## Abstract

Recent high-profile articles highlight increasing mortality rates among low-educated White Americans, raising concern about the overall poor health of this sociodemographic group. But how does the population health of both low-educated and highly-educated African Americans and Mexican Americans compared with both low-educated and highly-educated Whites? This paper examines racial/ethnic-education disparities in infant mortality, a key measure of population health. Using 2007-10 linked birth and infant death cohort files, we find that while education-specific infant mortality rates are similar for Mexican Americans and Whites, infants of college-educated African American women experience 46 percent higher mortality than infants of White women with a high school degree or less. Compared with infants of White women with a high school degree or less, infants of African American women with the same level of education exhibit more than twice the rate of mortality. The high rate of infant mortality among infants born to African American women is fully accounted for by their shorter gestational lengths than the other groups, implicating the racialized stress process. Analysis of ancillary data from Add Health shows that both low and high educated African American women exhibit substantial socioeconomic, contextual, psychosocial, and health disadvantages across the life course relative to low-educated White women, highlighting heightened patterns of long-term stress exposure for African American women of all educational levels. The findings suggest that recent focus on the increasing mortality of low-educated Whites, while important and real, should not detract attention from the disadvantaged health of African Americans of all educational levels.

**Keywords**: Race/ethnicity, Infant Mortality, Health, Education

## Introduction

Recent high-profile studies document increasing mortality rates in the United States (US) among White adults with a high school education or less (Case and Deaton 2015, 2017). While this problematic mortality trend is disturbing and worthy of scholarly and policy attention, it remains unclear how the population health of low-educated Whites compares with that of low-educated African Americans and Mexican Americans in the contemporary US. Do low educated members of these racial/ethnic minority groups now exhibit a population health advantage relative to low educated Whites? Equally interesting is how the population health of low-educated Whites compares with their highly-educated African American and Mexican American counterparts. Do highly-educated African Americans and Mexican Americans exhibit modest or even substantial population health advantages relative to low-educated Whites? In a provocative interview on National Public Radio (Boddy and Greene 2017), Nobel Prize winning economist Angus Deaton summarized that, "It's as if poorly educated White Americans have now taken over from African Americans as the lowest rung of society in terms of mortality rates." If true, this raises important theoretical and policy issues that have been overlooked in the sociological, demographic, and population health literatures. Answers to the above questions have important implications for debates surrounding race/ethnicity, social stratification, and health in the contemporary US.

The current paper addresses these questions with an emphasis on racial/ethnic-education disparities in infant mortality. Infant mortality remains a key indicator of population health in the US and around the world, given that infants completely depend upon the society around them for health and survival. But few studies examine disparities in infant mortality for subgroups defined by both race/ethnicity and maternal education (e.g., White women with a high school degree or less, African American women with a bachelor's degree or more), and none to our knowledge investigate specifically how racial/ethnic-education groups compare with low-educated Whites.

Focusing on groups defined by race/ethnicity and educational attainment (and, in our case, gender given this paper's emphasis on infant mortality and its close connection with maternal health) also aligns well with recent scholarship that conceptualizes race/ethnicity, socioeconomic status (SES), and gender as intersecting identities that interact to influence the health of individuals (Brown 2018; Author, Date; Richardson and Brown 2016).

This study employs data from the 2007-10 US linked birth and infant death (BID) cohort files and the National Longitudinal Study of Adolescent to Adult Health (Add Health) to better understand population health disparities between US-born African American, Mexican American, and White women across three levels of educational attainment: high school degree or less, some college, and college degree or higher. Thus, we compare nine population subgroups and examine differences between low-educated Whites and the other eight racial/ethnic-education groups. We first assess whether sociodemographic, maternal behavioral, and infant health characteristics available in the BID data account for infant mortality disparities across these groups. Second, we use data from Add Health (Harris and Udry 2013) to explore a rich set of measures that vary by race/ethnicity-education and are associated with women's health, including socioeconomic, social, contextual, psychosocial, and biobehavioral factors. We draw on data from both adolescence and adulthood to provide insight on the life course factors associated with population health disparities between racial/ethnic-education groups of women of childbearing age. Together, our findings from the two data sets strongly suggest that recent focus on the increasing mortality of low-educated Whites, while important and real, should not detract scientific and policy attention from the continued disadvantaged population health prospects of African Americans of all educational levels.

## Prior Studies

US infant mortality rates (IMR) vary by maternal educational attainment: infants born to women with relatively low education (e.g., a high school degree or less) have roughly twice the probability of dying in the first year of life compared with infants born to women with a college degree or more (Gage et al. 2013; Sosnaud 2019). Furthermore, there is a persistent and substantial African American-White disparity in infant mortality. While IMRs have fallen impressively for all race/ethnic subpopulations over recent decades, with the declines largely attributable to specific public health programs and medical innovations (Frisbie et al. 2010; Author, Date), high rates persist for infants born to African American women (11.7 per 1000 live births) compared with infants born to White women (4.8) (Riddell, Harper, and Kaufman 2017).

Infant mortality disparities between Whites and most other race/ethnic groups are less pronounced. For example, infants of US-born Mexican American women recently exhibited a nine percent higher IMR compared with infants of US-born White women (Author, Date). This disparity may be due to educational composition differences between groups. Indeed, previous research indicates that US-born Mexican Americans have substantially lower levels of educational attainment than Whites (Author, Date)), which likely contributes to the observed difference in infant mortality risk between these groups.

Following the theme of differential educational attainment as a key potential explanation for racial/ethnic disparities in infant mortality, much scholarship in this area has emphasized the extent to which differences in socioeconomic and demographic factors affect the African American-White disparity. The overall lower SES of African American women relative to their White counterparts—due to the historical and continued influences of racism on educational attainment, earnings, income, and wealth holdings among African Americans (Author, Date);

Phelan and Link 2015; Williams 2012)—is undoubtedly an important reason for the IMR disparity. However, common controls for SES offer an incomplete explanation, as documented by many articles on this issue (Elder et al. 2014, 2016; Author, Date; Loggins and Andrade 2014). For example, Elder et al. (2014) found that a wide set of controls for SES (i.e., maternal education), demographic factors (i.e., maternal age, marital status, previous pregnancy loss, birth order, and plurality), and prenatal health behaviors explained only 25 percent of the infant mortality disparity between African Americans and Whites.

Other literature, mainly in public health and medical journals, shows that the high rate of infant mortality experienced by African Americans relative to their White counterparts is strongly related to the higher proportion of African American babies who are born prematurely and/or at very low weights (e.g., Butler and Behrman 2007; Saigal and Doyle 2008; Schempf et al. 2007). While crucial to understand, such work tends to overlook the life course-based socioeconomic, psychosocial, contextual, and health factors that place African American women at higher risk of adverse birth outcomes (i.e., higher rates of prematurity and low birthweight) than White women. These factors may be the structural underpinnings of higher levels of mortality among infants born to African American women.

No study to date has fully explained the African American-White disparity in infant mortality. Moreover, few studies have focused specifically on African American and White women with different levels of educational attainment. The two most closely related papers to the current effort is the landmark study by Schoendorf and colleagues (1992) and the recent paper by Green and Hamilton (2018). Schoendorf et al. (1992) used national data on births and infant deaths from 1983-85 and found that infants of college-educated African American parents died at 1.8 times the rate compared with infants of college-educated White parents. Equalizing educational attainment across groups at that time did not eliminate infant mortality disparities. The authors speculated that racial differences in maternal health and infant perinatal care might have contributed to the stark IMR difference between the two groups of college educated parents. Given that the data used from that study are now over 30 years old, preceding the impressive declines in infant mortality and substantial gains in life expectancy among African Americans relative to Whites (Arias and Xu 2018), it is possible that the racial disparity in infant mortality among highly-educated women is smaller than it was in the mid-1980s. Moreover, Schoendorf et al. (1992) did not make comparisons between relatively low educated African Americans and Whites, among whom recent scholarly and media attention has focused and among whom rates of infant mortality are the highest.

More recently, Green and Hamilton (2018) investigated the intersection of maternal race/ethnicity and educational attainment as predictors of US infant mortality. Using data from the late 1990s and early 2000s, they demonstrated that educational gradients in infant mortality were larger for Whites than for racial/ethnic minority groups. Among college-educated women, US-born Whites exhibited the lowest rate of infant mortality (2.85 deaths per 1,000 births), US-born Hispanics were slightly higher (3.12), and African Americans (8.76) were substantially higher. At lower levels of education, the most favorable rate was exhibited among US-born Hispanic women, with Whites and African Americans significantly higher. Their findings strongly suggested differences in the health returns of educational attainment across groups, with Whites benefitting most from high levels of education and African Americans and other non-White groups benefitting least. Earlier research has observed similar patterns (Din-Dzietham and Irva Hertz-Picciotto 1998; Gage et al. 2013; Kimbro et al. 2008).

## Conceptual Framework and Expectations

The infant mortality rate has long been considered a social mirror – a reflection of how society cares for its most vulnerable individuals (Wise and Pursley 1992; Yankauer 1990). As such, racial/ethnic and education-based disparities in infant mortality help to illuminate inequalities that result in life and death outcomes for the youngest members of society (Eberstein 1989). Given that women's health is so tightly coupled with infant health and survival, the understanding of infant mortality disparities in American society necessitates emphasis on the life course processes that are associated with conditions for women's health and childbearing outcomes (Geronimus 1992; Lu and Halfon 2003; Strutz et al. 2014).

