Socioeconomic Status and Infant Mortality in the United States: Variation by Race, Ethnicity, and Maternal Age

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Abstract

I construct an enhanced measure of socioeconomic status to examine socioeconomic disparities in infant mortality in the U.S. I document how the socioeconomic gradient of infant mortality varies by race, ethnicity, and nativity status. I examine whether the association between socioeconomic status and infant mortality varies by maternal age for the different subpopulations. I find significant heterogeneity in the socioeconomic gradient with whites exhibiting a stronger association between socioeconomic status and infant mortality, and Hispanics exhibiting a weaker association. Within each subpopulation, socioeconomically disadvantaged women undergo a faster health deterioration as maternal age increases compared to their advantaged counterparts. Disadvantaged women have excess mortality relative to their advantaged counterparts across the entire maternal age distribution. The disparity increases with age which is consistent with the weathering framework. My results highlight the importance of looking at the interplay among socioeconomic status, race/ethnicity, and maternal age to understand disparities in infant mortality.

I. Introduction

Infant mortality is an important indicator of the health status and socioeconomic development of a population. It ranks as a leading health indicator for Healthy People 2020, the United States' agenda for improving the country's health (Healthy People 2020). Despite a steady decrease in infant mortality from 1961 to 2010 (IMR=5.8), the US ranks last among 20 Organization for Economic Cooperation and Development (OECD) countries, with the infant survival disadvantage of the US relative to these countries widening since the 1980s. Although all countries exhibited declines in their infant mortality rates (IMRs), these reductions were not equally distributed. The US displayed the slowest rate of decline for infant mortality (2% per year, on average) whereas Italy, Austria, and Spain had the fastest rates of improvement (5 to 5.7%). During the decade 2001-2010, infants in the US had a 76% higher risk of death compared to the OECD average risk (Forrest et al. 2018). The unfavorable health outcomes of the US have been attributed to the high and growing levels of racial/ethnic, social, and economic inequality that characterize the country (Gortmaker and Wise 1997; Singh and Kogan 2006 ; Forrest et al. 2018). Despite marked reductions in the absolute IMRs in the US, substantial socioeconomic and racial/ethnic relative disparities persist and have widened over time (Singh and Yu 1995; Singh and Kogan 2006).

A large body of literature has documented the association between maternal education and infant mortality. Infants born to mothers with <12 years of education are approximately twice as likely to die as infants born to mothers with 16+ years of education, and infants born to mothers with 12 and 13-15 years of education have IMRs that are 1.8 and 1.4 higher than those of infants born to mothers with 16+ years of education. Recent studies have found that the effect of maternal education on birth outcomes varies by race and ethnicity. Gage (2013) found that the association between birth weight and infant mortality with maternal education was much stronger among African Americans and European Americans than among Mexican Americans. A negative association between low birth weight and maternal education was revealed for whites whereas no statistically significant association was established for Mexican-origin infants Kimbro et al. (2007). Meara (2001) found similar results when examining the correlation between SES and birth weight for black and white infants, with whites having a significantly steeper gradient.

Although the analysis of the maternal education gradient for infant mortality is valuable when studying socioeconomic disparities in in infant mortality, socioeconomic status (SES) is a broader concept. Socioeconomic status has been defined as a composite measure that typically incorporates economic status, measured by income; social status, measured by education; and work status, measured by occupation (Dutton & Levine 1989). The existence of independent associations between each of these socioeconomic indicators and health suggest that a broader underlying dimension of social stratification is a compelling factor (Adler et al. 1994). Further, Adler (2002) established that all SES components provide access to different resources and affect health through different pathways. Hence, using a broader measure for SES might lead to a better understanding of socioeconomic disparities than using maternal education or income independently.

Recent work has started using a more encompassing measure of socioeconomic status. Studies on the intergenerational transmission of inequality have examined the association between maternal disadvantage and health at birth as proxied by the incidence of low birth weight (Aizer & Currie 2014). Using maternal race, marital status, and education as characteristics that are strongly related to socioeconomic status, they group women into an economically advantaged (white, college educated, and married) and an economically disadvantaged group (African American, less than high school, and single). Their results show that the incidence of low birth weight among the most disadvantaged group is more than three times that of the most advantaged mothers. A similar categorization was employed by Chen et al. (2016) to investigate the disadvantage exhibited by the US in infant and postneonatal mortality relative to peer developed countries.

Another strand of literature has looked at the association between being disadvantaged and maternal age patterns of infant mortality. Research on the interaction among age, race/ethnicity/nativity status, and the decline in reproductive health indicates that the effect of maternal disadvantage on birth outcomes differs by maternal age (Geronimus 1986, 1992, 1996). The "weathering hypothesis" suggests that individuals age at different rates as a consequence of differential levels of exposure to racial discrimination and socioeconomic disadvantage. The cumulative adverse effect of being exposed to disadvantage is larger at older maternal ages.

Geronimus (1986) found that the maternal age patterns of neonatal mortality (NMR) varied by race/ethnicity. The NMRs patterns for whites approximated a "reverse-J shape", a "J-shape" for Mexican Americans, and sloped upwards for blacks and Puerto Ricans. Unlike white infants, black and Puerto Rican infants born to teen mothers experienced a survival advantage relative to infants born to older mothers. The black-white disparity in NMRs increased with maternal age. Black women experienced an increase in smoking, hypertension, and hypertension with maternal age (Geronimus 1986; Geronimus 1992). Likewise, black women have been found to exhibit the highest allostatic load scores among black and white men and women with the disparity increasing with age suggesting there are differences in the health deterioration and rate of aging by race (Geronimus 2006).

Recent literature has examined the "weathering hypothesis" among the Mexican-origin population. Wildsmith (2002) documented the existence of weathering in the neonatal mortality rate (NMR) and pregnancy related hypertension patterns within the Mexican-origin population, particularly the US-born group. An analysis of maternal-age specific IMRs revealed that although infants born to younger Mexican-origin women exhibit a survival advantage relative to whites, infants born to older Mexican women experience a survival disadvantage which is consistent with the weathering framework (Powers 2013).

Although there are many studies examining how weathering varies for whites, blacks, and the Mexican origin populations, little research has looked at the existence of differences in weathering within each subpopulation by socioeconomic group. The relationship between advancing maternal age and low birth weight was documented to be stronger among black mothers in low socioeconomic groups than in others (Geronimus 1996). These results suggest that an examination of how the association between maternal age at birth and infant mortality varies by socioeconomic status can further our understanding of disparities in infant mortality.

My study brings together the literature on the socioeconomic gradient for birth outcomes, racial/ethnic/nativity disparities, and the weathering hypothesis framework in an attempt to better understand the association between maternal disadvantage and infant mortality and how this association varies by maternal age. Specifically, this chapter answers the following questions. First, how strongly is the index of socioeconomic disadvantage related to the risk of infant mortality and how does this association vary across racial, ethnic, and nativity groups in the US? Second, how does the association between maternal age and infant mortality vary by race, ethnicity, and nativity status? Third, within each racial/ethnic/nativity subpopulation, does the association between maternal age and infant mortality vary by socioeconomic group? Fourth, within each socioeconomic group (advantaged/disadvantaged), does the association between maternal age and infant mortality vary by race, ethnicity, and nativity status?

I argue that the strength of the association between maternal socioeconomic status and infant mortality varies by race, ethnicity, and nativity status. I anticipate that non-Hispanic whites will exhibit a stronger association between the socioeconomic index and infant mortality (e.g., higher gains from higher SES) and foreign-born Hispanics will display the weakest association. I anticipate that the association between advancing maternal age and increasing infant mortality will be stronger for US-born Mexicans, US-born Other Hispanics, and non-Hispanic blacks. Further, I expect that within each racial/ethnic/nativity subpopulation, the increase with maternal age in infant mortality will be more rapid among members of socioeconomically disadvantaged groups than among advantaged groups. Lastly, within each socioeconomic group, I expect the increase in IMRs with maternal age to be steeper for racial/ethnic minority groups such as Mexicans, Other Hispanics, and non-Hispanic blacks due to their prolonged exposure to racial discrimination.

Although past research has pointed to the association between maternal education or income and infant mortality, few studies have used a comprehensive measure of SES to understand socioeconomic disparities in infant mortality. Further, little research has examined how this association varies by race, ethnicity, and nativity status. My findings suggest that there are differences in the returns to high socioeconomic status. Non-Hispanic whites, and to a lesser extent US-born Mexicans and Other Hispanics, display the largest benefit from being socioeconomically advantaged. Foreign-born Hispanics and non-Hispanic blacks reveal the smallest gains from belonging to a socioeconomically advantaged group. Likewise, the maternal age patterns of IMRs by race, ethnicity, and nativity status provide evidence of weathering for

US-born Mexicans and Other Hispanics and for blacks. Further, my findings point to the existence of variability in weathering by race, ethnicity, nativity status, and by socioeconomic group. Within each racial/ethnic/nativity subpopulation, health deteriorates more rapidly among socioeconomically disadvantaged women contributing to their increasing risk in infant mortality with maternal age. Moreover, within each socioeconomic group, there is evidence of heterogeneity in weathering by race, ethnicity, and nativity status. US-born Hispanics and non-Hispanic blacks experience a steeper worsening of their health with maternal age. This is particularly the case among socioeconomically disadvantaged women. A more homogenous pattern is observed among advantaged women. Understanding why some groups benefit from higher SES while others do not (e.g., foreign-born Hispanics), and why older maternal age represents a significantly higher risk than younger ages for some racial/ethnic and socioeconomic subgroups is essential for understanding the high absolute IMR and relative disparities in infant mortality in the US. Moreover, this is the first study to use a comprehensive socioeconomic (SES) index to examine disparities by race, ethnicity, nativity status, and maternal age using the most comprehensive and recent representative data on births and infant deaths in the US.

II. Background

The association between maternal education and infant mortality is well documented. Infants born to mothers with < 12 years of education are approximately twice as likely to die as are infants born to mothers with 16+ years of education, and infants born to mothers with 12 and 13-15 years of education have IMRs that are 1.8 and 1.4 higher than those of infants born to mothers with 16+ years of education (Singh and Kogan 2007). Similarly, the maternal education gradient of infant mortality has been found to be steeper for whites than for blacks and Mexican origin infants (Gage 2013; Elder 2016). Similar patterns have been observed when looking at other birth outcomes such as low birth weight and gestation length and their graded relationship by educational attainment (Meara 2001; Currie and Moretti 2003; Goldman et al. 2006).Other studies have examined the association between income and infant health. Finch (2003) found that household income matters for infant mortality especially at very low income levels. Nepomnyaschy (2009) also found an income gradient, particularly for whites, in the probability of low birth weight (under 2500 g).

Although the analysis of the maternal education and income gradient for infant mortality is valuable when studying socioeconomic disparities in infant mortality, socioeconomic status (SES) is a broader concept. Socioeconomic status has been defined as a composite measure that typically incorporates economic status, measured by income; social status, measured by education; and work status, measured by occupation (Dutton & Levine 1989). The fact that independent associations have been found between each of these socioeconomic indicators and health suggests that a broader underlying dimension of social stratification is a compelling factor (Adler et al. 1994). Further, Adler (2002) states that all SES components provide access to different resources and affect health through different pathways. For example, although education shapes future occupational opportunities and earning potential, it also provides knowledge and life-skills that allow better educated people to gain more access to information and resources to promote health. Income provides access to health care, better nutrition, and better housing in good neighborhoods. Additionally, being married can provide access not only to economic resources but also to networks and social capital that can encompass greater health knowledge. Hence, looking at all SES components and their interaction can prove to be more informative when studying infant mortality than looking only at maternal education.

Recent studies on the intergenerational transmission of inequality have looked at the association between maternal disadvantage and health at birth as proxied by the incidence of low birth weight (Aizer & Currie 2014). Aizer and Currie (2014) use maternal race, marital status, and maternal education as characteristics that are strongly related to income to define a socioeconomically advantaged and a socioeconomically disadvantaged group of women. The socioeconomically advantaged group consists of women who are non-Hispanic white, college educated, and married. The socioeconomically disadvantaged group is defined as women who are African American, have less than a high school education, and are single. Their results show that the incidence of low birth weight (lbw) among infants born to disadvantaged women is more than three times that of infants born advantaged women. Nevertheless, the difference between the most and least advantaged mothers has declined over the 20 years suggesting that birth weight is a malleable birth outcome which can be influenced by policies. Chen et al. (2016) employ a similar categorization to examine the high infant mortality (IMR) and postneonatal mortality rates (PNMRs) exhibited by the US relative to peer developed countries. Their results indicated that the observed higher US postneonatal mortality relative to Austria and Finland was due almost entirely to higher mortality among disadvantaged groups (low education/occupation, single, and African American). No significant difference is observed in mortality among infants born to advantaged women (high education/occupation, married, and white).

