Maternal Education and the Hispanic Paradox: Evidence from Infant Mortality in the United States

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Abstract

Using pooled data from the 2000-2008 U.S. NCHS linked cohort birth-infant death files, we document how the maternal education gradient of infant mortality varies by race, ethnicity, and nativity. We find significant heterogeneity in the maternal education gradient with U.S.-born non-Hispanic whites exhibiting a stronger association between maternal education and infant mortality, and Hispanics having a flatter gradient which is indicative of a weaker association for this group. This comparison also reveals the existence of an education paradox for foreign-born Mexican and Other Hispanics with women with low levels of education having infant mortality rates comparable to the rates of highly educated non-Hispanic whites, and additional levels of maternal education being accompanied by very small reductions in mortality rates relative to the other groups. I also reexamine the Hispanic epidemiologic paradox of lower overall infant mortality rates in the Hispanic population relative to U.S.-born non-Hispanic whites to determine whether the survival advantage is specific to a certain a level of maternal education and whether the variability in the maternal education gradient is responsible for the paradox. This comparison reveals that the survival advantage of Hispanics is considerable at low levels of maternal education and narrows down as education increases with no significant difference observed among women with 16+ years of schooling. Furthermore, the heterogeneity in the maternal education gradient of infant mortality appears to be responsible for the Hispanic paradox of lower infant mortality at the low end of the maternal education distribution.

I. Introduction

Infant mortality is an important indicator of the health status and socioeconomic development of a population because it is associated with a variety of factor such as socioeconomic conditions, maternal health, quality and access to health care, and public health practices. In addition, infant mortality ranks as one of the leading health indicators for Healthy People 2020, the United States' agenda for improving the country's health (Healthy People 2020). Despite the continuous decrease in infant mortality, the United States ranks 26th in infant mortality among the 29 Organization for Economic Cooperation and Development (OECD) countries and the gap between the U.S. infant mortality rates and the rates for the countries with the lowest infant mortality rates seems to be widening over time (MacDorman and Matthews 2014). The unfavorable position of the United States in such an important indicator of overall health relative to other developed countries has been attributed to the high and growing levels of racial/ethnic, social, and economic inequality that characterize the country (Gortmaker and Wise 1997, Wise 2004). Despite marked reductions in the absolute infant mortality rate (IMR) in the U.S., substantial educational, income, and racial/ethnic relative disparities persist and have even widened over time (Gortmaker and Wise 1997, Singh and Yu 1995, Finch 2003, Singh and Kogan 2005). Infants born to mothers with less than 12 years of schooling are approximately twice as likely to die as are infants born to mothers with 16 or more years of education, and infants born to mothers with 12 years of education and with 13-15 years of education have mortality rates that are 1.8 and 1.4 higher than those of infants born to mothers with 16 or more years of education (Singh and Kogan 2007). Likewise, racial/ethnic disparities in infant mortality have been extensively documented in the literature. For example, infants born to non-Hispanic

black mothers have mortality rates that are twice as high as those of infants born to non-Hispanic white mothers (Singh and Kogan 2007, Hummer et al 1993, Hummer et al 1999). On the contrary, despite being socioeconomically disadvantaged with respect to non-Hispanic whites (NHW), Hispanics mortality outcomes are on par or better than those of NHW and more favorable than those of non-Hispanics blacks (NHB) who resemble their socioeconomic risk profile (Hummer 1993, Hummer et al 1999, Frisbie et al 2004). The epidemiologic paradox term has been used to refer to the more favorable health and mortality outcomes for Hispanics relative to non-Hispanic whites despite being socioeconomically disadvantaged relative to this group (Hummer et al 2007, Markides and Coreil 1986, Turra and Elo 2008). Nativity has been found to have a crucial impact on these racial/ethnic differences with mortality rates of infants born to foreign-born Hispanic mothers explaining a large percentage of the advantage (Hummer et al 1999, Hummer et al 2007). This evidence suggests that being socioeconomically disadvantaged does not have the same effect on the infant mortality rates of different racial, ethnic, and nativity groups. Although a vast amount of literature has looked at racial/ethnic disparities and at socioeconomic disparities in infant mortality separately, a study looking at the interaction between socioeconomic status (measured by maternal education) and race/ethnicity and nativity status is needed to complement this existing research. Determining whether variations in the association between socioeconomic status and infant mortality among the different racial/ethnic subgroups exist and understanding the risk factors and resources that can lead to such variability is crucial for reducing social, economic, and racial disparities in infant mortality in the U.S. Furthermore, determining whether different racial/ethnic groups have a survival advantage at certain levels of education is important when trying to understand disparities in infant mortality since it indicates that maternal education and race/ethnicity interact to produce such inequalities.

In this spirit, this study uses data from the National Center for Health Statistics (NCHS) linked birth / infant death cohort files for the period 2000-2008 to explore the association between maternal education (proxy for socioeconomic status) and infant mortality in the U.S., and whether the maternal education gradient exhibits variability across racial/ethnic population subpopulations and by nativity status. Two main questions guide this investigation: 1) Does the maternal education gradient vary across racial/ethnic subpopulations and by nativity status? 2) Is the difference in maternal education gradients across subpopulations responsible for the existence of the Hispanic paradox in overall infant mortality in the U.S.? In our first set of analyses we use logistic regressions with maternal education and race/ethnicity/nativity as the only explanatory variables in the models. This allows us to determine whether a maternal education gradient exists for infant mortality and whether the magnitude of this gradient varies across groups. A set of treatment effect models is also estimated to determine whether the effect of a given level of education differs across subpopulations. Based on the fundamental cause theory (Link and Phelan 1995) and on research on the maternal education gradient for birth outcomes (Currie &Moretti 2003, Meara 2002), we expect to find a strong, inverse association between maternal education and infant mortality. Although we expect a maternal education gradient to exist for all groups, we hypothesize it will be steeper (stronger association between education and mortality) for U.S.-born non-Hispanic white women who have exhibited the largest, widening educational gap in adult mortality among all racial/ethnic groups (Olshanksy 2009, Masters et al 2013). Furthermore, a comparison of the maternal education-specific unadjusted IMRs allows us to examine whether Hispanics exhibit a survival advantage relative to U.S.-born non-Hispanic whites as has been established in the literature (Hummer et al. 1999,

Hummer et al 2007), and whether this advantage is particular to a specific education level. Our second set of analyses consists of a series of logistic regressions that control for different risk factors that affect infant mortality. These risk factors are interacted with maternal education and race/ethnicity/nativity in order to allow for the effect of these factors to vary across subgroups. The predicted IMRs obtained from the adjusted models will allow us to identify the main mechanisms through which maternal education affects infant mortality, the percentage of the educational gradient that is explained by differences in the distribution of these risk factors, and how the importance of these risk factors varies across groups. Given the strong association between education and health behaviors (Cutler and Lleras-Muney 2010), I expect health behaviors such as smoking, prenatal care, and weight gain to be the risk factors with the greatest contribution to the educational gradient. The comparison of the adjusted maternal education-specific IMRs of each Hispanic subgroup relative to U.S.-born non-Hispanic whites will allow us to establish whether the survival advantage of infants born to Hispanic women can be explained by the distribution of risk factors in the populations or if other unobserved factors are responsible for the racial gap. (**Note:** a decomposition analysis can be done to determine how much of the difference in mortality rates between education subgroups can be accounted for differences in maternal education).

Determining the relationship between maternal education and infant mortality and how the educational gradient varies across population subgroups is relevant for policy making. First, maternal education has a protective effect on infant health (Currie and Moretti 2003), and reducing socioeconomic disparities might lead to reductions in the absolute and relative socioeconomic disparities. Second, accounting for the heterogeneity of the US population can better inform us on how education operates differently across race/ethnicity which can aid in

policy making with group specific targets. This article carries out a comparative analysis of infant mortality in the U.S. by race, ethnicity, nativity, and maternal education. The unadjusted maternal education-specific IMRs show that a maternal education gradient for infant mortality exists for all subpopulations; however, the magnitude of this association is stronger among U.S.-born non-Hispanic whites and U.S.-born Hispanics. Foreign-born Hispanics exhibit a flatter gradient which indicates a weak to nonexistent association between maternal education and infant morality. An **"education paradox"** is observed for foreign-born Hispanics since infants born to the less educated women have low mortality rates that are comparable to those of highly educated U.S.-born non-Hispanic whites and increasing maternal education yields just a slight reduction in infant mortality. These results also show that infants born to Mexican and Other Hispanic exhibit a survival advantage relative to their U.S.-born non-Hispanic white counterparts. Although the survival advantage is observed among the less educated women U.S.-born Mexican and Other Hispanic women, the racial gap is larger and existent across the entire education distribution among the foreign-born group. These results are evidence of a **"Hispanic paradox"** for infant mortality with the gap being more pronounced for the less educated group and for foreign-born Mexican and Other Hispanics. Adjusting for the different risk factors explains part of the educational gradient for U.S.-born non-Hispanic whites and U.S.-born Hispanics. A less pronounced education gradient is observed for all groups with an "education paradox" now being observed for U.S.-born and foreign-born Mexican and Other Hispanics. Although the survival advantage of Hispanics relative to U.S.-born non-Hispanic whites was reduced, it still persisted after controlling for the risk factors with a **"Hispanic paradox"** emerging for highly educated Mexican and Other Hispanic women. The reduction in the IMRs of the less educated women and the narrowing of the racial gap among the less educated groups

suggests that risk factors and the differences in the distribution of risk factors in the population are important in explaining the education gradient of infant mortality in the U.S. Moreover, even though the risk factors provided a partial explanation of the racial gap observed at the low end of the education distribution, a large percentage remained unexplained. This might imply that other factors such as health selectivity, culture, norms, social support, and/or the gradient in the sending countries might account for the remainder of the gap and might explain, to a given extent, the weak or nonexistent gradient (flat gradient) characterizing infants born to foreign-born Hispanic women.

II. Background

- **Socioeconomic Status and Health Outcomes**

The association between educational attainment and health outcomes has been widely documented in the literature (Kitigawa and Hauser 1973, Mirowsky and Ross 2003). A positive gradient has been found to exist between education and adult mortality with individuals with high levels of educational attainment living longer and healthier lives than those with low levels of education (Hummer and Lariscy 2011; Montez and Hayward (2014) and exhibiting lower death rates at every age (Hummer and Hernandez 2013). Studies documenting the association between education and mortality have found that even though a significant portion of the association is mediated by economic resources, social-psychological resources and health behaviors (Denney et al 2010, Cutler & Lleras-Muney 2009), the knowledge and use of health technologies (Glied & Lleras-Muney 2008, Phelan et al 2010), and the enhancement of cognitive skills (Baker et al 2011) also represent important pathways through which education affects mortality risks. Furthermore, the graded association between socioeconomic status and health outcomes has been shown to exist at all levels of the SES hierarchy indicating that differences in social position relate to morbidity and mortality even at the upper levels of the hierarchy (Adler et al 1994). Recent research has also identified significantly widening socioeconomic disparities in adult mortality (Masters et al 2012, Olshanksy et al 2012, Hummer & Hernandez 2012) with some groups of adults (e.g. low educated women in the South) observing increasing mortality rates over the past decades (Montez and Zajacova 2013, Hummer & Hernandez 2012).

