HHS Public Access
Author manuscript
Biodemography Soc Biol. Author manuscript; available in PMC 2021 March 11.

Published in final edited form as:
Biodemography Soc Biol. 2020 ; 66(1): 1–26. doi:10.1080/19485565.2020.1793659.

Race/Ethnicity, Maternal Educational Attainment, and Infant Mortality in the United States

Samuel H. Fishman[1,*], **Robert A. Hummer**[2], **Gracia Sierra**[2], **Taylor Hargrove**[2], **Daniel A. Powers**[3], **Richard G. Rogers**[4]

[1]Department of Sociology, Duke University, 276 Soc/Psych Building, 417 Chapel Dr., Durham, North Carolina 27708, USA

[2]Department of Sociology and Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

[3]Population Research Center, University of Texas at Austin, Austin, Texas, USA

[4]Department of Sociology and Population Program, IBS, University of Colorado Boulder, Boulder, Colorado, USA

Abstract

This study examines patterns of and explanations for racial/ethnic-education disparities in infant mortality in the United States. Using linked birth and death data (2007–2010), we find that while education-specific infant mortality rates are similar for Mexican Americans and Whites, infants of college-educated African American women experience 3.1 more deaths per 1,000 live births (Rate Ratio=1.46) than infants of White women with a high school degree or less. The high mortality rates among infants born to African American women of all educational attainment levels is fully accounted for by shorter gestational lengths. Supplementary analyses of data from the National Longitudinal Study of Adolescent to Adult Health show that college-educated African American women exhibit similar socioeconomic, contextual, psychosocial, and health disadvantages as White women with a high school degree or less. Together, these results demonstrate African American-White infant mortality and socioeconomic, health, and contextual disparities within education levels, suggesting the role of life course socioeconomic disadvantage and stress processes in the poorer infant health outcomes of African Americans relative to Whites.

Introduction

Recent high-profile studies document increasing mortality rates in the United States (US) among White middle-aged adults with a high school education or less (Case and Deaton 2015, 2017). 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 demographic, population health, and sociological literatures.

* samuel.fishman@duke.edu; (Phone) 847-858-9165.

Yet, it is vital to contextualize education-health disparities among non-Hispanic Whites (henceforth Whites) by comparing population health patterns at the intersection of race/ethnicity and education. For example, how does the population health of low-educated Whites compare with their low-educated non-Hispanic African American (henceforth African American) and Mexican American counterparts? Alternatively, do highly educated African Americans and Mexican Americans exhibit modest or even substantial population health advantages relative to low-educated Whites? Lastly, what factors or contexts might account for differences in population health by race/ethnicity and educational attainment? Answers to the above questions have key implications for debates surrounding race/ethnicity, social stratification, and health in the contemporary United States.

Infant mortality remains a key indicator of population health because the health and survival of infants depends upon the characteristics of the society in which they are born. Few studies, however, 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 which suggests that health disparities by race/ethnicity, socioeconomic status (SES), and gender should be examined in concert with one another rather than independently (Brown 2018; Hargrove 2018; Richardson and Brown 2016).

This study employs data from the 2007–10 US linked birth and infant death (BID) cohort files to examine infant mortality 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 use BID data to document infant mortality disparities. Next, we assess whether sociodemographic, maternal behavioral, and infant health characteristics explain infant mortality disparities across the race/ethnicity-education groups. Third, we use data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) to explore the potential social and health contexts associated with the infant mortality disparities. By applying comparable gender, age, and fertility selection criteria to the BID files, use of the Add Health data, which spans adolescence and adulthood, offers insights into the life course factors potentially associated with infant mortality disparities between racial/ethnic-education groups of women of childbearing age. Pairing BID analyses with Add Health life course data is a unique contribution to the literature on racial/ethnic-education disparities in infant mortality. Indeed, information from Add Health allows us to richly describe the life course contexts associated with racial/ethnic-education disparities in the lives of US childbearing aged women—an examination that is not possible with the BID data alone. This data pairing helps overcome gaps in the BID and aids in extending understanding of racial/ethnic-education disparities in infant mortality.

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 are persistent and substantial racial/ethnic disparities in infant mortality. While IMRs have fallen 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; Powers 2013), 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).

Scholarship has emphasized socioeconomic and demographic factors as key potential explanations of racial/ethnic disparities in infant mortality. Furthermore, the 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 (Hummer 1996; Phelan and Link 2015; Williams 2012)—is a significant factor for the IMR disparity. However, common controls for SES offer an incomplete explanation, as several studies document a sizable racial/ethnic disparity after accounting for socioeconomic measures (Elder et al. 2014, 2016; Hummer et al. 1999; Loggins and Andrade 2014). For example, Elder and colleagues (2014) found that 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 medicine, shows that the high IMR experienced by African Americans relative to their White counterparts is 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 may overlook the life course-based socioeconomic, psychosocial, contextual, and health factors that place African American women at higher risk of adverse birth outcomes (e.g., premature birth) than White women. These factors may be the structural underpinnings of higher mortality levels 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 (2019). Schoendorf et al. (1992) used national data on births and infant deaths from 1983–1985 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. Therefore, 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 2019), 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 and associates (1992) did not make comparisons between relatively low educated African Americans and Whites, among whom IMRs are the highest and recent scholarly and media attention has focused.

More recently, Green and Hamilton (2019) investigated the intersection of maternal race/ethnicity and educational attainment as predictors of infant mortality. Using data from 1998–2002, 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 (2.9 deaths per 1,000 births), US-born Hispanics were slightly higher (3.1), and African Americans (8.8) were substantially higher. Among those with lower education levels, the most favorable rate was exhibited among US-born Hispanic women, with Whites and African Americans significantly higher. Their findings suggested differences in the health returns of educational attainment across groups, with Whites benefitting most from high education and African Americans and other non-White groups benefitting least.

Infant mortality disparities between Whites and other disadvantaged race/ethnic groups, however, are less pronounced. For example, infants of US-born Mexican American women exhibit a nine percent higher IMR compared with infants of US-born White women (Hummer et al. 2007). This disparity may be attributable to SES. For example, previous research indicates that US-born Mexican Americans have substantially lower levels of educational attainment than Whites (Everett et al. 2011). In accordance, the introduction of parental educational attainment (or income) as covariates accounted for Mexican American-White differences in mortality between the ages of 1 and 24 (Rogers et al. 2017). At the same time, low rates of prenatal smoking may account for some of Mexican Americans’ low infant mortality rates (Fishman et al. 2018). Therefore, we expect Mexican American-White infant mortality gaps to be relatively modest and closely tied to SES inequality and maternal health behaviors.