Previous studies examining socioeconomic disparities using a proxy measure for SES have relied on samples of births and infant deaths from certain neighborhoods, cities, or states (Geronimus 1996). This is the first study to use comprehensive vital statistics data for the years 2000-2008 to examine socioeconomic disparities in infant mortality. Additionally, recent studies have used available SES measures such as race, marital status, and education to examine disparities in infant mortality (Aizer and Currie 2014). Although informative, socioeconomic status encompasses a broader dimension of underlying stratification. Thus, the use of a composite measure provides a more accurate assessment of socioeconomic status which is more useful in the study of socioeconomic disparities in infant mortality.

Another strand of literature has looked at the association between maternal age and infant mortality. Literature has documented the existence of a curvilinear pattern of birth outcomes by maternal age whereby infants born to teenage mothers are more likely to experience preterm birth, low birth weight (lbw), and mortality than infants born to older women (Geronimus 1986; Matthews and MacDorman 2008). Nevertheless, evidence suggests that this pattern does not hold for all racial groups. For example, Geronimus (1986) found that black infants with teen mothers exhibit a survival advantage in neonatal mortality relative to infants born to older mothers (not the case for whites). Among whites, teenagers experienced excessive neonatal mortality compared to mothers in their mid-20s with the size of the rate ratios decreasing as teen age increased which is consistent with the curvilinear pattern. These results showed that the maternal age pattern for neonatal mortality in the US varies by race. Furthermore, they suggested that aside from being a measure of biological development, maternal age variables might be a proxy for social disadvantage.

Along that line, a substantial body of research has found evidence supporting the existence of an interaction among maternal age, race/ethnicity, and the decline in reproductive health which results in different optimal childbearing ages with regard to infant mortality (Geronimus 1992, 1996). The “weathering hypothesis” delineated by this research suggests that the meaning of maternal age varies by race/ethnicity such that certain groups age more rapidly than others, including experiencing a more rapid decline in reproductive health. This more rapid aging, or weathering, is a consequence of a lifetime of exposure to socioeconomic disadvantage, racial/ethnic discrimination, and racial bias in exposures to psychosocial or environmental hazards faced by many minority groups. Minority populations, particularly blacks, are concentrated in areas characterized by high levels of residential segregation and of neighborhood disadvantage including limited access to educational and employment opportunities (Massey 2001; Rosenbaum and Friedman 2001). Coping with socioeconomic, racial, and environmental insults might have a negative effect on a woman’s health and health behaviors leading to adverse birth outcomes.

Further, Geronimus (1992, 1996) examined the maternal age patterns of poor birth outcomes among disadvantaged populations. When stratified by racial group, Geronimus (1992) found that the maternal age patterns of neonatal mortality varied by race/ethnicity. The maternal age pattern of infant mortality for whites was found to approximate a “reverse-J shape”, a “J-shape” for Mexican Americans, and it sloped upwards for blacks and Puerto Ricans. Unlike white infants, black and Puerto Rican infants born to teen mothers experienced a survival advantage relative to infants born to older mothers. Consequently, the black-white neonatal mortality differential was found to increase with maternal age being larger at older ages. Geronimus (1992) found that the widening racial gap in neonatal mortality with maternal age was due to black women's health deteriorating more rapidly than the health of whites. The prevalence of hypertension, blood lead levels, and smoking was higher among black than white women at every maternal age with the magnitude of the black-white disparity being larger at older ages. These results are consistent with the "weathering hypothesis" whereby the health of black women begins to deteriorate in early adulthood as a physical consequence of cumulative racial discrimination and socioeconomic disadvantage. In a more recent study, Geronimus (2006) showed that blacks had higher allostatic load scores than whites at all ages (18-64 years). This difference was observed among poor and nonpoor groups. Blacks experience poor health at earlier ages than whites with the black-white gap disparity increasing with age. For example, the mean allostatic load score for blacks was found to be comparable to that of whites who were 10 years older. Poor and nonpoor black women were found to have the highest and second highest probability of high allostatic load scores among all groups.

Research has also looked at how maternal age patterns for birth outcomes vary by socioeconomic status within racial/ethnic groups. In a study on very low (vlbw) and low birth weight (lbw), Geronimus (1996) explored whether "weathering" among African American women contributes to observed increases with maternal age in the black/white disparity in birth weight. She examined whether the increase in lbw or vlbw with maternal age was more rapid among members of low socioeconomic status (SES) compared to others. The first set of results showed that the odds of lbw among blacks increase with maternal age. Among whites, the maternal age patterns for lbw and vlbw resemble a "reversed J-shape" leading to increasing black-white disparities in lbw with maternal age. Second, the relationship between advancing maternal age and poor birth outcomes was found to be stronger among black mothers in low SES groups than in high SES. The odds of lbw for women in the low SES category displayed a steep increase with maternal age. Conversely, there was no change in the odds of lbw with maternal age for women in the high SES category. Moreover, she showed that the gap in the odds of lbw between low and high SES women was approximately 3 times larger for ages 34 and older than for teenage mothers. Hence, whether older maternal age is higher or lower risk for birth outcomes varies not only by race/ethnicity but also by SES. More recently, Geronimus et al. (2006) estimated the extent to which upward socioeconomic mobility limits the probability that white and black women who spent their childhoods in poverty will give birth to a lbw infant. They showed that upward socioeconomic mobility contributed to improved birth outcomes among infants born to white women who were poor as children. This was not the case for upward mobile black women who displayed a probability of lbw comparable to their poor counterparts. These findings suggest that the benefits of socioeconomic advantage on birth outcomes vary by race/ethnicity.

Although most research has primarily focused on black-white differences, the “weathering hypothesis” refers to the cumulative effects of stressors associated with long-term racial discrimination and socioeconomic disadvantage (individual and community level) experienced by minority groups. Mexican-origin populations experience higher levels of socioeconomic and neighborhood disadvantage relative to non-Hispanic whites (Albrecht et al. 1996; Markides and Coreil 1986; Saenz 1997) which suggests that Mexican-origin women would also experience weathering. Nativity has been found to play a significant role in adverse pregnancy outcomes with foreign-born populations experiencing more favorable outcomes than their native-born counterparts. Past research suggests that “Americanization” has a negative impact on infant mortality (Frisbie et al. 1998; Hummer et al. 1999; Singh and Yu 1996) and low birth weight (Cobas et al. 1996). Consequently, one would expect a steeper increase in infant mortality rates with maternal age for the Hispanic population born in the US because of the more prolonged exposure to US social and economic disadvantaged compared to their foreign-born counterparts.

Recent studies have found support for the “weathering hypothesis” when applied to the Mexican-origin population. Wildsmith (2002) examined the maternal age patterns of neonatal mortality, low birth weight, and maternal health indicators to test the weathering hypothesis among Mexican-origin women. The maternal age-specific patterns of neonatal mortality and pregnancy related hypertension provided evidence of weathering within the Mexican-origin population, particularly the US-born group (Wildsmith 2002). Using more recent data, Powers (2013) investigated racial/ethnic differences in infant mortality by maternal age. An analysis of maternal-age specific IMRs revealed a survival advantage for infants born to younger Mexican-origin women relative to whites which is consistent with the Hispanic epidemiologic paradox. Infants born to older Mexican-origin mothers experienced a survival disadvantage relative to whites, which is consistent with the weathering hypothesis. Several of his findings are in line with the conceptual framework of weathering (Geronimus 1992). He found that Mexican Americans experienced higher mortality compared with Mexican immigrants over the entire maternal age distribution. Second, he found that Mexican immigrant women have a lower prevalence of maternal risk factors at older ages than Mexican American women. Further, the predicted IMRs for infants born to older Mexican-origin women were not adjusted downward to the extent of those of whites suggesting that factors such as long-term exposure to racial discrimination are responsible for the relative survival disadvantage. Nonetheless, he found no evidence of a growing within-Mexican-origin gap in IMR which provides less support for a weathering explanation of infant mortality differences.

Overall, the differential survival within the Mexican-origin population outlined in these studies suggests that a longer exposure to social conditions in the US undermines the health of women who have more favorable health endowments than their white counterparts as evidenced by their lower IMRs at younger ages. The finding of a stronger weathering effect among Mexican Americans runs counter to assimilation theory (Gordon 1996), but is consistent with a segmented assimilation perspective that suggests increased divergence over time and across generations for Mexican Americans accompanied by an increased disadvantaged resulting from prolonged exposure to community-level socioeconomic disadvantage and racial/ethnic discrimination (Portes 1995; Portes and Zhou 1993). Several studies have shown that a process of negative US acculturation may erode the generally positive health and mortality outcomes among Hispanics over time and across generations (Ceballos and Palloni 2010; Cho et al. 2004). Hence, an examination of the maternal age patterns of birth outcomes by race/ethnicity and nativity status is necessary to further understand weathering among the Hispanic population.

My study contributes to the existing literature in several important ways. First, it is the first study to use a composite measure for maternal socioeconomic status. Previous studies have used maternal education or income when examining disparities in infant mortality. A few studies (Aizer and Currie 2014; Chen et al. 2016) have employed the socioeconomically advantaged/disadvantaged categorization but have not used income as one of the main economic variables. I construct a socioeconomic index using income, education, and marital status that provides a more accurate measure of the combined resources that socioeconomic status encompasses. Second, this is the first study that examines how the association between a socioeconomic index and infant mortality varies by race, ethnicity, and nativity status in the US. Third, this study contributes to the literature by looking at the interplay between race/ethnicity/nativity, socioeconomic status, maternal age, and infant mortality using the most recent NCHS birth cohort data for the years 2000-2008. Although previous research has analyzed weathering for blacks and Mexicans in the US, this is the first study to also examine weathering among US and foreign-born Other Hispanics in the US using the most recent data. Moreover, this study examines whether within each racial/ethnic/nativity subpopulation there is heterogeneity in weathering by socioeconomic group. Further, this study investigates whether within each socioeconomic group (advantaged/disadvantaged) there are differences in weathering by race, ethnicity, and nativity status. Infant health is strongly linked to maternal characteristics. I expect the socioeconomic disparities and the racial/ethnic differentials in the association between the socioeconomic index and infant mortality to resemble the patterns exhibited by maternal education. I expect the association between the socioeconomic index and infant mortality to be stronger for non-Hispanic whites and weak to non-existent for Hispanics. Further, I expect to find differences in weathering among each subpopulation by socioeconomic group. Finally, I expect the maternal age-specific IMRs within each socioeconomic group to vary by race, ethnicity, and nativity status. More specifically, I anticipate that women who are exposed to racial discrimination, socioeconomic disadvantage, or both will have the most pronounced health deterioration and higher IMRs with increasing maternal age among all groups.

Overall, my analytical approach is novel in that it allows me to use two high quality data sources (Vital Statistics and the Integrated Public Use Microdata Series (IPUMS-USA)) to overcome 1) the limitations of socioeconomic status (SES) measurement of the NCHS Vital

Statistics where there is no data on income and 2) the limitations of previous studies which did not provide a detailed examination of infant mortality by race, ethnicity, nativity status, and maternal age. Altogether this approach provides for a more thorough and comprehensive examination of racial/ethnic and socioeconomic disparities in infant mortality.

III. Data, measures, and methods

I use pooled cross-sectional data from the National Center for Health Statistics (NHCS) linked birth and infant death cohort files for the years 2000-2005 and 2007-2008. The information from the death certificate for infants born in those years is linked to their corresponding birth certificate. The complete dataset includes information on 33 million births among which 222,279 infants died for an overall IMR of 6.7. Due to the focus of my research questions, I limit my analytic file to infants born to US-born non-Hispanic white, Mexican (US and foreign-born), Other Hispanic (US and foreign-born), and non-Hispanic black (US-born) women who were residents of the US during those years which leaves me with approximately 25 million births, 191,000 deaths, and an IMR=6.7 deaths. In the second section of my analysis I focus on infants born to women who are 20 years or older due my interest in looking at the weathering hypothesis by socioeconomic status. Following these exclusions, the sample for the second section includes 25.3 million births among whom 159,748 died during the first year of life (IMR=6.3). I use the maternal identification reported on the birth certificate to ascertain the race, ethnicity, and nativity status of the infant. Infants for whom maternal race/ethnicity or nativity status is missing are excluded from the sample. Overall, I specify 6 groups of infants defined by maternal race, ethnicity, and nativity status. Moreover, I focus the analysis on four maternal age categories (20-24, 25-29, 30-34, and 35 and older) to examine the maternal age patterns of infant mortality for the different subpopulations.