Based on the previous research reviewed above and a life course perspective for understanding disparities in maternal/infant health outcomes, we consider five potential explanations for understanding contemporary racial/ethnic-education disparities in infant mortality and develop expectations related to each of them. The first is stimulated by the recent work of Case and Deaton (2015, 2017) demonstrating an increase in the young adult and midlife mortality rates among low-educated Whites alongside decreases in the young adult and midlife mortality rates for African Americans and Mexican Americans. Such trends, if applicable to infant mortality, may result in a convergence of racial/ethnic disparities, particularly when comparing low-educated Whites with low-educated African Americans and Mexican Americans. Thus, while highly educated White women may continue to experience a population health advantage relative to African American and Mexican American women with a similar level of education, low educated White women may no longer have a health advantage in comparison with African American and Mexican American women with comparable levels of education. This expectation stems from the idea of increased stress and despair among low-educated Whites in the 21st century (Case and Deaton 2015, 2017), which has placed the population health prospects of this group on par with or even disadvantaged to low-educated African Americans and Mexican Americans. We refer to this as the low-educated White disadvantage hypothesis.

The second potential explanation, which we term the classic socioeconomic hypothesis, contends that racial/ethnic disparities in infant mortality are driven by group differences in educational attainment. Thus, once educational attainment is statistically equalized across groups, racial/ethnic disparities in infant mortality will disappear. This hypothesis is consistent with the idea that educational attainment is a fundamental cause of health and mortality (Link and Phelan 1995; Phelan et al. 2010), and that educational attainment operates similarly for all racial/ethnic groups. Fundamental cause theory argues that differences in educational attainment across groups influences the availability of flexible resources that can be used to protect health. This unequal availability of resources leads to inequalities in health risks, such as health behaviors, stress, and access to important social networks and high-quality medical care. Thus, equating the powerful influence of educational attainment across groups will yield similar risks of infant mortality for Whites, African Americans, and Mexican Americans. Given previous research that has tested this hypothesis (Elder et al. 2014; Green and Hamilton 2018; Author, Date; Schoendorf et al. 1992), we do not expect it to receive strong support when comparing African American and White women. Nonetheless, we use the latest available data and test the hypothesis for both the African American-White and Mexican American-White contrasts to provide the most updated assessment.

Third, group differences in sociodemographic and behavioral characteristics may also account for racial/ethnic-education infant mortality disparities. For example, higher levels of unmarried and high parity women may help account for higher levels of infant mortality among racial/ethnic minority women relative to Whites. Alternatively, racial/ethnic differences in prenatal smoking and initiation of prenatal care may also contribute to these infant mortality disparities. Yet prior research has found that these sociodemographic and behavioral differences only play a modest role in African American-White infant mortality gaps (Elder et al. 2011; Author, Date; Giscombé and Lobel 2005; Author, Date). Thus, we test whether the sociodemographic characteristics hypothesis and the behavioral hypothesis explain racial/ethnic-education disparities in infant mortality, while recognizing that previous studies have not provided strong support for either of them (Elder et al. 2011; Author, Date; Author, Date).

Fourth, a large body of research suggests that differences in infant health, as measured by gestational age and birthweight, account for the vast majority of African American-White American infant mortality differences (Butler and Behrman 2007; Elder et al. 2011; Saigal and Doyle 2008; Schempf et al. 2007). We refer to this as the prematurity hypothesis. Adverse birth outcomes such as preterm birth (i.e., short gestational age) and low birthweight have long been conceptualized as the most important proximate determinants of infant mortality (Solis et al. 2000). As such, we expect that controlling for gestational length and birth weight will work to eliminate differences in infant mortality between racial/ethnic-education groups. If this is the case, it provides important insight into the key biological mechanism that is associated with racial/ethnic-education disparities in infant mortality. At the same time, however, it does not answer the question of why there may be differences in adverse birth outcomes between racial/ethnic-education groups in the first place, to which we now turn.

Finally, most prior empirical work indicates that there are racial/ethnic disparities in both adverse birth outcomes and infant mortality even after controlling for demographic, socioeconomic, and behavioral differences between groups. Since the seminal Schoendorf et al.

(1992) study documenting wide Black-White differences in infant mortality among college educated parents, researchers have speculated on life course differences between groups defined by both race/ethnicity and educational attainment that may be associated with both adverse birth outcomes and infant mortality. This informs our final expectation, labeled the within education-level inequality hypothesis, which posits that there are substantial differences in the life courses of individuals across racial/ethnic groups, even within the same level of educational attainment, that work together to produce disparities in population health outcomes (Boen 2016; Farmer and Ferraro 2005). Within education-level racial/ethnic inequalities may be driven by disparities in socioeconomic factors (e.g., income, wealth, neighborhood SES), earlier life socioeconomic status (e.g., parental SES), life course stress exposures (e.g., differences in parental incarceration, experiences with discrimination), or the neighborhoods and schools within which individuals were raised. For example, past literature has documented wide African American-White differences in earnings and wealth at a given level of education (Card and Krueger 1992; Heckman, Lyons, and Todd 2000; Leicht 2008; Western and Pettit 2005; Williams et al. 2010). It is unlikely, however, that financial inequality fully accounts for this gap; prior literature finds reduced birthweight returns to income for blacks relative to whites (Colen et al. 2006). Other research suggests that racial/ethnic-education differences in neighborhood context stemming from historical segregation patterns that continue to persist to the present day may play an important major role in generating African American-White American health disparities (Massey and Denton 1993; Osypuk and Acevedo-Garcia 2010). Additional literature contends that high rates of incarceration among African Americans may account for a substantial portion of the African American-White infant mortality gap (Wildeman 2012). Moreover, African American women may be exposed to much higher levels of life course stress and lower quality healthcare based on discrimination than their White counterparts, which take a substantial toll on physiological well-being during pregnancy and childbearing (Earnshaw et al. 2011; Geronimus et al. 2006; Rosenthal and Lobel 2011; Turner and Avison 2003). These forms of racial/ethnic inequality may unfold across the life-course, meaning that basic measures of current SES (e.g., educational attainment) and other sociodemographic and behavioral factors are insufficient in accounting for the ways that racial/ethnic inequalities operate to influence population health, even within equivalent educational levels (Boen 2016). In sum, the "within education-level inequality" hypothesis posits that infant mortality rates will be higher among African American and Mexican American women compared to White women with similar levels of education. Moreover, this hypothesis postulates that African Americans and Mexican Americans will exhibit substantial disadvantages throughout the life course based socioeconomic, contextual, psychosocial, and health characteristics relative to their White counterparts with the same level of educational attainment.

In sum, our research addresses whether the health plight of low educated whites exceeds the health disadvantages experienced by African Americans and Mexican Americans by examining the relationship between race/ethnicity, maternal education and infant mortality in the United States. We propose several potential explanations for these infant mortality patterns: low-educated White disadvantage, educational inequality, demographic characteristics and health behaviors, infant health, and, lastly, within education-level inequality.

## Data, Measures, and Methods

*Data.* We first use data from the National Center for Health Statistics (NCHS) linked birth and infant death (BID) cohort files for 2007 through 2010. These files include all recorded births in the US during those four years. Death certificate information for infants who were born during those four years but who died before their first birthday is linked back to their corresponding birth certificate to create a cohort-based file. The linkage rate is exceptional: 98 to 99 percent of deaths occurring to infants born in 2007 through 2010 were successfully linked (CDC 2012, 2014a, 2014b, 2015). The complete 2007-10 BID dataset includes information on over 16,000,000 births, among whom over 100,000 died prior to their first birthday.

We restrict our analytic file to infants born to US-born women to reduce heterogeneity in educational experiences for women who were born outside the country.[1] We include births to women who identified as African American, Mexican American, or White on the infant birth certificates, and excluded smaller racial/ethnic groups. In addition, we exclude births to women under age 25 to effectively assess completed educational attainment.[2] Our analytic file is also restricted to births among women who are residents of the 50 US states or Washington, DC. Finally, we dropped cases with missing maternal education. Our final analytic file includes 7,215,833 births, of whom 40,970 died during the first year of life.

We use five rounds of chained multiple imputation to preserve cases with missing data. Information on maternal smoking and timing of prenatal care use is missing from specific states and thus is imputed more frequently; all other variables have less than one percent of missing cases. We weight our descriptive statistics and regression analyses to account for the very small number of infant deaths that were not linked to a birth certificate. NCHS provides these weights, which allows us to correct for slightly varying linkage success rates across states.

*Measures.* Infant death within the first year of life (versus survival) is the outcome in our analysis and is measured dichotomously (1=infant death). We specify three maternal racial/ethnic categories: non-Hispanic African American, Mexican American, and non-Hispanic

White. We then disaggregate these racial/ethnic groups by education status: high school degree or less, some college, and bachelor's degree or more. This yields nine racial/ethnic-education subgroups; infants born to White women with a high school degree or less serve as the reference group.