Conceptual Framework and Expectations

The IMR 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 illuminate inequalities that result in life and death outcomes for the youngest members of society (Eberstein 1989). Given that women’s health is 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). This life course perspective suggests that cumulative effects of (dis)advantage lead to differing health trajectories over time (Willson, Shuey, and Elder 2007). Prior research suggests that such life course-based disadvantage plays a key role in African American-White and Mexican American-White adult health disparities (Boen 2016; Boen and Hummer 2019). Similarly, these life course (dis)advantages are thought to influence preterm birth (i.e., short gestational age) and low birthweight, which are the primary biological pathways that help account for African American-White and Mexican American-White infant mortality gaps (Butler and Behrman 2007; Elder et al. 2011; Saigal and Doyle 2008; Schempf et al. 2007). Almost 90 percent of African American-White infant mortality differences are accounted for gestational age at birth and birthweight (Elder et al. 2011).

Based on the previous research reviewed above framed within a life course perspective, we consider four 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), which demonstrates recent increases 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, namely at lower education levels. Thus, while highly educated White women may continue to experience an infant mortality 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 may have 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 next three potential explanations draw on the idea that racism is a fundamental cause of health disparities, operating across the life course to influence critical access to social resources and exposures (Geronimus 1992; Phelan and Link 2015; Pearson 2008), which then influences health. Therefore, inequalities in socioeconomic status, access to care, and health behaviors are mechanisms for racism’s influence on racial/ethnic health disparities. In turn, these characteristics influence infant mortality through gestational age and birthweight.

In that overarching framework, the second potential explanation, which we term the socioeconomic hypothesis, contends that racial/ethnic disparities in infant mortality are driven by life course process of educational attainment. Once educational attainment is statistically equalized across groups, racial/ethnic disparities in infant mortality will disappear. This expectation 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 assumes that educational attainment operates similarly for all racial/ethnic groups. Fundamental cause theory claims that differences in educational attainment across groups influences the availability of flexible resources that can be used to protect health. Because inequalities in educational attainment are driven by broader racial inequalities in US society, they serve as mechanisms for racism’s influence on health (Phelan and Link 2015). This unequal availability of resources leads to inequalities in health risks, such as health behaviors, stress, and access to 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; Hummer et al. 1999; Schoendorf et al. 1992), we do not expect it to receive strong support when comparing African American and White women. Like African American women, Mexican American women's educational opportunities are also constrained by broader processes of racial stratification (Pearson 2008). In contrast with African Americans, however, prior research suggests that education inequality may explain a large portion of the disparity in early life mortality between Mexican Americans and Whites (Hummer et al. 1999; Rogers et al. 2017). Nonetheless, we use the latest available data and test the hypothesis for both the African American-White and Mexican American-White contrasts.

Third, racial stratification that leads to differences in access to care and behavioral characteristics may also—independent of educational attainment—account for racial/ethnic-education infant mortality disparities. Access to health resources—such as quality health care and health knowledge—may be key mechanisms by which racism influences infant mortality (Phelan and Link 2015). For example, rates of prenatal smoking and late initiation of prenatal care may help explain the higher levels of infant mortality among racial/ethnic minority women relative to Whites. Yet prior research has found that these behavioral and health care differences only play a modest (if any) role in African American-White infant mortality gaps (Elder et al. 2011; Finch et al. 2000; Giscombé and Lobel 2005; Hummer et al. 1999). Accordingly, we test whether the behavioral-care hypothesis explains racial/ethnic-education disparities in infant mortality, while recognizing that previous studies have not provided strong support (Elder et al. 2011; Finch et al. 2000; Hummer et al. 1999). In contrast, we expect that controlling for low prenatal smoking rates among Mexican Americans may actually widen infant mortality disparities between Mexican Americans and Whites (Fishman et al. 2018).

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 course experiences of individuals across racial/ethnic groups, even within the same level of educational attainment; such differences work together to produce disparities in population health outcomes (Boen 2016; Farmer and Ferraro 2005; Pearson 2008).

Within education-level racial/ethnic inequalities may be driven by disparities in unmeasured 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. Even African Americans with high educational attainment may experience substantial barriers in using their education to generate the same quantity of health-beneficial resources as their White counterparts (Pearson 2008). 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). Other research suggests that persistent racial/ethnic-education differences in neighborhood context stemming from historical segregation patterns play a major role in generating African American-White American health disparities (Massey and Denton 1993; Osypuk and Acevedo-Garcia 2010). Additional literature maintains 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 due to discrimination than their White counterparts (Howard and Sparks 2015), which exerts a substantial toll on physiological well-being during pregnancy and childbearing (Earnshaw et al. 2011; Geronimus 1992; Rosenthal and Lobel 2011; Turner and Avison 2003). This physical health deterioration may occur at earlier ages than Whites regardless of SES (Geronimus et al. 2006). Given this "weathering" pattern (Geronimus 1992), delaying birth until older ages—which benefits educational attainment (Kane et al. 2013)—may negatively affect African American women's infant health outcomes.[1]

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). These patterns may relate to underlying racial inequality in the United States. Although this perspective may be a useful framework for explaining African American-White infant mortality disparities, it may be less salient for Mexican American-White differences—which are considerably narrower and typically explained by SES differences across groups (Hummer et al. 1999; Rogers et al. 2017). In sum, the "within education-level inequality" hypothesis posits that IMRs will be higher among African American and (possibly) 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 relative to their White counterparts with the same level of educational attainment.

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:

[1]Our paper does not directly incorporate the weathering hypothesis (Geronimus 1992) because it does not include maternal age interactions.

98 to 99 percent of deaths occurring to infants born in 2007 through 2010 were successfully linked (CDC 2012, 2014a, 2014b, 2015).

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.[2] 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 include births to women age 25 and over to effectively assess completed educational attainment. In contrast, births to younger mothers are associated with disadvantage and may, in turn, reduce educational attainment (Kane et al. 2013). 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. Maternal education has a missingness rate under one percent across the three racial/ethnic groups. Our final analytic file includes 7,215,833 births, of whom 40,970 died during the first year of life (see Appendix A1 for descriptive statistics).