The data from the National Center for Health Statistics (NHCS) linked birth and infant death cohort files does not contain information on income. I use data from the Integrated Public Use Microdata Series (IPUMS-USA) in order to predict the average household income for women ages 20-54 in the NCHS dataset. The Integrated Public Use Microdata Series (IPUMS-USA) consists of more than fifty high-precision samples of the American population drawn from fifteen federal censuses and from the American Community Surveys of 2000-2012. Since my linked birth and infant death cohort files are for the years 2000-2008, I use IPUMS data for the corresponding period of time. The IPUMS data for the years 2000-2008 comes from the American Community Surveys (ACS). The ACS is an ongoing survey by the US Census Bureau that gathers information on individual (ancestry, educational attainment, income, language proficiency, migration, disability, employment) and household level characteristics (geographic, economic, household composition, dwelling). The survey is sent to approximately 3.5 million people per year and is the largest survey the Census Bureau administers. The sample size for those pooled years consists of approximately 14 million individuals ages 20-54 which is the age range relevant for my research questions. Out of the 14 million individuals, 52% are women and 48% are men. I use geographic, economic, education, demographic, and employment variables from the ACS data to estimate the income for the different women in my NCHS dataset (e.g., income for white single women with <12 years of education living in the Northeast). A detailed explanation of how I use the IPUMS dataset to estimate average income for women ages 20-54 is provided in the methods section.

Measures

The outcome variable is whether the infant died in the first year of life or not. Infant death is dichotomized as survived the first year of life (0) versus died in the first year (1). The main explanatory variables are the socioeconomic index measure, maternal race/ethnicity/nativity status, and maternal age. I construct the socioeconomic index variable using three variables: maternal education, maternal household income, and marital status. The socioeconomic index is coded 0 if the mother belongs to the socioeconomically advantaged group and 1 if she belongs to the socioeconomically disadvantaged group. A woman is socioeconomically advantaged if she has 16+ years of schooling, belongs to the 75th percentile of the income distribution, and is married. A woman is socioeconomically disadvantaged if she has 12 or fewer years of education, belongs to the 25th percentile of the income distribution, and is single. Aizer and Currie (2014) and Chen et al. (2016) used a similar categorization to group women into socioeconomically advantaged and disadvantaged categories. Nevertheless, they did not include income as one of the measures used for the categorization. The composite measure I construct is an enhanced measure of socioeconomic status as it not only maternal education and marital status but it also incorporates predicted income. Race/ethnicity/nativity status is a categorical variable consisting of 6 categories corresponding to each of the subpopulations being analyzed. The six subgroups are US-born non-Hispanic whites (reference group), US-born Mexicans, Foreign-born Mexicans, US-born Other Hispanics, Foreign-born Other Hispanics, and US-born non-Hispanic blacks. This categorization allows for an examination of infant mortality by race/ethnicity and by nativity status which has been shown to play a relevant role in birth outcomes particularly among the Hispanic population (Hummer 1999; Hummer et al. 2007). Maternal age is a categorical variable with five different categories: <20, 20-24, 25-29, 30-34, and 35 and older. Births to younger women are included for the first set of descriptive analyses but are excluded from the section focusing on socioeconomic status. This categorization of maternal age at birth allows me to examine how maternal age patterns for infant mortality vary by race/ethnicity/nativity status and by socioeconomic status across subpopulations and within each subgroup.

Methods

i. Stage 1

To address the research questions in this chapter, I divide the analysis into two different stages. In the first stage, I use the IPUMS dataset for the years 2000-2008 to estimate the predicted income for women in the NCHS dataset. In the absence of an income measure in the birth death linked cohort data, I use the IPUMS dataset to estimate what the predicted household income would be for women in the NCHS dataset who have demographic, socioeconomic, and geographic characteristics that are comparable to women in the IPUMS data. Accordingly, I specify four multivariate regression models, one model for each of the maternal age categories in my analysis (20-24, 25-29, 30-34, and 35 and older). Fitting separate models for women in the different age categories is appropriate since it allows me to account for variability in the intercept across age categories. This is important since women in the older age category (35 and above) have a higher income compared to younger women (e.g., 20-24) all else constant, due to factors such as years of work experience. The regression model I fit to predict income for women in the different age categories is given by equation 1.

$$\begin{aligned} Y_{ij} &= f(\text{educ., married, sex, race, nativity, citizen, English, empl., occ., metro, state}), \\ &\quad \text{for } j \in \{\text{age } 20-24,\ \text{age } 25-29,\ \text{age } 30-34,\ \text{age } 35+\}. \end{aligned} \qquad (1)$$

As depicted in Equation 1, I follow the human capital approach to estimate income (Mincer 1974). The dependent variable Y_i is the household income measured in thousands of dollars. I regress the household income for each individual on a series of socioeconomic, demographic, and geographic characteristics such as education ($educ_i$), marital status ($marital_i$), sex (sex_i), racial/ ethnic group ($race_i$), nativity status ($nativity_i$), citizenship status ($citizen_i$), English fluency ($english_i$) , employment status ($employment_i$), occupation/industry ($occupation_i$), metropolitan area of residence ($metro_i$) , state of residence ($state_i$), and other characteristics which are important determinants of income. All the models control for state of residence which accounts for any unobserved heterogeneity among states. Although the purpose of the models is to adjust for, rather than interpret, the effects of the different explanatory variables, all of the control variables operated in the expected way. More specifically, higher levels of education, being non-Hispanic white, being US-born, being married, working in a city/metropolitan area, working in a high skilled occupation (engineer, scientist, attorney among other professions), and working in states in the Northeast and Western regions of the US have a positive coefficient and a larger magnitude effect on income.

Predicted income for women in the 4 different age categories are readily produced by these four multivariate regressions. Although women in the IPUMS dataset are not the same sample of women that are in the NCHS dataset, I can use age-specific regression models to predicted household income for women with specific socioeconomic and demographic characteristics. My goal is to obtain the predicted income for women in the IPUMS dataset who share the same sociodemographic and economic profiles of women in the NCHS dataset. Thus, I generate the average predicted income for different combinations of racial, ethnic, nativity, marital status, education, and geographic location characteristics for women in the different age categories using the IPUMS dataset. I use these variables to construct the combinations as they are the only relevant variables that are present in both the IPUMS and NCHS datasets. More specifically, the variables I use and their corresponding categories are as follows: race/ethnicity/nativity status (US-born non-Hispanic whites, US-born Mexicans, foreign-born Mexicans, US-born Other Hispanics, foreign-born Other Hispanics, US-born non-Hispanic blacks), marital status (married, single), education (<12 years of education, 12 years of education, 13-15 years of education, and 16+ years of education), and the nine regional divisions used by the US Census Bureau (New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific). I treat each possible combination of the aforementioned factors that are common to the IPUMS and NCHS data as a cell or stratum in large cross-classification and generate the average predicted income in each of the strata. Thus, predicted values in the IPUMS can be effectively and uniquely matched to the same cross-classification in the NCHS. For example, I use the coefficients from the age-specific model I fit using the IPUMS data for women ages 20-24 to predict the income of women ages 20-24 who are US-born non-Hispanic white, are married, have 16+ years of education, and live in the New England regional division. I generate the average predicted income for the different racial/ethnic/nativity, marital status, education, and regional combinations. Given that there are 432 possible combinations or strata based on the categories for the different variables, I generate 432 average predicted household income values for women ages 20-24 corresponding to the different combinations. Since I fitted 4 age-specific regression models, I repeat this process separately for each of the age specific-models. Ultimately, I predict a total of 1,748 average incomes corresponding to the total number of combinations for the different age categories (e.g., 432 combinations for 4 different models).

Mathematically this is equivalent to $\hat{\bar{Y}}_k = \sum_{i=1}^{N_k} \hat{Y}_i / N_k, \qquad k = 1,\ldots,1{,}748$, where N_k denotes the size of the kth stratum.

The predicted incomes correspond to groups of women in the IPUMS dataset with different characteristics. That is, the estimated average income is a group-level predicted value rather than an individual-level prediction. Once I predict the average income for the 1,748 combinations, the following step consists in assigning those predicted values of income to women in the NCHS dataset who belong to the corresponding categories. For example, if the mean predicted income for US-born non-Hispanic white women ages 20-24 who are married, have 16+ years of education, and live in the New England region obtained from the IPUMS dataset is of $65,206, I assign this value to all women in the NCHS dataset who fulfill all those characteristics (e.g., US-born non-Hispanic white, ages 20-24, married, 16+ years of education, and living in the New England region). In order to match the predicted average income of women in the IPUMS dataset to women in the NCHS, I create a unique identifier number denoted by N_k where k=1,2,…,1,748. This number uniquely identifies the 1,748 possible combinations in both the NCHS and the IPUMS datasets respectively. I then proceed to merge the NCHS and IPUMS using the unique identifier N_k This matching process results in women in the NCHS dataset being assigned the predicted mean income estimated for women in the IPUMS who are comparable to them in the relevant sociodemographic, economic, and geographic characteristics. Women in the NCHS dataset who did not fall in any of the 1,748 strata were assigned a missing value for their predicted mean income. The matching process results in approximately 24 million women in the NCHS dataset having a predicted average income assigned to them. The resulting mean household income based on the predicted values is of $53, 619 for the 24 million women sample.

It is not possible to estimate the mean income for women in the NCHS at the individual level. Nevertheless, the predicted income I obtain for different groups of women using the IPUMS dataset is good proxy for what the average income would be for women in the NCHS who are comparable to them along socioeconomic, demographic, and geographic dimensions. Hence, I use those predicted income values when constructing the socioeconomic index measure used in the rest of my analysis.

Once I have assigned the predicted average income to women in the NHCS dataset, I proceed to construct the measure for socioeconomic advantage/disadvantage. As previously discussed, I construct a socioeconomic index using maternal education, marital status, and the estimated mean income values. The socioeconomic index is a dichotomous variable that can take values of 0 or 1. The socioeconomic index is coded 0 if the mother belongs to the socioeconomically advantaged group. The socioeconomically advantaged group consists of women who have 16+ years of education, are married, and are in the 75th percentile of the income distribution. Women in the NCHS dataset who are in the 75th percentile are women who have a predicted household income of $80,000 and higher. The socioeconomically disadvantaged group consists of women who have 12 or less years of schooling, are single, and are in the 25th percentile of the income distribution. Women who belong to the 25th percentile have a predicted average income of $29,000 and less.

The use of a composite measure of socioeconomic status provides a more accurate measure of resources as socioeconomic status is a broader concept than just education or income. Adler (2002) established that all SES components (income, education, and occupation) provide access to different resources and affect health through different pathways. Hence, using a broader measure for SES might lead to a better understanding of socioeconomic disparities than using maternal education or income alone. As previously discussed, I construct a socioeconomic composite measure using maternal education, predicted mean income, and marital status. Aizer and Curie (2013) used race, marital status, and education-all measured characteristics that are related to income-as a proxy measure for maternal advantage/disadvantage. Nonetheless, my approach differs in three important ways. First, I disaggregate the analysis by race/ethnicity and nativity status instead of including race as a component of the index. Previous studies have shown that the effect of maternal education on infant mortality varies by race, ethnicity, and nativity status (Gage 2013). Thus, it is likely that the effect of being socioeconomically advantaged/disadvantaged might also vary across subpopulations. Second, I do not include maternal age as one of the maternal characteristics used to identify whether a woman belongs to a given socioeconomic group. The weathering hypothesis (Geronimus 1984, 1992, 1996) states that the health of women from certain groups deteriorates at a faster pace due a prolonged exposure to racial discrimination and socioeconomic disadvantage. Hence, an examination of how the maternal age patterns of infant mortality vary by race/ethnicity/nativity and by socioeconomic status is necessary to further understand disparities in infant mortality. I use this novel and comprehensive measure of socioeconomic status to address my four main research questions.

ii. Stage 2

In the second stage of my analysis I use infant mortality rates and IMR ratios. In the first set of analyses, I estimate the socioeconomic-specific IMRs (per 1,000 live births) by race, ethnicity, and nativity status and for the overall population. This allows me to measure how strongly the indicator of socioeconomic disadvantage is related to the risk of infant mortality. Further, it enables me to examine whether the strength of the association between the socioeconomic index and infant mortality varies by race, ethnicity, and nativity status. I use absolute (and relative) differences in IMRs to calculate the excess mortality of socioeconomically disadvantaged women compared to advantaged women for the overall population and for the different subgroups.

I then estimate the maternal age-specific IMRs (per 1,000 live births) for the different racial, ethnicity, and nativity groups and for the overall population. I also calculate the IMR ratios of each subpopulation relative to non-Hispanic whites. The maternal age patterns of infant mortality for the different subpopulations and the IMR ratios relative to non-Hispanic whites are used to determine whether there is evidence of weathering for Mexicans, Other Hispanics, and non-Hispanic blacks.