A socioeconomic gradient for infant mortality has also been identified with sizable differences in mortality risks by maternal education level observed for all racial groups (Frisbie et al. 2010, Gage et al. 2013). Socioeconomic disparities in infant mortality have persisted and even widened

despite significant reductions in absolute mortality rates in the U.S. Using a deprivation index at the county level and maternal education at the individual levels as measures of socioeconomic status, Singh and Kogan (2007) find that although absolute disparities have narrowed over time, relative socioeconomic disparities have increased since 1985 for infant, neonatal, and postneonatal mortality with disparities being the greatest among normal birth weight infants. The relative risk of infant mortality for infants born to women with < 12 years of education than for those born to mothers with ≥ 16 years of education increased from 22% in 1986 to 41% in 2001. Relatively larger declines in infant and postneonatal mortality among higher socioeconomic groups have contributed to the widening of the gap since 1985. These disparities can be a reflection of how income differentials between educational strata have widened over time, how the ratio of mean earnings has increased, and how the absolute differences between deprivation groups in income, wealth, assets have widened over time. Risk factors such as smoking, delayed or no prenatal care, health behaviors, and lack of health care coverage vary substantially by county deprivation levels and maternal education denoting the importance of education as a predictor of infant mortality not only through access to income and employment, but through other pathways (Singh and Kogan 2005). 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. Increases in maternal education have been found to have significant positive effects on birth outcomes with an additional year of education reducing the incidence of low birth weight and preterm births in the US by 10% and 6% respectively. The main channels through which education operated were maternal behavior (reducing smoking by 30%), an improved marriage market, and a reduction in expected fertility (Currie and Moretti 2003). Using education and income as measures of socioeconomic status, Meara (2001) found a strong

correlation between SES and low birth weight with maternal health behaviors during pregnancy, particularly smoking, explaining about half (one third) of the association among white (black) mothers. Moreover, Finch (2003) found that household income was an important determinant of infant mortality especially at very low levels of income with the strength of the association persisting after controlling for covariates.

Education allows individuals to qualify for higher status jobs and higher incomes granting them access to resources such as health insurance, prenatal care, proper nutrition, and safe environments all of which are linked to infant health and mortality (Currie et al 2011, Finch 2003, Strully et al 2010). Results from both strands of literature suggest that a maternal education gradient for infant mortality exists and educational disparities might be larger in the 2000's relative to previous decades given the increase in educational attainment and the access to resources higher levels of education encompass.

- **Socioeconomic Status, Health Outcomes, and Race/Ethnicity/Nativity Status**

Studies on the educational gradient for health outcomes have gone past the existence of the gradient to determining whether the educational gradient for mortality and health outcomes exhibits variability across race, ethnicity, and nativity status. Looking at the gap in longevity between the highly educated and the less educated group, Olshansky et al. (2012) established that educational disparities were larger for whites followed by blacks and Hispanics (both sexes). The difference in life expectancy between those with the highest and the lowest level of education in 2008 was 10.4 years for white females, 6.5 years for black females, 2.9 years for Hispanic females, 12.9 years for white males, 9.7 years for black males, and 5.5 years for Hispanic males. Trends in life expectancy within the four educational categories showed that among those with a

high school education or higher, only Hispanic females did not experience rising longevity. Among the low educated, whites with less than a high school education experienced a consistent pattern of decreasing longevity while low educated blacks and Hispanics of both sexes exhibited increasing longevity. Moreover, even though highly educated black men and women live longer then less educated whites, educational disparities persisted at the highest level of education with highly educated black men living less than comparably educated whites and Hispanics. The largest disparity was found between white U.S. men and women with 16 years or more of schooling and black American men and women with fewer than 12 years of schooling. Although highly educated men and women were found to have better life expectancies than their less educated counterparts, differences found in the educational gradient for life expectancy across racial groups demonstrate that the effect of education and its socioeconomic status correlates is partially moderated by racial/ethnic group membership.

Studies looking at the educational gradient for a myriad of adult health outcomes and behaviors have shown that education gradient for different health measures and behaviors varies by race, ethnicity, and nativity. Contrary to the steep education gradient exhibited by Whites, a weak association between education and numerous health-related variables such as smoking, drinking, physical disabilities, work limitations, obesity, and fair/poor health was found to exist for the adult Hispanic population (Goldman et al 2006, Kimbro et al 2008). The education differentials for foreign-born Hispanics and Asians were found to be more modest than those of their U.S.-born counterparts suggesting the importance of nativity differentials in the education-health association. Their results indicated that the flatter gradient observed for the foreign-born subpopulation was largely driven by the less educated group which exhibited more positive health behaviors and outcomes than their U.S.-born counterparts while no significant difference

was observed among the highly educated group. This weak to nonexistent association between education and adult health outcomes observed for the Hispanic population (particularly the foreign-born) constitutes an **"education paradox"** (Goldman et al 2008). The healthy migrant effect, the socioeconomic gradient for health outcomes in the sending countries of migrants, and the assimilation of immigrants have been posited as potential explanations for the existence of a flat educational gradient.

Even though highly educated black and Hispanic adults display lower mortality rates than their less-educated counterparts; the "payoff of a high education" for these minority groups has been found to be smaller than for whites (Hummer & Hernandez 2013). One possible explanation for the difference in payoffs is that blacks and Hispanics are more likely to attend and graduate from lower-quality high schools and colleges compared to whites leading to differences in health and longevity benefits from higher education compared to whites. Existing literature has also established that Black and Hispanic adults, even those with high levels of education, encounter discrimination in various forms and contexts such as disparate employment opportunities and wage earnings (Rosenfiled and Kleykamp 2012) which prevent them from acquiring the health-related resources higher levels of education encompass. The strength of the association between education and mortality in the U.S. has been found to be affected by the ability to transfer higher educational attainment into personal resources which can lead to longer and healthier lives. Thus, the racial and ethnic variation in the education gradient for U.S. adult mortality risk is partly explained by the discrimination and disparate abilities faced by certain groups when trying to effectively translate resources into good health (Crimmins et al 2004).

Although the variation in the education gradient for adult health has been extensively documented, the degree to which the gradient for infant health varies across racial/ethnic groups

has been studied to a lesser extent. Research on the trends and differences in infant mortality by maternal education has shown that although maternal education has been inversely associated with infant mortality over time for all groups, the effect of maternal education on mortality has been greater for White than for Black infants (Singh and Yu 1996). Using data from the NCHS Linked Birth and Infant Death data sets, Singh & Yu (1996) found that Black infants had significantly higher infant mortality rates than White infants at all levels of maternal education. Moreover, they found the Black-White disparity to be greater at higher levels of education and to have widened across all educational levels over time. In addition, their results showed that although infant mortality fell substantially across all educational levels for both Whites and Blacks, it did so at disparate rates with infants born to women with 16 or more years of education experiencing the largest decline in their mortality rates. The unequal rates of decline in mortality rates increased educational inequalities over time for both groups with inequalities been more pronounced among Whites than Blacks. They also found a steeper gradient and a larger income gap for White relative to Black infants when family income was used as a proxy for socioeconomic status. Although an educational and income gradient for infant mortality was evident for both Whites and Blacks, the benefits of higher levels of maternal education were larger among White women who also exhibited the largest educational disparity in IMRs. Meara (2001) found similar results when examining the correlation between SES and birth weight for Black and White infants. Aside from establishing the existence of a steeper gradient for Whites, Meara (2001) found differences in the importance of the mediating mechanisms for both groups. While maternal behaviors during pregnancy, particularly smoking, explained half of the association among white mothers, they only accounted for one third of the association among blacks.

A more comprehensive study of the maternal education gradient for birth weight and infant mortality for European Americans, African Americans, and Mexican Americans in the U.S. also manifested the existence of a variation in the educational gradient across racial groups (Gage 2013). Using data from the 2001 U.S. NCHS Vital Statistics, Gage (2013) looked at the direct and indirect effect of maternal education on birth weight and infant mortality for these three racial/ethnic groups. Looking at normal and compromised births separately, he found that maternal education had the largest effect on normal births where an increase in maternal education resulted in a significant increase in mean birth weight and in a decrease in infant mortality rates, whereas the effect on compromised births was small and inconsistent. A large percentage of the increase in the overall mean birth weight and overall infant mortality due to higher maternal education was found to be driven by the direct effect of education on normal births and not mediated by improved birth weight. Moreover, he showed that the educational gradient varied considerably among the three groups. The effect of maternal education on birth weight and infant mortality was highest for European Americans births and smallest among Mexican Americans. For instance, higher maternal education increased the mean birth weight of Mexican American normal births by only approximately one-third of the amount by which the mean weight increased for European American and African American births. The impact of education on the infant mortality of Mexican Americans was found to be small relative to the other groups. Nevertheless, Mexican Americans had the lowest infant mortality rates of all groups which might be explained by the "Hispanic Paradox". Furthermore, the African American-European American racial disparity in infant mortality widened with increasing education levels despite both groups experiencing declines in their IMRs as education increased. The largest absolute and relative differences were found in the high-education group. Racial

differences in the effect of higher maternal education compromised births (with a larger benefit accrued by European Americans) were responsible for the widening of the gap. A maternal education gradient for mean birth weight, low birth weight rate, and infant mortality was identified for all racial and ethnic groups; however, the gradient was found to vary across the different groups. Maternal education had the largest effect on the birth outcomes of European Americans followed by African Americans and Mexican Americans with the latter group experiencing the smallest improvements in birth outcomes as education increased.

- **Variation in the Maternal Education Gradient of Infant Mortality and the Hispanic Paradox**

Differences in the education gradient of infant mortality by race, ethnicity, and nativity status denote that high levels of maternal education are not always accompanied by significant reductions in IMRs. Likewise, women with a low educational attainment might not always be "penalized" with high IMRs as is the case for the Hispanic origin population (except for Puerto Ricans). Literature examining the IMR gap between whites and Hispanics has consistently found that Hispanics have similar or slightly lower infant mortality rates vis-à-vis non-Hispanic whites. The existence of the epidemiologic paradox for health and mortality outcomes among Hispanics in the U.S. has been extensively documented in the literature (Markides and Coreil 1986, Palloni and Morenoff 2001). Despite having relatively low levels of education, income, and health insurance coverage relative to non-Hispanic whites, Hispanics have been found to exhibit similar mortality rates and health outcomes vis-a-vis non-Hispanic whites and better health outcomes than those of non-Hispanic blacks who have similar socioeconomic profile. The first evidence of an epidemiologic paradox for infant mortality was revealed by Teller and Clyburn (1974) who, using data from Texas, found that the infant mortality rates for the Spanish-surname

population in the Southwest were similar or lower than that of non-Hispanic whites in the 1960s and lower than the rates of non-Hispanic blacks although socioeconomically their status resembled the latter group (Markides and Coreil 1986).

Recent studies on the Hispanic paradox for infant mortality have looked at other Hispanic subpopulations such as Cubans, Central, and South Americans to determine whether the paradox observed for infants born to Mexican origin women is also found among other groups. In a comprehensive analysis of the racial/ethnic gap in infant mortality, Hummer (1993) found that infants born to Mexican, Cuban, and Central American women had similar or lower mortality rates relative to their white counterparts with the survival advantage being larger among infants born to foreign-born Hispanic women. Puerto Ricans were an exception since they exhibited the second highest IMRs among all groups regardless of their nativity status. The contribution of nativity status to the existence of the Hispanic paradox was particularly relevant for groups who have a high share of foreign-born population. This is the case for Cubans and Central/South Americans for whom the lower infant mortality risks relative to non-Hispanic whites were fully attributable to the protective effect and the large concentration of births to foreign-born women among these groups. The nativity effect was found to work through a variety of sociodemographic, behavioral, maternal health, and birth outcome risk factors with the importance of each varying across racial/ethnic groups. Furthermore, these racial mortality differentials persisted even after controlling for sociodemographic and proximate factors (Hummer 1993, Hummer et al. 1999). Frisbie and Song (2003) looked at mortality indicators for short gestational age and low birth weight differentiating Hispanics by country of origin and nativity status. They also found that Hispanic groups had similar or lower IMRs than whites with foreign-born Mexicans exhibiting the largest survival advantage. A detailed studied on infant

mortality by age of death found that the survival advantage of Hispanics was not explained by selective out-migration since most of the advantage occurred among deaths in the first day (Hummer et al. 2007). On the other hand, infants born to U.S.-born non-Hispanic black women consistently exhibited the highest IMRs of all groups and were twice as high relative to whites (Hummer 1993, Hummer et al 1999). The black-white gap in infant mortality remains large and significant even after controlling for different socioeconomic, health, and behavioral factors (Almond et al 2006, Chay and Greenestone 2000). Recent studies have also looked at the Hispanic paradox by maternal age at birth (Powers 2013). A comparison of the maternal age-specific IMRs for U.S.-born non-Hispanic white, Mexican American, and Mexican immigrant women showed that infants born to Mexican origin women exhibited a relative survival advantage at young maternal ages; however, a relative survival disadvantage is observed at older maternal ages. The relative survival disadvantage at older ages was partially explained by differences in the composition of socioeconomic characteristics of the Mexican origin population relative to whites.