We use five rounds of chained multiple imputation to preserve cases with missing data. Information on maternal smoking (10.2%) and timing of prenatal care use (4.0%) is missing from specific states; all other variables have less than one percent of missing cases. To model missingness accurately, we include indicators for state-based missingness in the imputation-models. 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 racial/ethnic categories: African American, Mexican American, and White. We then disaggregate these racial/ethnic groups by maternal education attainment: 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, maternal age, parity, and plurality. We measure plurality as a dummy variable (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+. Categorical representation of maternal age is preferred because of non-linearity in the cross-sectional association between maternal age and infant

[2]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.

health (Goisis et al. 2017). Using a linear term for maternal age does not alter estimates. We consider two behavioral characteristics during pregnancy. Initiation of prenatal care (PNC) is divided into three categories: first trimester (referent), second trimester, and 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 birthweight. A z-score of birthweight is used to purge the correlation between gestational age and birthweight. To construct this z-score, we subtract each infant's birthweight from the mean birthweight for all births from 2007–2010 at each specific weekly gestational age, and then divide the difference by the standard deviation of birthweight at that gestational age. 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, 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, addressing the 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, testing a behaviorally based explanation for the disparities and drops demographic covariates from the second model. The fourth model includes all demographic and health behavior covariates. The fifth model adds a variable for gestational age, and the sixth model adds 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 birthweight. The logistic regression models are used to calculate average marginal effects (AME). These AME represent the average discrete change in infant mortality risk for race/ethnicity-education groups relative to the reference group (White women with a high school degree or less). The original AME (proportions) are multiplied by 1,000, indicating differences in deaths per 1,000 live births (or differences in predicted IMR). Unlike odds ratios (Appendix Table A2), AME provide accurate comparisons across nested models (Mood 2010) and use IMR-based units. We display the AME's 95 percent confidence intervals to compare across models.

[3]We also estimated models using the Kotelchuck Index. We observed no meaningful change in results. This index rates prenatal care adequacy by the number of visits per trimester.

Add Health Analysis

BID data lack detailed information on the life course contexts that may underlie racial/ethnic-education inequalities in infant mortality. We therefore turn to the rich information provided by Add Health to describe potential life course sociodemographic, neighborhood, behavioral, psychosocial, and health contexts that provide insight to the observed patterns of infant mortality across race/ethnicity-education subgroups. Consequently, these data aid in assessing the conceptual model, especially the within-education-level 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 (Wave I) school year, with follow-up interviews in 1996 (Wave II), 2001–02 (Wave III), 2008–09 (Wave IV), and 2016–2018 (Wave V) (Harris and Udry 2013). To approximate fertility selection, we use data from female respondents who have had a live birth at age 25 or above—as indicated in Wave IV or V. We draw on 830 US-born African American, 285 US-born Mexican American, and 2,458 US-born White women with different educational attainment levels 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). The age range (24–32) of Add Health respondents at Wave IV and its collection period in 2008–09 best complements the BID files. We do not use Wave V information because contextual and biomarker data has not yet been released. To parallel our analysis of the BID files, we disaggregate race/ethnicity by three categories of educational attainment.

Add Health is based on a multistage stratified probability sample, with oversampling for key population strata. Obtaining consistent (i.e., asymptotically unbiased) estimates of population parameters and their sampling variances in a complex design such as Add Health requires applying specialized survey weighting methods (Harris and Udry 2013). Thus, we computed means, medians, and percentages and their corresponding standard errors while accounting for the Add Health survey design. We then calculated 95 percent confidence intervals for comparing socioeconomic, psychosocial, behavioral and health characteristics by race/ethnicity-education, assigning White women with a high school degree or less to the reference group. Differences relative to the reference group are shaded grey. These estimates and standard errors are consistent with estimates from weighted bivariate regressions.

Add Health Measures

Four sociodemographic indicators from Wave I capture respondents' early life sociodemographic contexts: parental education, household income, parental occupation, and mother's relationship status. Parental education is treated as a linear indicator of education years, ranging from less than high school (10), high school (12), some college (14), bachelor's degree (16), and more than a bachelor's degree (18). Because mean household income has considerable right skew, we compare median household income—akin to a bivariate median quantile regression. The dichotomous measure of parental occupation captures respondents who grew up with parents with professional (1=yes) versus non-professional occupations. Maternal relationship status, which captures the potential of additional economic resources, is assessed with a dummy variable of whether the respondent's mother is married/cohabitating in Wave I (yes=1).

We then selected five indicators of neighborhood disadvantage from Wave I to assess early life neighborhood context: median income, proportion unemployed, proportion in poverty, proportion white, and proportion of single mother households. These Census tract-level indicators are obtained from the 1990 Census. Each of these indicators are measured as mean values. Income, unemployment, and poverty rates reflect neighborhood economic characteristics. The proportion white reflects racial/ethnic segregation. The proportion of single mother household serves as indicator of family and economic inequality.

Drawing on Add Health's school-based design we selected two school-level contextual characteristics. The percentage of attendees receiving free lunch serves as an indicator of economic disadvantage. The proportion of white students in the school serves as an indicator of segregation.

We evaluate the role of adult sociodemographic context with four indicators in Wave IV: household income, household assets, employment, and respondent's relationship status. The Add Health team aggregated household income into income levels from less than $5,000 to $150,000 or more. We measured household income as a mean value because the indicator did not have right skew. We used a dichotomous indicator for assets to indicate disadvantaged status: household assets under $10,000 (referent) and household assets over $10,000. Using data on current employment hours from all respondents, we dichotomized the employment indicator: full time at 35 or more hours and not full time at less than 35 hours (referent). Similar to the Wave I indicator of maternal relationship status, we assessed respondent relation status as a dummy variable: married or cohabiting (yes=1) and not married or cohabiting (referent).

We selected the same five neighborhood indicators as those used in Wave I for the Wave IV analysis: median income, proportion unemployed, proportion in poverty, proportion white, and proportion of single mother households. These data were obtained from the 2009 American Community Survey 5-year estimates and are operationalized in the same manner as in the Wave I analysis.

We selected five measures of stress from Wave IV to reflect capture the psychosocial context of Add Health respondents: perceived stress, perceived unfair treatment, crime victimization, parental death, and parental incarceration. Cohen's Stress Index (0–16) indicates the level of perceived stress the respondent is experiencing (Cohen, Kamarck, and Mermelstein 1983). The stress index was constructed by the Add Health team (see Appendix B). Unfair treatment is captured with the item: "In your day-to-day life, how often do you feel you have been treated with less respect or courtesy than other people?" Responses range from 0 (never) to 4 (often). We dichotomize the response into sometimes/often (yes=1) and never/rarely (referent). Crime victimization in the past year is measured by a dummy variable indicating whether the respondents was a victim of a crime victim in the past year (1=yes). Given the high rates of mortality among African American adults (Masters et al. 2014; Rogers et al. 2019) and the relationship between parental mortality and long-term health (Luecken and Roubinov 2012), we included parental death by Wave IV as an indicator of stress. This dichotomized indicator captures whether at least one biological parent died by Wave IV (1=yes). Because mass incarceration of African American parents may impact the health and well-being of their children, including increased risk of infant mortality (Wildeman 2012, 2014), we included an indicator of parental incarceration: at least one biological parent incarcerated by Wave IV (1=yes) and no biological parents incarcerated by Wave IV (referent).