Next, I calculate the maternal age-specific IMRs (per 1,000 live births) for socioeconomically advantaged and disadvantaged women for the different racial, ethnic, and nativity subgroups. Once I have the maternal-age specific IMRs (per 1,000 live births) for both socioeconomic groups, I estimate two sets of IMR ratios for the remainder of the analysis. I first estimate the IMR ratio of socioeconomically disadvantaged women relative to advantaged women for each maternal age. I use absolute and relative differences in IMRs to examine whether the excess mortality of socioeconomically disadvantaged women increases over the maternal age distribution and whether those patterns vary by subgroup. The maternal age-specific IMR ratios (rate ratios) by socioeconomic group will allow me to examine whether there is within-group heterogeneity in "weathering" by socioeconomic status for the different racial/ethnic populations and by nativity status. Further, I also calculate the IMR ratios of older women (25-29, 30-34, and 35+) relative to younger women (reference category: 20-24) for each racial/ethnic subpopulation by socioeconomic group (e.g., socioeconomically advantaged whites). An examination of these IMR ratio patterns will allow me to further analyze whether there are differences in weathering by socioeconomic group within each racial/ethnic subpopulation. Lastly, I calculate the maternal age-specific IMR ratios (rate ratios) for each racial/ethnic/nativity subpopulation relative to non-Hispanic whites. I estimate these IMR ratios for socioeconomically advantaged women and disadvantaged women separately. This allows me to examine whether there is evidence of weathering for Mexicans, Other Hispanics, and non-Hispanic blacks and whether this varies by socioeconomic group membership. More specifically, research has shown that there is weathering for blacks and Mexican Americans. However, little is known about how weathering varies not only by racial, ethnic, and nativity status, but also by socioeconomic group. Altogether, the maternal age-specific IMRs by socioeconomic status and by subpopulation allows me to examine the individual and interactive effects socioeconomic status, maternal age, and race/ethnicity/nativity status have on infant mortality and on infant mortality relative disparities.

The infant mortality rates (IMRs), IMR ratios, and the information used to conduct the significance tests corresponding to the different sets of analyses come from unadjusted models.

IV. Results

1) Distribution of Births and infant mortality rates (IMRs) by maternal SES and by race, ethnicity, and nativity status

As discussed in the measures section, I construct a socioeconomic index measure that groups women into socioeconomically advantaged and disadvantaged categories. The socioeconomically advantaged group consists of women who have 16+ years of education, are married, and are in the 75th percentile of the income distribution. The socioeconomically disadvantaged group consists of women who have 12 or less years of schooling, are single, and are in the 25th percentile of the income distribution. Women who only fulfill two or less of the previously mentioned characteristics (e.g., are married and in the 75th percentile but have 13-15 years of education) are grouped in a middle SES category. I focus the analysis of this chapter on comparing IMRs of socioeconomically advantaged and disadvantaged women. Comparing these two groups is appropriate given that the largest socioeconomic differences and more interesting patterns occur between the two extremes of the socioeconomic spectrum.

Figure 1 presents the distribution of births by maternal socioeconomic status for each of the racial, ethnic, and nativity subgroups and for the overall population. Figure 1 shows that while 23% of total births occur to socioeconomically advantaged women, approximately 13% of all births are to socioeconomically disadvantaged women. Nonetheless, an examination of the distribution of births by race, ethnicity, and nativity status shows that there is variation in the percent of infants born to advantaged and disadvantaged women among subpopulations. For example, while 32% of US-born non-Hispanic white infants are born to socioeconomically advantaged women, only 6% to 14% and 2% to 8% of US-born Mexicans and Other Hispanics and of Foreign-born Mexicans and Other Hispanics are born to socioeconomically advantaged women respectively. Similarly, only 3% of US-born non-Hispanic black infants are born to socioeconomically advantaged women.

An analysis of the distribution of births to socioeconomically disadvantaged women by race, ethnicity, and nativity status yields similar results. For instance, only 8% of non-Hispanic white infants are born to socioeconomically disadvantaged women. On the contrary, 16% to 18% and 22% of US-born Mexican and Other Hispanic and of foreign-born Hispanic infants respectively are born to disadvantaged women. This percent is even higher for non-Hispanic blacks. Approximately 35% of non-Hispanic black infants are born to socioeconomically disadvantaged women.

Altogether, these results show that among minority groups, a significant share of births is to socioeconomically disadvantaged women. Non-Hispanic whites have the highest percentage of births to advantaged women and the lowest percentage of births to disadvantaged women.

[Insert Figure 1 about here]

Figure 2 presents the infant mortality rates (IMRs) by maternal socioeconomic status for each of the racial, ethnic, and nativity subpopulations and for the overall population. Figure 2 shows the existence of a strong association between maternal socioeconomic status and infant mortality for the overall population and for the different subpopulations in the analysis. An analysis of the IMRs for the overall population shows that socioeconomically disadvantaged women have approximately 6 more deaths compared to their advantaged counterparts. An examination of the socioeconomic-specific IMRs by race, ethnicity, and nativity status reveals that the strength of the association between maternal socioeconomic status and infant mortality varies by subgroup. US-born non-Hispanic whites depict the strongest association. More specifically, socioeconomically advantaged white women have 5 fewer deaths than their disadvantaged counterparts. A similar absolute difference in mortality rates by socioeconomic status is observed for non-Hispanic blacks. Nevertheless, the IMRs for non-Hispanic blacks are extremely high even for socioeconomically advantaged women (IMR=9.6). The within-group disparity in IMRs is smaller for US and foreign-born Mexicans and Other Hispanics. Socioeconomically disadvantaged US-born Mexican and Other Hispanic women have approximately 3 to 3.7 more deaths compared to their advantaged counterparts. Foreign-born Mexicans and Other Hispanics display the smallest within-group socioeconomic disparity with disadvantaged women having approximately 1.5 more deaths compared to advantaged women. Thus, the results presented in Figure 2 show that infants born to socioeconomically disadvantaged women have higher IMRs than infants born to advantaged women. Nevertheless, the deleterious effect of being born to socioeconomically disadvantaged women is larger for US-born non-Hispanic whites and non-Hispanic blacks and smallest for Mexicans and Other Hispanics, particularly the foreign-born.

Figure 2 also allows for the comparison of IMRs by race, ethnicity, and nativity status for socioeconomically advantaged and disadvantaged women separately. With the exception of non-Hispanic blacks (IMR=9.6), the IMRs among socioeconomically advantaged women do not exhibit statistically significant variation by race, ethnicity, or nativity status. On average, the IMRs range from 3.3 to 3.8 deaths per 1,000 live births. This is not the case among infants born to socioeconomically disadvantaged women. A detailed examination shows that the IMRs of disadvantaged women vary by subpopulation. US-born non-Hispanic blacks (IMR=14.4) and non-Hispanics whites (IMR=8.6) born to disadvantaged women have the highest overall infant mortality rates among all disadvantaged subpopulations. US-born Mexicans and Other Hispanics have IMRs of 6.2 and 7.2 deaths per 1,000 live births respectively. Foreign-born Mexicans (IMR=4.9) and Other Hispanics (IMR=5.1) have the lowest IMRs among infants born to socioeconomically disadvantaged women.

[Insert Figure 2 about here]

In summary, Figures 1 and 2 show that there is heterogeneity by race, ethnicity, and nativity status in both the share of births to socioeconomically advantaged/disadvantaged mothers and in the socioeconomic-specific IMRs. Non-Hispanic whites have the largest share of births to socioeconomically advantaged women. Foreign-born Hispanics and non-Hispanic black infants are more likely to be born to disadvantaged mothers. Furthermore, non-Hispanic whites and non-Hispanic blacks have the highest IMRs (8.6 and 14.4 respectively) among all socioeconomically disadvantaged groups whereas foreign-born Hispanics have the lowest IMRs (IMR=5). With the exception of non-Hispanic blacks, IMRs among socioeconomically advantaged women are homogenous. Socioeconomically advantaged black women have higher IMRs than both the socioeconomically disadvantaged and advantaged women from the other subpopulations. This shows that belonging to a high SES group does not lead to significant lower IMRs for this subgroup. These results support by first hypothesis that the strength of the association between the socioeconomic index and infant mortality varies by race, ethnicity, and nativity status with non-Hispanic whites exhibiting the strongest association and foreign-born Hispanics displaying the smallest within-group disparity.

2) Infant mortality rates by maternal age and by race, ethnicity, and nativity status

The maternal age-specific IMRs (per 1,000 live births) of Table 1 show the typical curvilinear pattern (e.g., initially high mortality rates that decrease through the prime childbearing years and increase at older ages) for the overall population and for all racial/ethnic subgroups. The IMRs for non-Hispanic whites exhibit a substantial decline with maternal age with a 20% increase in mortality rates occurring at older ages. US and foreign-born Mexican and Other Hispanic women experience mostly constant IMRs during their prime childbearing years (20-34) followed by a 30% to 40% increase in IMRs for infants born to women ages 35 and older. In absolute terms, Mexican and Other Hispanic women ages 35+ have 1.5 to 2 more deaths per 1,000 live births compared to younger women (20-34). A similar pattern is displayed by non-Hispanic black women. Non-Hispanic whites exhibit the lowest IMRs at older ages while non-Hispanic blacks display the highest mortality.

[Insert Table 1 about here]

A comparison of the maternal age patterns of IMRs for Mexicans and Other Hispanics relative to non-Hispanic whites provides evidence of a differential decline in infant survival with advanced maternal age. Table 2 shows that although Hispanics have lower IMRs at younger maternal ages, infants born to Mexican and Other Hispanic women ages 25 and older (US-born) and 30 and older (foreign-born) exhibit a survival disadvantage compared to non-Hispanic white infants. The IMR ratio of US-born Mexicans relative to non-Hispanic whites shows a steady increase with maternal age with the largest increase occurring after age 30. In the case of US-born Other Hispanics, the disparity remains constant from ages 25 to 34 followed by a substantial increase at ages 35 and over.

Moreover, an examination of the maternal age-specific IMRs within the Mexican and Other Hispanic subpopulations shows that US-born Mexicans and Other Hispanics have relatively higher mortality compared to Mexican and Other Hispanic immigrants over the entire maternal age distribution. Nevertheless, there is no evidence of a growing within-Mexican-origin and within-Other Hispanic-origin gap in IMR with maternal age. Since there is an association between infant survival and maternal health, differential infant survival within the Mexican-origin and the Other Hispanic populations suggests that longer exposure to racial, social, and economic conditions in the US undermines the health of women who appear to have more favorable health endowments than their non-Hispanic white counterparts as evidenced by their lower IMRs at younger ages.

An analysis of the maternal age-specific IMRs of non-Hispanic blacks relative to non-Hispanic whites shows that blacks experience higher IMRs across the entire maternal age distribution. Additionally, their survival disadvantage increases with maternal age as depicted by their IMR ratios presented in Table 2. Furthermore, non-Hispanic blacks exhibit higher mortality than Mexicans and Other Hispanics (US and foreign-born) at every maternal age. Overall, these results suggest that non-Hispanic blacks experience the fastest deterioration in maternal health among all groups and reflect the existence of weathering for this subpopulation.

[Insert Table 2 about here]

Additionally, Table 1 also shows the distribution of births by maternal age. US-born Mexican and Other Hispanic women are more likely to give birth at younger maternal ages than their immigrant counterparts. This can be attributed to the lower IMRs experienced by US-born Hispanics at younger ages and the significantly higher IMRs observed at older maternal ages (e.g., 35 and older). A similar pattern is evident for non-Hispanic blacks. In general, approximately 50 to 60% of births to US-born Hispanics and non-Hispanic blacks are to women ages 24 and younger. On the contrary, only 30% of non-Hispanic white births are to women younger than 24 which are the ages that represent the highest mortality risk for this group. The smallest share of births to US and foreign-born Mexicans and Other Hispanics occurs to women ages 35 and older (US-born: 6% to 9%; Foreign: 11% to17%). Births to older non-Hispanic black women account for approximately 8% of all births. Older maternal ages represent a high risk for these subpopulations as depicted by their high IMRs. The distribution of births for the different racial/ethnic/nativity groups shows that the prime childbearing ages varies by subgroup and women tend to have births at ages when the infant mortality risk is lowest which is consistent with the weathering framework.

Altogether, these results suggest maternal health deteriorates more rapidly among US-born Mexicans and Other Hispanics compared to non-Hispanic whites and to their immigrant counterparts which is consistent with the weathering hypothesis. Nevertheless, there is no evidence of a growing within-Mexican-origin or within-Other Hispanic-origin gap in IMR with increasing maternal age which provides less support for a weathering explanation of infant mortality differences. The results provide evidence for weathering among the non-Hispanic black population. Their survival disadvantage increases with maternal age with non-Hispanic blacks having IMRs that are 3 times higher than non-Hispanic whites for women ages 35+. This is an increase from the racial disparity observed at younger ages where blacks have IMRs that are about 1.5 higher compared to non-Hispanic whites. This supports my second hypothesis that the association between advancing maternal age and increasing IMRs is stronger among minority groups who have greater exposure to racial discrimination, social stress, and economic disadvantage. This leads to a rapid health deterioration among US-born Hispanics and non-Hispanic blacks which results in increasing IMRs with maternal age for these groups.