- **Differences in the Maternal Education Gradient and the Hispanic Paradox**

Existing literature has documented the strong association between socioeconomic status and health outcomes. An inverse association between maternal education and birth outcomes has been established with highly educated outcomes having more favorable outcomes than their less educated counterparts. Variability in the education gradient for adult health outcomes has been documented with an "education paradox" observed for foreign-born Hispanics. Additionally, research on racial/ethnic disparities in infant mortality have shown that infants born to Hispanic women have equal or lower mortality rates than infants born to non-Hispanic whites despite being socioeconomically disadvantaged relative to the latter group. We bring together both

strands of literature in an attempt to understand whether any potential variation in the maternal education gradient of infant mortality might be responsible for the Hispanic paradox. The main questions leading this study are the following. 1) Is the maternal education gradient of infant mortality invariant across different racial/ethnic groups and by nativity status? 2) Is the difference in education gradients across groups responsible for the "Hispanic Paradox" observed for infant mortality in the U.S.?

Contribution of the Present Research

Substantive literature has documented the association between education and health and mortality outcomes. While a strong association between education and adult health outcomes has been established for non-Hispanic whites, a weaker association between education and health outcomes has been found to characterize the Hispanic population (Kimbro et al 2007). This weak to non-existent association has come to be known as the "education paradox" of the Hispanic subpopulation (Goldman et al 2006; Kimbro et al 2007). It indicates that the penalty of low levels of education and the benefits of higher education vary by race, ethnicity, and nativity status. Most research on the "education paradox" has focused on adult health outcomes with very few studies looking at birth outcomes such as birth weight (Goldman et al 2006). The existent literature suggests that the "education paradox" found for Hispanics when studying adult health and mortality might extend to birth outcomes such as infant mortality. This study contributes to the literature by answering the following question: Is there heterogeneity in the maternal education gradient for infant mortality? Second, Hispanics have been found to exhibit another paradox ("Hispanic paradox") with their health and mortality outcomes closely resembling non-Hispanic whites despite having a more disadvantage socioeconomic profile relative to this group (Markides & Coreil 1986). Research has found that infants born to Hispanic women have lower

overall IMRs relative to non-Hispanic whites (Hummer 1993, Hummer et al 1999). Although existing studies control for maternal socioeconomic status, limited attention has been given to the existence of the "Hispanic paradox" at different levels of maternal education. This research will extend the literature by determining whether the variability in the maternal education gradient across subgroups is responsible for the "Hispanic paradox'. This will also allow us to identify the main drivers of the racial gap at each level of education.

III. Results

1. Descriptive

Previous studies have established the existence of an association between socioeconomic status (SES) and health and mortality outcomes with lower mortality rates and better health outcomes being associated with a higher socioeconomic status (SES). Furthermore, the association between adult health outcomes and maternal education has been found to be stronger for non-Hispanic whites and weaker for Hispanics (Goldman et al 2006, Kimbro et al 2008). In addition, Hispanics in the U.S. have been found to have health and mortality outcomes that are on par with those of non-Hispanics whites and better than those of non-Hispanic blacks despite having a socioeconomic profile that closely resembles the latter group. This has become widely known as the Hispanic paradox (Markides & Coreil 1986; Hummer et al 1999). This paper is centered on two main research questions. First, is the maternal education gradient invariant across racial/ethnic subpopulations and by nativity status? Second, is the difference in the maternal education gradient across subgroups responsible for the "Hispanic paradox"?

1. Maternal Education Gradient of Infant Mortality

1.1. Maternal Education Gradient for the Overall Population

We begin by providing a comparative analysis of the infant mortality rates (IMRs) by race, ethnicity, and nativity status and describing the association between maternal education and infant mortality for the overall population (all 7 subpopulations combined). Table 1 shows the total and the maternal education-specific infant mortality rates (per 1,000 live births) for the different racial/ethnic groups and by nativity status as well as for the overall population. When

looking at the total infant mortality rate (IMR) of each racial/ethnic group we can see that foreign-born Mexican and Other Hispanic women have the lowest mortality rates among all groups (IMR=4.8 deaths per 1,000 live births) followed by U.S.-born non-Hispanic whites who exhibit an infant mortality rate of 5.6 deaths per 1,000 live births. U.S.-born Mexican and Other Hispanic women have an infant mortality rate of approximately 6 deaths per 1,000 live births which is slightly higher relative to U.S.-born non-Hispanic whites. Puerto Ricans and U.S.-born non-Hispanic blacks have the highest IMRs among all groups with their mortality rates being of approximately 7.9 and 13.7 deaths per 1,000 live births.

When looking at the maternal education-specific infant mortality rates (IMRs) for the overall population (all 7 racial/ethnic subgroups combined), the inverse association between maternal education and infant mortality is clearly depicted. It can be seen that higher levels of maternal education result in lower IMRs with infants born to mothers with <12 years of education exhibiting IMRs that are 2 times higher than the mortality rates of infants born to women with 16+ years of schooling. Each additional level of maternal education results in a reduction of IMRs with the smallest decline accruing to women who have 12 years of education (compared to those with <12) who only experience a reduction of 11% in their mortality rates.

Nevertheless, the payoff of higher levels of maternal education can differ by race, ethnicity, and nativity status. Literature on adult health has established the existence of a stronger association between education and health characterizes non-Hispanic whites and a weaker to non-existent association is observed for Hispanics (Goldman et al 2006, Kimbro et al 2008). This suggests that a similar pattern might be observed for birth outcomes such as infant mortality. Thus, our following set of analyses looks at the maternal education gradient of infant mortality by race, ethnicity, and nativity status.

1.2.Maternal-Education Specific IMRs

Table 1 presents the maternal education-specific infant mortality rates (IMRs) for each subpopulation. It is evident that significant educational disparities exist with the degree of the inequality varying across race, ethnicity, and nativity status. For example, when comparing the two ends of the maternal education distribution (<12 years of education versus 16+ years of education) we can see that infants born to women with <12 years of schooling have IMRs that are higher than those of infants born to women with 16+ years of education with the magnitude of the disparity varying widely across subgroups.

More specifically, U.S.-born non-Hispanic whites exhibit the largest education inequality with infants born to women with <12 years of education having IMRs that are approximately 3 times higher than infants born to highly educated women. Similarly, infants born to U.S.-born Mexican, U.S.-born Other Hispanic, Puerto Rican women (U.S. and foreign-born), and U.S.-born non-Hispanic black women with <12 years of education have IMRs that are approximately 2 times higher than the rates of infants born to women with 16+ years of education. Foreign-born Mexican and Other Hispanic women display the smallest educational disparity among all groups. Infants born to low educated women from these groups have IMRs that are 1.3-1.4 times higher than infants born to highly educated women. An in-depth analysis of the entire maternal education distribution illustrates the benefits of each additional level of maternal education on infant mortality. As depicted in Table 1, every additional level of maternal education results in a decline in infant mortality with the largest reduction in IMRs experienced by women with 12 years of education (relative to <12) and with 16+ years of education (relative to 13-15). Moreover, the benefit of having 12 years of education (relative to 12) was higher for U.S.-born non-Hispanic white infants who observed a reduction of 32% in their mortality rates compared to

the 4-24% reduction experienced by other groups. Infants born to foreign-born Mexican and Other Hispanic with 12 years of education only see a reduction of 4% in their mortality rates relative to women with <12 years of schooling. Similarly, the benefit of attaining 12 years of education (relative to <12) results in a reduction of 8% in the IMR of U.S.-born non-Hispanic blacks.

Panels A and B of Figure 1 illustrate the IMRs that were depicted in Table 1. As displayed in the figures, an inverse association between maternal education and infant mortality is evident for all groups with infants born to women with <12 years of education having significantly higher mortality rates than infants born to highly educated women. The steepness/flatness of the slope tells us the strength of the association between maternal education and infant mortality. The steepness of the slope of U.S.-born non-Hispanic whites indicates the existence of a stronger association between maternal education and infant mortality for this group relative to the other groups. A similar pattern is observed for Puerto Ricans (U.S. and foreign-born). A strong association between maternal education and infant mortality, although to a lesser extent compared to non-Hispanic whites, is also observed for infants born to U.S.-born Mexican and Other Hispanic women. On the contrary, a flatter slope is displayed by foreign-born Mexicans and Other Hispanics. This reveals the existence of a weaker or nonexistent association between maternal education and infant mortality. For example, the steeper gradient of U.S.-born non Hispanic whites and U.S.-born Hispanics shows that women with <12 years of education from these groups have 3.3-6.2 more deaths per 1,000 live births vis-à-vis infants born to their highly educated counterparts whereas this difference is of only 1.3 more deaths per 1,000 live births for foreign-born Hispanics. Furthermore, the flat segment of the slope observed for foreign-born

Hispanics between the <12 and 12 years of education categories conveys the almost non-existent benefit of achieving 12 years of schooling (relative to <12) for infant mortality.

In summary, the descriptive results from Table 1 and Figure 1 confirm the well-known association between maternal education and infant mortality which has been widely documented in the literature. Women with <12 years of education have IMRs that are 1.3-3 times higher vis-à-vis highly educated women. In addition, the maternal education-specific IMRs reveal variability in the education gradient across racial/ethnic subgroups and by nativity status which supports our first hypothesis. The heterogeneity of the educational gradient shows that although maternal education has a protective effect on infant mortality for all groups, the payoff varies considerably across groups. U.S.-born non-Hispanic white women see the largest reduction in mortality rates with each additional level of maternal education followed by U.S.-born Hispanics. Foreign-born Mexican and Other Hispanic women experience the smallest reduction. This is consistent with the existence of an "educational paradox" for the latter two subpopulations. In addition, infants born to foreign-born Mexican and Other Hispanic women with <12 and 12 years of education have low levels of infant mortality suggesting that having a low level of maternal education is not a penalty for these two groups. Likewise, an important nativity differential is visible for the Hispanic population with a stronger maternal education gradient observed for U.S.-born Hispanics and a weaker to nonexistent association observed for the foreign-born subpopulation.

[Insert Table 1 about here]

{Insert Figure 1 about here]

1.3.Heterogeneity in the Maternal Education Gradient of Infant Mortality and the Hispanic Paradox

Hispanics in the U.S. have been characterized for exhibiting better or similar health and mortality outcomes vis-a-vis U.S.-born non-Hispanic whites and better health and mortality outcomes relative to U.S.-born non-Hispanic blacks despite having a socioeconomic profile that closely resembles the latter group and which is disadvantaged compared to whites. A comparison of the maternal-education specific IMRs of each racial/ethnic subgroup relative to U.S.-born non-Hispanic whites will allow us to determine whether the heterogeneity in the maternal education gradient described in Section 1.2 is responsible for the "Hispanic Paradox" observed for infant mortality. Likewise, this comparison will enable us to determine whether the survival advantage exhibited by infants born to Hispanic women exists across the entire maternal education distribution or whether it is characteristic of a specific level of education.