Health context is assessed with three indicators of substance use from Wave IV: smoking, alcohol dependence, and drug use. The dichotomous smoking measure indicates whether the respondent smokes daily (1=yes). The alcohol dependence indicator is obtained from a constructed variable from the DSM-IV indicator of alcohol dependence (American Psychological Association 1994). The measure was dichotomized: at least one alcohol dependence symptom or no dependence symptoms (referent) (see Appendix B). We also dichotomized drug use: drug use in the past year and no drug use in the past year (referent).

Lastly, we selected four biological health indicators from Wave IV: C-reactive protein (CRP), obesity, hypertension, and diabetes. We dichotomize the CRP indicator: high CRP and not high CRP (referent). Obesity is also dichotomized: reported body-mass index or 30 or above or under 30 (referent). We dichotomize a blood pressure indicator based on clinical cutoff points (130+ mmHg systolic and/or 80+ mmHg diastolic): high blood pressure or no high blood pressure (referent). The diabetes indicator is obtained from an A1C marker and is dichotomized: type 2 diabetes (A1C level 6.5 percent or more) and no type 2 diabetes (referent).

Results

The first column of Table 1 provides IMRs by race/ethnicity. As previous research has documented, IMRs are highest among infants born to African American women (12.7 deaths per 1,000 live births), followed by infants born to Mexican American women (5.4) and infants born to White women (4.6). The second column of Table 1 shows the educational composition for each group. African American and Mexican American women have, on average, lower levels of educational attainment than White women. Forty-four percent of African Americans and 47 percent of Mexican Americans have a high school degree or less compared to just 23 percent of Whites. The third column of Table 1 shows the IMRs for each racial/ethnic-education subgroup; rate ratios (compared to Whites with a high school degree or less) are presented in the fourth column. Within each racial/ethnic group, infants born to women with higher levels of education have lower IMRs, as expected. Moreover, 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, consistent with reports on this pattern dating back into the 1980s (Schoendorf et al. 1992). Indeed, infants of college-educated African American women experience 3.1 more infant deaths per 1,000 live births (or 46 percent higher mortality) when compared to infants of White women with a high school degree or less. Moreover, infants of African American 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 African American-White disparities do not support either the low-educated White disadvantage hypothesis or the socioeconomic hypothesis. In contrast, education specific IMRs for Mexican Americans are quite similar to those of Whites, which supports the socioeconomic hypothesis for the disparity between

Mexican Americans and Whites. That is, higher infant mortality among Mexican Americans relative to Whites is associated with the lower overall educational attainment among Mexican Americans.

The logistic regression models in Table 2 present average marginal effects (AME) of infant mortality by race/ethnicity-education (odds ratios are available in Appendix Table A2). These AME represent differences in predicted IMR relative to White women with a high school degree or less. 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 African Americans-White infant mortality disparities. For example, compared to White women with a high school degree or less, the AME for African American women with some college declines from a 5.4 to a 4.3 difference in predicted IMR when comparing Models 1 and 2, respectively. In contrast, the AME for Mexican Americans remain similar to those of Whites at each educational level.

The introduction of controls for initiation of prenatal care and smoking (Model 3) do not have a meaningful influence on the gaps between African American and low-educated Whites—with the exception of African American women with a bachelor's degree or more—and has little influence on Mexican American-White differences. But compared to White women with a high school degree or less, the AME for African American women with a bachelor's degree or more increases from 2.4 to 4.1 differences in predicted IMR. Thus, the African American-White gaps in infant mortality would be even higher if Black women smoked at the same rate as White women. Even after accounting for demographic background and health behaviors in Model 4, African American women with a bachelor's degree or more and a high school degree or less have 3.2 and 6.5 more deaths per 1,000 live births, respectively, than White women with a high school degree or less. These regression results provide only modest support for the health behavior and health care hypothesis.

Controlling for gestational age (Model 5) reverses the African American-White disparity in infant mortality. Net of gestational age, the AME of infant mortality for all African American women, regardless of educational attainment, is either equal to or lower than those of White women with a high school degree or less. For example, the AME for African American women with a bachelor's degree or more reverses from a 3.2 to a −0.4 difference in predicted IMR with the inclusion of gestational age in the model (see Models 4 and 5). This finding underscores the importance of gestational length in the higher IMR among African American women across all educational attainment levels (see also Hummer et al. 1999).[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 mortality rates relative to White women with a high school degree or less. The introduction of birthweight in Model 6 results in little meaningful change in AME for all race/ethnicity-education

[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.

groups. In sum, findings from these models provide strong evidence for prematurity as the key mechanism underlying African American-White disparities in infant mortality.

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

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

During adolescence, African American women from all education-levels lived in similar or 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 similar poverty rates to low-educated White women. Furthermore, African American women who eventually earned a college degree or more attended schools with similar rates of free lunch to 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 obtained 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. In general, the disadvantages exhibited by African American women in adolescence, even those who went on to achieve a college degree or more, in many ways mirror the patterns of infant mortality shown above in Table 1.

Table 4 presents characteristics of these same women in young adulthood. Among each racial/ethnic group, education-level disparities in most sociodemographic outcomes are observed. For example, women with bachelor's degrees have higher household incomes than women with a high school degree or less. Although African American women who 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 White women with a bachelor's degree or more. Moreover, African American women with a high school degree or less have disadvantaged income and asset profiles compared with White women with a high school degree or less. In contrast, Mexican American women have similar income and asset profiles to their White counterparts who have completed the same level of education. In sum, African American women are substantially economically disadvantaged relative to Mexican American and White women who have completed the same education-level by young adulthood.

African American women of all educational attainment levels also exhibit disadvantages in neighborhood characteristics during young adulthood compared with similarly educated White women. 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, unemployment rates, and poverty 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 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 stressors 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 similar rates of stress, victimization, parental death, and parental incarceration. Further, African American women who have completed a high school degree or less report much higher rates of parental imprisonment than low-educated Whites. However, when 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.

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 (with the exception of those with a bachelor's degree or less), and drug use than Whites with a high school degree or less. Mexican American women have similar or lower rates of smoking, alcohol dependence, and drug use than their White counterparts with the same education-level. Accordingly, 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 use.