3) Infant mortality rates (IMRs) by maternal age and by race, ethnicity, and nativity status and by socioeconomic status

Although the previous results provide some support for weathering among US-born Mexicans, US-born Other Hispanics, and US-born non-Hispanic blacks, there might be differences in weathering within each subpopulation by socioeconomic group. Minority group women are exposed to racial discrimination which can result in an accelerated deterioration of their health as they age. Similarly, prolonged exposure to social and economic disadvantage can result in low SES women undergoing an earlier and faster aging process compared to their high SES counterparts (Geronimus 1996). The interactive negative effect of being exposed to both racial discrimination and socioeconomic stress from dealing with economic hardships can accumulate with age resulting in socioeconomically disadvantaged women from minority groups having a more rapid health deterioration compared to high SES minority women and to low SES non-Hispanic white women. Hence, this section looks at the maternal age patterns of infant mortality for each racial/ethnic/nativity subpopulation by socioeconomic group. This allows me to examine whether there is within-group heterogeneity in weathering by socioeconomic group status. Furthermore, it allows me to analyze whether weathering among socioeconomically advantaged and disadvantaged women varies by race, ethnicity, and nativity status.

Tables 3.1 and 3.2 and Figures 3.1 and 3.2 illustrate the maternal age-specific IMRs for the different racial, ethnic, and nativity subgroups for socioeconomically advantaged and disadvantaged women in the US. Given my focus on maternal socioeconomic status and the absence of deaths for socioeconomically advantaged women younger than 20 years, I focus the discussion of the results on women ages 20 and older.

Table 3.1 and Figure 3.1 show the maternal age patterns for socioeconomically advantaged women for the overall population and by race, ethnicity, and nativity status. An analysis of the IMRs for the overall population shows there is no significant increase in infant mortality from ages 20 through 34. Women ages 35 and older do experience approximately one more death per 1,000 live births than women in the younger age categories. A detailed examination of the maternal age patterns of infant mortality by subpopulation shows that they do not vary significantly by race, ethnicity, and nativity status. More specifically, with the exception of non-Hispanic blacks, the maternal age pattern of infant mortality for advantaged women is homogenous across subpopulations with relative constant IMRs for women ages 20 to 34 and slightly higher IMRs for women ages 35 and older. On average, women 35 years and older experience 0.7 to 1 more deaths per 1,000 live births relative to women ages 30-34. Non-Hispanic blacks exhibit a steeper increase in IMRs after age 25 compared to the other groups. Moreover, their maternal age-specific IMRs are about 2 to 3 times higher than the IMRs of the other subgroups at every maternal age. Likewise, non-Hispanic blacks observe a sharp increase in their IMRs after age 30 which is not evident for the remaining populations.

Table 3.2 and Figures 3.2 present the maternal age-specific IMRs for socioeconomically disadvantaged women for the overall population and by race, ethnicity, and nativity status. The maternal age-specific IMRs for socioeconomically disadvantaged women are on average 3 times higher than the IMRs for advantaged women with values ranging from 9 to 12 deaths per 1,000 live births. An analysis of the maternal age-specific IMRs for the overall population shows that although the IMRs remain constant from ages 20 through 34, a substantial increase in mortality occurs after age 35 with older women having on average 2.4 more deaths than women ages 30 to 34 and 3more deaths than younger women (20-24). An analysis by race, ethnicity, and nativity status reveals that the maternal age patterns of infant mortality for each subgroup resemble the pattern displayed by the overall population with sharp increases in IMRs occurring at older ages. Nevertheless, there is variability in the magnitude of the increase in mortality occurring between maternal ages 30-34 and 35 and older. For example, non-Hispanic white women ages 35+ have approximately 1.7 more deaths than their younger counterparts (30-34). US-born Hispanics (Mexicans and Other Hispanics) and non-Hispanic blacks experience the largest increase in infant mortality with advancing maternal age. For example, US-born Hispanic and non-Hispanic black women ages 35 and older experience approximately 4 and 3 more deaths per 1,000 live births than women ages 30 to 34 respectively. This difference increases to 5 to 7 more deaths per 1,000 live births when using women ages 20 to 24 as the comparison group. Moreover, non-Hispanic blacks are the only racial/ethnic group that exhibits a steep increase in IMRs across the entire age distribution. All other subpopulations display a gradual increase in IMRs with a sharp increase occurring after age 35. Foreign-born Mexicans and Other Hispanics have the lowest IMRs at every maternal age among all disadvantaged women.

The previous results show that within each subpopulation the increase in infant mortality with maternal age is significantly steeper for socioeconomically disadvantaged women than for women in the advantaged category. This holds for all racial, ethnic, and nativity subpopulations and is more evident for US-born Mexicans, US-born Other Hispanics, and non-Hispanic blacks. This suggests that a lifetime exposure to social and economic stress leads to a faster health deterioration among socioeconomically disadvantaged women leading to significantly larger increases in IMRs with maternal age. Further, it points to the importance of looking at the joint effect of racial discrimination and socioeconomic disadvantage on infant mortality. Being disadvantaged has a more detrimental effect on minority populations.

Further, an examination of the IMR ratios for women in older maternal age categories (25-29, 30-34, and 35+) relative to the IMRs of younger women (reference: 20-24) provides further evidence for differences in weathering within each racial/ethnic subpopulation by socioeconomic group. The IMR ratios depicted in Tables 4a and 4b show that within each subpopulation, health worsens at a faster pace among women in the socioeconomically disadvantaged group. This is especially the case for US-born Mexicans, US-born Other Hispanics, and non-Hispanic blacks. More specifically, socioeconomically disadvantaged US-born Mexican and Other Hispanic women ages 35 and above have IMRs that are 89% and 88% higher than the IMRs of their younger (20-24) counterparts. These groups exhibit the steepest deterioration in health among disadvantaged women. Overall, disadvantaged US-born Hispanic and non-Hispanic black women ages 25-54 have mortality risks that are 5% to 89% higher compared to their younger counterparts with the gap increasing with maternal age. A different pattern emerges for socioeconomically advantaged women. Broadly speaking, the mortality risk of infants born to socioeconomically advantaged non-Hispanic whites and US and foreign-born Mexicans and Other Hispanics remains constant across the maternal age distribution. On the contrary, socioeconomically advantaged Non-Hispanic blacks exhibit increasing IMRs with maternal age with women ages 25 to 54 having IMRs that are 67% to 189% higher than the IMRs of younger women. Moreover, the IMR ratios for advantaged foreign-born Hispanics show that infants born to women ages 35 and older have mortality risks that are 22% to 39% higher than those of infants born to younger women. This suggests that there is some weathering occurring at older ages for foreign-born Hispanic women. This is not evident among socioeconomically advantaged US-born Mexicans and Other Hispanics.

Additionally, it is important to analyze whether the excess mortality of disadvantaged women relative to their advantaged counterparts increases with maternal age. Table 5 depicts the maternal age-specific IMR ratios (rate ratios) for socioeconomically disadvantaged women relative to advantaged women by race, ethnicity, and nativity status and for the overall population. The IMR ratios for the overall population show that disadvantaged women have IMRs that are on average 2 to 3 times higher relative to the IMRs of advantaged women. The rate ratios in Table 5 also quantify the excess mortality risk of socioeconomically disadvantaged women by maternal age for the different subpopulations. The maternal age patterns of these IMR ratios show that socioeconomically disadvantaged women from every subpopulation have higher mortality than their advantaged counterparts at every maternal age. As depicted in Table 5, socioeconomically disadvantaged non-Hispanic white women exhibit the largest relative disadvantage among all subpopulations. More specifically, disadvantaged non-Hispanic white women have IMRs that are on average 2.5 times higher than the IMRs of their advantaged counterparts across the entire maternal age distribution. A different pattern is revealed by US-born Mexicans and Other Hispanics. The excess mortality exhibited by disadvantaged women increases monotonically with maternal age. While low SES US-born Hispanics have IMRs that are 1.5 times higher than the IMRs of their high SES counterparts at younger maternal ages, these rate ratios increase with age and are about 3 times higher at older maternal ages. Socioeconomically disadvantaged foreign-born Hispanics and non-Hispanic blacks have IMRs that are on average between 1.5 and 2 times higher than the rates of their high SES counterparts respectively. This pattern is uniform across the maternal age spectrum.

In summary, these results demonstrate that the maternal age-specific IMRs within each racial, ethnic, and nativity population vary by socioeconomic group. My findings support my third hypothesis that within each subpopulation, socioeconomically disadvantaged women undergo a deterioration of their health that progresses at a faster pace as maternal age increases compared to their advantaged counterparts. US-born Mexicans, US-born Other Hispanics, and non-Hispanic blacks experience the most pronounced weathering among socioeconomically disadvantaged women with older women having significantly higher IMRs relative to their younger counterparts. Socioeconomically advantaged non-Hispanic blacks also experience a substantial health deterioration over time as revealed by the steady increase in their IMRs with advancing maternal age. Likewise, socioeconomically disadvantaged women have excess mortality relative to their advantaged counterparts across the entire maternal age distribution with the disparity increasing with age. Disadvantaged non-Hispanic white women are the racial/ethnic subpopulation that exhibits the largest within-group socioeconomic disparity in infant mortality. Additionally, socioeconomically advantaged non-Hispanic black women have IMRs are about 2 times higher than the average infant mortality rate of advantaged women. This suggests that belonging to an advantaged socioeconomic group does not benefit all subpopulations equally, which is consistent with the findings of Colen et al. (2006) for black infants. I now proceed to look at the intertwined association between race/ethnicity/nativity and socioeconomic status to determine whether there is heterogeneity in weathering by race, ethnicity, and nativity status for socioeconomic advantaged and disadvantaged women.

4.1. Weathering among socioeconomically advantaged women

Section 2 showed that US-born Mexicans, US-born Other Hispanics, and non-Hispanic black women experience a more pronounced health deterioration with age (particularly at ages 35 and older) than non-Hispanic whites. This health deterioration was evidenced by the increasing US-born Mexican (US-born Other Hispanic, non-Hispanic black)/US-born non-Hispanic white disparity in infant mortality with maternal age presented in Table 2. No evidence of weathering was observed for foreign-born Mexicans and Other Hispanics. Section 3 showed that within each subpopulation there is heterogeneity in weathering by socioeconomic group. I now investigate whether within each socioeconomic group there are differences in weathering by race, ethnicity, and nativity status.

I first examine whether there are differences in weathering by race, ethnicity, and nativity status among socioeconomically advantaged women. Table 3.1 presents the maternal age-specific IMR patterns for advantaged women by race, ethnicity, and nativity status. A comparison of the IMRs of US-born Mexicans and Other Hispanics relative to non-Hispanic whites shows that US-born Hispanics have mortality rates that are comparable to those of non-Hispanic whites at every maternal age. They exhibit slightly higher IMRs among women ages 20-24 but the difference is negligible. More specifically, Table 6.1 shows that the IMR ratio for US-born Mexicans and Other Hispanics relative to whites does not increase with maternal age. A comparison of the IMRs of US-born Mexicans and Other Hispanics relative to their immigrant counterparts is necessary in light of the weathering hypothesis. If weathering reflects long-term exposure to socioeconomic disadvantage and racial discrimination, then increasing US-born Mexican and Other Hispanic IMR ratios (relative to their foreign-born counterparts) with age should be observed. In this case, although all women are socioeconomically advantaged, women from minority groups might suffer from racial discrimination which can be detrimental for their health. This is specially the case for US-born Mexicans and Other Hispanics. A comparison of the IMRs within the Mexican population shows that although Mexican immigrants have lower IMRs at younger maternal ages, there is no evidence that the maternal age-specific IMR ratios increase with age. An examination of the within-group IMR ratios for the Other Hispanic population yields similar results. Thus, these results indicate that there is no evidence for weathering among the socioeconomically advantaged Mexican and Other Hispanic subgroups.