Table 2 shows the maternal education-specific IMR ratios (rate ratios) for each group relative to non-Hispanic whites. The rate ratios for Puerto Ricans (U.S. and foreign-born) and U.S.-born non-Hispanic blacks are uniformly higher at all levels of maternal education with the excess mortality being larger at the highest levels of education (13-15 and16+ years of schooling. Infants born to U.S.-born Mexican and Other Hispanic women with <12 years of education face 28% and 20% lower risk of dying when compared to their U.S.-born non-Hispanic white counterparts, while infants born to women with 12 years of education have risks that are 11-12% lower. The survival advantage exhibited among less educated women erodes at high levels of

maternal education where U.S.-born Mexican and Other Hispanic women exhibit IMRs that are slightly higher relative to their non-Hispanic white counterparts. An analysis of foreign-born Mexicans and Other Hispanics shows that these groups exhibit a larger survival advantage than their U.S.-born counterparts which spans the entire maternal education distribution. Infants born to foreign-born Mexican women have a 3-50% lower risk of dying when compared to their U.S.-born non-Hispanic white counterparts, while infants born to foreign-born Other Hispanic women have risks that are 16-50% higher except for those born to women with 16 or more years of education where there is no difference in risks. The survival advantage is the greatest among low educated women with infants born to women with <12 years of schooling having a 50% lower risk of dying relative to their similarly educated non-Hispanic white counterparts. As maternal education increases, the initial survival advantage drops to 30% for women with 12 years of education, 14-16% for women with 13-15 years of schooling, and no advantage observed among the highly educated group.

Panel A and Panel B of Figure 1 illustrate the survival advantage (disadvantage) of the different racial/ethnic subgroups relative to U.S.-born non-Hispanic whites at each level of maternal education. Panel A illustrates the racial/ethnic gap of U.S.-born Hispanics and U.S.-born non-Hispanic blacks relative to non-Hispanic whites. Infants born to U.S.-born Mexican and Other Hispanic women exhibit a survival advantage at the low end of the maternal education distribution. Women with <12 and 12 years of education have approximately 2-2.8 and 1 fewer deaths per 1,000 live births respectively than non-Hispanic whites with comparable levels of education. No difference in IMRs exists at high levels of education as is depicted by the convergence of the maternal education graphs. Panel B displays the racial/ethnic gap of foreign-

born Hispanics relative to non-Hispanic whites. Foreign-born Mexican and Other Hispanic women with <12 and 12 years of schooling have 5 and 3 fewer deaths per 1,000 live births respectively relative to their non-Hispanic white counterparts with the advantage diminishing as maternal education increases. It is important to note that the IMRs of infants born to low educated foreign-born Hispanic women are comparable to the rates of non-Hispanic whites with 13-15 or 16+ years of schooling. A nativity differential is evident with the racial gap at <12 and 12 years of education being 2 and 3 times greater for foreign-born Hispanics relative to their U.S.-born counterparts. Puerto Ricans (U.S. and foreign-born) exhibit a survival disadvantage across the maternal education distribution except at <12 years of schooling where their IMRs are on par with non-Hispanic whites.

The descriptive results from Table 2 and Figure 1 show that a "Hispanic paradox" exists for infants born to Mexican and Other Hispanic women. Although the survival advantage occurs among infants born to U.S.-born Mexican and Other Hispanic women with <12 and 12 years of education, it extends to infants born to women with 13-15 years education in the case of the foreign-born population. No difference in mortality rates is observed among infants born to highly educated women (16+). As displayed by Figure 1, the heterogeneity in the maternal education gradient of infant mortality across subpopulations appears to be responsible for the existence of the Hispanic paradox providing support for our second hypothesis. As portrayed in Figure 1, non-Hispanic whites have a steep maternal education gradient of infant mortality with very high IMRs at low levels of maternal education and sizable reductions in their mortality rates as education increases. Hispanics, particularly the foreign-born subpopulation, have a flatter slope with lower IMRs (relative to non-Hispanic whites) at the left tail of the maternal distribution and smaller reductions in mortality accompanying increases in educational

attainment. The flatter slope is representative of an "educational paradox". Thus, the difference in the level of infant mortality at low levels of education and the variability in the gradient give rise to the existence of a "Hispanic Paradox". The racial gap is larger among low educated women (<12 and 12 years of schooling) where the difference in gradients is greater. Nevertheless, although there is convergence in the slopes among the highly educated, the IMRs of Hispanics are on par with the rates of whites.

[Insert Table 2 about here]

2. Multivariate Analysis

The observed patterns in maternal education-specific IMRs previously described do not account for any set of sociodemographic, maternal health, or maternal behavior characteristics. We now proceed to determine whether this pattern holds after adjusting for an array of sociodemographic characteristics and maternal health risk factors. In doing so, we will be able to examine whether the adjusted maternal education-specific rates and ratios after controlling for risk factors. While maternal education, race/ethnicity, and other sociodemographic characteristics are recognized as distal causes of infant mortality (Frisbie 2005, Mosley & Chen 1984), maternal health and maternal behavior characteristics are considered to be more proximate determinants of birth outcomes and infant mortality.

2.1. Risk Factors

The full analytic model includes several sociodemographic, maternal health, biological, and behavioral risk factors which are important proximate determinants of infant mortality. The sociodemographic covariates included in the model include a binary variable for marital status coded 1 if the mother was single at the time of birth (0 otherwise) and a categorical variable for

maternal age at the time of birth where 25-34 is the less risky age for giving birth, ages 18-20 and 35 and above are considered to be of higher risk for birth outcomes, and 21-24 is the fourth category. In order to measure parity, we use the Kleinman–Kessel Parity Index (Kleinman and Kessel 1987), which accounts for the interaction between maternal age at birth and birth order. Our variable for this index has three categories: first births, low parity which encompasses second-order births to women 18 and older and third- or higher-order births to women 25 and older, and high parity which includes second- or higher-order births to women under 18, third- or higher-order births to women under 25, and fourth- or higher-order births to women 25 and older. The model includes a binary variable for maternal morbidity coded 1 (0 otherwise) for a positive response to any of the following: diabetes, chronic hypertension, pregnancy associated hypertension, and eclampsia. A binary variable for labor and delivery complications is constructed similarly and is coded 1 (0 otherwise) for a positive response to any of the following: meconium, breech, and precipitous labor. A measure for prenatal care is derived following the Adequacy of Prenatal Care Utilization (APNCU) Index (Kotelchuck 1994). In order to determine the adequacy of prenatal care, the number of prenatal visits is compared with the expected number of visits for the period between when care began and delivery date where the expected number of visits if based on the American College of Obstetricians and Gynecologists recommendations. The ratio of observed to expected visits is calculated and groups into the following four categories: inadequate prenatal care (fewer visits than the expected number of prenatal care visits), adequate-plus prenatal care (possibly indicating maternal health problems during pregnancy), intermediate, and adequate care. Other risk factors such as pregnancy loss (i.e. coded 1 if the total number of births is greater than the total number of live births and 0 if they are equal), plural birth (i.e. nonsingleton birth), maternal smoking (i.e. tobacco use during

pregnancy), and a categorical variable for maternal weight gain during pregnancy are also included in the model.

Table 3 shows the distribution of risk factors as they vary by maternal education across subpopulations. The distribution of these risk factors shows that the percentage of women who are unmarried, smoke during pregnancy, receive inadequate prenatal care, receive adequate-plus prenatal care, have an inadequate weight gain during pregnancy (<15 or 40+), and who have high parity decrease as maternal education increases. Although this pattern is consistent for all racial/ethnic and nativity subgroups, a steeper education gradient is observed for U.S.-born non-Hispanic whites who experience the largest declines. For example, the steepest gradient is observed in smoking where 41.9 % of U.S.-born non-Hispanic white women with <12 years of schooling smoke compared to 1.8% of their highly educated counterparts (16+). The education gradient for high parity, inadequate prenatal care, weight gain, and unmarried exhibited for non-Hispanic whites is steeper than the gradient of the other groups. No education gradient is observed for plurality intermediate prenatal care, maternal morbidity, labor complications, and previous pregnancy loss. A positive association between education and adequate-plus prenatal care is exhibited by all groups. This might not be indicative of highly educated women having riskier pregnancies, but might reflect instead that educated women are more likely to get regular prenatal care during their pregnancies. Thus, they are more likely to identify whether there is a problem with their pregnancy in which case highly educated women are more likely to increase their number of prenatal care visits than are their less educated counterparts. Furthermore, a comparison of each racial/ethnic subgroup relative to U.S.-born non-Hispanic at each level of education reveals the existence of significant differences at low levels of maternal education (i.e. <12 years) with a more homogenous distribution characterizing the highly educated groups. For

instance, when looking at women with <12 years of education, 42% of non-Hispanic white women smoke whereas only 6-10% and 0.5-0.8% of their U.S.-born Hispanics (Mexican and Other Hispanic) and foreign-born Hispanics (Mexican and Other Hispanic) do. A similar racial gap among the less educated is observed for inadequate weight gain (40+).

[Insert Table 3 about here]

2.2.Multivariate Adjustment

We fit a multivariate model which allows for the effects of the different risk factors to vary across subgroups by maternal education. This allows us to obtain the maternal education-specific infant mortality rates (IMRs) that would characterize each subgroup if all the risk factors were eliminated. Although we are trying to adjust for risk factors instead of interpreting them, we must also mention whether they behave as is expected based on theory and, most importantly, how important these risk factors are in explaining the group-specific education gradient and the racial gap that was observed at different education levels. When testing for the main effects of the different risk factors on infant mortality, our results showed that smoking during pregnancy, inadequacy of prenatal care, and inadequate weight gain had the largest marginal effect on the mortality rates with the results being consistent across all subpopulations. Having inadequate prenatal care had a more detrimental effect on infant mortality than did having adequate-plus prenatal care. Likewise, when looking at weight gain, gaining less than 15 pounds or more than 40 increased the likelihood of dying in the first year of life. Being unmarried, giving birth at ages 18-20, having a plural birth, the presence of maternal morbidity, the presence of labor

complications, and having had a previous pregnancy loss were all found to increase the odds of infant mortality.

In order to carry out the analysis, we specify a general multivariate logistic model which compares each subgroup against U.S.-born non-Hispanic whites which represent our reference group. We use the odds ratios and their standard errors to obtain the predicted probabilities of dying for the i^{th} infant in the four maternal educational categories under consideration: less than 12 years, 12 years, 13-15 years, and 16 or more years of education for the different racial, ethnic, and nativity groups. Since we allow for the effects of the risk factors to vary across subgroups, our logit model is specified as follows:

$$\textbf{logit}\,(p_i/1-p_i)=a_{ij}R_{ij}M_{i1}+\ldots+a_{4j}R_{ij}M_{i4}+\sum b_{1jk}R_{ij}X_{ik}M_{i1}+\ldots+b_{4jk}R_{ij}X_{ik}M_{i1}$$

where we have that $p_i=Pr(d_i=1)$ where $d_i=1$ denotes infant death and $d_i=1$ denotes infant survival. R_j denotes the different maternal race/ethnicity/nativity categories where $j \in$ {U.S.-born non-Hispanic whites, U.S.-born Mexicans, Foreign-born Mexicans, U.S.-born Puerto Ricans, Foreign-born Puerto Ricans, U.S.-born Other Hispanics, Foreign-born Other Hispanics, and U.S.-born non-Hispanic blacks}, X_k denotes the different covariates for risk factors, and M_1- M_4 denote the four maternal educational categories under consideration. We run the models in two different ways. First, we run the model for two subgroups at a time where each of the racial/ethnic subpopulations is compared with U.S.-born non-Hispanic whites (reference group). Second, we evaluate the model for all the subgroups combined with U.S.-born non-Hispanic whites as a comparison group to check for consistency. We present the results of the analysis excluding observations that had missing values on maternal education, race/ethnicity/nativity, or any of the covariates. Similar results are obtained when estimating the models including

dummies for any missing data. We end up with a sample size of 24.6 millions births and 134,876 deaths which gives us estimates with high statistical precision. The estimation of this model provides us with risk-adjusted maternal education-specific infant mortality rates and rate ratios for each group relative to U.S.-born non-Hispanic whites. The risk adjusted maternal education-specific IMRs and the rate ratios for each subgroup relative to U.S.-born non-Hispanic whites are presented in Table 4.