African American women have higher obesity rates than White women at the same education-level. However, we find no 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 yield few differences by race/ethnicity-education. However, African American women—regardless of education-level—have higher diabetes rates than White women of all educational levels and Mexican American women who have less than a bachelor's degree.

Discussion

Substantial attention has centered on the recently observed mortality increases among low educated Whites (Case and Deaton 2015, 2017). Such a trend has raised speculation that low educated Whites may have the most unfavorable mortality patterns in the United States (Boddy and Greene 2017). We labelled this the White disadvantage hypothesis and tested but 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, 3.1 more infant deaths per 1,000 live births occurred among infants of highly educated African American women than among infants born to low-educated White women. Furthermore, 7.9 more infant deaths per 1,000 live births occurred among African American women with a high school degree or less than among their White counterparts with the same level of education. Our analysis also found no evidence in support of the socioeconomic hypothesis for African African-White population health disparities, i.e., that racial/ethnic infant mortality differentials are fully explained by differences in educational attainment.

We also found that African American-White infant mortality disparities modestly widened with controls for maternal prenatal behaviors, which provides limited support for the health behavior and care hypothesis. In fact, infant mortality disparities would be even wider if African American women smoked at similar rates to White women with a high school degree or less. Furthermore, we observed that African American-White infant mortality disparities were fully accounted for by controlling for infant gestational length, consistent with prior research. Below, we 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, 0.9 more Mexican American infants die per 1,000 live births 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 infant mortality risks as White women with similar educational attainment levels. Such results suggest that policies that improve educational attainment among Mexican Americans—which continue to lag behind other racial/ethnic groups (Everett et al. 2011)—will be important in closing Mexican American-White gaps in population health.

Overall, 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 gestational length. 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 provide 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]

To contextualize the BID analyses and provide insight into the life course contexts underlying these racial/ethnic-education infant mortality patterns, we used data from Add Health to describe 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 who have at least one birth—some before and others after 2008–09—at age 25 or above. This analysis revealed that African American women experience substantial individual-level and contextual disadvantages across adolescence and young adulthood relative to White women, even for those who eventually attained a college degree. 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. In contrast, Mexican American women have similar profiles to White women with the same education-level.

Moreover, African American women with high education generally exhibited disadvantaged adult health relative to White women of low education and tended to exhibit 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 with low education in adulthood, but also for those who attain high levels of education in adulthood – 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 unsurprising that infant mortality rates for African Americans remain far higher than those of Whites. Simply put, substantial disadvantages across the life course, 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

[5]To test the robustness of our infant mortality findings, we performed several sensitivity analyses. First, 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 IMR compared with White women with less than a high school degree. Next, we re-ran our analyses including women who were less than age 25 at the time of their child's birth. This analysis is important given the "weathering" pattern observed among African American women (Geronimus 1992). However, we note that this analysis does directly test the weathering hypothesis (see Footnote 1). Rather, it tests if estimates would could be influenced by changes in our age sample selection. 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 6.2, 4.1, and 2.3 more deaths per 1,000 live births, respectively, 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 1.2 fewer deaths per 1,000 live births 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.

the two datasets in this analysis, when understood 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 who have achieved very high levels of educational attainment.

Our research 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; Geronimus et al. 2006; Pearson 2008). Importantly, such life course histories are inseparable from the broader social histories underlying each group's health and mortality patterns (Masters et al. 2014), 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; Hummer 1996; Phelan and Link 2015; Williams et al. 2010). Consequently, we suggest that future research must consider multilevel 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). We contend that these patterns—observed in both the BID and Add Health data—are consistent with Phelan and Link's (2015) idea of racism as a fundamental cause of health. A life course perspective may further develop knowledge on the mechanisms by which racism impacts infant health.

Finally, it is important to point out that low-educated Whites in both the vital statistics-based and Add Health datasets 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 those attributable to poisonings, suicide, and alcohol-related deaths (Case and Deaton 2015, 2017). Unfortunately, parental substance use can have long-term harmful health impacts on infants and children. 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 and perpetuated by institutional and structural forces (e.g., corporations, governments).

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 influenced by omitted variables, such as household income, education of partner, possession of health insurance, and the presence of extended family members in the household. 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 life course contextual disparities we documented are in fact associated with infant mortality. Rather, the Add Health analysis offers rich information on the social contexts in which infant mortality disparities play out.

Thus, our Add Health analysis provides key insights but does not formally test hypotheses. Finally, we examined just one, albeit important, population health measure: infant mortality. In addition to infant mortality, it is vital to examine race/ethnic and parental educational disparities at other ages as well (e.g. Braudt et al. 2019; Rogers et al. 2017). Still, infant mortality is both a reflection of how well society is treating its youngest members and a key indicator of women's health status. 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 in infant mortality is especially wide, both when comparing similarly educated individuals or when comparing highly educated African Americans with low-educated Whites. Beyond that, however, the life course disadvantages of African Americans continue to be striking relative to Whites, reflecting long-term and continued patterns of racial discrimination that create more stressful and health-compromised lives for African American individuals relative to Whites. Together, our findings 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.

Racial/ethnic population health disparities are unlikely to close without 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. Indeed, our findings indicate that processes occurring prior to and during pregnancy play a significant role in generating African American-White disparities in infant mortality across all educational levels. Such processes involve the accumulation of stressors across the life course, particularly for African American. Thus, economic and social policies that boost material resources available to African American women in childhood and adolescence (e.g., better funded and resourced schools; access to college without loans) may ease socioeconomic attainment processes and improve maternal and reproductive health. Furthermore, given that educational attainment may have fewer protective health consequences among African Americans due to increased exposure to interpersonal discrimination during and after the attainment processes (Cole and Omari 2003; Hudson et al. 2013), aggressive policy attention should also be given to programs that stamp out stressful, discriminatory experiences in higher education and labor market contexts. In sum, a variety of aggressive social policy interventions across the life course may be necessary to reduce the persistent African American-White infant mortality gap.

Acknowledgements

We thank the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD grant R01HD082106) for research support; the NICHD-funded Carolina Population Center (Award Number P2CHD050924) and Population Research Training program (Award Number T32HD007168), the NICHD-funded

Population Research Center at University of Texas at Austin (Award Number P2CHD042849), and the NICHD-funded University of Colorado Population Center (Award Number P2CHD066613); and the National Center for Health Statistics (NCHS) for making the restricted-use linked birth and infant death cohort files available. This research also uses data from Add Health, a program project directed by Kathleen Mullan Harris and designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill, and funded by grant P01HD31921 from the NICHD, with cooperative funding from 23 other federal agencies and foundations. Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Information on how to obtain the Add Health data files is available on the Add Health website (http://www.cpc.unc.edu/addhealth). No direct support was received from grant P01HD31921 for this analysis. The content of this manuscript is the sole responsibility of the authors and does not necessarily represent the official views of NICHD or NCHS.

