |
| High school diploma | 1.65 (0.53–5.11) | 1.04 (0.51–2.09) | 1.48 (0.56–3.92) |
| Family poverty status (ref = not in poverty) | | | |
| Lives below poverty threshold | 0.92 (0.16–5.33) | 0.73 (0.20–2.62) | 1.40 (0.50–3.89) |
| At 130% of poverty | 0.01 (0.00–0.01) | 1.03 (0.38–2.79) | 0.89 (0.26–2.93) |
| At 185% of poverty | 0.37 (0.04–3.24) | 0.29 (0.08–1.03) | 1.69 (0.69-4.15) |

**Table 4** continued

| | Native Americans | Asians | Other Hispanics |
|---|---|---|---|
| Married at child's birth | 1.00 (0.39–2.59) | 1.17 (0.45–3.03) | 0.73 (0.25–2.08) |
| Mother used WIC in past 12 months | 0.27 (0.11–0.67)** | 1.14 (0.42–3.12) | 0.90 (0.42–1.91) |
| *Health care access, health status & behaviors* | | | |
| Any form of insurance (ref = no insurance) | 0.40 (0.15–1.07) | 1.00 (0.49–2.05) | 0.68 (0.29–1.59) |
| Prenatal care adequacy (ref = adequate care) | | | |
| No care | 7.64 (1.21–48.38)* | 3.39 (0.80–14.41) | 1.39 (0.14–13.91) |
| Inadequate care | 0.31 (0.04–2.86) | 3.06 (0.89–10.53) | 0.75 (0.14–13.91) |
| Intermediate care | 0.83 (0.07–10.39) | 0.81 (0.27–2.42) | 0.24 (0.04–1.37) |
| Adequate plus care | 4.89 (1.08–22.17)* | 3.96 (1.59–9.83)** | 8.58 (2022–22.11)*** |
| Pregnancy weight gain (ref = normal) | | | |
| Weight gain low | 1.29 (0.19–8.71) | 2.71 (1.09–6.73)* | 6.38 (2.08–19.61)*** |
| Weight gain high | 0.27 (0.03–2.73) | 0.71 (0.23–2.20) | 0.06 (0.01–0.26)*** |
| Mental illness | 1.18 (0.24–5.83) | 0.01 (0.00–0.01) | 0.28 (0.05–1.33) |
| Poor self rated health status | 1.96 (0.61–6.28) | 1.57 (0.58–4.29) | 2.70 (1.11–6.60)* |
| Maternal health complications (ref = no risk) | | | |
| Low health risk | 0.37 (0.09–1.56) | 2.93 (1.44–5.99)** | 1.97 (0.93–4.18) |
| High health risk | 2.36 (0.63–8.82) | 3.80 (1.38–10.51)** | 44.59 (15.76–126.17)*** |
| Smoking during pregnancy | 4.31 (1.24–15.02)* | 0.65 (0.14–3.12) | 3.17 (1.07–9.35)* |
| *n* (rounded to the nearest 50) | 500 | 1,350 | 400 |
| −2 log likelihood | 6378.54 | 31883.48 | 57446.44 |
| Degrees of freedom | 21 | 21 | 21 |

*Weight* W1R0; * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$

the mother and the subsequent parental survey, nativity and ethnicity were used to construct the seven different racial/ethnic categories used for this analysis. Racial/ethnic stratified analyses indicated that not all maternal characteristics operate in the same way across these racial/ethnic groups to influence LBW. Additionally the three different Hispanic groups included here showed different associations with individual covariates and the outcome. Research grouping Hispanic or Latino mothers together into one heterogeneous group thus runs the risk of masking associations noted between Hispanic individuals of specific ethnicities and infant health outcomes. While this research was able to assess associations between characteristics of Asian and Native American mothers and LBW, future research should explore the nativity and ethnicity relationships between LBW and other infant health outcomes for these heterogeneous racial groups at a national level. This type of research will help us to better understand the health advantages and/or disadvantages associated with individuals identifying with different ethnicities in these racial categories.

Third, the more descriptive component of the analysis indicates wide variation in the distribution of variables included in this analysis based on race/ethnicity. To some degree these differences are not surprising based on other empirical studies indicating differences in these characteristics based on race/ethnicity [5, 6, 16, 21, 23, 25, 26]. However, this analysis included a more comprehensive and diverse set of racial/ethnic groups in a single empirical analysis. These statistically significant differences across all variables indicate that more theoretical development is needed in determining the specific mechanisms leading to racial/ethnic LBW differentials and potentially other infant health outcomes. One interesting finding to emerge across the logistic regression models presented in Tables 2 and 4 is that a traditional measure of SES, operationalized in these models as maternal educational level, does not have a direct association with LBW. Alternatively, the measures of relative poverty operate differently across racial/ethnic groups in the race-stratified models (Table 4) while no direct association is observed in the full logistic regression model between the relative measures of poverty and LBW when all covariates are controlled (Model 3, Table 2). This implies that maternal health care access, health status, and health behaviors have stronger, direct associations with LBW regardless of a family's relative poverty status.