Our regression analysis includes demographic, behavioral, and infant health characteristics that help explain infant mortality disparities by race/ethnicity-education. Demographic information includes marital status, plurality, parity, and maternal age. We measure plurality as a dummy variable and differentiate single (referent) versus multiple births. We code parity into three categories: first birth (referent), 2-3, and 4+. Maternal age at time of birth is broken into 25-29 (referent), 30-34, 35-39, and 40+. We consider two behavioral characteristics during pregnancy. Initiation of prenatal care (PNC) is divided into three categories: first trimester (referent), second trimester, third trimester or no prenatal care.[3] Maternal prenatal tobacco use is measured dichotomously (yes/no, with no as the referent). Infant health is assessed with gestational age at birth, measured in weeks, and birth weight. A z-score of birth weight is used to purge the correlation between gestational age and birth weight. To construct this z-score, we subtract each infant's birth weight from the mean birth weight for all births from 2007-2010 at each specific weekly gestational age, and then divide the difference by the standard deviation of birth weight at that gestational age. Thus, a z-score of 0.50 for an infant born at 40 weeks of gestational age is interpreted as half of a standard deviation of birthweight above the average birthweight at 40 weeks of gestational age. For similar coding, see Solis et al. (2000).

*Methods.* First, we calculate IMRs by racial/ethnic-education group to describe basic disparities in infant mortality. This description allows us to document racial/ethnic-education group differences and assess if births to low-educated White women are at an especially high risk of death, thus testing the low-educated White disadvantaged hypothesis. This basic description also allows us to determine if group differences in educational attainment drives racial/ethnic differences in infant mortality, thus addressing the classic socioeconomic hypothesis. Second, we estimate logistic regression models of infant mortality. Our first model estimates baseline disparities across racial/ethnic-education subgroups. The second model includes controls for demographic characteristics, including marital status, birth order, plurality, and maternal age at birth. This model tests the notion that racial/ethnic-education disparities in infant mortality are due to the demographic composition of births occurring in each subgroup. The third model includes information on initiation of prenatal care and prenatal smoking, thus testing a behaviorally-based explanation for the disparities. The fourth model includes a variable for gestational age, and the fifth model includes birthweight z-scores. These final two models assess whether racial/ethnic-education disparities are due to group differences in the physiological processes that produce gestational length and low birthweight. All results are displayed as odds ratios.

*Supplementary Add Health Analysis*. BID data lack detailed information on mechanisms for racial/ethnic inequality in infant mortality. We therefore turn to the rich information provided by the National Longitudinal Study of Adolescent to Adult Health (Add Health) to document the extent to which life course patterns of socioeconomic, social, behavioral, psychosocial, and health factors may provide insight to the observed patterns of infant mortality, thus providing insight on the within-education inequality hypothesis.

Add Health is a longitudinal study of a nationally representative sample of 20,745 US adolescents in grades 7-12 during the 1994-95 school year, with follow-up interviews in 1996, 2001-02, and 2008-09 (Harris and Udry 2013). The age range (24-32) of Add Health respondents at Wave IV and its collection period in 2008-09 suitably complement the BID files. We draw on 1,762 US-born African American, 504 US-born Mexican American, and 4,256 US-born White women with different educational backgrounds (N=6,522) to examine disparities in socioeconomic, social, contextual, behavioral, psychosocial, and health characteristics both in adolescence (Wave 1; respondents aged 12-19) and in young adulthood (Wave IV; respondents aged 24-32). To parallel our analysis of the BID files, we disaggregate race/ethnicity by three categories of educational attainment. We use 95 percent confidence intervals to compare socioeconomic, psychosocial, behavioral and health characteristics by race/ethnicity-education, treating White women with a high school degree or less as the reference group.

## Results

The first column of Table 1 provides IMRs by race/ethnicity for women aged 25 and above. IMRs are highest among infants born to African American women (12.74 deaths per 1,000 births), followed by infants born to Mexican American women (5.44) and infants born to White women (4.59). The second column of Table 1 shows the educational composition for each group. African American and Mexican American women have lower levels of educational attainment than White women. Forty-four percent of African Americans and 47 percent of Mexican Americans but just 23 percent of Whites have a high school degree or less. The third column of Table 1 shows the IMRs for each racial/ethnic-education subgroup, with rate ratios (compared to Whites with a high school degree or less) presented in the fourth column. Within each racial/ethnic group, infants born to women with higher levels of education have lower IMRs, as expected. But the IMR for infants born to African American women in each educational attainment subgroup is substantially higher than for infants born to White women with a high school degree or less. Indeed, infants of college-educated Black women experience 46 percent higher mortality when compared to infants of White women with a high school degree or less. Moreover, infants of Black women with a high school degree or less exhibit more than twice the rate of mortality than White women with a high school degree or less. These Black-White disparities do not support either the low-educated White disadvantage hypothesis or the classic socioeconomic hypothesis. In contrast, education-specific IMRs for Mexican Americans are very similar to those of Whites, which supports the classic socioeconomic hypothesis for the disparity between Mexican Americans and Whites.

**Table 1 about here**

Table 2 turns to the logistic regression models, which present odds ratios of infant mortality by race/ethnicity-education. Model 1 displays results from the bivariate model that reiterate Table 1's IMR disparities. Introducing controls for demographic characteristics in Model 2 modestly attenuates infant mortality disparities between African Americans and Whites. For example, compared to White women with a high school degree or less, the odds ratio for African American women with a bachelor's degree or more declines from 1.47 to 1.36 in Models 1 and 2, respectively. In contrast, the odds ratios for Mexican Americans at each educational level remain strikingly similar to those of Whites at each educational level. The introduction of controls for initiation of prenatal care and smoking (Model 3) exacerbate the gaps between Blacks and low-educated Whites, indicating that controlling for behavioral factors widens rather than narrows the observed disparities. For example, compared to White women with a high school degree or less, the odds ratio of infant mortality for African American women with a bachelor's degree or more increases from 1.36 to 1.50. In contrast with the health behavior hypothesis, African American women are somewhat protected by low smoking rates from infant mortality. The odds ratios for all Mexican American women and the odds ratios for highly educated White women exhibit only modest changes when comparing Model 3 with Model 2. The results from these models provide modest support for the sociodemographic and health behavior hypotheses.

**Table 2 about here**

Controlling for gestational age (Model 4) reverses the African American-White disparity in the odds of infant mortality; net of gestational age, the odds ratios of infant mortality for all African American women, regardless of educational attainment, are either equal to or lower than those of White women with a high school degree or less. For example, the odds ratio for African American women with a bachelor's degree or more reverse from 1.50 to 0.91 with the inclusion of gestational age in the model (see Models 3 and 4). Consistent with the prematurity hypothesis, this finding underscores the importance of gestational length in the higher odds of infant mortality among African American women across all levels of educational attainment.[4] Net of gestational length, Mexican American women of all educational attainments and White women with more than a high school degree also exhibit lower odds of infant mortality relative to White women with a high school degree or less. The introduction of birthweight in Model 5 further widens the net advantage in infant mortality among all African American and Mexican American, as well as highly educated White women relative to White women with a high school degree or less. In sum, findings from these logistic regression models provide strong evidence in support of the prematurity hypothesis for understanding racial/ethnic-education disparities in infant mortality.

## Racial/Ethnic-Education Disparities in the Life Courses of Childbearing Age Women: Supplementary Add Health Analyses

Table 3 assesses evidence regarding the within-education-level hypothesis by presenting racial/ethnic-education disparities in socioeconomic and contextual characteristics when Add Health respondents were adolescents (Wave I). Clearly, African American women who obtained a college degree in adulthood exhibited much lower socioeconomic status in adolescence than White and Mexican American women who obtained a college degree in adulthood; moreover, as adolescents, highly educated African American women were more socioeconomically similar to White women who ended up with a high school degree or less. Indeed, compared with White women who eventually completed a high school degree or less, African American women who eventually completed a bachelor's degree or more exhibited no difference in median household income (during adolescence). Their median income was also much lower than that of White women who eventually completed a bachelor's degree. In contrast, African American adolescents who eventually obtained less than a bachelor's degree had lower median incomes (during adolescence) than White women with less than a high school degree. Mexican American women, on the other hand, had similar adolescent socioeconomic characteristics to White women who eventually obtained the same education level.

**Table 3 about here**

During adolescence, African American women from all education subgroups lived in more disadvantaged neighborhoods and attended similar or more disadvantaged schools than White women who ended up with a high school degree or less. For example, African American women who achieved a bachelor's degree or more lived in neighborhoods with similar median incomes, higher unemployment rates, and higher poverty rates compared to low-educated White women. Furthermore, African American women who eventually earned a college degree or more on average attended schools where 38% of students received free or reduced price lunch compared with 27% for White women who eventually earned a high school degree or less. In contrast, Mexican Americans from all education levels experienced less contextual disadvantage than African Americans, with similar median incomes, unemployment rates, and poverty rates as White women who achieved a high school degree or less. Thus, we find that African American women who went on to earn a college degree or more exhibited disadvantaged socioeconomic, school, and neighborhood characteristics relative to White women who completed only a high school degree or less by young adulthood. Moreover, African American women who eventually earned some college (but no bachelor's degree) and those who went on to earn a high school degree or less exhibited pronounced socioeconomic, school, and neighborhood disadvantages compared with low educated Whites. The disadvantages exhibited by African American women in adolescence, even those who went on to achieve a college degree or more, mirror the patterns of infant mortality shown above in Table 1.