Appendix A:: Supplemental Analyses

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)	−0.1	−0.2	−0.3	0.1	0.1	0.1	0.2	0.2	0.0

	African American			Mexican American			White		
	BA+	Some College	HS or Less	BA+	Some College	HS or Less	BA+	Some College	HS or Less
(Standard Deviations)									
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

Table A2:

Logistic Regression of Infant Mortality on Race/Ethnicity-Education and Covariates in the US from 2007 through 2010 (95% Confidence Intervals)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Race/Ethnicity (ref = White, HS or Less)						
African American BA+	1.47 (1.40, 1.54)	1.36 (1.29, 1.42)	1.66 (1.58, 1.75)	1.52 (1.44, 1.59)	0.92 (0.87, 0.97)	0.80 (0.76, 0.85)
African American Some College	1.82 (1.75, 1.89)	1.63 (1.57, 1.70)	2.00 (1.93, 2.08)	1.82 (1.75, 1.90)	0.94 (0.90, 0.99)	0.81 (0.78, 0.85)
African American HS or Less	2.20 (2.13, 2.27)	1.88 (1.82, 1.95)	2.31 (2.23, 2.38)	2.03 (1.96, 2.11)	0.98 (0.94, 1.02)	0.86 (0.82, 0.89)
Mexican BA+	0.50 (0.45, 0.57)	0.51 (0.46, 0.57)	0.57 (0.51, 0.64)	0.57 (0.50, 0.64)	0.68 (0.61, 0.77)	0.67 (0.60, 0.76)
Mexican Some College	0.79 (0.73, 0.84)	0.81 (0.75, 0.87)	0.89 (0.83, 0.95)	0.90 (0.84, 0.97)	0.84 (0.78, 0.91)	0.81 (0.75, 0.88)
Mexican HS or Less	0.95 (0.90, 1.01)	0.95 (0.90, 1.01)	1.06 (1.01, 1.13)	1.07 (1.01, 1.14)	0.86 (0.81, 0.92)	0.84 (0.79, 0.90)
White BA+	0.52 (0.50, 0.53)	0.51 (0.50, 0.53)	0.59 (0.57, 0.61)	0.56 (0.54, 0.58)	0.78 (0.76, 0.81)	0.83 (0.80, 0.86)
White Some College	0.71 (0.69, 0.73)	0.72 (0.70, 0.74)	0.76 (0.74, 0.78)	0.76 (0.74, 0.78)	0.88 (0.85, 0.91)	0.90 (0.87, 0.93)
Unmarried (ref = Married)		1.36 (1.32, 1.39)		1.28 (1.25, 1.31)	1.09 (1.06, 1.12)	1.08 (1.05, 1.11)
Birth Order (ref = 1)						
2–3		0.73 (0.71, 0.75)		0.72 (0.70, 0.74)	1.00 (0.97, 1.02)	1.16 (1.13, 1.19)
4+		0.90 (0.87, 0.92)		0.87 (0.84, 0.90)	1.19 (1.15, 1.23)	1.45 (1.40, 1.50)
Plural (ref = Singleton)		5.22 (5.09, 5.36)		5.27 (5.13, 5.40)	0.93 (0.90, 0.96)	0.66 (0.65, 0.68)
Maternal Age (ref = 25–29)						
30–34		1.01 (0.99, 1.04)		1.02 (1.00, 1.04)	0.89 (0.87, 0.91)	0.88 (0.86, 0.90)
35–39		1.15 (1.12, 1.19)		1.16 (1.13, 1.19)	0.89 (0.86, 0.91)	0.86 (0.83, 0.89)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
40+		1.38 (1.32, 1.45)		1.40 (1.33, 1.47)	1.02 (0.97, 1.08)	0.97 (0.93, 1.02)
Initiation of Prenatal Care (ref = 1st Trimester)						
2nd Trimester			0.93 (0.90, 0.95)	0.92 (0.89, 0.94)	1.18 (1.15, 1.22)	1.18 (1.14, 1.22)
3rd Trimester or None			1.08 (1.02, 1.14)	1.08 (1.03, 1.14)	1.51 (1.42, 1.61)	1.54, 1.45, 1.63)
Smoking (ref = No)			1.56 (1.50, 1.61)	1.52 (1.47, 1.58)	1.25 (1.20, 1.30)	1.08 (1.04, 1.12)
Gestational Age					0.68 (0.68, 0.68)	0.67 (0.67, 0.67)
Birthweight Z-Score						0.45 (0.45, 0.46)

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

N_{Births} = 7,215,833; N_{Deaths} = 40,970

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.

Appendix B:: Variable coding

Below are descriptions of Add Health's indicator's for Cohen's stress index and alcohol dependence symptoms. Both variables were constructed by the Add Health team. We dichotomized alcohol dependence symptoms: at least one dependence symptom or no dependence symptoms (referent). The original variable names are provided along with the questions and common Likert scale and dummy variable responses for the measures.

Cohen Stress Index:

Constructed from the sum of the following variables.

H4MH3: In the last 30 days, how often have you felt that you were unable to control the important things in your life?

H4MH4: In the last 30 days, how often have you felt confident in your ability to handle your personal problems?

H4MH5: In the last 30 days, how often have you felt that things were going your way?

H4MH6: In the last 30 days, how often have you felt that difficulties were piling up so high that you could not overcome them?

Common Response:

0 (Never), 1 (Almost Never), 2 (Sometimes), 3 (Fairly Often), 4 (Very Often)

Alcohol Dependence Symptoms:

Any respondent with at least one symptom is considered to have alcohol dependence.

H4TO51: Have you ever found that you had to drink more than you used to in order to get the effect you wanted?

H4TO52: Has there ever been a period when you spent a lot of time drinking, planning how you would get alcohol, or recovering from a hangover?

H4TO53: Have you often had more to drink or kept drinking for a longer period of time than you intended?

H4TO55: Has there ever been a period of time when you wanted to quit or cut down on your drinking?

H4TO56: When you decided to cut down or quit drinking, were you able to do so for at least one

H4TO58: During the first few hours of not drinking, do you experience withdrawal symptoms such as the shakes, feeling anxious, trouble getting to sleep or staying asleep, nausea, vomiting, or rapid heart beats?

H4TO59: Have you ever continued to drink after you realized drinking was causing you any emotional problems (such as feeling irritable, depressed, or uninterested in things or having strange ideas) or causing you any health problems (such as ulcers, numbness in your hands/feet or memory problems)?