A different pattern emerges for socioeconomically advantaged non-Hispanic blacks. Non-Hispanic blacks exhibit uniformly higher IMRs relative to non-Hispanic whites over the entire maternal age distribution. Although the racial disparity in infant mortality does not increase substantially with maternal age, there is a gradual increase in the IMR rate ratio after age 25 as depicted by Table 6.1. Further, Non-Hispanic blacks have higher IMRs than Mexicans and Other Hispanics (US and foreign-born) at every maternal age. Altogether, this indicates that the health of non-Hispanic black advantaged women deteriorates at a significantly faster rate compared to advantaged non-Hispanic whites, Mexicans, and Other Hispanics. Although socioeconomically advantaged Hispanic women have low IMRs, advantaged non-Hispanics blacks exhibit IMRs that are comparable to the IMRs of socioeconomically disadvantaged women and significantly higher than the IMRs of advantaged women from the other racial/ethnic groups. Hence, belonging to a socioeconomically advantaged group does not appear to benefit women from different racial/ethnic subpopulations equally.

It is also important to look at the distribution of births among socioeconomically advantaged women. Table 3.1 shows that approximately 60% to 70% of births to non-Hispanic white, Mexican, and Other Hispanic advantaged women occur at ages 25 to 34. Only 4% to 9% of all births occur to women ages 24 and younger with the remaining births (20% to 30%) occurring to women ages 35 and older. This distribution of births shows that the prime childbearing years for socioeconomically advantaged women are ages 25 to 34. These maternal ages present the lowest mortality risk for all subpopulations relative to younger and older ages. Nonetheless, the IMRs for advantaged women are mostly uniform across the maternal age distribution with slightly higher IMRs for women ages 20 to 24 and 35 and older. Interestingly, approximately 50% and 60% of Foreign-born Other Hispanics and non-Hispanic black births respectively are to women ages 35 and older. It is worth mentioning that women in the socioeconomically advantaged group have completed 16+ years of schooling which can lead to delays in childbearing.

In summary, an examination of the maternal age-specific IMRs by race, ethnicity, and nativity status for socioeconomically advantaged women provides no evidence of weathering for Mexicans and Other Hispanics. This indicates that although Hispanic women-particularly the US-born-are exposed to stress due to racial/ethnic discrimination, the benefits of belonging to a high socioeconomic status group offsets any of the potential negative effects discrimination might have on their health. More specifically, their socioeconomic status provides them with access to health care, knowledge, housing in good neighborhoods, good social networks, among others all of which have an important positive effect on maternal health and on birth outcomes such as infant mortality. High SES non-Hispanic blacks experience a faster aging process relative to non-Hispanic whites (and Mexicans and Other Hispanics) as depicted by their maternal age-increasing IMRs and IMR rate ratios. This suggests that being socioeconomically advantaged is not as beneficial for non-Hispanic blacks as it is for other minority groups. This provides partial support for my fourth hypothesis that within socioeconomically advantaged women, the relationship between advancing maternal age and increasing IMRs would be stronger for women from racial/ethnic minority groups. This result was revealed by non-Hispanic blacks but not for Mexicans or Other Hispanics.

3.2. Weathering among socioeconomically disadvantaged women

I now examine whether there are differences in weathering by race, ethnicity, and nativity status among socioeconomically disadvantaged women. Table 3.2 presents the maternal age-specific IMRs (per 1,000 live births) for disadvantaged women by subpopulation. I first study whether there is evidence of weathering for the US-born Mexican and Other Hispanic population. A comparison of the maternal age-specific IMRs of disadvantaged US-born Mexicans and Other Hispanics relative to non-Hispanic whites shows that US-born Hispanics have lower IMRs from ages 20 through 34. Nonetheless, a different pattern emerges at older maternal ages. US-born Mexican and Other Hispanic women ages 35 and above experience 1.3 to 1.6 more deaths per 1,000 live births than non-Hispanic whites respectively. Moreover, an examination of the maternal age patterns of infant mortality shows that the IMRs of US-born Mexicans and Other Hispanics increase steadily after age 25 with the steepest increase happening at older maternal ages (35 and above). Consequently, the IMR ratio of US-born Mexicans (Other Hispanic) to non-Hispanic whites depicted in Table 6.2 increases with maternal age with the largest widening occurring among women ages 35 and older.

An analysis of weathering also calls for an examination of within-group differences in IMRs for Mexicans and Other Hispanics. A comparison of the IMRs of disadvantaged US-born Mexicans relative to their immigrant counterparts shows that US-born Mexicans have higher mortality rates at every maternal age (Table 3.2). Furthermore, the IMR rate ratio between Mexican Americans and Mexican immigrant women consistently increases with maternal age with the largest within-group disparity observed at ages 35 and older. More specifically, while the within-Mexican absolute difference is of 1.6 deaths for women ages 20 to 24, it increases to 4 deaths per 1,000 live births for women ages 35 and older. A detailed examination of within-group differences in infant mortality among Other Hispanic women yields similar results. The increasing within-group IMR rate ratio combined with the higher IMRs at older ages exhibited by US-born Mexicans and Other Hispanics relative to non-Hispanic whites suggests that socioeconomically disadvantaged US-born Mexicans and Other Hispanics experience weathering. Their health appears to deteriorate at a faster pace compared to non-Hispanic whites and to their immigrant counterparts as evidenced by their maternal age-specific infant mortality patterns. Although all women in this analysis are socioeconomically disadvantaged, US-born Mexicans and other Hispanics experience a prolonged exposure to racial discrimination in addition to socioeconomic stress, which negatively affects their health.

An examination of the maternal age patterns of infant mortality for non-Hispanic blacks relative to non-Hispanic whites shows that their IMRs increase steadily with maternal age while the IMRs for non-Hispanic whites remain constant only increasing slightly after age 35. A test of the weathering hypothesis shows that the IMRs of non-Hispanic blacks are uniformly higher than the IMRs of non-Hispanic whites over the entire maternal age distribution. Moreover, Table 6.2 shows that the non-Hispanic black/non-Hispanic white IMR ratio increases with maternal age.

More specifically, while the IMRs of non-Hispanic black ages 20 to 24 are 1.5 times higher compared to white women, this racial disparity increases to approximately 2 times larger for women ages 35 and older. Moreover, US-born non-Hispanic black women ages 35 and older have on average 5 more deaths per 1,000 live births compared to their younger (20-29) counterparts which is higher than the excess mortality for non-Hispanic whites of 1.7 deaths. Altogether, these results indicate that health deteriorates more rapidly among non-Hispanic blacks than whites which points to the existence of weathering among disadvantaged non-Hispanic blacks.

These results point to the joint effect racial discrimination and socioeconomic disadvantage have on infant mortality. As can be observed, being exposed to both racial discrimination (e.g., belonging to a minority group) and belonging to a low SES leads to higher IMRs which increase significantly with maternal age. Although these two variables are good proxies for maternal health, it is important to note that I am not using any maternal health indicators in the analysis. Additionally, the NCHS does not provide data on how long women have lived in the US. Hence, I rely on US-born and foreign-born status as a proxy for exposure to racial discrimination. Although not a perfect measure, it can be concluded that on average Hispanic women born in the US have suffered from discrimination for a longer period of time than their foreign-born counterparts.

Overall, the examination of the maternal age-specific IMRs among socioeconomically disadvantaged women in the US shows that US-born Mexicans, US-born Other Hispanics, and non-Hispanic blacks undergo a faster aging process than non-Hispanic whites and foreign-born Hispanics. This supports my fourth hypothesis that within the disadvantaged group, minority women would experience a significant worsening of their health relative to whites. The weathering experienced by these racial/ethnic groups suggests that although all women in this analysis are socioeconomically disadvantaged, racial discrimination adds another layer of stress and social isolation which can have an adverse effect on maternal health which accumulates with maternal age. The worsening of health as age increases results in IMRs steadily rising with maternal age for these 3 subgroups.

Additionally, an examination of births by maternal age shows that approximately 50% to 62% of non-Hispanic white, US-born Hispanic, and non-Hispanic black births occur to women younger than 24. About 30% to 40% of all births are to women ages 25 to 34, and only 3% to 5% of births are to women ages 35 and older. This distribution of births shows that socioeconomically disadvantaged women have the majority of their births at younger ages (20 to 29) which are the ages characterized by the lowest mortality risk. Similarly, the smallest share of births corresponds to older ages which exhibit the highest IMRs. This pattern suggests that childbearing for socioeconomically disadvantaged women occurs at younger ages before social and economic stress takes a cumulative toll on their health leading to higher IMRs at older ages. Most births to foreign-born Mexicans and Other Hispanic women occur at slightly older ages. Nonetheless, the increase in IMRs with maternal age for these subpopulations is not as steep as the one observed for their non-immigrant counterparts.

In summary, the results presented in Parts 3 and 4 of the results section show that within each socioeconomic group, there are differences in weathering by race, ethnicity, and nativity status. The results for socioeconomically advantaged women show that with the exception of US-born non-Hispanic blacks, there is no evidence of weathering for any of the other subpopulations. This suggests that if Mexican and Other Hispanic women who are socioeconomically advantaged experience any racial discrimination, their high socioeconomic status provides them with a set of resources (money, access to health care, knowledge, social capital, power) that are protective of their health and help offset any negative effect from discrimination**.** The maternal age patterns of infant mortality for the socioeconomically disadvantaged group show that US-born Mexicans, US-born Other Hispanics, and non-Hispanic blacks women experience significant weathering with age as depicted by their increasing maternal age-specific IMRs. This suggests that the prolonged exposure to social and economic disadvantage combined with the stress from racial discrimination has a significant negative effect on minority women which leads to significant increases in IMRs with maternal age. Furthermore, the results also show that the relationship between advancing maternal age and increasing infant mortality is stronger among women in the low socioeconomic groups among all subpopulations. This supports my second hypothesis that the increase in infant mortality with maternal age will be more rapid among members of low socioeconomic groups particularly if they belong to a racial minority as well. Overall, these results highlight the importance of looking at the interaction of race/ethnicity/nativity, socioeconomic group, and maternal age when examining weathering and its effect on infant mortality.

V. Conclusion

I begin with a core set of questions. First, how strongly is the socioeconomic index related to the risk of infant mortality and does this association vary across different racial/ethnic groups and by nativity status? Second, how does the association between maternal age and infant mortality vary by race, ethnicity, and nativity status? Third, within each racial/ethnic/nativity subpopulation, does the association between maternal age and infant mortality vary by socioeconomic group? Fourth, within each socioeconomic group, does the association between maternal age and infant mortality vary by race, ethnicity, and nativity status? I use U.S. Vital Statistics data from the years 2000-2008 to examine the association between a novel composite measure of socioeconomic status and infant mortality and how this association varies across subpopulations in the US. I also examine whether there are differences in the association between maternal age and increasing infant mortality by race, ethnicity, nativity status, and by socioeconomic group. More specifically, I examine whether within each racial/ethnic and nativity subpopulation, the increase with maternal age in infant mortality is more rapid among women belonging to socioeconomically disadvantaged groups than among women in the advantaged group. In addition, I examine whether within each socioeconomic group the association between maternal age and infant mortality varies by race, ethnicity, and nativity status. Understanding the individual and joint effect differential exposure to racial/ethnic discrimination and to social and economic disadvantage has on infant mortality is necessary for understanding racial and socioeconomic disparities in infant mortality. The different set of analyses led to the following findings.

First, I show that the association between the socioeconomic index and infant mortality exhibits significant variability by race, ethnicity, and nativity status. Socioeconomic disparities in infant mortality are largest among US-born non-Hispanic whites and US-born non-Hispanic blacks, and smallest among foreign-born Hispanics. Socioeconomically disadvantaged US-born non-Hispanic white and non-Hispanic black women have approximately 5 more deaths per 1,000 live births than their advantaged counterparts. The within-group socioeconomic disparity for US and foreign-born Hispanics is of about 3 and 1.5 deaths per 1,000 live births respectively. Furthermore, I find that there is heterogeneity in the share of births to socioeconomically advantaged/disadvantaged women. Although 32% of US-born non-Hispanic white infants are born to socioeconomically advantaged women, only 6% to14% and 2% to 8% of US and foreign-born Hispanics respectively are born to socioeconomically advantaged women. On the contrary, approximately 16% to 18% and 22% of US and foreign-born Hispanic infants are born to disadvantaged women compared to only 8% of non-Hispanic whites. These findings support my first hypothesis which established that the association between socioeconomic status and infant mortality varied across race, ethnicity, and nativity status. The association is stronger for non-Hispanic whites and weaker for Hispanics, particularly the foreign-born population. Although Aizer and Currie (2014) and more recently Chen et al. (2016) used a similar approach that grouped women into socioeconomically advantaged and disadvantaged categories, the SES index I construct is a more comprehensive measure as it incorporates a predicted measure of income in addition to maternal education and marital status. Moreover, my measure is racial/ethnic-specific and I extend the analysis to 6 subpopulations as opposed to the comparison of whites and blacks addressed in similar papers.