2.2.1. Maternal Education Gradient for Predicted Infant Mortality

Model 1 of Table 4 is our baseline model and it only controls for maternal education. Hence, the rates given by this model are equivalent to the observed maternal education-specific infant mortality rates and rate ratios that were displayed for each racial/ethnic and nativity subgroup in Table 1. These are the unadjusted IMRs since we do not control for any risk factors. Panel B displays the adjusted maternal education-specific infant mortality rates (IMRs) that result from adjusting for the different sociodemographic, health, and behavioral characteristics that were previously described. As mentioned previously, each of those risk factors was interacted with maternal education and race/ethnicity and nativity status to allow for the effect of risk factor to vary across subpopulations. We first look at the adjusted infant mortality rates (IMRs) for each subpopulation to determine how the mortality levels and the maternal education gradient changed after adjusting for the risk factors. Second, we look at the rate ratios to determine whether the survival advantage that was exhibited by infants born to low educated Hispanic women (Mexican and Other Hispanic) relative to their U.S.-born non-Hispanic white counterparts still persists after adjusting for the different risk factors.

Model 2 (full model) in Table 4 gives the predicted maternal education-specific infant mortality rates after adjusting for the different sociodemographic, health, and behavioral risk factors. The predicted infant mortality rates are 15-36% lower for U.S.-born non-Hispanic whites, 8-26 % and 12-32% lower for U.S.-born Mexican and Other Hispanic women respectively, 18-38% lower for foreign-born Hispanics, 20-27% for Puerto Ricans, and 16-33% lower for U.S.-born non-Hispanic blacks after adjusting for risk factors. In general, women with <12 years of education exhibit the largest downward adjustment with the degree of adjustment ranging from 23-36%. Among the least educated group, U.S.-born non-Hispanic white women experience the largest decline in their IMRs which indicates that non-Hispanic white women with <12 years of schooling have an unfavorable distribution of risk factors relative to the rest of the population. Among women with 12 years of education, the predicted adjusted rates are 13-29% lower after adjusting for risk factors with the largest reduction experienced by Puerto Ricans, Other Hispanics, and U.S.-born non-Hispanic blacks. A different pattern emerges among the highly educated women. A different trend was observed for highly educated (16+) U.S.-born non-Hispanic white and Other Hispanic women (U.S. and foreign-born) who saw an increase in their mortality rates after adjusting for the different risk factors which signals that these groups had a better risk profile relative to the rest of the population.

Panels A and B of Figure 2 provide a graphic representation of the predicted maternal education-specific rates (conditional on risk factors) for each of the subgroups. A significant flattening of the maternal education gradient occurs for all groups with the exception of foreign-born Mexicans and foreign-born Other Hispanics who exhibit a flat gradient similar to the one depicted for them when we looked at the observed (unadjusted) IMRs. Although less educated women display higher IMRs relative to their highly educated counterparts, the educational

disparity narrows down after adjusting for risk factors with U.S.-born non-Hispanic whites experiencing the largest reduction of the gap. Non-Hispanic whites with <12 years of education have predicted mortality rates that are 1.3 times higher (3 times higher under unadjusted IMRs) relative to women with 16+ years of schooling In absolute terms, this represents 1.6 more deaths per 1,000 live births relative to their highly educated counterparts which is considerably smaller when compared to the education disparity of 6.2 more deaths per 1,000 live births that was revealed by the observed IMRs (unadjusted). Similar patterns were observed for U.S.-born Mexican, U.S.-born Other Hispanic, Puerto Rican, and U.S.-born non-Hispanic black women. The adjusted IMRs of women with <12 years of education were 1.1-1.6 times higher relative to their more educated counterparts (2 times higher with observed IMRs). More specifically, less educated U.S.-Mexican, U.S.-Other Hispanic, and U.S.-non Hispanic black women have 1.9, 1.1, and 1.2 more deaths vis-à-vis women with 16+ years of education. Nevertheless, although an educational inequality is still apparent, it represents a substantial reduction relative to the disparity of 3.3, 4.3, and 4.7 more deaths per 1,000 live births which was observed before adjusting for risk factors. Lastly, no significant change was observed for foreign-born Mexican and Other Hispanic women who continued to exhibit a flat slope suggesting the existence of a weak relationship between education and infant mortality for these two subgroups.

In summary, Table 4 and Figure 2 show the within-group educational disparities in infant mortality declined substantially after adjusting for maternal risk factors. Even though a maternal education in infant mortality still exists, the magnitude is smaller relative to the gradient that was revealed by the unobserved IMRs. This suggests that the distribution of risk factors used in the analysis is largely responsible for the educational inequality in infant mortality observed for the different subpopulations.

Panels A and B of Figure 2 display the maternal education gradient for the adjusted IMRs graphically. As can be seen, the educational gradient is flatter after adjusting for risk factors. This suggests that the difference in the distribution of risk factors (e.g. unfavorable risk profile of women with <12 years of education) was largely responsible for the large within-group education disparity displayed by the unadjusted IMRs. Although the educational gradient is not as steep as in the baseline scenario, differences in IMRs by maternal education are still evident. Moreover, the graphic depiction of the predicted IMRs in Figure 2 illustrates the existence of heterogeneity in the maternal education gradient of infant mortality. U.S.-born non-Hispanic whites and U.S.-born Mexicans have the steepest slope indicating a stronger association between maternal education and infant mortality for these subgroups. An "education paradox" is displayed by foreign-born Mexican and foreign-born Other Hispanic women. First, the IMRs at low levels of education for women from these two subgroups are lower than those of highly educated non-Hispanic white women. Second, increasing maternal education has little to no effect on the mortality rates of these subgroups. The existence of variability in the education gradient after adjusting for risk factors yields additional support for our first hypothesis.

2.2.2. Predicted Infant Mortality Rates and the Hispanic Paradox

The previous section addressed the change in the maternal education gradient that resulted from adjusting for different risk factors. As was discussed, heterogeneity in the maternal education of infant mortality was still evident, although to a lesser extent, after controlling for risk factors. The following analysis will now look at whether the "Hispanic paradox" of infant mortality observed in the baseline model (unadjusted IMRs) still exists after controlling for risk factors.

Model 2 of Table 4 shows the rate ratios for each racial/ethnic subgroup relative to U.S.-born non-Hispanic whites for each level of maternal education after adjusting for risk factors. A Hispanic paradox for infant mortality is still evident for Mexicana and Other Hispanic women after adjusting for risk factors. Infants born to U.S.-born Mexican and Other Hispanic women have a 4-29% and 9-18% lower risk of dying relative o infants born to U.S.-born non-Hispanic white women. Likewise, infants born to foreign-born Mexican and Other Hispanic women have 35-41% and 8-48% lower risk of dying respectively than their non-Hispanic white counterparts. Although Hispanics exhibit a survival advantage across the entire maternal education distribution, the advantage is greatest among women with <12 years of education where U.S.-born Hispanics (Mexicans and Other Hispanics) and foreign-born Hispanics (Mexicans and Other Hispanics) have a 17% and 40% lower risk of dying than infants born to non-Hispanic white women with a comparable level of education. A nativity differential is evident when looking at the magnitude of the survival advantage of U.S. and foreign-born Hispanics. The survival advantage of the foreign-born Mexicans and Other Hispanics is greater vis-à-vis their U.S.-born counterparts at every level of maternal education with the exception of the16+ category where the predicted IMRs of the U.S.-born group are on par or lower. Furthermore, it should be noted that the survival advantage observed for Hispanic women with 16+years of

education emerged after adjusting for risk factors. Infants born to Puerto Rican and U.S.-born non-Hispanic black women have a higher risk of dying at every level of maternal education with the disadvantage being larger among the highly educated group for non-Hispanics blacks and nonexistent among foreign-born Puerto Rican women with 16+ years of education.

Panel A and Panel B of Figure 2 illustrate the existence of the Hispanic paradox that after controlling for risk factors. As can be observed, infants born to Mexican and Other Hispanic women exhibit a survival advantage relative to their non-Hispanic white counterparts at every level of maternal education. The largest racial gap is visible among women with <12 years of education. For example, U.S.-born Mexican and Other Hispanic women have 1.1 more deaths per 1,000 live births relative to low educated non-Hispanic whites. This gap is larger for low educated foreign-born Mexican and Other Hispanic women who have 2.6 and 3.1 more deaths per 1,000 live births relative to whites. Adjusting for risk factors resulted in a reduction of the racial gap of approximately 40-40% for foreign-born Mexicans and Other Hispanics and a 31-39% decline in the gap of the U.S.-born subgroups. This suggests that the risk factors and their corresponding distributions at low levels of education are partly responsible for the survival advantage of infants born to low educated Hispanic women relative to their non-Hispanic white counterparts. In this case, U.S.-born non-Hispanic white women appear to have a less favorable risk profile relative to Hispanic women with the same educational attainment. The survival advantage narrows down as education increases with the racial gap being the smallest among women with 16+ years of education. In general, the racial gap seems to be driven by the heterogeneity in the maternal education of infant mortality with the variability in the gradient across groups being more pronounced among the less educated group.

In summary, the results presented in Table 4 and Figure 2 show that a Hispanic paradox for infant mortality is still evident after adjusting for risk factors. Moreover, this survival advantage spans the entire education distribution for both Mexicans and Other Hispanics (U.S. and foreign-born). The Hispanic paradox appears to be driven by the heterogeneity in the maternal education gradient across racial/ethnic subgroups with the survival advantage being largest among women with <12 and 12 years of education. It is at these levels of maternal education where the variability in the education gradient is more noticeable with non-Hispanic whites having a steeper slope and Hispanics, particularly the foreign-born, having a weaker association between maternal education and infant mortality as depicted by the flatter slope of their graph. Altogether, this supports our second hypothesis that the heterogeneity in the gradient is the main driver of the Hispanic paradox of infant mortality.

[Insert Table 4 about here]

[Insert Figure 2 about here]

IV. Discussion

Our findings are discussed around the main hypotheses that were established in our paper. First, our results support the existence of a maternal education gradient for infant mortality for all racial/ethnic/nativity subgroups with a steeper gradient characterizing U.S.-born non-Hispanics white women. Maternal education has a protective effect on birth outcomes with women with 16 or more years of education having the lowest IMRs among all education levels (unadjusted mortality rates). Our estimates from the adjusted models show that the maternal education gradient for infant mortality is largely explained by the observable risk factors and the distribution of risk factors in the population. This is consistent with the literature suggesting that the main mechanisms through which maternal education affects birth outcomes are smoking, prenatal care, weight gain, maternal health, and sociodemographic factors. Controlling for these risk factors resulted in a significant reduction in the IMRs of women with less than 12 years of education and in an increase in the IMRs of highly educated U.S.-born non-Hispanic white women and Other Hispanic women with the former group experiencing the largest decline and increase respectively. This indicates that the less educated U.S.-born non-Hispanic white women have a very unfavorable distribution of risk factors relative to the rest of the population (below average) whereas their highly educated counterparts have a very favorable distribution of risk factors compared to the population average.