H4TO60: Have you ever given up or cut down on important activities that would interfere with drinking like getting together with friends or relatives, going to work or school, participating in sports, or anything else?

Common Response:

0 (No), 1 (Yes)

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Table 1:

Infant Mortality Rates and Rate Ratios by Race/Ethnicity and Maternal Education in the US from 2007 through 2010 (95% Confidence Intervals)

	Total IMR	Race/Ethnic Education Composition (%)	Race/Ethnic Education-Specific IMR	Rate Ratio of IMR Compared to Whites With HS or Less Education
African American	12.7 (12.5, 13.0)			
BA+		22.0	9.8 (9.4, 10.3)	1.5 (1.4, 1.5)
Some College		34.3	12.2 (11.8, 12.5)	1.8 (1.8, 1.8)
HS or Less		43.7	14.7 (14.3, 15.0)	2.2 (2.2, 2.2)
Mexican American	5.4 (5.2, 5.7)			
BA+		19.4	3.4 (3.0, 3.8)	0.5 (0.5, 0.6)
Some College		33.6	5.3 (4.9, 5.7)	0.8 (0.8, 0.8)
HS or Less		47.0	6.4 (6.1, 6.7)	1.0 (0.9, 1.0)
White	4.6 (4.5, 4.7)			
BA+		48.8	3.5 (3.4, 3.6)	0.5 (0.5, 0.5)
Some College		28.5	4.8 (4.7, 4.9)	0.7 (0.7, 0.7)
HS or Less		22.7	6.7 (6.6, 6.9)	--

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

N_{Births} = 7,215,833; N_{Deaths} = 40,970

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

Table 2:

Average Marginal Effects (AME) from Logistic Regressions of Infant Mortality (Per 1,000 Live Births) on Race/Ethnicity-Education and Covariates (95% Confidence Intervals)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Race/Ethnicity (ref = White, HS or Less)						
African American BA+	3.1 (2.7, 3.6)	2.4 (2.0, 2.8)	4.1 (3.6, 4.5)	3.2 (2.8, 3.7)	−0.4 (−0.7, −0.2)	−1.0 (−1.2, −0.8)
African American Some College	5.4 (5.0, 5.8)	4.3 (3.9, 4.6)	6.1 (5.7, 6.5)	5.2 (4.8, 5.6)	−0.3 (−0.5, −0.1)	−0.9 (−1.1, −0.7)
African American HS or Less	7.9 (7.6, 8.2)	5.9 (5.5, 6.3)	8.0 (7.6, 8.4)	6.5 (6.1, 6.9)	−0.1 (−0.3, 0.1)	−0.7 (−0.9, −0.5)
Mexican BA+	−3.3 (−3.7, −2.9)	−3.3 (−3.7, −2.9)	−2.6 (−3.1, −2.2)	−2.8 (−3.2, −2.3)	−1.6 (−2.1, −1.2)	−1.7 (−2.1, −1.2)
Mexican Some College	−1.4 (−1.8, −1.0)	−1.3 (−1.7, −0.9)	−0.7 (−1.1, −0.3)	−0.6 (−1.0, −0.2)	−0.8 (−1.1, −0.5)	−0.9 (−1.3, −0.6)
Mexican HS or Less	−0.3 (−0.7, 0.0)	−0.3 (−0.7, −0.1)	0.4 (0.0, 0.8)	0.5 (0.1, 0.9)	−0.7 (−1.0, −0.4)	−0.8 (−1.1, −0.5)
White BA+	−3.2 (−3.4, −3.1)	−3.3 (−3.5, −3.2)	−2.5 (−2.7, −2.4)	−2.8 (−3.0, −2.6)	−1.1 (−1.3, −0.9)	−0.8 (−1.0, −0.7)
White Some College	−2.0 (−2.1, −1.8)	−1.9 (−2.1, −1.7)	−1.5 (−1.7, −1.3)	−1.5 (−1.7, −1.3)	−0.6 (−1, −0.5)	−0.5 (−0.6, −0.3)
Covariates						
Demographic	No	Yes	No	Yes	Yes	Yes
Health Behavior	No	No	Yes	Yes	Yes	Yes
Gestational Age	No	No	No	No	Yes	Yes
Birth weight	No	No	No	No	No	Yes

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

N=7,215,833

Notes: The AME reflect differences in infant deaths per 1,000 live births (or differences in predicted IMR) relative to White women with a high school degree or less. The AME are obtained from the logistic regression models with odds ratios displayed in Table A2; the original estimates (proportions) are multiplied by 1,000. Demographic covariates include marital status, birth order, plurality, and maternal age at birth. Health behavior covariates include initiation of prenatal care and prenatal smoking. Gestational age is measured in weeks and birth weight is an index—raw birth weight relative to the mean birth weight per gestational age. The average predicted IMR for White women with a high school degree or less from Models 1 through 6 are 6.7, 6.8, 6.2, 6.4, 6.3, and 6.4, respectively.

Table 3:

Sociodemographic, Neighborhood, and School Characteristics of US-born Women with a Live Birth at Age 25 or Above 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 (11, 13)	11 (11, 12)	15 (15, 16)	14 (13, 14)	13 (12, 13)
Household Income ($1000) (Median)	34 (28, 40)	24 (20, 28)	15 (11, 19)	35 (25, 45)	24 (19, 29)	25 (18, 32)	60 (55, 65)	40 (37, 43)	30 (27, 33)
Parent has Professional Job (%)	29 (21, 39)	20 (14, 27)	4 (2, 9)	19 (9, 37)	21 (9, 41)	4 (1, 15)	41 (35, 46)	17 (13, 20)	10 (8, 14)
M other Married or Cohabiting (%)	59 (52, 66)	47 (40, 54)	47 (40, 54)	83 (64, 94)	77 (60, 89)	82 (65, 92)	87 (84, 89)	81 (77, 84)	77 (72, 81)
Neighborhood Characteristics									
Median Income ($1000)	23 (20, 26)	23 (19, 26)	20 (18, 21)	28 (22, 34)	26 (23, 30)	31 (26, 37)	36 (33, 39)	31 (28, 33)	27 (25, 29)
Unemployment Rate (%)	11 (10, 13)	11 (10, 13)	12 (11, 13)	8(7, 10)	9 (7, 10)	8 (6, 10)	5 (5, 6)	6 (5, 8)	8 (7, 9)
Poverty Rate (%)	19 (16, 23)	18 (16, 20)	19 (17, 22)	14 (12, 16)	14 (12, 16)	13 (11, 15)	12 (11, 13)	13 (11, 15)	15 (13, 16)
Proportion White (%)	43 (32, 54)	42 (32, 51)	41 (33, 49)	66 (57, 76)	65 (58, 73)	69 (61, 78)	92 (90, 94)	93 (91, 95)	90 (87, 93)
Percent Single Mother (%)	19 (16, 21)	19 (17, 21)	21 (18, 24)	12 (7, 17)	16 (11, 21)	14 (9, 20)	13 (11, 16)	15 (13, 17)	16 (13, 19)
School Characteristics									
Free Lunch (%)	39 (28, 51)	40 (32, 47)	47 (38, 56)	29 (18, 41)	36 (30, 43)	33 (25, 41)	16 (12, 20)	18 (14, 22)	27 (22, 33)
Proportion White (%)	38 (20, 56)	40 (29, 51)	37 (25, 49)	35 (14, 56)	32 (18, 47)	35 (19, 52)	83 (79, 87)	86 (82, 90)	79 (73, 85)
Observations	251	316	263	62	110	113	1,038	798	622