Second, my results show that there is heterogeneity in the association between maternal age and infant mortality by race, ethnicity, and nativity status. An analysis of maternal age-specific infant mortality rates (IMRs) reveals that although infants born to younger Hispanic mothers exhibit a survival advantage relative to non-Hispanic whites, infants born to older Mexican and Other Hispanic mothers experience a survival disadvantage relative to non-Hispanic whites (Geronimus 1992, 1996). My findings are consistent with the conceptual framework of weathering (Geronimus 1992, 1996) insofar as relatively higher mortality is experienced by US-born Mexicans and Other Hispanics compared with their immigrant counterparts over the entire maternal age range. Nevertheless, I find no evidence of a growing within-Mexican-origin and within-Other Hispanic-origin gap in IMR with increasing maternal age which provides somewhat less support for a weathering explanation of infant mortality differences. These results are consistent with Powers (2013) who found similar patterns for Mexicans Americans and Mexican immigrants. Non-Hispanic blacks exhibit a survival disadvantage over the entire maternal age range. Moreover, the black-white disparity in infant mortality increases with maternal age which is consistent with the weathering hypothesis. These results support my second hypothesis that US-born Mexicans and Other Hispanics experience a faster health deterioration and increasing IMRs with maternal age than whites and Hispanic immigrants due to their exposure to racial discrimination and social and economic stress.

Third, an examination of the maternal age patterns of infant mortality for each racial, ethnic, and nativity subpopulation by socioeconomic group showed that there are differences in weathering within each subpopulation by socioeconomic status. I showed that the relationship between advancing maternal age and increasing infant mortality is stronger among mothers in the socioeconomically disadvantaged group than among mothers in the advantaged group. These findings are consistent with the theoretical perspective that within each racial/ethnic group, health deteriorates more rapidly over the young adult ages among the socioeconomically disadvantaged group than among the advantaged group which contributes to their increasing risk in mortality as maternal age increases (Geronimus 1996). US-born Mexicans, US-born Other Hispanics, and non-Hispanic blacks experience the most pronounced weathering with maternal age among socioeconomically disadvantaged women with the steepest decline in their health occurring after age 35. I found that with the exception of non-Hispanic blacks, there is no substantial evidence for weathering among socioeconomically advantaged women. Furthermore, I showed that socioeconomically disadvantaged women have excess mortality relative to the advantaged group over the entire maternal age distribution with the disparity increasing steadily with maternal age. US-born Mexicans and Other Hispanics display the largest within-group disparity at older ages. These results support my third hypothesis that within each racial/ethnic group health deteriorates at a younger age and at a more rapid pace among socioeconomically disadvantaged women leading to steeper increases in IMRs with maternal age.

Lastly, I show that the association between maternal age and infant mortality within each socioeconomic group varies by race, ethnicity, and nativity status. An analysis of the maternal age-specific infant mortality rates (IMRs) for socioeconomically advantaged women revealed that there is no evidence of weathering for Mexicans and Other Hispanics (US and foreign-born). I find that socioeconomically advantaged non-Hispanic blacks exhibit a survival disadvantage relative to whites across the entire maternal age distribution with the racial disparity increasing steadily with age. An examination of the maternal age patterns of infant mortality for socioeconomically disadvantaged women provides evidence of weathering for US-born Mexicans, US-born Other Hispanics, and non-Hispanic blacks. An analysis of the maternal age-specific infant mortality rates reveals a survival advantage for infants born to younger US-born Mexican and Other Hispanic mothers. However, I find that infants born to older (ages 35 and above) US-born Mexican and Other Hispanic women experience a survival disadvantage relative to non-Hispanic whites which is consistent with the weathering framework. Further, the IMR ratio of disadvantaged US-born Mexican and Other Hispanic women relative to socioeconomically disadvantaged non-Hispanic whites increases with maternal age, which suggests that US-born Hispanic women undergo a more rapid aging process compared to whites. Moreover, I show that disadvantaged US-born Mexicans and Other Hispanics experience higher mortality relative to their immigrant counterparts over the entire maternal age range which is consistent with the weathering explanation (Geronimus 1992; Wildsmith 2002; Powers 2013). Similarly, non-Hispanic blacks have higher IMRs than whites at every maternal age with the racial gap widening at older ages. Altogether, these findings support my fourth hypothesis that among socioeconomically disadvantaged women US-born Hispanics and non-Hispanic blacks experience a steeper health deterioration compared to whites and foreign-born Hispanics. On the contrary, with the exception of non-Hispanic blacks, I find no evidence for weathering among socioeconomically advantaged women. Advantaged non-Hispanic blacks have higher IMRs than their non-Hispanic white counterparts at every maternal age with the disparity increasing at older ages. Likewise, blacks have higher IMRs compared to Mexicans and Other Hispanics.

In summary, I highlight the existence of variability in the association between the socioeconomic index and infant mortality in the US. The strength of the association varies substantially across race, ethnicity, and nativity status. Non-Hispanic whites display significantly larger socioeconomic inequalities relative to other groups. Foreign-born Mexicans and Other Hispanics exhibit the smallest within-group socioeconomic disparities with socioeconomically advantaged women having about 1.5 more deaths per 1,000 live births compared to their disadvantaged counterparts compared to the 5 deaths disparity exhibited by non-Hispanic whites. Moreover, my results show that the association between maternal age and infant mortality varies by race, ethnicity, nativity status, and by socioeconomic group. An examination of differences in weathering by socioeconomic group yields two important results. First, there are differences in weathering within each racial/ethnic subpopulation by socioeconomic group. Socioeconomically disadvantaged women experience a faster health deterioration compared to their advantaged counterparts as depicted by their higher and increasing IMRs with maternal age. Second, within each socioeconomic group (advantaged and disadvantaged) the relationship between maternal age and infant mortality varies across race, ethnicity, and nativity status. The maternal age-specific IMRs for advantaged women show that, with the exception of non-Hispanic blacks, all subpopulations have comparable IMRs at every maternal age. Thus, the results provide no evidence for weathering among advantaged Mexican and Other Hispanic women but reveal the existence of weathering among advantaged non-Hispanics blacks. The results show the existence of heterogeneity in the maternal age patterns of infant mortality among socioeconomically disadvantaged women. US-born Mexicans, US-born Other Hispanics, and non-Hispanic blacks experience a more rapid aging process than non-Hispanic whites and foreign-born Hispanics. This is consistent with the weathering framework which states that women who are exposed to racial discrimination and socioeconomic disadvantage face a more rapid health deterioration (Geronimus 1992; Geronimus 1996). There is no evidence of weathering for non-Hispanic whites or for foreign-born Hispanics. Overall, these results highlight the importance of looking at the interaction of socioeconomic status, race/ethnicity/nativity status, and maternal age when trying to understand disparities in infant mortality. The analyses show that being exposed to racial discrimination, socioeconomic disadvantage, or both results in an earlier and more rapid maternal health deterioration leading to increasing IMRs with maternal age.

These results have important policy implications. The use of a composite measure of socioeconomic status showed that socioeconomically advantaged women have significantly lower IMRs compared to their disadvantaged counterparts with the results holding for all racial/ethnic groups and maternal ages. Belonging to a socioeconomically advantaged group provides women with resources that grants them access to information, knowledge, money, power, and beneficial social networks that allow them to protect and improve their health. This is consistent with the fundamental cause theory (FCT) proposed by Link and Phelan (1995). More specifically, belonging to the economically advantaged group makes getting health insurance, access to quality health care, and access and use of health information more likely. Hence, efforts to extend health care to all disadvantaged groups (e.g., universal health care) regardless of citizenship could have positive benefits on the health of disadvantaged women of all racial/ethnic/nativity backgrounds leading to lower IMRs. Moreover, the National Healthcare Disparities Report (2012) showed that aside from unequal access to health care, there is a disparate treatment of minority women by physicans which is attributed to statistical discrimination (e.g., stereotyping by race/ethnicity and by socioeconomic background). Thus, efforts should be made to grant minority and poor women access to high quality health care.

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Figure 1. Percent of Births by Maternal Socioeconomic Status (SES) and by Race, Ethnicity, and Nativity Status, United States 2000-2008

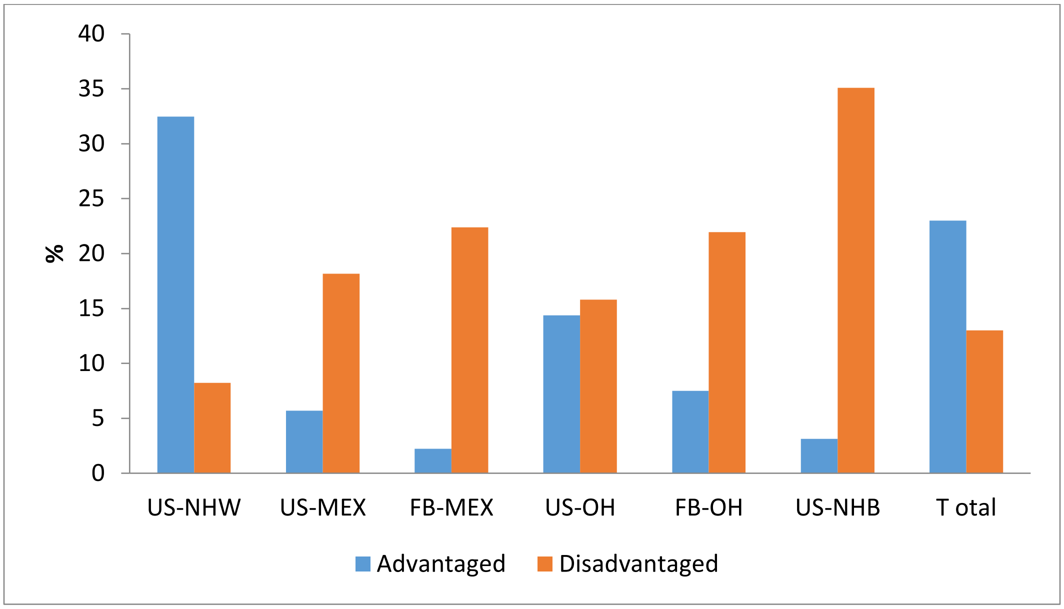


Figure 2. Infant Mortality Rates (IMRs) by Maternal Socioeconomic Status (SES) and by Race, Ethnicity, and Nativity Status, United States 2000-2008

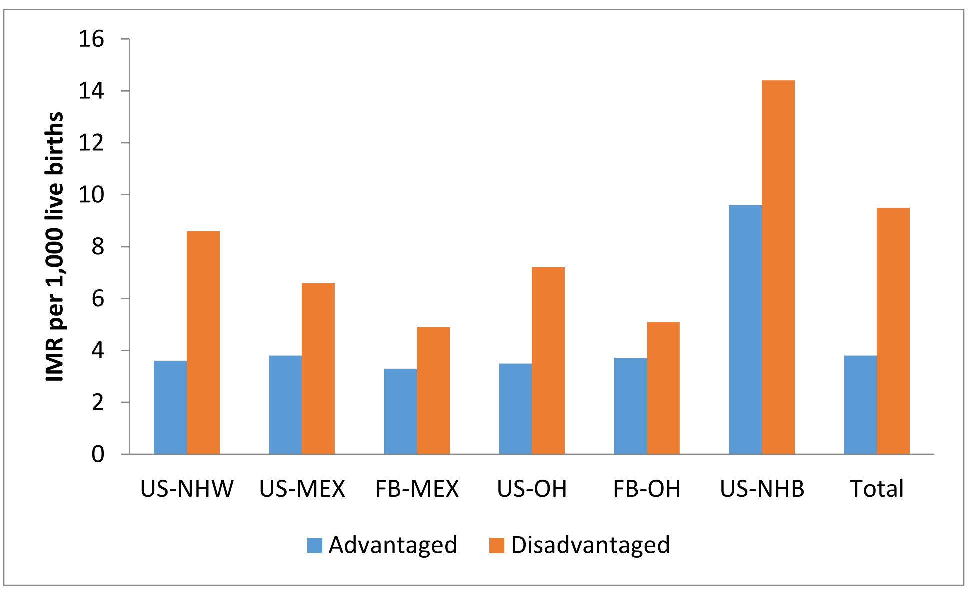


Table 1. Infant mortality rates by maternal age and race, ethnicity, and nativity status, United States 2000-2008

Maternal Age	US-NHW		US-MEX		FB-MEX		US-OH		FB-OH		US-NHB		Total	
	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR
<=19	8.0	9.4	22.4	7.0	11.5	5.7	19.2	7.6	7.1	6.1	19.6	14.0	11.3	9.8
20-24	22.8	6.8	34.0	5.7	28.3	4.5	30.8	5.9	23.3	4.5	34.4	13.2	26.1	7.6
25-29	27.6	4.9	23.9	5.4	28.8	4.3	24.2	5.2	28.8	4.2	23.2	13.0	26.8	5.9
30-34	25.5	4.4	13.3	5.7	20.2	4.6	16.8	4.8	24.1	4.3	14.1	13.8	22.2	5.4
35+	16.0	5.3	6.4	7.1	11.3	6.5	8.9	6.8	16.7	5.7	8.7	15.2	13.6	6.8
Total	100.0	5.6	100.0	6.0	100.0	4.8	100.0	5.9	100.0	4.7	100.0	13.5	100.0	6.7
Births	17,353,248		1,918,625		3,362,261		571,548		1,169,526		4,160,367		28,535,575	
Deaths	97,722		11,517		16,274		3,393		5,468		56,362		190,736	