Secondly, we wanted to determine whether the maternal education gradient for infant mortality varied across subgroups. Our unadjusted models exhibited significant variation across subgroups with U.S.-born non-Hispanic white women and U.S.-born Hispanics having a steeper gradient which reflects a stronger association between maternal education and infant mortality for these

groups. A flat gradient is observed for foreign-born Hispanics which represents an "educational paradox" for this population since low levels of education are characterized by low IMRs (comparable to those of highly educated U.S.-born non-Hispanic whites) and the reductions in mortality rates from additional maternal education are of a smaller magnitude relative to the other subgroups. This is consistent with research suggesting the existence of a flat education gradient for adult health outcomes of foreign-born Hispanics, but contrary to the weak or nonexistent gradient found for U.S.-born Hispanic adults. After adjusting for risk factors, lower IMRs and flatter education gradients are observed for all subgroups. These results demonstrate that the observable risk factors explain part of the association between maternal education and infant mortality. In addition, the predicted IMRs from the adjusted models exhibit substantial variation in the protective effect of maternal education on birth outcomes. U.S.-born non-Hispanic white women exhibit the steepest education gradient with additional education resulting in a statistically significant reduction in IMRs (except for college educated where there is an increase). U.S.-born Puerto Ricans have a similar pattern with each additional education level resulting in mortality rates that are statistically significantly lower than the rates of the previous educational category. When looking at U.S.-born Mexicans, no statistically significant difference in rates is observed between women with 12 years of education (relative to less than 12), 13-15 years of education (relative to 12), and 13-15 years (relative to less than 12). Thus, higher maternal education does not seem to benefit U.S.-born Mexicans as it does non-Hispanic white women. A similar pattern is observed for U.S.-born Other Hispanics. Foreign-born Mexicans and Other Hispanic women exhibit a similar pattern with the educational gradient being almost nonexistent for both groups. There is no significant difference between the different education-specific IMRs for foreign-born Mexicans and a statistically difference for Other Hispanics is

observed only when comparing the rates of the least educated women with those of women with 16 or more years of education. These results support the variability of the maternal education gradient for infant mortality which indicates that the protective effect of higher levels of education and the penalty of a low education varies across subgroups. Additionally, the lower IMRs and flatter gradient that were observed from the adjusted models support the importance of the risk factors and their distribution in explaining the maternal education gradient of the different groups. Finally, the predicted IMRs from the adjusted models show that all Hispanics have a very weak to nonexistent gradient. Although the predicted IMRs are lower for the foreign-born, all Hispanics (except Puerto Ricans) exhibit an **"education paradox"** which was only observed for the immigrant group in the adjusted models. That is, women with low levels of education have low IMRs and increasing maternal education does not result in significant reductions in the mortality rates. Since the observable risk factors did not explain the "education paradox", we should look into health selectivity, norms, culture, social support, and the SES gradient in the sending countries of migrants to determine what factors might explain this paradox.

Lastly, we looked at the racial gap in infant mortality at different ends of the education distribution (each group relative to U.S.-born non-Hispanic whites). Our findings from the unadjusted model showed that infants born to low educated U.S.-born Mexican and Other Hispanic women had a survival advantage relative to their U.S.-born non Hispanic counterparts, while foreign-born Mexican and Other Hispanic women had substantially lower IMRs across the entire education distribution except for the 16 or more years of education category where the IMRs were on par with those of U.S.-born non-Hispanic whites. These results illustrated the existence of a **"Hispanic paradox"** especially at the low end of the education distribution. As

has been established in the literature, the "Hispanic paradox" refers to the fact that Hispanics have mortality rates and health outcomes that are comparable (or better) than those of non-Hispanic whites and better than non-Hispanic blacks even though they are socioeconomically disadvantaged relative to non-Hispanic whites, but similar to blacks (Markides and Coreil 1986). In our analysis, we compare Hispanics to U.S.-born non-Hispanic whites at each education level. Even though we compare infants born to women from both groups who have the same level of education (e.g. less than 12 years), we cannot argue that Hispanics are not socioeconomically disadvantage vis-à-vis non-Hispanic whites because they have the same level of maternal education. Data from the Bureau of Labor Statistics (BLS) shows that non-Hispanic white women have higher wages than Hispanics women with the same level of education. Non-Hispanic white women are more likely to work in managerial, technical, sales, among other positions, whereas Hispanic women tend to work in low-wage occupations. Hispanic women are more likely to be uninsured and face multiple barriers to health care than U.S.-born non-Hispanic white women with their same level of education. This is even more predominant among foreign-born Hispanic women. Thus, a comparison of U.S.-born non-Hispanic white women with Hispanic women in the same educational category will result in the former having a more socioeconomically advantaged profile (better job, higher income, less barriers to health care) than their equally educated Hispanic counterparts. We can then say that there is a "Hispanic paradox" for infant mortality at the low levels of maternal education (less than 12 and 12 years) for infants born to U.S.-born Mexican and Other Hispanic women and at all levels of the education distribution for infants born to foreign-born Mexican and Other Hispanic women. The existence of a "Hispanic paradox" among the less educated groups is particularly puzzling since the survival advantage infants born to Hispanic women exhibit relative to their U.S.-born non-

Hispanic white counterparts is significantly larger at the low end of the distribution. This survival advantage exists despite Hispanic women having a more socioeconomically disadvantaged profile. The extremely high IMRs of low educated U.S.-born non-Hispanic white women and the very low IMRs for Hispanics might be partially responsible for this racial gap. Adjusting for the risk factors yielded predicted IMRs for the different groups. The racial gap of Mexicans and Other Hispanics (U.S. and foreign-born) was observed in every maternal education category after controlling for the different risk factors. Second, the unadjusted racial gap found among the less educated women was reduced by 42-53% for U.S.-born Mexicans and Other Hispanics, and by 31-39% for the foreign-born groups. These findings suggest that a large part of the survival advantage of Hispanics was explained by risk factors; however, a significant percent of the gap remained unexplained after controlling for all observables. The persistence of the gap after adjusting for risk factors combined and the fact that the adjusted gap is not specific to the less educated groups lead us to believe that there is something specific about the Hispanic population which is unrelated to education and to the risk factors that can account for the survival advantage of infants born to Mexican and Other Hispanic women. This is especially the case for foreign-born Hispanics. Health selectivity, a weak education gradient in sending countries, norms/culture, and social support should be considered as factors responsible for the unexplained part of the racial gap.

This study provided a detailed comparison of maternal education-specific infant mortality rates across subpopulations with U.S.-born non-Hispanics whites as our reference group. Our results showed the existence of a maternal education gradient which is steeper for U.S.-born non-Hispanic white women and flatter for foreign-born Hispanics. In addition, the difference in the educational gradient leads to the existence of a Hispanic paradox which is more pronounced for

foreign-born Hispanics and among the less educated. Future research will focus on determining which factors explain the "educational paradox" observed for Hispanics and the percentage survival advantage of Hispanics relative to non-Hispanic whites which was not explained by the observable risk factors. Health selectivity, culture, social support, and the gradient in the sending countries are some of the factors that must be explored as potential explanations.

Table 1. Infant mortality rates by maternal education, race/ethnicity, and nativity status: 2000-2008 linked births

Maternal Education	US-NHW		US-MEX		FB-MEX		US-PR		FB-PR		US-OH		FB-OH		US-NHB		Overall	
	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%
Less than high school	9.9	11.6	7.1	32.2	4.9	64.9	9.7	30.1	10.0	30.9	7.9	24.3	4.9	38.5	15.2	24.8	7.1	26.5
High School	6.7	28.6	5.9	38.0	4.7	23.7	8.3	34.9	7.7	31.4	6.0	32.8	4.7	30.4	14.0	38.9	6.3	22.2
Some College	4.9	25.6	5.1	21.0	4.2	7.3	6.4	24.7	6.4	22.5	5.1	26.2	4.1	16.4	12.3	25.0	4.9	29.0
College +	3.7	34.2	3.8	8.8	3.6	4.1	4.5	10.3	5.6	15.2	3.6	16.7	3.7	14.7	10.5	11.3	3.7	22.4
Total	5.6	100.0	6.0	100.0	4.8	100.0	7.9	100.0	7.9	100.0	5.9	100.0	4.7	100.0	13.7	100.0	5.5	100.0
Deaths		97,722		11,517		16,274		2,652		1,240		3,393		5,468		56,362		134,876
Births		17,247,068		1,901,111		3,287,587		332,392		154,397		564,766		1,145,839		4,113,552		24,633,160

Note: The year 2006 is excluded due to incomplete data on place of birth of the mother.

Note: The overall infant mortality rates on the right column of Table 1 are calculated taking into account only the 8 subpopulations in our analysis.

Table 2. Rate ratios relative to U.S.-born non-Hispanic whites by maternal education, race, and nativity: All births 2000-2008

Maternal Education	US-MEX	FB-MEX	US-PR	FB-PR	US-OH	FB-OH	US-NHB
All Births							
Less than HS	0.72 *	0.50 *	0.99 *	1.01 *	0.80 *	0.50 *	1.54 *
HS	0.88 *	0.70 *	1.24 *	1.14 *	0.89 *	0.70 *	2.08 *
Some college	1.04 *	0.86 *	1.31 *	1.30 *	1.04 *	0.84 *	2.51 *
College +	1.04 *	0.97	1.21 *	1.51 *	0.99 *	1.01	2.85 *
Overall	1.07 *	0.86 *	1.41 *	1.41 *	1.05 *	0.84 *	2.45 *

Note: US-MEX=U.S.-Born Mexicans; FB-MEX=Foreign-born Mexicans; US-PR=U.S.-Born Puerto Ricans;

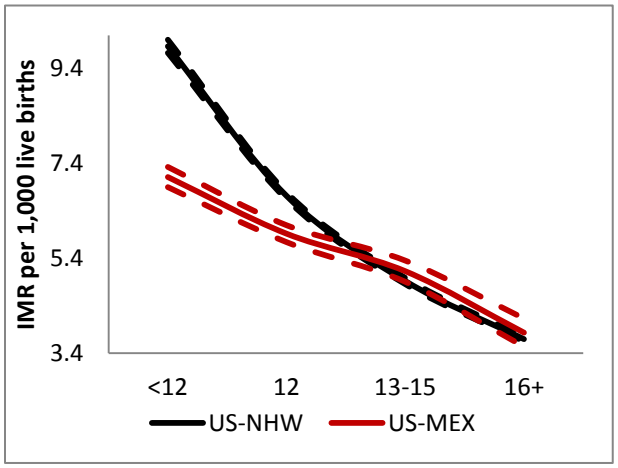
FB-PR=Foreign-Born Puerto Ricans; US-OH=U.S.-Born Other Hispanics; FB-OH=Foreign-Born Other Hispanics

*Significantly different from 1 at the 95% significance level (2-tail test)

Figure 1. Infant mortality rate (per 1,000 live births) by race, ethnicity, and nativity status. Dashed lines represent 95% confidence intervals for each group