Table 4 presents characteristics of these same women in young adulthood. First, we turn to information on household income and assets. Although African American women who had completed a bachelor's degree or more have a higher income and similar assets relative to White women with a high school degree or less, they have much lower income and fewer assets than Whites and Mexican women with a bachelor's degree or more. Moreover, lower educated African American women (e.g., completed some college or a high school degree or less) have substantially disadvantaged income and asset profiles compared with White women with a high school degree or less. In contrast, Mexican American women have similar (in one instance more favorable) income and asset profiles to their White counterparts who have completed the same level of education. In sum, African American women are clearly economically disadvantaged relative to Mexican American and White women who have completed the same level of education by young adulthood.

**Table 4 about here**

African American women of all educational attainment levels exhibit substantial disadvantages in neighborhood characteristics during young adulthood compared with similarly-educated White women. Strikingly, African American women with a bachelor's degree or more have a similar neighborhood profile to Whites with a high school degree or less; their neighborhood median incomes and unemployment rates do not differ. African American women with a bachelor's degree have higher levels of neighborhood disadvantage than White women with some college or bachelor's degree. Moreover, African American women with less than a bachelor's degree exhibit substantial disadvantages in neighborhood median income, unemployment, poverty, and proportion of single mothers relative to low-educated Whites. African American women, regardless of educational attainment, also tend to live in neighborhoods that are less than 50 percent White. In contrast, Mexican American women of all educational attainment levels live in neighborhoods that are over 60 percent White.

Table 4 next examines psychosocial characteristics by race/ethnicity-education. Compared with White women with a high school degree or less, African American women with a bachelor's degree or more report fewer stressors and depressive symptoms, but similar rates of victimization, parental death, and parental incarceration; and African American women who have completed some college or a high school degree or less report much higher rates of victimization and are more likely to have had a parent die or imprisoned than low-educated Whites. In contrast, compared to White women with a high school degree or less, Mexican

American women who have completed some college or a bachelor's degree or more report fewer stressors and depressive symptoms. In general, African American women experience significantly more psychosocial stressors than white and Mexican American women with the same level of education.

Finally, Table 4 examines differences in substance use and health by race/ethnicity-education. African American women from all education subgroups have substantially lower rates of smoking, alcohol dependence, and drug use than Whites with a high school degree or less. Mexican American women have lower rates of smoking than their White counterparts with the same education-level, and similar rates of alcohol dependence and drug use compared to their White counterparts. Thus, we find no evidence supporting the idea that African American women's disadvantaged infant health outcomes is associated with more substance use; in contrast, compared to White women, African American women report lower rates of substance abuse. In terms of biological indicators of health, African American women with some college or less have higher rates of obesity than White women with a high school degree or less. African American women have higher rates of obesity than White women at the same education level. However, we find no significant difference in C-reactive protein (CRP) levels, a measure of chronic stress, between African Americans and Whites at the same education-level. Comparisons of hypertension also yields few significant differences by race/ethnicity-education. However, African American women with all levels of education have higher diabetes rates compared with White women of all educational levels and with compared with Mexican American women who have less than a bachelor's degree.

## Discussion

Substantial scholarly and media attention has centered on the recently observed mortality increases among low educated, middle-aged Whites. Such a trend has raised speculation that low educated Whites may have the most unfavorable mortality patterns in the United States, which would be a phenomenon heretofore undetected in the sociological, demographic, and public health literatures. We labelled this the White disadvantage hypothesis and tested it using infant mortality as a key indicator of population health. However, we found no support for this hypothesis. Instead, our vital records analysis reveals that White women who have completed a high school degree or less have lower IMRs than African American women of all educational levels. Strikingly, the odds of infants born to highly educated African American women dying within the first year of life was 47 percent higher than that of infants born to low-educated White women. Furthermore, African American women with a high school degree or less had 120 percent higher odds of infant mortality than their White counterparts with the same level of education. Thus, our analysis also found no evidence in support of the classic socioeconomic hypothesis for African African-White population health disparities, i.e., that racial/ethnic infant mortality differentials are fully explained by socioeconomic disparities. We also found that African American-White infant mortality disparities were only modestly attenuated with demographic controls and widened with controls for maternal prenatal behaviors. Thus, we found limited support for the demographic and health behavior hypotheses. In fact, infant mortality disparities would be even wider if African American women—at all education levels—smoked at similar rates to White with a high school degree or less. Rather, we observed that African American-White infant mortality disparities were fully accounted for by controlling for infant gestational length, in support of the prematurity hypothesis. Below, we more thoroughly discuss the reasons underlying differences in gestational length between infants born to African American and White women.

Turning to infant mortality disparities between Mexican American and White women of varying educational levels, we identified an overall 19 percent higher rate of infant mortality among Mexican American infants relative to Whites. This difference—in contrast with the African American-White disparity— was fully accounted for by differences in educational attainment between groups. That is, we found that Mexican Americans have similar risks of infant mortality as their White counterparts with identical levels of educational attainment. Such results suggest that policies that improve educational attainment among Mexican Americans–which continue to lag behind other racial/ethnic groups (Author, Date)–may be important in closing Mexican American-White gaps in population health.

Overall, then, we found that African American-White disparities in infant mortality were distinct; infants born to African American women of all educational levels demonstrated substantial disadvantages relative to infants born to low-educated White women. At the same time, infant mortality differences between African Americans of all educational levels and low-educated Whites were fully accounted for by controlling for the gestational length of pregnancy. This implicates differences in the life course stress process between groups–even when comparing African American women with a high level of education to low-educated Whites. These findings thus provided very strong support for the within education-level hypothesis, which contends that African Americans experience worse health relative to Whites even within the same education-level.[5] In this case, the findings are even more striking: African Americans with a high educational level exhibited worse population health than Whites with low education.

To provide insight into the potential life course mechanisms underlying these racial/ethnic-education infant mortality patterns, we used data from Add Health to explore differences in socioeconomic, psychosocial, contextual, behavior, and health profiles in adolescence and young adulthood among US-born African American, Mexican American, and White women aged 24-32 in 2008-09. This analysis revealed that African American women experience substantial individual-level and contextual disadvantages across adolescence and young adulthood, even for those who eventually attained a very high level of educational attainment. Indeed, African American women with a college degree or more exhibit financial characteristics in adulthood similar to those of White women who have some college and live in neighborhoods with socioeconomic characteristics similar to White women with a high school degree or less. Moreover, African American women with high education exhibited disadvantaged adult health on some indicators relative to White women of low education and exhibited generally higher levels of life course stressors than their similarly educated White counterparts and, in some cases, their low-educated White counterparts. When such life course disadvantages for African American women – especially those of low education in adulthood, but also for those of high education – are considered in the context of the most compelling frameworks for understanding high levels of prematurity among African American women in American society (Geronimus 1992; Kramer and Hogue 2009), it is no surprise that infant mortality rates for African Americans remain far higher than those of Whites. Simply put, life course-based disadvantages, even among highly educated African American women, likely increase their risks of poor preconception health. Poor preconception health and higher levels of stress in turn increase the likelihood of vascular dysfunction, hypothalamic-pituitary-adrenal (HPA) dysfunction, and inflammation during pregnancy for African American women, resulting in considerably higher rates of prematurity relative to their White counterparts (Kramer and Hogue 2009). Findings from the two data sets in this analysis, when understood in tandem and in conjunction with prior theory and findings, strongly suggest that racial disadvantage remains a cruel, punishing, and deadly phenomenon for African Americans in the United States, even for those that have achieved a very high level of individual socioeconomic achievement.

Our research thus provides additional evidence that education is not the great equalizer for African American-White health disparities (Elder et al. 2014, 2016; Loggins and Andrade 2014; Williams et al. 2010). Population health disparities between African Americans and Whites necessarily involve attention to the unique life course histories unfolding within each group (Geronimus 1992). Importantly, such life course histories cannot be separated from the broader social histories underlying each group's health and mortality patterns (Author, Date), particularly the institutional and individual forms of racism that have been proposed as the driving forces behind contemporary patterns of African American health (Kramer and Hogue 2009; Author, Date; Phelan and Link 2015; Williams et al. 2010). Consequently, we suggest that future research must consider multi-level and life course perspectives on the relationships between race and health. For example, the inclusion of information on social context – at the state and local levels – and changes in SES over time may extend our knowledge of racial health disparities (Boen 2016; Sosnaud 2018).

Finally, we would be remiss if we did not point out that low-educated Whites in both the vital statistics-based and Add Health data sets exhibited far more damaging health behavior than African Americans of any educational level—in particular, much higher levels of smoking, alcohol dependence, and drug use. Such patterns are consistent with behaviorally-based trends in increasing midlife mortality among low-educated Whites, especially due to poisonings, suicide, and alcohol-related deaths (Case and Deaton 2015, 2017). Clearly, one major population health charge for future years is to reduce such detrimental health behaviors, especially among low-educated Whites. This is a steep challenge because behaviors are strongly rooted in institutional and structural forces (e.g., corporations, industries, governments) that create the conditions for individuals to partake in such damaging behavior.