Source: NCHS linked birth death cohort files 2000-2008

Table 2. Rate ratios relative to US-born non-Hispanic whites by maternal age and race, ethnicity, and nativity status, United States 2000-2008

Maternal Age	US-MEX		FB-MEX		US-OH		FB-OH		US-NHB	
<=19	0.74	*	0.61	*	0.81	*	0.65	*	1.49	*
20-24	0.84	*	0.66	*	0.87	*	0.66	*	1.94	*
25-29	1.10	*	0.88	*	1.06	*	0.86	*	2.65	*
30-34	1.30	*	1.05	*	1.09	*	0.98	*	3.14	*
35+	1.34	*	1.23	*	1.28	*	1.08	*	2.87	*
Overall	1.07	*	0.86	*	1.05	*	0.83	*	2.41	*

Source: NCHS linked birth death cohort files 2000-2008

*Significantly different from 1.0 ($p<0.05$, two-tailed test)

Table 3.1. Infant mortality rates by maternal age and by race, ethnicity, and nativity status for socioeconomically advantaged women: 2000-2008 linked files

Maternal Age	US-NHW		US-MEX		FB-MEX		US-OH		FB-OH		US-NHB		Total	
	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR
<=19	0.0	NA	0.0	NA	0.0	NA	0.0	NA	0.0	NA	0.0	NA	0.0	NA
20-24	4.1	3.6	9.9	4.1	6.9	3.3	5.2	4.4	5.9	2.9	2.7	8.9	4.3	3.7
25-29	28.8	3.4	30.1	3.6	28.5	2.2	30.3	3.3	17.9	3.2	13.6	6	28.4	3.5
30-34	41.2	3.4	33.1	3.6	33.0	3.2	41.0	3.3	27.2	3.5	19.8	9.3	40.3	3.5
35+	25.8	4.1	27.0	4.3	31.6	4.6	23.5	4.1	49.1	4.4	64.0	10.4	27.0	4.5
Total	100.0	3.6	100.0	3.8	100.0	3.3	100.0	3.5	100.0	3.7	100.0	9.6	100	3.8
Births	5,636,225		108,953		75,242		82,169		87,828		129,840		6,120,248	
Deaths	20,290		419		252		291		329		1,241		22,822	

Source: NCHS linked birth death cohort files 2000-2008

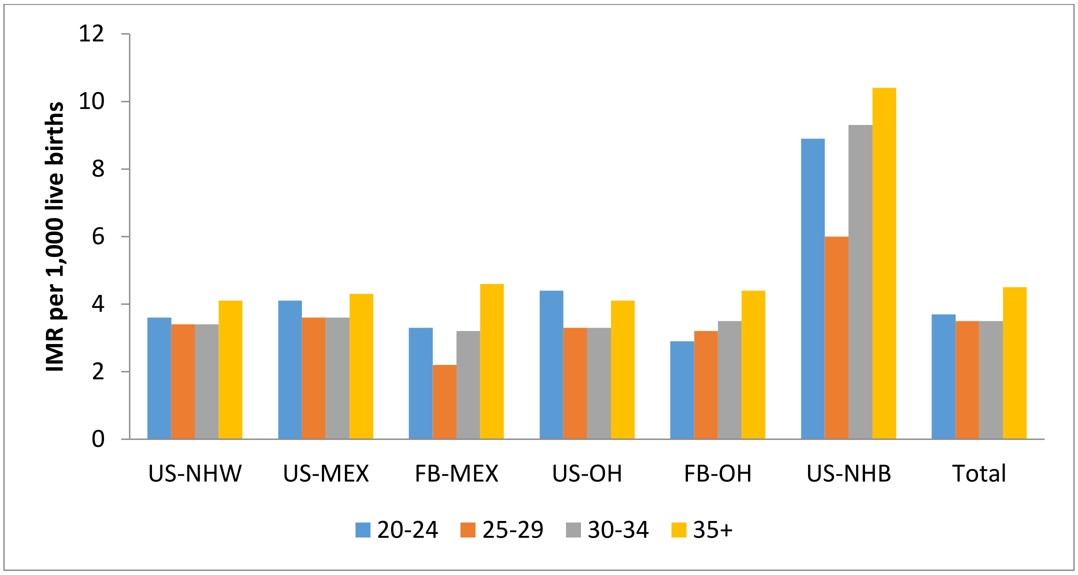
*NA denotes categories in which no infant deaths occurred

Table 3.2. Infant mortality rates by maternal age and by race, ethnicity, and nativity status for socioeconomically disadvantaged women: 2000-2008 linked files

Maternal Age	US-NHW		US-MEX		FB-MEX		US-OH		FB-OH		US-NHB		Total	
	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR
<=19	4.1	7.8	8.3	7.7	9.7	4.8	8.0	10.0	3.2	5.9	16.3	14.0	9.5	9.4
20-24	45.3	8.7	51.8	6.2	37.0	4.6	48.1	6.4	34.2	4.8	46.1	13.7	44.0	8.9
25-29	31.3	8.2	27.0	6.5	28.8	4.4	28.2	7.0	33.1	4.9	22.4	14.7	27.6	9.3
30-34	14.1	8.7	10.2	7.0	16.0	5.0	11.2	7.7	21.0	5.2	9.8	15.9	13.0	11.7
35+	5.3	10.4	2.7	11.7	8.5	7.3	4.6	12.0	8.5	6.7	5.4	18.3	5.9	9.5
Total	100	8.6	100	6.6	100	4.9	100	7.2	100	5.1	100	14.4	100	
Births	1,428,381		348,346		752,695		90,340		256,650		1,460,467		4,336,879	
Deaths	12,261		2,297		3,664		653		1,315		21,061		41,251	

Source: NCHS linked birth death cohort files 2000-2008

Figure 3.1. Infant mortality rates by maternal age and by race, ethnicity, and nativity status for socioeconomically advantaged women: 2000-2008 linked files



*No infant deaths occurred in the <=19 age category among advantaged women

Figure 3.2. Infant mortality rates by maternal age and by race, ethnicity, and nativity status for socioeconomically disadvantaged women: 2000-2008 linked files

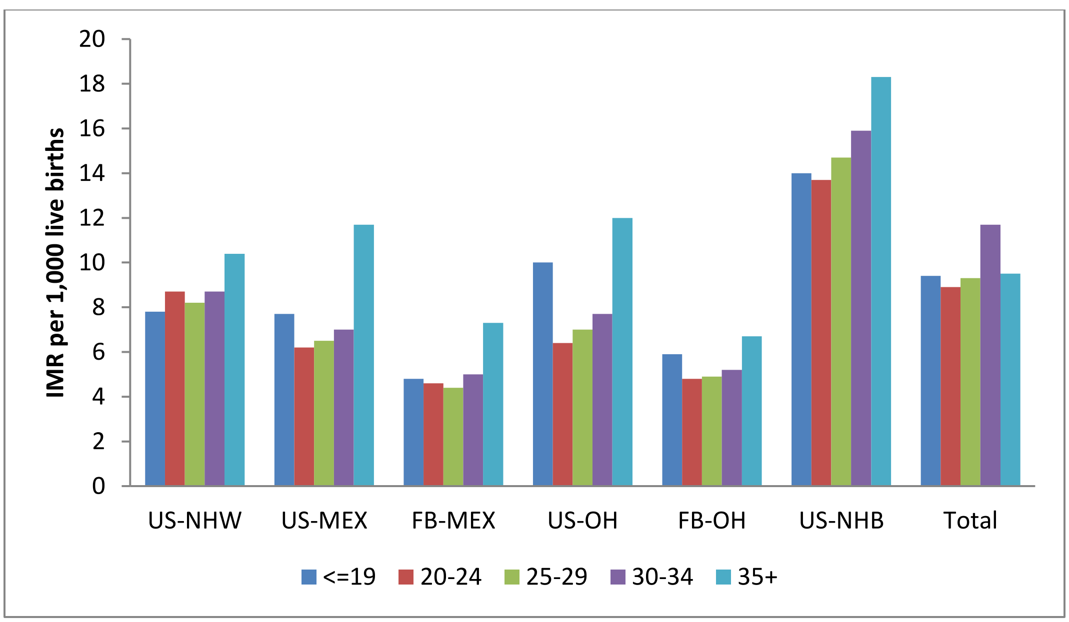


Table 4a. Infant mortality rates (IMRs) and rate ratios for socioeconomically advantaged women ages 25 to 54 relative to women ages 20 to 24, United States 2000-2008

Maternal Age	US-NHW		US-MEX		FB-MEX		US-OH		FB-OH		US-NHB		Total	
25-29	0.94		0.88		0.67		0.75		0.89		1.67	*	0.97	
30-34	0.94		0.88		0.97		0.75		0.97		2.58	*	0.97	
35+	1.14	*	1.05	*	1.39	*	0.93		1.22	*	2.89	*	1.25	*

Note: IMR rate ratios (RRs) are calculated using the 20-24 maternal age category as the reference.
*Significantly different from 1.0 (p<0.05, two-tailed test)

Table 4b. Infant mortality rates (IMRs) and rate ratios for socioeconomically disadvantaged women ages 25 to 54 relative to women ages 20 to 24, United States 2000-2008

Maternal Age	US-NHW		US-MEX		FB-MEX		US-OH		FB-OH		US-NHB		Total	
25-29	0.94		1.05	*	0.96		1.09	*	1.02		1.07	*	1.04	*
30-34	1.00		1.13	*	1.09	*	1.20	*	1.08		1.16	*	1.31	*
35+	1.20	*	1.89	*	1.59	*	1.88	*	1.40	*	1.34	*	1.07	*

Note: IMR rate ratios (RRs) are calculated using the 20-24 maternal age category as the reference.
*Significantly different from 1.0 (p<0.05, two-tailed test)

Table 5. Rate ratios of socioeconomically disadvantaged women relative to socioeconomically advantaged women by maternal age and by race, ethnicity, and nativity status, United States 2000-2008

Maternal Age	US-NHW		US-MEX		FB-MEX		US-OH		FB-OH		US-NHB		Total	
20-24	2.4	*	1.5	*	1.4	*	1.5	*	1.7	*	1.5	*	2.4	*
25-29	2.4	*	1.8	*	2.0	*	2.1	*	1.5	*	2.5	*	2.7	*
30-34	2.6	*	1.9	*	1.6	*	2.3	*	1.5	*	1.7	*	3.3	*
35+	2.5	*	2.7	*	1.6	*	2.9	*	1.5	*	1.8	*	2.1	*
Overall	2.4	*	1.7	*	1.5	*	2.1	*	1.4	*	1.5	*	2.5	*

Source: NCHS linked birth death cohort files 2000-2008

*Significantly different from 1.0 (p<0.05, two-tailed test)

Table 6.1. Rate ratios relative to US-born non-Hispanic whites by maternal age and race, ethnicity, and nativity status for socioeconomically advantaged women, United States 2000-2008

Maternal Age	US-MEX	FB-MEX	US-OH	FB-OH	US-NHB
20-24	1.1	0.9	1.2	0.8 *	2.5 *
25-29	1.1	0.6 *	1.0	0.9 *	1.8 *
30-34	1.1	0.9	1.0	1.0	2.7 *
35+	1.0	1.1	1.0	1.1	2.5 *
Overall	1.1	0.9	1.0	1.0	2.7 *

Source: NCHS linked birth death cohort files 2000-2008

*Significantly different from 1.0 (p<0.05, two-tailed test)

Table 6.2. Rate ratios relative to US-born non-Hispanic whites by maternal age and race, ethnicity, and nativity status for socioeconomically disadvantaged women, United States 2000-2008

Maternal Age	US-MEX	FB-MEX	US-OH	FB-OH	US-NHB
20-24	0.7 *	0.5 *	0.7 *	0.6 *	1.6 *
25-29	0.8 *	0.5 *	0.9 *	0.6 *	1.8 *
30-34	0.8 *	0.6 *	0.9 *	0.6 *	1.8 *
35+	1.1 *	0.7 *	1.2 *	0.6 *	1.8 *
Overall	0.8 *	0.6 *	0.8 *	0.6 *	1.7 *

Source: NCHS linked birth death cohort files 2000-2008

*Significantly different from 1.0 (p<0.05, two-tailed test)