In the full sample logistic regression models, no LBW differences are noted between USMO, FBMO, and other Hispanic infants compared to NHW infants. Additionally Native American and Asian infants are shown to have similar odds of LBW compared to NHW infants with all variables included in the models. By limiting the sample to

only singleton, non-SGA infants, no statistically or substantively significant differences in LBW are observed for most of the racial/ethnic groups. It is interesting to note that when the distribution of SGA infants was examined across the seven racial-ethnic groups, no significant differences were found (results not shown). This would imply that racial disparities in LBW are not determined by differences in fetal development by race/ethnicity, but that more socially based measures may influence LBW differentials across racial/ethnic groups.

Two significant relationships noted in the full and race-stratified models deserve some discussion. First, WIC usage by women for their own nutrition needs during pregnancy is protective against LBW. While a NHB LBW disadvantage is noted compared to NHWs in the full model (Model 3, Table 2), maternal WIC usage lowers the odds that a mother will have a LBW infant. Therefore women of all races/ethnicities making use of WIC benefits during pregnancy have lower odds of LBW. The race-stratified models also show the protective benefit of maternal WIC usage against LBW for NHW, NHB, and Native American mothers. Almost 65% of NHB mothers make use of WIC benefits during their pregnancy. Increasing access to WIC benefits, particularly access to nutritious and appropriate food during pregnancy as part of this program, may be one way to reduce the black-white disparity noted in LBW. Second, prenatal care adequacy varies significantly across the seven racial/ethnic groups examined. Much like other research noting higher rates of poor birth outcomes among women receiving adequate plus care [33, 39–41], mothers of all races/ethnicities have much higher odds of LBW if they receive adequate plus care compared to mothers receiving adequate care. The bivariate results presented in Table 1 showed significant differences in prenatal care adequacy among the racial/ethnic categories. Further, higher odds of LBW are observed for NHW, FBMO, NHB, and Native American mothers receiving no prenatal care compared to women of each of these racial/ethnic groups receiving adequate prenatal care. These results demonstrate that equal access to appropriate prenatal care varies among racial/ethnic groups and eliminating the disparities in access to appropriate and adequate care may further reduce LBW among all races/ethnicities.

Policy implications based on results from this research indicate that differences associated with health care access, health behaviors, and maternal WIC usage lead to variation in infant health outcomes among a diverse set of racial/ethnic groups. Adequate and appropriate prenatal care must be made available to all pregnant women in an effort to identify potential health risks for the mother and her infant. Local providers of prenatal care should also consider working closely with WIC offices to give easier access to potential programs that would benefit the overall nutrition and health behaviors of pregnant women. The integration of prenatal care and social service delivery systems may serve as one mechanism to improve infant health outcomes by addressing the cumulative negative social, economic, and environmental insults that are disproportionately found among certain racial/ethnic minority groups [21, 42]. Most importantly, this research highlights the need to address racial/ethnic disparities in LBW by using approaches that can meet the unique needs of specific racial and ethnic groups instead of offering broad, comprehensive policies or programs that mask important associations with infant health outcomes in these diverse populations.

**Acknowledgements** The author gratefully acknowledges funding for this project from a Faculty Research Grant from the College of Public Policy at the University of Texas at San Antonio and a Faculty Summer Research Award from the San Antonio Health Services Research Program. This study was approved by the Institutional Review Board of the University of Texas at San Antonio.