*Limitations*. Although our BID files are exceptionally strong because of their national coverage, they only allow for cross-sectional analyses. Further, relationships observed from our models may be driven by omitted variables. It is unlikely that our analysis suffers from reverse causality because maternal race/ethnicity and educational attainment precede infant health outcomes. In addition, our Add Health analysis does not directly test if the proposed mechanisms, in fact, have relationships with infant mortality or prematurity. Add Health has not identified enough infant deaths in the cohort for meaningful analyses. Finally, we examined just one, albeit very important, population health measure: infant mortality. That said, infant mortality is both a reflection of how well society is treating its youngest members and a very important indicator of women's health status. Thus, while we encourage other researchers to examine different health outcomes, we assert that our findings reflect large-scale patterns of racial and ethnic stratification in US society.

## Conclusion

Racial/ethnic health disparities in American society continue to exhibit stark disadvantages for African Americans and modest disadvantages for Mexican Americans relative to their White counterparts. The African American-White disparity is especially wide, even when comparing similarly educated individuals and when comparing highly-educated African Americans with low-educated Whites. Any notion suggesting that low-educated Whites exhibit the most disadvantaged health and mortality outcomes in the United States is clearly incorrect, at least for the critical population health measure of infant mortality. The population health of both Mexican Americans and African Americans would most likely benefit from policies and programs that increase their educational attainment to become similar to Whites. Beyond that, however, the life course disadvantages of African Americans continue to be very striking relative to Whites, reflecting long-term and continued patterns of racial discrimination that create more disadvantaged, stressful, and health-damaging lives for African American individuals relative to Whites. Racial/ethnic population health disparities are not likely to close without very aggressive and sustained social and health policy efforts aimed at erasing the historical and continued disadvantages faced by African Americans of all educational levels in US society.

**References**


Acevedo-Garcia, Dolores, Mah-J. Soobader, and Lisa F. Berkman. 2005. “The Differential Effect of Foreign-Born Status on Low Birth Weight by Race/Ethnicity and Education.” *Pediatrics* 115 (1): e20–30.

Alexander, Greg R., Michael Kogan, Deren Bader, Wally Carlo, Marilee Allen, and Joanne Mor. 2003. “US Birth Weight/Gestational Age-Specific Neonatal Mortality: 1995-1997 Rates of Whites, Hispanics, and Blacks.” *Pediatrics* (1): e61-66.

Arias, Elizabeth, and Jiaquan Xu. 2018. “United States Life Tables, 2015.” *National Vital Statistics Reports* 67(7): 1-64.

Boddy, Jessica, and David Greene. 2017. “The Forces Driving Middle-Aged White People’s ‘Deaths of Despair.’” National Press Radio. https://www.npr.org/sections/health-shots/2017/03/23/521083335/the-forces-driving-middle-aged-white-peoples-deaths-of-despair.

Boen, Courtney. 2016. “The Role of Socioeconomic Factors in Black-White Health Inequities across the Life Course: Point-in-Time Measures, Long-Term Exposures, and Differential Health Returns.” *Social Science & Medicine* 170: 63–76.

Brown, Tyson H. 2018. “Racial Stratification, Immigration, and Health Inequality: A Life Course-Intersectional Approach.” *Social Forces* 96 (4): 1507–40.

Butler, Adrienne Stith, and Richard E. Behrman. 2007. *Preterm Birth: Causes, Consequences, and Prevention*. Washington, DC: National Academies Press.

Card, David, and Alan B. Krueger. 1992. “School Quality and Black-White Relative Earnings: A Direct Assessment.” *The Quarterly Journal of Economics* 107 (1): 151–200.

Carolina Population Center. 1999. "Add Health Wave I In-Home Interview Data (Restricted)." Chapel Hill, NC: University of North Carolina.

Carolina Population Center. 2009. "Add Health Wave IV In-Home Interview Data (Restricted)." Chapel Hill, NC: University of North Carolina.

Case, Anne, and Angus Deaton. 2015. "Rising Morbidity and Mortality in Midlife among White Non-Hispanic Americans in the 21st Century." *Proceedings of the National Academy of Sciences* 112 (49): 15078–83.

Case, Anne, and Angus Deaton. 2017. "Mortality and Morbidity in the 21st Century." *Brookings Papers on Economic Activity* 2017: 397–476.

Centers for Disease Control and Prevention. 2012. "2009 Cohort Linked Public-Use Record Layout." Hyattsville, MD: Department of Health and Human Services.

Centers for Disease Control and Prevention. 2014a. "2007 Cohort Linked Public-Use Record Layout." Hyattsville, MD: Department of Health and Human Services.

Centers for Disease Control and Prevention. 2014b. "2008 Cohort Linked Public-Use Record Layout." Hyattsville, MD: Department of Health and Human Services.

Centers for Disease Control and Prevention. 2015. "2010 Cohort Linked File Public-Use Record Format." Hyattsville, MD: Department of Health and Human Services.

Colen, Cynthia G., Arline T. Geronimus, John Bound, and Sherman A. James. 2006. "Maternal Upward Socioeconomic Mobility and Black–White Disparities in Infant Birthweight." *American Journal of Public Health* 96(11):2032–39.

Din-Dzietham, Rebecca and Irva Hertz-Picciotto. 1998. "Infant Mortality Differences between Whites and African Americans: The Effect of Maternal Education." *American Journal of Public Health* 88(4):651–56.

Drake, Patrick, Anne K. Driscoll, and T.J. Mathews. 2018. “Cigarette Smoking During Pregnancy: United States, 2016.” *NCHS Data Brief* 305:1-8.

Earnshaw, Valerie A., Lisa Rosenthal, Jessica B. Lewis, Emily C. Stasko, Jonathan N. Tobin, Tené T. Lewis, Allecia E. Reid, and Jeannette R. Ickovics. 2012. “Maternal Experiences with Everyday Discrimination and Infant Birth Weight: A Test of Mediators and Moderators among Young, Urban Women of Color.” *Annals of Behavioral Medicine* 45(1):13–23.

Eberstein, Isaac W. 1989. “Demographic Research on Infant Mortality.” *Sociological Forum* 4 (3): 409–22.

Elder, Todd E, John H. Goddeeris, and Steven J Haider. 2011. “A Deadly Disparity: A Unified Assessment of the Black-White Infant Mortality Gap.” *The BE Journal of Economic Analysis & Policy* 11 (1).

Elder, Todd E, John H. Goddeeris, and Steven J Haider. 2016. “Racial and Ethnic Infant Mortality Gaps and the Role of Socio-Economic Status.” *Labour Economics* 43: 42–54.

Elder, Todd E, John H. Goddeeris, Steven J Haider, and Nigel Paneth. 2014. “The Changing Character of the Black–White Infant Mortality Gap, 1983–2004.” *American Journal of Public Health* 104 (S1): S105–11.

(Author, Date)

Farmer, Melissa M., and Kenneth F. Ferraro. 2005. “Are Racial Disparities in Health Conditional on Socioeconomic Status?” *Social Science & Medicine* 60 (1): 191–204.

(Author, Date)

(Author, Date)

Gage, Timothy B., Fu Fang, Erin O'Neill, and Greg DiRienzo. 2013. "Maternal Education, Birth Weight, and Infant Mortality in the United States." *Demography* 50 (2): 615–35.

Geronimus, Arline T. 1992. "Teenage Childbearing and Social Disadvantage: Unprotected Discourse." *Family Relations* 41 (2): 244–48.

Geronimus, Arline T., Margaret Hicken, Danya Keene, and John Bound. 2006. "'Weathering' and Age Patterns of Allostatic Load Scores among Blacks and Whites in the United States." *American Journal of Public Health* 96 (5): 826–33.

Giscombé, Cheryl L., and Marci Lobel. 2005. "Explaining Disproportionately High Rates of Adverse Birth Outcomes among African Americans: The Impact of Stress, Racism, and Related Factors in Pregnancy." *Psychological Bulletin* 131 (5): 662-683.

Green, Tiffany, and Tod Hamilton. 2019. "Maternal Educational Attainment and Infant Mortality in the United States: Does the Gradient Vary by Race and Nativity?" *Demographic Research* (Forthcoming).

(Author, Date)

Harris, Kathleen Mullan, and J. Richard Udry. 2013. "National Longitudinal Study of Adolescent to Adult Health [Restricted Use]." Chapel Hill, NC: University of North Carolina.

Heckman, James J., Thomas M. Lyons, and Petra E. Todd. 2000. "Understanding Black-White Wage Differentials, 1960-1990." *The American Economic Review* 90 (2): 344–49.

(Author, Date)

(Author, Date)

(Author, Date)

Kimbro, Rachel Tolbert, Sharon Bzostek, Noreen Goldman, and Germán Rodríguez. 2008. "Race, Ethnicity, and the Education Gradient in Health." *Health Affairs* 27 (2): 361–72.

Kramer, Michael R., and Carol R. Hogue. 2009. "What Causes Racial Disparities in Very Preterm Birth? A Biosocial Perspective." *Epidemiologic Reviews* 31(1): 84–98.