Source: Wave I of the National Longitudinal Study of Adolescent to Adult Health (Add Health). N=3,573

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 with a Live Birth at Age 25 or Above 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)	67 (58, 75)	42 (37, 48)	27 (23, 30)	83 (69, 97)	55 (47, 64)	59 (51, 67)	81 (78, 84)	61 (57, 64)	47 (43, 51)
Household Assets Under $10,000 (%)	36 (27, 46)	55 (47, 63)	63 (54, 71)	12 (4, 29)	48 (33, 63)	37 (23, 55)	16 (14, 19)	31 (26, 35)	42 (37, 48)
Employed Fulltime (35+ Hours) (%)	88 (81, 93)	82 (75, 87)	82 (75, 88)	91 (77, 97)	79 (61, 90)	81 (69, 89)	85 (81, 88)	72 (68, 76)	75 (70, 79)
Married or Cohabiting (%)	61 (52, 69)	60 (53, 67)	53 (46, 59)	88 (75, 95)	78 (63, 89)	86 (70, 94)	82 (78, 85)	81 (78, 84)	85 (80, 89)
Neighborhood Characteristics									
Median Income ($1000)	47 (44, 51)	40 (37, 42)	36 (34, 38)	53 (45, 60)	48 (42, 54)	53 (47, 58)	61 (59, 64)	52 (50, 54)	46 (44, 49)
Unemployment Rate (%)	11 (9, 12)	12 (11, 13)	12 (11, 13)	7 (5, 10)	8 (7, 9)	8 (7, 9)	6 (6, 7)	7 (6, 8)	8 (7, 9)
Poverty Rate (%)	17 (15, 19)	23 (21, 26)	25 (23, 27)	13 (9, 19)	17 (13, 20)	16 (13, 20)	10 (9, 11)	12 (11, 13)	15 (13, 16)
Percent White (%)	47 (40, 54)	44 (37, 50)	44 (37, 51)	66 (57, 75)	66 (59, 74)	67 (61, 73)	82 (81, 84)	86 (84, 88)	83 (80, 86)
Percent Single Mother (%)	37 (32, 41)	43 (39, 47)	43 (39, 47)	28 (22, 35)	24 (20, 28)	24 (20, 28)	21 (20, 22)	23 (22, 25)	25 (23, 27)
Stressors									
Cohen's Stress Index (0–16) (Mean)	4.9 (4.4, 5.5)	5.2 (4.8, 5.6)	5.7 (5.2, 6.3)	4.3 (3.4, 5.2)	4.8 (3.7, 5.9)	4.7 (3.5, 5.9)	3.8 (3.6, 4.0)	5.2 (4.9, 5.4)	5.6 (5.3, 5.9)
Sometimes/Often Disrespected (%)	24 (17, 33)	29 (22, 38)	36 (30, 42)	20 (8, 38)	25 (13, 41)	22 (13, 34)	13 (11, 15)	25 (22, 29)	27 (23, 32)
Crime Victim Last Year (%)	34 (26, 43)	42 (35, 51)	50 (40, 59)	35 (17, 59)	37 (24, 52)	32 (20, 48)	26 (23, 30)	32 (28, 36)	36 (31, 41)
Parent Death (%)	15 (10, 22)	29 (22, 37)	32 (25, 40)	6 (1, 21)	5 (1, 18)	9 (3, 20)	10 (8, 13)	13 (11, 16)	20 (16, 24)
Parent Incarcerated at Least Once (%)	19 (11, 30)	29 (22, 37)	32 (24, 42)	11 (3, 32)	29 (16, 48)	32 (18, 50)	4 (3, 6)	17 (14, 20)	24 (20, 28)
Substance Use									
Smoke Daily (%)	6 (3, 10)	15 (10, 23)	17 (11, 24)	3 (9, 12)	11 (4, 28)	7 (2, 20)	10 (8, 13)	30 (26, 34)	44 (39, 49)
Alcohol Dependence (%)	18 (12, 25)	14 (10, 20)	8 (5, 14)	26 (13, 45)	40 (27, 56)	13 (5, 28)	38 (34, 42)	30 (26, 35)	27 (22, 32)
Drug Use in Last Year (%)	2 (1, 7)	5 (2, 9)	2 (1, 4)	6 (2, 20)	12 (5, 29)	4 (1, 21)	5 (3, 7)	8 (6, 11)	11 (8, 15)
Health Characteristics									
High CRP (%)	34 (23, 47)	40 (32, 49)	45 (34, 56)	57 (39, 73)	36 (23, 51)	63 (45, 78)	34 (30, 37)	38 (33, 43)	43 (37, 49)
Obese (%)	46 (39, 54)	51 (45, 58)	61 (53, 67)	35 (18, 57)	43 (28, 60)	39 (25, 55)	20 (17, 24)	35 (31, 40)	43 (38, 49)
Hypertension (%)	17 (10, 27)	20 (14, 28)	18 (13, 24)	12 (4, 31)	10 (3, 27)	7 (2, 20)	13 (10, 17)	12 (9, 15)	10 (7, 13)

	African American			Mexican American			White		
	BA+	Some College	HS or Less	BA+	Some College	HS or Less	BA+	Some College	HS or Less
Diabetes (%)	10 (6, 16)	10 (6, 17)	13 (9, 19)	6 (1, 32)	1 (0, 2)	0 (0, 2)	0 (0, 1)	1 (1, 3)	1 (0, 2)
Observations	251	316	263	62	110	113	1,038	798	622

Source: Wave IV of the National Longitudinal Study of Adolescent to Adult Health (Add Health). N=3,573

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.