## References

1. Markides, K. S., & Coreil, J. (1986). The health of Hispanics in the Southwestern United States—an epidemiologic paradox. *Public Health Reports, 101*, 253–265.
2. Collins, J. W., & Shay, D. K. (1994). Prevalence of low-birthweight among Hispanic infants with United States-born and foreign-born mothers—the effect of urban poverty. *American Journal of Epidemiology, 139*, 184–192.
3. Abrams, B., & Guendelman, S. (1995). Nutrient intake of Mexican-American and non-Hispanic white women by reproductive status—results of 2 national studies. *Journal of the American Dietetic Association, 95*, 916–918. doi:10.1016/S0002-8223(95)00253-7.
4. Guendelman, S., & Abrams, B. (1995). Dietary-intake among Mexican-American women: Generational differences and a comparison with white non-Hispanic women. *American Journal of Public Health, 85*, 20–25. doi:10.2105/AJPH.85.1.20.
5. Acevedo-Garcia, D., Soobader, M. J., & Berkman, L. F. (2005). The differential effect of foreign-born status on low birth weight by race/ethnicity and education. *Pediatrics, 115*, E20–E30.
6. Acevedo-Garcia, D., Soobader, M. J., & Berkman, L. F. (2007). Low birthweight among US Hispanic/Latino subgroups: The effect of maternal foreign-born status and education. *Social Science and Medicine, 65*, 2503–2516. doi:10.1016/j.socscimed.2007.06.033.
7. Weigers, M. E., & Sherraden, M. S. (2001). A critical examination of acculturation: The impact of health behaviors, social support and economic resources on birth weight among women of Mexican descent. *The International Migration Review, 35*, 804–839.
8. English, P. B., Kharrazi, M., & Guendelman, S. (1997). Pregnancy outcomes and risk factors in Mexican Americans: The effect of language use and mother's birthplace. *Ethnicity and Disease, 7*, 229–240.
9. Page, R. L. (2004). Positive pregnancy outcomes in Mexican immigrants: What can we learn? *Journal of Obstetric, Gynecologic, and Neonatal Nursing, 33*, 783–790. doi:10.1177/0884217504270595.
10. Goldman, N., Kimbro, R. T., Turra, C. M., & Pebley, A. R. (2006). Socioeconomic gradients in health for white and