Landale, Nancy S., Ralph S. Oropesa, and Bridget K. Gorman. 2000. "Migration and Infant Death: Assimilation or Selective Migration among Puerto Ricans?" *American Sociological Review* 65 (6): 888–909.

Leicht, Kevin T. 2008. "Broken down by Race and Gender? Sociological Explanations of New Sources of Earnings Inequality." *Annual Review of Sociology* 34: 237–55.

Link, Bruce G., and Jo Phelan. 1995. "Social Conditions as Fundamental Causes of Disease." *Journal of Health and Social Behavior*, 80–94.

Loggins, Shondra, and Flavia Cristina Drumond Andrade. 2014. "Despite an Overall Decline in US Infant Mortality Rates, the Black/White Disparity Persists: Recent Trends and Future Projections." *Journal of Community Health* 39 (1): 118–23.

Lu, Michael C, and Neal Halfon. 2003. "Racial and Ethnic Disparities in Birth Outcomes: A Life-Course Perspective." *Maternal and Child Health Journal* 7 (1): 13–30.

Massey, Douglas S., and Nancy A. Denton. 1993. *American Apartheid: Segregation and the Making of the Underclass*. Cambridge, MA: Harvard University Press.

(Author, Date)

Osypuk, Theresa L., and Dolores Acevedo-Garcia. 2010. "Beyond Individual Neighborhoods: A Geography of Opportunity Perspective for Understanding Racial/Ethnic Health Disparities." *Health & Place* 16 (6): 1113–23.

Phelan, Jo C., and Bruce G. Link. 2015. "Is Racism a Fundamental Cause of Inequalities in Health?" *Annual Review of Sociology* 41: 311–30.

(Author, Date)

Richardson, Liana J., and Tyson H. Brown. 2016. "(En) Gendering Racial Disparities in Health Trajectories: A Life Course and Intersectional Analysis." *SSM-Population Health* 2: 425–35.

Riddell, Corinne A., Sam Harper, and Jay S. Kaufman. 2017. "Trends in Differences in US Mortality Rates between Black and White Infants." *JAMA Pediatrics* 171 (9): 911–13.

Rosenthal, Lisa and Marci Lobel. 2011. "Explaining Racial Disparities in Adverse Birth Outcomes: Unique Sources of Stress for Black American Women." *Social Science & Medicine* 72(6):977–83.

Saigal, Saroj, and Lex W. Doyle. 2008. "An Overview of Mortality and Sequelae of Preterm Birth from Infancy to Adulthood." *The Lancet* 371 (9608): 261–69.

Schempf, Ashley H., Amy M. Branum, Susan L Lukacs, and Kenneth C Schoendorf. 2007. "The Contribution of Preterm Birth to the Black–White Infant Mortality Gap, 1990 and 2000." *American Journal of Public Health* 97 (7): 1255–60.

Schoendorf, Kenneth C., Carol JR. Hogue, Joel C. Kleinman, and Diane Rowley. 1992. "Mortality among Infants of Black as Compared with White College-Educated Parents." *New England Journal of Medicine* 326 (23): 1522–26.

Singh, Gopal K., and Stella M. Yu. 1996. "Adverse Pregnancy Outcomes: Differences between US-and Foreign-Born Women in Major US Racial and Ethnic Groups." *American Journal of Public Health* 86 (6): 837–43.

Solis, Patricio, Starling G. Pullum, and W. Parker Frisbie. 2000. "Demographic Models of Birth Outcomes and Infant Mortality: An Alternative Measurement Approach." *Demography* 37 (4): 489–98.

Sosnaud, Benjamin. 2019. "Inequality in Infant Mortality: Cross-State Variation and Medical System Institutions." *Social Problems* 66: 108-127.

Strutz, Kelly L, Vijaya K Hogan, Anna Maria Siega-Riz, Chirayath M Suchindran, Carolyn Tucker Halpern, and Jon M Hussey. 2014. "Preconception Stress, Birth Weight, and Birth Weight Disparities among US Women." *American Journal of Public Health* 104 (8): e125–32.

Turner, R. Jay, and William R. Avison. 2003. "Status Variations in Stress Exposure: Implications for the Interpretation of Research on Race, Socioeconomic Status, and Gender." *Journal of Health and Social Behavior* 44 (4): 488–505.

Western, Bruce, and Becky Pettit. 2005. "Black-White Wage Inequality, Employment Rates, and Incarceration." *American Journal of Sociology* 111 (2): 553–78.

Wildeman, Christopher. 2012. "Imprisonment and Infant Mortality." *Social Problems* 59(2):228–57.

Williams, David R. 2012. "Miles to Go before We Sleep: Racial Inequities in Health." *Journal of Health and Social Behavior* 53 (3): 279–95.

Williams, David R., Selina A. Mohammed, Jacinta Leavell, and Chiquita Collins. 2010. "Race, Socioeconomic Status, and Health: Complexities, Ongoing Challenges, and Research Opportunities." *Annals of the New York Academy of Sciences* 1186 (1): 69–101.

Wise, Paul H., and DeWayne M. Pursley. 1992. "Infant Mortality as a Social Mirror." *New England Journal of Medicine* 326: 1558-1560.

Yankauer, Alfred. 1990. "What Infant Mortality Tells Us." *American Journal of Public Health* 80 (6): 653–54.

Table 1: Infant Mortality Rates and Rate Ratios by Race/Ethnicity and Maternal Education in the US from 2007 through 2010

| | Total IMR | Race/Ethnic Education Composition | Race/Ethnic Education-Specific IMR | | Education-Specific Rate Ratio | |
|---|---|---|---|---|---|---|
| **African American** | 12.74 | | | | | |
| BA+ | | 0.22 | 9.84 | (9.42-10.26) | 1.46 | (1.43-1.49) |
| Some College | | 0.34 | 12.15 | (11.78-12.53) | 1.81 | (1.79-1.82) |
| HS or Less | | 0.44 | 14.66 | (14.30-15.03) | 2.18 | (2.17-2.19) |
| **Mexican American** | 5.44 | | | | | |
| BA+ | | 0.19 | 3.40 | (3.04-3.81) | 0.51 | (0.46-0.55) |
| Some College | | 0.34 | 5.29 | (4.94-5.66) | 0.79 | (0.75-0.82) |
| HS or Less | | 0.47 | 6.39 | (6.06-6.73) | 0.95 | (0.92-0.98) |
| **White** | 4.59 | | | | | |
| BA+ | | 0.49 | 3.50 | (3.44-3.57) | 0.52 | (0.52-0.52) |
| Some College | | 0.29 | 4.77 | (4.66-4.87) | 0.71 | (0.71-0.71) |
| HS or Less | | 0.23 | 6.72 | (6.58-6.87) | -- | -- |

Source: National Vital Statistics System Linked Birth and Death Certificates 2007-2010

N = 7,215,833

Notes: Data include births to US-born women, ages 25+.

Table 2: Logistic Regression of Infant Mortality on Race/Ethnicity-Education and Covariates Education in the US from 2007 through 2010

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| **Race/Ethnicity (ref = White, HS or Less)** | | | | | |
| Black BA+ | 1.47* | 1.36* | 1.50* | 0.91* | 0.80* |
| Black Some College | 1.82* | 1.63* | 1.82* | 0.94* | 0.81* |
| Black HS or Less | 2.20* | 1.88* | 2.04* | 0.98 | 0.86* |
| Mexican BA+ | 0.50* | 0.51* | 0.56* | 0.68* | 0.67* |
| Mexican Some College | 0.79* | 0.81* | 0.90* | 0.84* | 0.81* |
| Mexican HS or Less | 0.95 | 0.95 | 1.08 | 0.86* | 0.84* |
| White BA+ | 0.52* | 0.51* | 0.55* | 0.78* | 0.83* |
| White Some College | 0.71* | 0.72* | 0.76* | 0.88* | 0.90* |
| **Unmarried (ref = Married)** | | 1.36* | 1.29* | 1.10* | 1.09* |
| **Birth Order (ref = 1)** | | | | | |
| 2-3 | | 0.73* | 0.72* | 1.00 | 1.16* |
| 4+ | | 0.90* | 0.88* | 1.19* | 1.46* |
| **Plural (ref = Singleton)** | | 5.22* | 5.25* | 0.93* | 0.66* |
| **Maternal Age (ref = 25-29)** | | | | | |
| 30-34 | | 1.01 | 1.02 | 0.89* | 0.88* |
| 35-39 | | 1.15* | 1.16* | 0.89* | 0.86* |
| 40+ | | 1.38* | 1.40* | 1.02 | 0.98 |
| **Initiation of Prenatal Care (ref = 1st Trimester)** | | | | | |
| 2nd Trimester | | | 0.84* | 1.19* | 1.17* |
| 3rd Trimester or None | | | 0.93 | 1.46* | 1.44* |
| **Smoking (ref = No)** | | | 1.53* | 1.25* | 1.08* |
| **Gestational Age** | | | | 0.68* | 0.67* |
| **Birthweight Z-Score** | | | | | 0.45* |

Source: National Vital Statistics System Linked Birth and Death Certificates 2007-2010

N=7,215,833

Notes: Data include births to US-born women ages 25 and above. Missing cases were recovered using multiple imputation. Coefficients are expressed in the form of odds ratios.