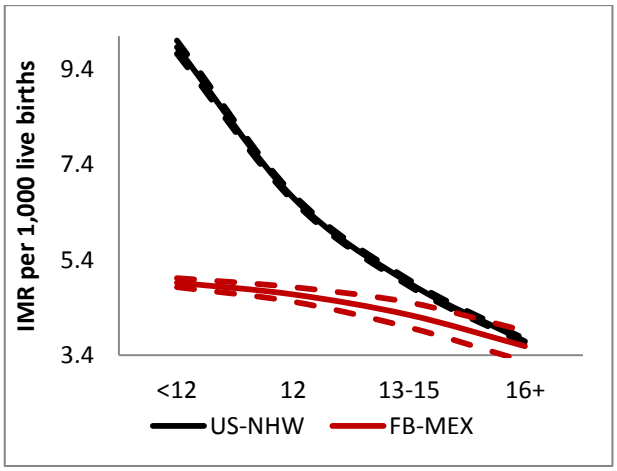
Panel A

US-MEX

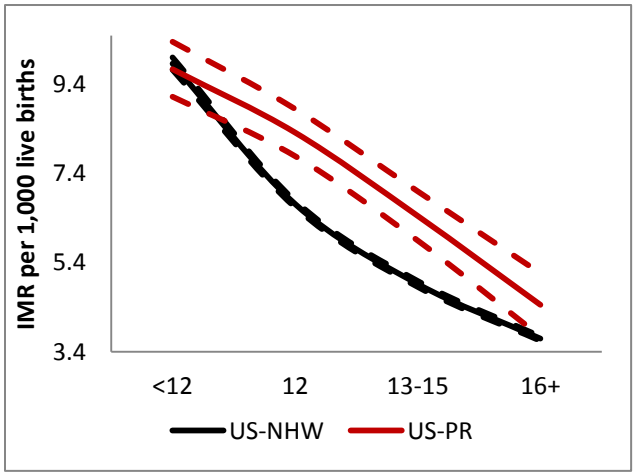


Panel B

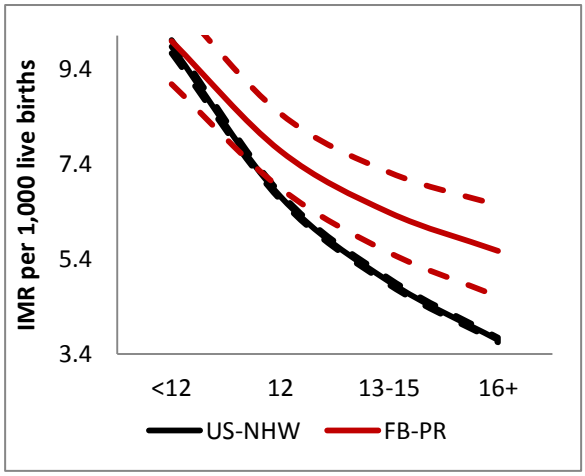
FB-MEX



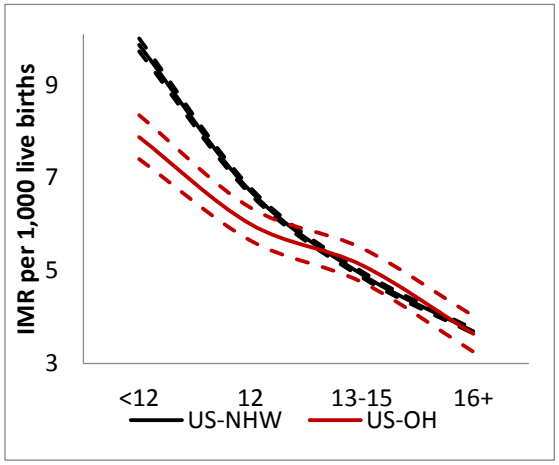
US-PR



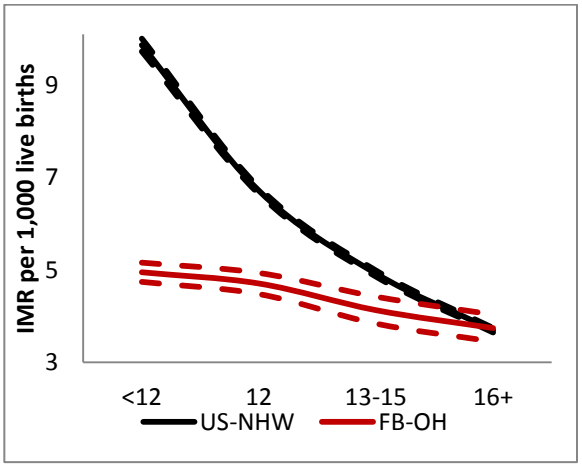
FB-PR



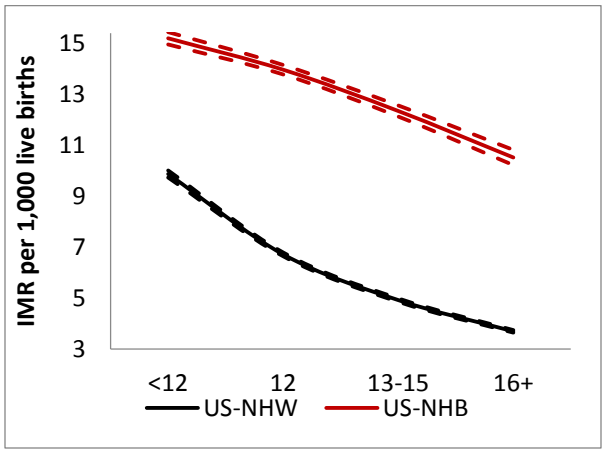
US-OH



FB-OH



US-NHB



Note: IMR per 1,000 live births. Solid lines indicate the maternal education-specific IMR of each subgroup and the dashed lines represent the corresponding 95% point-wise confidence interval

Table 3 Distribution of risk factors by maternal education, race/ethnicity, and nativity[a]

	Maternal Education (%)				
Risk Factors	**<12**	**12**	**13-15**	**16 +**	**Total**
Unmarried					
US-NHW	62.7	38.2	22.2	4.4	25.4
US-MEX	68.5	50.2	36.8	12.8	50.1
FB-MEX	45.5	40.7	31.3	17.8	42.3
US-PR	85.8	66.9	49.7	21.0	63.7
FB-PR	79.6	60.5	41.7	15.4	55.5
US-OH	74.4	55.1	40.3	12.9	49.0
FB-OH	61.5	47.2	34.6	17.8	46.5
US-NHB	92.4	79.8	64.3	32.2	73.7
Total	62.9	48.2	31.3	7.2	37.8
Plurality					
US-NHW	2.2	3.0	3.5	5.0	3.7
US-MEX	1.9	2.2	2.6	3.6	2.3
FB-MEX	1.8	1.9	2.2	2.8	1.9
US-PR	2.4	3.0	3.4	4.4	3.1
FB-PR	2.4	2.5	3.2	4.1	2.9
US-OH	2.0	2.4	2.9	4.3	2.8
FB-OH	1.9	2.3	2.7	3.5	2.4
US-NHB	3.0	3.6	3.9	4.3	3.6
Total	2.2	2.9	3.5	4.8	3.3
Smoking					
US-NHW	41.9	23.7	12.0	1.8	15.4
US-MEX	6.5	4.2	2.8	0.8	4.4
FB-MEX	0.5	0.5	0.7	0.5	0.5
US-PR	17.0	10.2	5.8	1.7	10.4
FB-PR	13.0	6.2	3.5	1.0	7.1
US-OH	10.7	6.8	4.1	1.0	6.2
FB-OH	0.8	1.0	1.0	0.6	0.9
US-NHB	17.0	9.7	5.9	1.5	9.8
Total	19.1	16.6	9.7	1.7	12.1
Previous Pregnancy Loss					
US-NHW	23.6	25.6	27.4	24.2	25.3
US-MEX	16.4	19.0	22.3	21.3	19.1
FB-MEX	14.9	15.0	17.0	16.7	15.1
US-PR	30.6	32.4	36.3	32.3	32.8
FB-PR	26.5	26.0	27.7	23.6	26.2
US-OH	19.7	23.1	27.2	25.0	23.7
FB-OH	17.6	22.1	24.9	23.0	20.9
US-NHB	21.9	27.5	33.6	33.5	28.3
Total	19.4	24.3	27.7	24.6	23.4

	Maternal Education (%)				
Risk Factors	**<12**	**12**	**13-15**	**16 +**	**Total**
Maternal Morbidity					
US-NHW	6.7	8.8	9.8	8.0	8.6
US-MEX	5.4	6.5	7.7	7.8	6.5
FB-MEX	6.3	6.1	6.4	6.2	6.3
US-PR	6.3	8.0	9.2	9.1	7.9
FB-PR	7.3	9.0	10.2	9.5	8.8
US-OH	6.1	7.5	8.0	7.3	7.3
FB-OH	6.5	6.8	6.9	6.7	6.7
US-NHB	7.8	8.4	10.4	8.2	9.0
Total	6.5	8.2	9.3	7.9	8.1
Labor Complications					
US-NHW	10.6	10.4	10.7	11.4	10.8
US-MEX	9.4	9.0	9.5	10.1	9.3
FB-MEX	11.7	10.8	10.2	9.9	11.3
US-PR	11.3	10.8	10.9	11.7	11.1
FB-PR	11.7	10.9	10.3	11.1	11.1
US-OH	10.8	10.2	10.1	10.3	10.3
FB-OH	12.7	10.9	10.7	10.6	11.5
US-NHB	11.9	11.3	11.4	11.4	11.5
Total	11.2	10.5	10.7	11.3	10.9
Inadequate Prenatal Care					
US-NHW	24.9	13.7	9.9	6.0	11.5
US-MEX	28.7	18.4	13.9	7.9	19.9
FB-MEX	27.1	22.0	19.2	17.8	25.3
US-PR	30.4	21.4	15.9	9.7	21.7
FB-PR	29.2	20.4	15.0	9.1	20.5
US-OH	32.2	21.3	15.8	8.3	20.6
FB-OH	29.3	19.7	15.8	12.0	22.0
US-NHB	35.6	25.6	19.1	11.1	25.1
Total	28.3	17.6	12.3	6.8	16.4
Intermediate Prenatal Care					
US-NHW	18.9	19.5	19.4	20.4	19.7
US-MEX	18.7	19.1	19.3	20.0	19.1
FB-MEX	20.9	21.1	20.7	20.8	20.9
US-PR	25.5	24.9	25.3	26.7	25.3
FB-PR	23.8	23.9	23.9	23.8	23.8
US-OH	20.8	20.7	21.6	21.2	21.0
FB-OH	22.0	24.1	23.5	23.4	23.0
US-NHB	19.4	20.1	19.6	20.5	19.8
Total	20.0	20.2	19.8	20.5	20.1
Adequate Plus Prenatal Care					
US-NHW	17.4	19.3	20.2	19.7	19.5
US-MEX	15.9	18.6	19.9	21.1	18.3
FB-MEX	15.0	16.1	17.6	17.4	15.5
US-PR	12.4	14.7	16.1	16.7	14.5
FB-PR	13.6	15.3	16.9	18.3	15.6
US-OH	13.0	16.8	18.0	20.7	16.8
FB-OH	13.4	14.8	16.6	18.0	14.9
US-NHB	14.6	17.3	20.0	21.4	17.7
Total	15.6	18.3	19.9	19.7	18.4

	Maternal Education (%)				
Risk Factors	**Less than high school**	**High school**	**Some college**	**College +**	**Total**
First Birth					
US-NHW	43.2	39.6	39.2	43.7	41.3
US-MEX	41.5	37.6	38.6	44.5	39.7
FB-MEX	28.7	36.0	38.8	43.6	31.8
US-PR	43.5	39.4	39.0	45.5	41.2
FB-PR	33.2	33.8	36.3	44.0	35.7
US-OH	47.1	41.5	42.2	46.7	43.9
FB-OH	30.5	38.9	43.3	47.8	37.7
US-NHB	43.0	35.0	35.7	43.4	38.1
Total	37.4	38.0	38.9	43.4	39.5
High Parity					
US-NHW	24.1	14.7	11.3	6.2	12.0
US-MEX	30.6	19.4	13.6	6.1	20.6
FB-MEX	25.7	14.7	11.0	6.2	21.3
US-PR	26.4	17.5	12.7	5.7	17.8
FB-PR	33.5	19.7	12.1	5.8	20.2
US-OH	25.7	16.7	11.5	5.1	15.6
FB-OH	24.0	10.9	7.2	4.1	14.3
US-NHB	32.4	24.9	18.1	7.8	23.1
Total	26.7	16.9	12.4	6.2	15.5
Low Parity					
US-NHW	32.7	45.7	49.5	50.1	46.7
US-MEX	27.9	43.0	47.8	49.4	39.7
FB-MEX	45.6	49.3	50.2	50.2	47.0
US-PR	30.1	43.1	48.3	48.8	41.0
FB-PR	33.3	46.5	51.6	50.2	44.1
US-OH	27.2	41.8	46.3	48.2	40.5
FB-OH	45.5	50.2	49.5	48.1	48.0
US-NHB	24.6	40.1	46.2	48.8	38.8
Total	35.9	45.1	48.7	50.4	45.0
Weight Gain					
Less than 14 lbs					
US-NHW	11.0	10.7	9.8	5.7	8.8
US-MEX	12.5	12.4	11.8	8.5	12.0
FB-MEX	16.4	12.2	11.7	9.8	14.8
US-PR	12.1	11.0	10.3	7.3	10.8
FB-PR	14.8	12.0	10.4	7.6	11.8
US-OH	12.4	11.6	10.5	6.6	10.7
FB-OH	15.6	9.3	8.0	6.3	10.9
US-NHB	16.2	15.8	14.9	12.2	15.3
Total	13.9	11.9	10.7	6.3	10.6

	Maternal Education (%)				
Risk Factors	**Less than high school**	**High school**	**Some college**	**College +**	**Total**
15-24 Lbs					
US-NHW	19.5	19.3	18.8	17.5	18.6
US-MEX	22.9	22.8	22.1	20.9	22.5
FB-MEX	30.6	27.2	25.8	25.7	29.2
US-PR	22.0	20.9	19.8	18.7	20.7
FB-PR	23.6	21.9	21.0	19.3	21.8
US-OH	22.0	21.3	20.4	18.4	20.8
FB-OH	29.0	23.0	20.9	20.7	24.5
US-NHB	23.6	22.9	21.7	21.2	22.6
Total	24.3	21.0	19.7	18.0	20.7
40+ Lbs					
US-NHW	31.1	29.3	28.4	26.0	28.2
US-MEX	24.9	23.8	24.2	23.4	24.2
FB-MEX	14.1	16.6	19.0	18.0	15.2
US-PR	28.2	28.3	28.5	27.6	28.3
FB-PR	23.8	25.0	26.5	25.8	25.1
US-OH	27.1	26.5	27.0	26.1	26.7
FB-OH	16.2	22.6	25.1	23.3	20.8
US-NHB	24.8	24.7	25.9	26.0	25.2
Total	23.7	26.8	27.4	25.8	26.0

Note:
a.Summary measures are calculated using nonmissing data. Ns include all observations.