Mexican-origin populations. *American Journal of Public Health, 96*, 2186–2193. doi:10.2105/AJPH.2005.062752.
11. Becerra, J. E., Hogue, C. J. R., Atrash, H. K., & Perez, N. (1991). Infant mortality among Hispanics: A portrait of heterogeneity. *Journal of the American Medical Association, 265*, 217–221. doi:10.1001/jama.265.2.217.
12. Engel, T., Alexander, G. R., & Leland, N. L. (1995). Pregnancy outcomes of United States-born Puerto Ricans: The role of maternal nativity status. *American Journal of Preventive Medicine, 11*, 34–39.
13. Hummer, R. A., Rogers, R. G., Amir, S. H., Forbes, D., & Frisbie, W. P. (2000). Mortality differentials among Hispanic subgroups and non-Hispanic whites. *Social Science Quarterly, 81*, 459–476.
14. Morales, L. S., Lara, M., Kington, R. S., Valdez, R. O., & Escarce, J. J. (2002). Socioeconomic, cultural, and behavioral factors affecting Hispanic health outcomes. *Journal of Health Care for the Poor and Underserved, 13*, 477–503. doi:10.1177/104920802762475120.
15. Kleinman, J. C., Fingerhut, L. A., & Prager, K. (1991). Differences in infant mortality by race, nativity status, and other maternal characteristics. *American Journal of Diseases of Children, 145*, 194–199.
16. Singh, G. K., & Yu, S. M. (2002). Adverse pregnancy outcomes: differences between U.S.- and foreign-born women in major U.S. racial and ethnic groups. In T. A. LaVeist (Ed.), *Race, ethnicity, and health: a public health reader* (pp. 265–279). San Francisco, CA: Jossey-Bass.
17. Ventura, S., & Taffel, S. (1985). Childbearing practices of U.S.-born and foreign-born Hispanic mothers. *Public Health Reports, 100*(64), 7–652.
18. Scribner, R., & Dwyer, J. H. (1989). Acculturation and low-birthweight among Latinos in the Hispanic HANES. *American Journal of Public Health, 79*, 1263–1267. doi:10.2105/AJPH.79.9.1263.
19. Franzini, L., Ribble, J. C., & Keddie, A. M. (2002). Understanding the Hispanic paradox. In T. A. LaVeist (Ed.), *Race, ethnicity, and health: a public health reader* (pp. 280–310). San Francisco, CA: Jossey-Bass.
20. Gould, J. B., Madan, A., Qin, C., & Chavez, G. (2003). Perinatal outcomes in two dissimilar immigrant populations in the United States: A dual epidemiologic paradox. *Pediatrics, 111*, E676–E682. doi:10.1542/peds.111.6.e676.
21. Reichman, N. E., Hamilton, E. R., Hummer, R. A., & Padilla, Y. C. (2008). Racial and ethnic disparities in low birthweight among urban unmarried mothers. *Maternal and Child Health Journal, 12*, 204–215. doi:10.1007/s10995-007-0240-1.
22. Schoendorf, K. C., Hogue, C. J. R., Kleinman, J. C., & Rowley, D. (1992). Mortality among infants of black compared to white college educated parents. *The New England Journal of Medicine, 326*, 1522–1526.
23. Colen, C. G., Geronimus, A. T., Bound, J., & James, S. A. (2006). Maternal upward socioeconomic mobility and black-white disparities in infant birthweight. *American Journal of Public Health, 96*, 2032–2039. doi:10.2105/AJPH.2005.076547.
24. Teitler, J. O., Reichman, N. E., Nepomnyaschy, L., & Martinson, M. (2007). A cross-national comparison of racial and ethnic disparities in low birth weight in the United States and England. *Pediatrics, 120*, E1182–E1189. doi:10.1542/peds.2006-3526.
25. Wang, X. B., Guyer, B., & Paige, D. M. (1994). Differences in gestational age-specific birth-weight among Chinese, Japanese, and white Americans. *International Journal of Epidemiology, 23*, 119–128. doi:10.1093/ije/23.1.119.
26. Rhoades, E. R., Brenneman, G., Lyle, J., & Handler, A. (1992). Mortality of American-Indian and Alaska Native infants. *Annual Review of Public Health, 13*, 269–285. doi:10.1146/annurev.pu.13.050192.001413.
27. U.S. Department of Education (Ed.). (2005). *User's manual for the ECLS-B nine-month private data file and electronic code book*. Washington, DC: U.S. Department of Education.
28. Geronimus, A. T. (1987). On teenage childbearing and neonatal mortality in United States. *Population and Development Review, 13*, 245–279. doi:10.2307/1973193.
29. Geronimus, A. T. (1996). Black/white differences in the relationship of maternal age to birthweight: A population-based test of the weathering hypothesis. *Social Science and Medicine, 42*, 589–597. doi:10.1016/0277-9536(95)00159-X.
30. Martin, J., Hamilton, B., Ventura, S., Menacker, F., & Park, M. (2002). Births: Final data for 2000. *National Vital Statistics Reports, 50*, 1–101.
31. Reichman, N. E., & Teitler, J. O. (2006). Paternal age as a risk factor for low birthweight. *American Journal of Public Health, 96*, 862–866. doi:10.2105/AJPH.2005.066324.
32. Kotelchuck, M. (1994). An evaluation of the Kessner Adequacy of Prenatal-Care Index and a proposed adequacy of prenatal-care utilization index. *American Journal of Public Health, 84*, 1414–1420. doi:10.2105/AJPH.84.9.1414.
33. Kotelchuck, M. (1994). The adequacy of prenatal-care utilization index—its US distribution and association with low birth weight. *American Journal of Public Health, 84*, 1486–1489. doi:10.2105/AJPH.84.9.1486.
34. Perreira, K. M., & Cortes, K. E. (2006). Race/ethnicity and nativity differences in alcohol and tobacco use during pregnancy. *American Journal of Public Health, 96*, 1629–1636. doi:10.2105/AJPH.2004.056598.
35. Ramakrishnan, U., Kuklina, E., & Stein, A. D. (2002). Iron stores and cardiovascular disease risk factors in women of reproductive age in the United States. *The American Journal of Clinical Nutrition, 76*, 1256–1260.
36. Ramos, R. G., & Olden, K. (2008). The prevalence of metabolic syndrome among US women of childbearing age. *American Journal of Public Health, 98*, 1122–1127. doi:10.2105/AJPH.2007.120055.
37. SAS. (2007). *SAS version 9.2*. Cary, NC: SAS Institute Inc.
38. An, A. B. (2002). Performing logistic regression on survey data with the new SURVEYLOGISTIC procedure. In *Proceedings of the twenty-seventh annual SAS® users group international conference*. Orlando, FL: SAS Institute Inc.
39. Shi, L. Y., Stevens, G. D., Wulu, J. T., Politzer, R. M., & Xu, J. H. (2004). America's health centers: Reducing racial and ethnic disparities in perinatal care and birth outcomes. *Health Services Research, 39*, 1881–1901. doi:10.1111/j.1475-6773.2004.00323.x.
40. Sparks, P. J. (2009). Do biological, sociodemographic, and behavioral characteristics explain racial/ethnic disparities in preterm births? *Social Science & Medicine*, *68*(9), 1667–1675.
41. Vintzileos, A. M., Ananth, C. V., Smulian, J. C., Scorza, W. E., & Knuppel, R. A. (2002). The impact of prenatal care in the United States on preterm births in the presence and absence of antenatal high-risk conditions. *American Journal of Obstetrics and Gynecology, 187*, 1254–1257. doi:10.1067/mob.2002.127140.
42. Lu, M. C., & Halfon, N. (2003). Racial and ethnic disparities in birth outcomes: A life-course perspective. *Maternal and Child Health Journal, 7*, 13–30. doi:10.1023/A:1022537516969.