Paradox Revisited: A Further Investigation of Race/Ethnic Differences in Infant Mortality by Maternal Age

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Abstract

We reexamine the epidemiological paradox of lower overall infant mortality rates in the Mexican-origin population relative to US-born non-Hispanic whites using the 1995-2002 U.S. NCHS linked cohort birth-infant death files. A comparison of infant mortality rates among US-born non-Hispanic white and Mexican-origin mothers by maternal age reveals an infant survival advantage at younger maternal ages when compared to non-Hispanic whites, which is consistent with the Hispanic infant mortality paradox. However, this is accompanied by higher infant mortality at older ages for Mexican-origin women, which is consistent with the weathering framework. These patterns vary by nativity of the mother and do not change when rates are adjusted for risk factors. The relative infant survival disadvantage among Mexican-origin infants born to older mothers may be attributed to differences in the socioeconomic attributes of US-born non-Hispanic white and Mexican-origin women.

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Paradox Revisited: A Further Examination of Race/Ethnic Differences in Infant Mortality by Maternal Age

The epidemiological paradox of more favorable health and mortality outcomes for Hispanics relative to non-Hispanic whites in the United States is the subject of considerable research (Franzini, Ribble, and Keddie 2001; Guendelman 2000; Hummer, Powers, Pullum, Gossman, and Frisbie 2007; Landale, Oropresa, and Gorman 2000; Markides and Coreil 1986; Markides and Eschbach 2005; Palloni and Morenoff 2001; Smith and Bradshaw 2006). The paradox centers on the observation that, whereas the socioeconomic profile of some Hispanic groups with regard to educational attainment, income, and health insurance coverage, closely resembles that of non-Hispanic blacks, this group as a whole consistently experiences lower mortality rates by comparison. Perhaps the most puzzling patterns are found in the Mexican-origin population in the United States, whose mortality rates are similar to non-Hispanic whites—and much lower than those of non-Hispanic blacks—across most of the life course (Elo et al. 2004; Frisbie and Song 2003; Hummer, Benjamins, and Rogers. 2004; Liao et al. 1998; Rogers, Hummer, and Nam 2000; Singh and Siahpush 2001, 2002).

Recent research traces some of the similarity in mortality rates between Mexican-origin and non-Hispanic white persons to the relatively lower mortality in the Mexican-origin immigrant population. On the other hand, the US-born Mexican-origin population experiences moderately higher mortality rates than Non-Hispanic whites, but they experience much lower mortality than Non-Hispanic blacks. Considerable debate exists about the definition of the paradox and its underlying mechanisms. For the elderly Mexican-origin population, lower relative mortality could be a methodological artifact of outmigration, which implies that a portion of the at-risk population returns to Mexico to die and, as such, does not appear in the numerator of the relevant U.S. vital rates. However, in the case of infant mortally, detailed examination of age-specific mortality patterns by race, ethnicity, and nativity reveal lower infant mortality rates among foreign-born mothers when compared to U.S. born women and show that implausible levels of outmigration at the earliest ages of death (i.e., within one week of birth) would be required to equalize Mexican-origin and non-Hispanic white infant mortality rates (Hummer et al. 2007).

Hummer at al. (2007) provide evidence that effectively closes the case on the paradox-as-data-artifact argument in the case of infant mortality in the neonatal period (i.e., within the first month of life). However, questions remain about the epidemiological paradox in infant mortality that cannot be answered by comparing overall rates or comparing age-specific mortality rates. For example, the U-shaped association of maternal age and infant heath is well-known (Geronimus 1986; Mathews and MacDorman 2008), and it is possible that the observed survival advantage of infants born to Mexican-origin mothers is mainly an artifact of that population's relatively younger age structure and earlier average ages of family formation when compared to non-Hispanic whites (Poston and Dan 1996). If the distribution of births is skewed toward childbearing ages where maternal health endowments are most favorable, we would expect this to result in a lower incidence of negative birth outcomes and lower overall infant mortality. In other words, the more favorable age structure of childbearing among Mexican-origin women relative to non-Hispanic whites may outweigh the negative effects of social disadvantage among Mexican-origin women. Thus, it is quite possible that the observed relative survival advantage among Mexican-origin infants is due to the salutary effects of their relatively earlier childbearing when compared to non-Hispanic whites.

We argue that the maternal age distribution is important to consider when studying infant mortality differentials by race/ethnicity, and in particular, when comparing rates in the Mexican-origin and non-Hispanic white populations. Although it is commonplace to account for maternal age effects in multivariate models—and considerable past research points to its salience in helping to understand maternal health and infant mortality differentials—maternal age has thus far not assumed a *central* role in the examination of the Hispanic infant mortality paradox. Specifically, in light of the age differences in childbearing across various populations, we may question whether the epidemiologic paradox is observed over the entire maternal age range.

This paper carries out a comparative analysis of infant mortality in the U.S. by race/ethnicity, nativity, and maternal age using the observed maternal age-specific rates obtained from several years of U.S. vital statistics data. We show that the Mexican-origin paradox is evident and strong at younger maternal ages but disappears at older maternal ages, with patterns that differ by nativity. These patterns do not change significantly after adjusting for an array of maternal risk and socioeconomic factors. We also show that the overall survival gap between US-born non-Hispanic white and Mexican-origin infants is largely attributable to population differences in maternal-age specific infant mortality rates and not to population differences in the maternal age distributions. Finally, we show that differences in the population composition of older mothers on key socioeconomic attributes provides a partial explanation of the observed differences at older ages in terms of the selective survival advantage accruing to infants born to older non-Hispanic whites.