US-NHW=U.S.-born non-Hispanic whites, US-MEX= U.S.-born Mexicans, FB-MEX=foreign-born Mexicans, US-PR=U.S.-born Puerto Ricans
FB-PR= foreign-born Puerto Ricans, U.S.-OH= U.S.-born Other Hispanics, FB-OH= foreign-born Other Hispanics, U.S.-NHB= U.S.-born non-Hispanic blacks

b. The maternal morbidity and labor complications measure yields low percentages because each includes only 4 risk factors respectively. We have 16 risk factors for each for the years 2000-2004, but only 4 from 2005 onwards.

For consistency purposes, we used only the ones for which data is available for every year of our period of analysis.

Table 4. Multivariate models adjusting for risk factors: Predicted IMR per 1,000 live births, rate ratios, and percentage reduction in predicted IMR from observed IMR

	NHW	Mexicans								Puerto Ricans								Other Hispanics						NHB		
	U.S.-Born	U.S.-Born			Foreign-Born					U.S.-Born			Foreign-Born					U.S.-Born			Foreign-Born			U.S.-Born		
Maternal Education	IMR	IMR	% Change	RR	IMR	% Change	RR		IMR	% Change	RR		IMR	% Change	RR		IMR	% Change	RR		IMR	% Change	RR		IMR		
Model 1[a]																										
Less than 12	9.9	NA	1	7.1	NA	0.72	*	4.9	NA	0.50	*	9.7	NA	0.99	*	10.0	NA	1.01	*	7.9	NA	0.80	*	4.9	NA	0.50	*	15.2	NA	1.5 *
12 years	6.7	NA	1	5.9	NA	0.88	*	4.7	NA	0.70	*	8.3	NA	1.24	*	7.7	NA	1.14	*	6.0	NA	0.89	*	4.7	NA	0.70	*	14.0	NA	2.1 *
13-15 years	4.9	NA	1	5.1	NA	1.04	*	4.2	NA	0.86	*	6.4	NA	1.31	*	6.4	NA	1.30	*	5.1	NA	1.04	*	4.1	NA	0.84	*	12.3	NA	2.5 *
16 or more	3.7	NA	1	3.8	NA	1.04	*	3.6	NA	0.97		4.5	NA	1.21	*	5.6	NA	1.51	*	3.6	NA	0.99	*	3.7	NA	1.01		10.5	NA	2.8 *
Model 2[b]																										
Less than 12	6.4	35.5	1	5.3	26.1	0.83	*	3.8	23.3	0.59	*	7.4	24.3	1.16	*	7.3	27.0	1.14	*	5.4	31.9	0.84	*	3.3	33.2	0.52	*	10.1	33.3	1.6 *
12 years	5.7	15.1	1	5.1	13.1	0.90	*	3.7	20.4	0.65	*	5.9	28.9	1.04	*	5.9	23.1	1.04	*	4.7	22.2	0.82	*	3.8	18.5	0.67	*	10.1	27.9	1.8 *
13-15 years	4.9	0.1	1	4.7	8.3	0.96	*	3.4	20.0	0.69	*	4.9	23.9	1.00		5.0	21.6	1.02	*	4.5	11.8	0.92	*	3.4	18.0	0.69	*	9.2	25.3	1.9 *
16 or more	4.8	-28.7	1	3.4	11.7	0.71	*	2.8	21.1	0.60	*	NA	NA	NA	NA	4.6	16.7	0.98	*	4.3	-18.4	0.91	*	4.4	-16.4	0.92	*	8.9	15.6	1.9 *

[a] Maternal education only.

[b]Maternal education and maternal risk factors: marital status, parity, plural birth, previous pregnancy loss, labor complications, maternal morbidity, smoking, weight gain during pregnancy, adequate-plus prenatal care, care, and intermediate prenatal care. All risk factors are interacted with the different maternal education categories and the interactions vary by race/ethnicity and nativity status. This allows for the effect of risk factors on infant mortality to vary across groups.

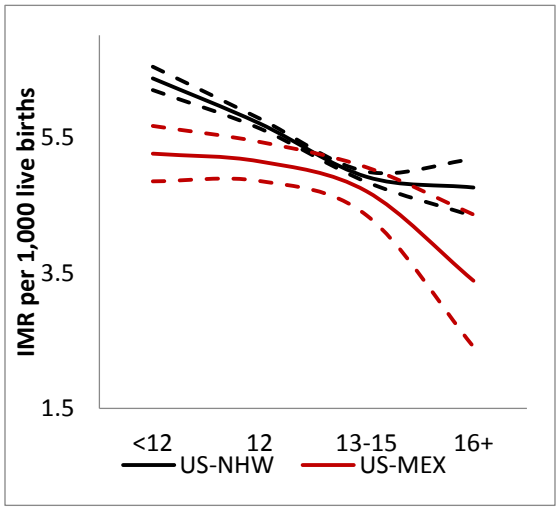
Statistically different from 1.0 ($p<0.1$); * statistically different from 1.0 ($p<0.05$)

Note: Predicted mortality rates for U.S.-born Puerto Ricans with 16+ years of education are still unreliable.

Figure 2. Predicted infant mortality rate (per 1,000 live births) by race, ethnicity, and nativity status. Dashed lines represent 95% confidence intervals for each group

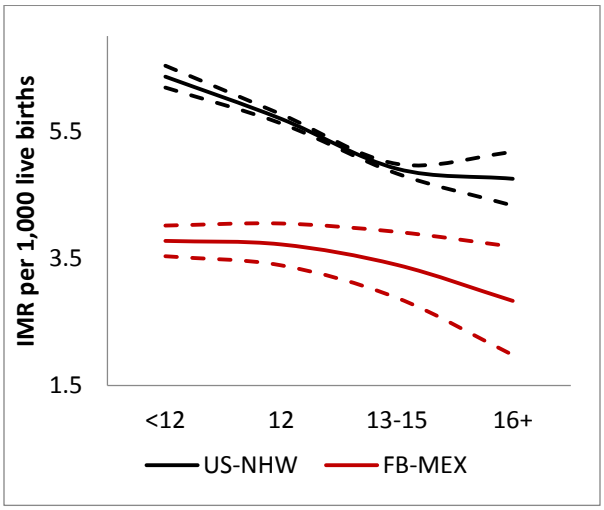
Panel A

US-MEX

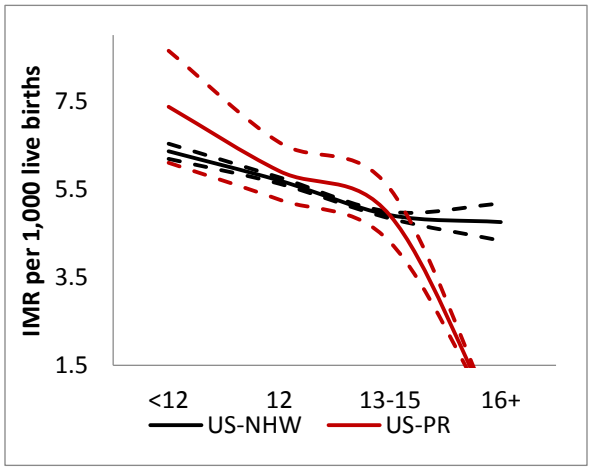


Panel B

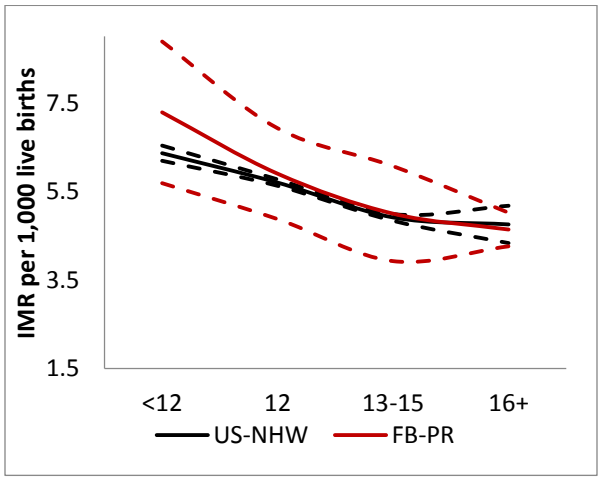
FB-MEX



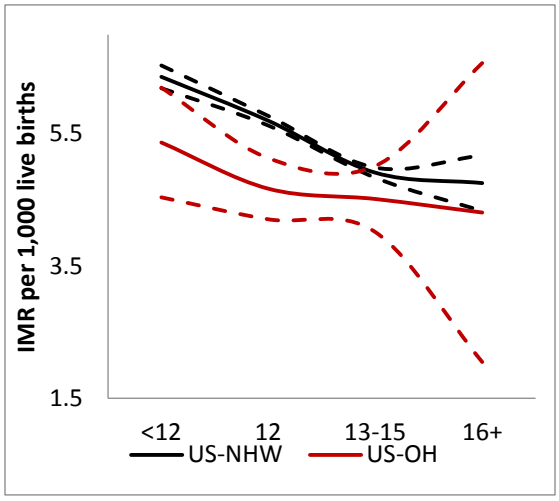
US-PR



FB-PR



US-OH



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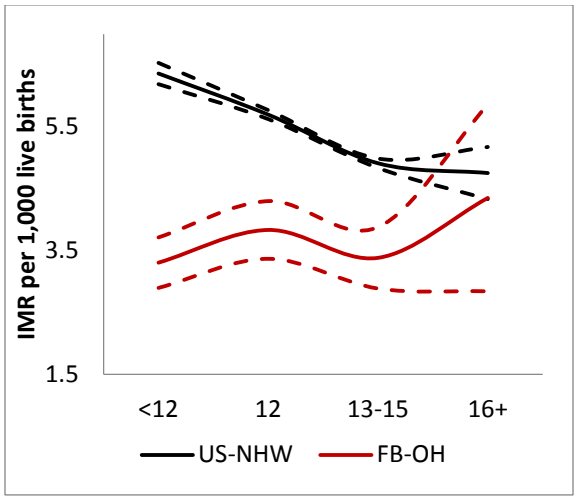
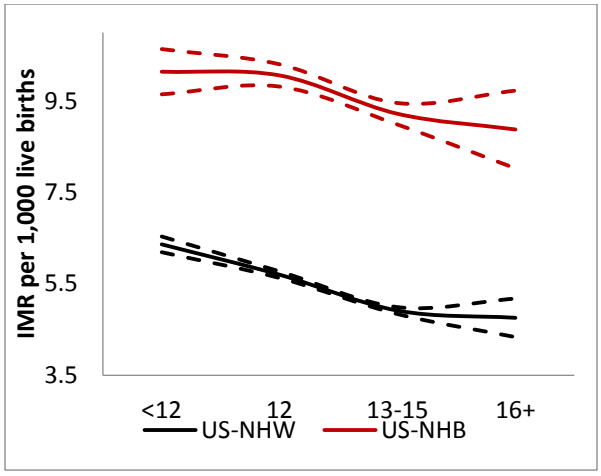


US-NHB



Note:

IMR per 1,000 live births. Solid lines indicate the maternal education-specific IMR of each subgroup and the dashed lines represent the corresponding 95% point-wise confidence interval

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