* $p \leq .05$

Table 3: Sociodemographic, Neighborhood, and School Characteristics of US-born Adolescents by Race/Ethnicity-Education in Wave I (Grade 7-12) of Add Health (95% Confidence Intervals)

| | African American | | | Mexican American | | | White | | |
|---|---|---|---|---|---|---|---|---|---|
| | BA+ | Some College | HS or Less | BA+ | Some College | HS or Less | BA+ | Some College | HS or Less |
| **Sociodemographic Characteristics** | | | | | | | | | |
| Parental Education Years (Mean) | 14 (14 - 15) | 13 (13 - 13) | 12 (12 - 12) | 13 (12 - 14) | 12 (12 - 13) | 12 (11 - 12) | 15 (15 - 16) | 14 (13 - 14) | 13 (12 - 13) |
| Household Income ($1000) (Median) | 35 (30 - 40) | 24 (21 - 27) | 15 (12 - 18) | 35 (28 - 41) | 27 (24 - 30) | 25 (21 - 29) | 60 (58 - 62) | 40 (38 - 42) | 32 (30 - 34) |
| Parent has Professional Job (%) | 34 (27 - 41) | 20 (16 - 24) | 10 (6- 16) | 22 (12 - 38) | 20 (10 - 34) | 3 (1 - 8) | 42 (37 - 47) | 19 (16 - 22) | 11 (9 - 14) |
| Mother Married or Cohabiting (%) | 61 (55 - 66) | 48 (43 - 54) | 44 (38 - 51) | 80 (64 - 90) | 77 (65 - 85) | 84 (73 - 91) | 86 (83 - 88) | 79 (76 - 82) | 79 (75 - 82) |
| **Neighborhood Characteristics** | | | | | | | | | |
| Median Income ($1000) (%) | 25 (21 - 28) | 22 (20 - 25) | 20 (18 - 21) | 33 (25 - 41) | 27 (23 - 30) | 31 (26 - 35) | 36 (33 - 39) | 30 (28 - 33) | 28 (26 - 30) |
| Unemployment Rate (%) | 11 (9 - 12) | 11 (10 - 13) | 12 (11 - 13) | 8 (6 - 9) | 8 (7 - 9) | 8 (7 - 10) | 5 (5 - 6) | 7 (6 - 8) | 7 (7 - 8) |
| Poverty Rate (%) | 19 (16 - 22) | 19 (16 - 21) | 19 (16 - 21) | 13 (11 - 15) | 14 (12 - 15) | 12 (10 - 14) | 12 (11 - 13) | 13 (12 - 15) | 14 (13 - 16) |
| Proportion White (%) | 43 (33 - 53) | 42 (35 - 50) | 41 (34 - 48) | 67 (58 - 77) | 67 (59 - 74) | 70 (63 - 76) | 92 (90 - 94) | 92 (90 - 94) | 89 (87 - 92) |
| **School Characteristics** | | | | | | | | | |
| Free Lunch (%) | 38 (26 - 49) | 41 (33 - 48) | 47 (38 - 55) | 28 (20 - 35) | 35 (27 - 43) | 32 (23 - 42) | 16 (12 - 20) | 20 (16 - 24) | 27 (22 - 32) |
| Proportion White (%) | 33 (18 - 47) | 39 (29 - 49) | 38 (28 - 47) | 37 (20 - 54) | 35 (21 - 50) | 44 (30 - 58) | 82 (78 - 87) | 85 (81 - 89) | 78 (73 - 84) |
| Observations | 561 | 635 | 566 | 187 | 173 | 105 | 1,186 | 1,444 | 1,626 |

Source: Wave I of the National Longitudinal Study of Adolescent to Adult Health (Add Health). N=6,522

Notes: White women with less than a high school degree are treated as the reference group. Race/ethnic-education groups with significantly different estimates were shaded grey. Data are weighted to account for study design. Estimates and confidence intervals are calculated to lower decimal points than displayed. Cases with missing data on individual variables are dropped. Household income was estimated as a median to account for right skew.

Table 4: Sociodemographic, Neighborhood, Psychosocial, Behavioral, and Health Characteristics of US-born Women by Race/Ethnicity-Education in Wave IV (Age 24-32) of Add Health (95% Confidence Intervals)

| | African American | | | Mexican American | | | White | | |
|---|---|---|---|---|---|---|---|---|---|
| | BA+ | Some College | HS or Less | BA+ | Some College | HS or Less | BA+ | Some College | HS or Less |
| **Sociodemographic Characteristics** | | | | | | | | | |
| Household Income ($1000) (Mean) | 63 (57 - 68) | 39 (35 - 44) | 25 (22 - 28) | 79 (70 - 89) | 53 (46 - 59) | 59 (51 - 67) | 78 (75 - 81) | 60 (57 - 62) | 48 (45 - 50) |
| Household Assets Under $10,000 (%) | 33 (26 - 40) | 54 (46 - 62) | 65 (59 - 71) | 11 (5 - 25) | 42 (30 - 55) | 37 (28 - 47) | 19 (16 - 22) | 35 (31 - 39) | 43 (39 - 47) |
| Employed Fulltime (35+ Hours) (%) | 89 (85 - 92) | 81 (76 - 85) | 80 (74 - 84) | 89 (77 - 95) | 80 (66 - 89) | 80 (70 - 87) | 86 (84 - 89) | 73 (70 - 75) | 76 (73 - 78) |
| Married or Cohabiting (%) | 45 (38 - 52) | 52 (47 - 58) | 54 (48 - 59) | 74 (61 - 84) | 71 (57 - 82) | 73 (63 - 81) | 71 (68 - 74) | 75 (73 - 78) | 77 (73 - 80) |
| **Neighborhood Characteristics** | | | | | | | | | |
| Median Income ($1000) | 48 (44 - 51) | 39 (37 - 41) | 34 (31 - 36) | 55 (49 - 61) | 50 (44 - 55) | 51 (45 - 56) | 62 (60 - 64) | 52 (50 - 54) | 47 (45 - 49) |
| Unemployment Rate (%) | 10 (9 - 12) | 12 (11 - 13) | 13 (12 - 14) | 7 (6 - 9) | 8 (7 - 9) | 9 (8 - 10) | 6 (6 - 6) | 8 (7 - 8) | 8 (7 - 9) |
| Poverty Rate (%) | 16 (14 - 18) | 22 (20 - 24) | 26 (24 - 28) | 12 (9 - 15) | 15 (13 - 18) | 16 (13 - 18) | 10 (9 - 11) | 12 (11 - 13) | 14 (13 - 16) |
| Percent White (%) | 46 (40 - 52) | 43 (38 - 49) | 40 (35 - 45) | 63 (54 - 71) | 66 (59 - 73) | 62 (57 - 68) | 82 (80 - 83) | 85 (83 - 87) | 82 (80 - 85) |
| Percent Single Mother (%) | 37 (33 - 40) | 43 (40 - 46) | 47 (43 - 50) | 27 (22 - 32) | 25 (22 - 28) | 25 (21 - 29) | 21 (21 - 22) | 24 (22 - 25) | 26 (24 - 27) |
| **Stressors** | | | | | | | | | |
| Cohen's Stress Index (0-16) (Mean) | 4.9 (4.5 - 5.3) | 5.5 (5.2 - 5.9) | 5.9 (5.5 - 6.4) | 4.4 (3.7 - 5.1) | 4.7 (4.0 - 5.5) | 5.2 (4.6 - 5.9) | 4.0 (3.9 - 4.2) | 5.2 (5.0 - 5.5) | 5.8 (5.5 - 6.0) |
| Sometimes/Often Disrespected (%) | 26 (21 -31) | 32 (27 - 37) | 37 (31 - 44) | 24 (14 - 38) | 27 (17 - 40) | 33 (20 - 49) | 15 (13 - 18) | 27 (25 - 30) | 32 (29 - 36) |
| Crime Victim Last Year (%) | 24 (19 - 28) | 34 (28 - 40) | 37 (31 - 44) | 30 (18 - 45) | 27 (18 - 38) | 33 (24 - 43) | 16 (14 - 18) | 25 (23 - 28) | 27 (24 - 31) |
| CESD Scale (0-15) | 2.5 (2.2 - 2.8) | 3.2 (2.9 - 3.5) | 4.0 (3.6 - 4.4) | 2.4 (1.9 - 3.0) | 2.5 (2.0 - 3.0) | 3.0 (2.4 - 3.5) | 2.1 (2.0 - 2.2) | 2.8 (2.6 - 2.9) | 3.5 (3.3 - 3.7) |
| Parent Death (%) | 17 (14 - 21) | 24 (19 - 29) | 30 (25 - 36) | 11 (5 - 24) | 11 (6 - 20) | 9 (5 - 17) | 10 (8 - 12) | 14 (12 - 17) | 16 (14 - 19) |
| Parent Incarcerated at Least Once (%) | 20 (14 - 28) | 34 (28 - 40) | 31 (26 - 36) | 10 (5 - 20) | 27 (16 - 41) | 26 (16 - 39) | 5 (4 - 7) | 19 (17 - 22) | 24 (21 - 28) |
| **Substance Use** | | | | | | | | | |
| Smoke Daily (%) | 4 (2 - 6) | 14 (10 - 19) | 15 (11 - 21) | 1 (0 - 2) | 11 (5 - 22) | 9 (4 - 18) | 9 (8 - 11) | 31 (28 - 34) | 45 (41 - 49) |
| Alcohol Dependence (%) | 13 (10 - 18) | 13 (10 - 18) | 9 (6 - 12) | 29 (17 - 43) | 32 (22 - 44) | 22 (14 - 34) | 39 (36 - 42) | 35 (31 - 39) | 27 (24 - 31) |
| Drug Use in Last Year (%) | 2 (1 - 4) | 4 (3 - 7) | 5 (3 - 8) | 6 (3 - 15) | 11 (5 - 20) | 6 (2 - 15) | 7 (5 - 8) | 12 (10 - 15) | 12 (10 - 15) |
| **Health Characteristics** | | | | | | | | | |
| High CRP (%) | 37 (28 - 46) | 42 (36 - 49) | 46 (38 - 54) | 51 (36 - 65) | 39 (27 - 52) | 57 (44 - 69) | 34 (32 - 37) | 39 (35 - 42) | 43 (40 - 48) |
| Obese (%) | 45 (41 - 50) | 52 (47 - 58) | 60 (55 - 66) | 40 (27 - 55) | 49 (37 - 62) | 54 (41 - 67) | 23 (20 - 26) | 38 (34 - 42) | 43 (40 - 47) |
| Hypertension (%) | 15 (11 - 20) | 18 (14 - 23) | 21 (17 - 25) | 11 (6 - 21) | 13 (5 - 30) | 9 (4 - 19) | 10 (8 - 13) | 12 (10 - 14) | 11 (9 - 13) |
| Diabetes (%) | 11 (8 - 14) | 14 (11 - 17) | 14 (11 - 19) | 7 (3 -18) | 1 (0 - 4) | 1 (0 - 3) | 0 (0 - 1) | 1 (1 - 2) | 3 (2 - 4) |
| Observations | 566 | 635 | 561 | 105 | 173 | 187 | 1,626 | 1,444 | 1,186 |

Source: Wave IV of the National Longitudinal Study of Adolescent to Adult Health (Add Health). N=6,522

Notes: White women with less than a high school degree are treated as the reference group. Race/ethnic-education groups with significantly different estimates were shaded grey. Data are weighted to account for study design. Estimates and confidence intervals are calculated to lower decimal points than displayed. Cases with missing data on individual variables are dropped. Household income is divided into 12 income ladders (e.g., $5,000 to 9,999). We used the midpoint of each income ladder as the estimate. Because this measure was normally distributed, we estimate household income as a mean, rather than a median. A respondent with alcohol dependence exhibits at least one DSM4 symptom of alcohol dependence. Drug use is the use of the respondent's preferred recreational drug—excluding marijuana. Currently pregnant women were dropped for biological health measures.

Appendix Table A1: Cross-Tabulation of Demographic, Behavioral, and Infant Health Characteristics by Race/Ethnicity-Education for US-born Women Age 25+

| | African American | | | Mexican American | | | White | | |
|---|---|---|---|---|---|---|---|---|---|
| | BA+ | Some College | HS or Less | BA+ | Some College | HS or Less | BA+ | Some College | HS or Less |
| **Marital Status (Married) (%)** | 68.1 | 40.0 | 22.8 | 87.0 | 67.4 | 53.9 | 95.1 | 79.3 | 64.8 |
| Unmarried | 31.9 | 60.1 | 77.2 | 13.0 | 32.7 | 46.1 | 4.9 | 20.7 | 35.2 |
| **Birth Order (1) (%)** | 39.7 | 20.7 | 12.9 | 42.1 | 24.9 | 13.7 | 42.3 | 29.8 | 20.8 |
| 2-3 | 51.1 | 56.1 | 48.2 | 51.3 | 58.0 | 52.1 | 51.0 | 56.4 | 55.5 |
| 4+ | 9.2 | 23.2 | 38.9 | 6.7 | 17.1 | 34.3 | 6.7 | 13.9 | 23.7 |
| **Plurality (Single) (%)** | 95.1 | 95.4 | 95.5 | 96.0 | 96.8 | 97.2 | 94.7 | 95.9 | 96.4 |
| Plural | 4.9 | 4.6 | 4.5 | 4.0 | 3.2 | 2.8 | 5.3 | 4.1 | 3.7 |
| **Maternal Age (25-29) (%)** | 37.5 | 53.4 | 59.2 | 37.1 | 55.0 | 61.1 | 32.3 | 49.7 | 56.8 |
| 30-34 | 36.0 | 29.9 | 26.9 | 40.1 | 31.0 | 27.3 | 41.6 | 32.2 | 27.7 |
| 35-39 | 21.3 | 13.5 | 11.1 | 19.3 | 11.8 | 9.6 | 21.3 | 14.7 | 12.3 |
| 40-44 | 5.2 | 3.2 | 2.8 | 3.5 | 2.2 | 2.0 | 4.7 | 3.4 | 3.2 |
| **Prenatal Care Initiation (1st Trimester) (%)** | 86.8 | 76.3 | 68.5 | 89.1 | 81.0 | 72.5 | 91.4 | 84.4 | 76.2 |
| 2nd Trimester | 11.3 | 19.6 | 24.3 | 9.5 | 16.3 | 22.0 | 7.6 | 13.4 | 19.2 |
| 3rd Trimester or None | 2.0 | 4.1 | 7.2 | 1.4 | 2.7 | 5.5 | 1.1 | 2.2 | 4.7 |
| **Prenatal Smoking (No) (%)** | 98.7 | 92.6 | 82.8 | 99.5 | 97.5 | 95.3 | 98.6 | 88.0 | 73.5 |
| Yes | 1.4 | 7.4 | 17.2 | 0.5 | 2.5 | 4.7 | 1.4 | 12.0 | 26.5 |
| **Gestational Age (Weeks)** | 38.1 | 37.9 | 37.8 | 38.6 | 38.5 | 38.4 | 38.7 | 38.6 | 38.5 |
| **Birthweight (Z-Score) (Standard Deviations)** | -0.1 | -0.2 | -0.3 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.0 |
| **IMR (Infant Deaths/1000 Births)** | 9.8 | 12.1 | 14.7 | 3.4 | 5.3 | 6.4 | 3.5 | 4.8 | 6.7 |
| **Observations** | 215,174 | 334,433 | 425,932 | 91,505 | 158,721 | 221,969 | 2,816,697 | 1,645,337 | 1,306,065 |

Source: National Vital Statistics System Linked Birth and Death Certificates 2007-2010

N=7,215,833

Endnotes

[1] Immigrant women of all racial/ethnic groups, including African American and White American women, are likely to be positively selected on good health and health behaviors—features that do not characterize the experiences of US-born racial/ethnic groups (Landale et al. 2000; Singh and Yu 1996). At the same time, past research suggests a much smaller educational gradient in infant health among children of immigrant compared to native-born women (Acevedo-Garcia et al. 2005; Green and Hamilton 2018; Kimbro et al. 2008). Given these health status differences and the education-health relationship by nativity, our analysis focuses on infants of US-born women.

[2] This restriction gives women in our data set sufficient time to complete a college degree, which is not possible for younger childbearing women.

[3] We also estimated models using the Kotelchuck Index. We observed no meaningful change in results.

[4] Consistent with prior public health research (Alexander et al. 2003; Saigal and Doyle 2008), higher rates of extremely preterm (<28 weeks), very preterm (28-31 weeks), and moderate preterm (32-36 weeks) births are responsible for high rates of infant mortality among African American women relative to white women. Descriptive findings suggest that (1) the gestational age distribution is shifted downward for African American women relative to white and Mexican American women, and (2) the distribution has a more negative (left) skew. The negative skew is more pronounced for highly educated African American women. We find little evidence of variation in kurtosis by race/ethnicity-education. Results remain largely unchanged when using a categorical measure of gestational age.

[5] To test the robustness of our infant mortality findings, we performed several sensitivity analyses. First, we included state and birth year dummy variables in our model; their inclusion did not meaningfully alter our results. Replacing state dummy variables with Census Division did not alter results. Second, we separated out women in each racial/ethnic group who have less than a high school degree to examine how their patterns of infant mortality compared with those with higher levels of education. Most striking, we found that African American women with a college degree or higher still exhibited higher odds of infant mortality compared with White American women with less than a high school degree. Lastly, we re-ran our analyses including women who were less than age 25 at the time of their child's birth. African American-White American gaps in infant mortality were somewhat narrower in this analysis. Nonetheless, we found that African American women with a high school degree or less, some college, or a bachelor's degree or more had 84, 56, and 31 percent higher odds of infant mortality than White American women with a high school degree or less. We also found in these models that Mexican American women with a high school degree or less had 16 percent lower odds of infant mortality than White American women with a similar level of education. Mexican American and White American women who had completed some college or a bachelor's degree or more had similar patterns to those found in the primary analysis. Thus, while the inclusion of younger women who had not necessarily completed their educational careers resulted in somewhat more muted results compared with the main analysis of births restricted to ages 25 and above, the core findings of the analysis did not change in appreciable ways.