Background

Teller and Clybern (1974) presented perhaps the earliest evidence on the existence of an epidemiologic paradox for the U.S. Hispanic population when they showed that infant mortality rates in the Spanish surname population of Texas were somewhat lower than those of non-Hispanic whites during the 1960s. Markides and Coreil (1986) later reviewed evidence on numerous health indicators and concluded that for specific health outcomes (including infant mortality, life expectancy, cardiovascular disease mortality, mortality from major types of cancer, and measures of functional health), Hispanics exhibited rates that were much more similar to whites than to blacks even though the socioeconomic status of Hispanics is closer to that of blacks.

Explanations for the paradox include the positive health selectivity of immigrants, positive aspects of Hispanic culture, and data quality issues. The immigration selectivity argument stresses the role of the process of immigration in selecting healthier individuals (Franzizi et al. 2001; Markides and Eschbach 2005). Thus, selectively healthy immigrant women of childbearing age would be expected to have healthier infants when compared to their non-selectively advantaged US-born counterparts (Hummer et al. 2007). The culture-based explanations tend to focus on characteristics that encourage healthy behaviors and the role of strong family ties in Hispanic immigrant communities in the U.S. (Franzizi et al. 2001; Scribner 1996). Similarly, it has been suggested that a process of negative U.S. acculturation may work to erode the generally positive health and mortality outcomes among Hispanics over time and across generations (Cho et al. 2004; Jasso et al. 2004).

Recent demographic research on the data quality-based explanation focuses mainly on adult mortality. The core argument is that out migration of Mexican-origin elders leads to loss to follow-up so that deaths occurring outside of the U.S. are not counted in the numerators of vital rates. This argument implies that the Mexican-origin mortality advantage is an artifact of return migration of less healthy immigrants, producing rates that are artificially low due to "salmon bias" (Abraido-Lanza et al. 1999; Palloni and Arias 2004). In the case of infant mortality, the inability to link births in the U.S. to deaths that occur in Mexico provides a potential explanation for undermining the case for a paradox (Palloni and Morenoff 2001). There is undoubtedly some out migration of Mexican-origin mothers and their infants out of the United States. However, the extent to which this is a plausible explanation of the paradox has been questioned in recent research. Hummer et al. (2007) present strong evidence against this explanation by noting that more than half of all infant mortality occurs within in the first week of life, and it is extremely unlikely that enough Mexican-origin mothers and infants would return to Mexico in sufficient numbers to have an impact on U.S. vital rates. This research has effectively closed the case on the under-registration explanation of the Mexican-origin epidemiologic paradox in the case of infant mortality.

Although this evidence suggests that the paradox is real, an analysis of *overall* race/ethnic mortality differentials, or differentials based on infant age at death, may mask important features of the dynamics of infant mortality when considered in combination with the maternal age structure of certain populations. In particular, there is a well-known curvilinear pattern of infant mortality by maternal age, with generally higher levels experienced by teenagers and older mothers (Freide, A., W. Baldwin, P. Rhodes, et al. 1987; Geronimus 1986; Mathews and MacDorman 2008). A great deal of research documents the interaction between age, race/ethnicity and the decline in reproductive health (Geronimus 1986; Geronimus 1992; Geronimus 1996). The "weathering hypothesis" delineated in this body of research suggests that individuals age at different rates as a consequence of differential levels of cumulative exposure to social disadvantage.

Rates of deterioration in maternal health are associated with socioeconomic disadvantages at many levels. Minority populations are disproportionately concentrated in areas characterized by high levels of residential segregation and neighborhood disadvantage (Massey 2001; Rosenbaum and Friedman 2001). While research has traditionally focused on black-white differences, Mexican-origin populations experience higher levels of socioeconomic and neighborhood disadvantage relative to non-Hispanic whites as well (Saenz 1997; Markiedes and Coreil 1986; Frisbie, Forbes, and Pullum 1996; Albrecht, Clarke, Miller, and Farmer 1996), which suggests that Mexican-origin women would also be expected to experience weathering. Nativity has been shown to play a significant role in adverse pregnancy outcomes and infant mortality, with foreign-born populations generally experiencing more favorable outcomes than the native-born. Results from past research suggest a negative impact of "Americanization" on infant mortality (Hummer, Biegler, DeTurk, Forbes, Frisbie, Hong, and Pullum 1999; Frisbie, Forbes, and Hummer 1998; Sing and Yu 1996), and low birth weight (Cobas, Balcazar, Benin, Keith, and Chong 1996; Scribner and Dwyer 1989). Therefore, we might expect to find increasing infant mortality gaps with maternal age within the Mexican origin population due to the more prolonged exposure of Mexican Americans to U.S. social conditions when compared to Mexican immigrants.

When examining the age distribution of neonatal mortality within the Mexican-origin population, Wildsmith (2002) finds that the optimal age at childbearing with regard to infant mortality occurs earlier among Mexican-American women than among Mexican immigrant women. Wildsmith's finding of stronger weathering effects in the US-born Mexican-origin population runs counter to assimilation theory (Gordon 1996), but is consistent with a segmented assimilation perspective that suggests increased divergence over time and across generations for

Mexican Americans accompanied by increased disadvantage on multiple dimensions as a result of prolonged exposure to community-level socioeconomic disadvantage and race/ethnic discrimination (Portes 1995; Portes and Zhou 1993).

Contribution of the Present Research

Given the race/ethnic and nativity variation in the maternal age profiles of childbearing, we question whether the Mexican-origin epidemiologic paradox is evident at all maternal ages or is characteristic of specific maternal age groups. A focus on maternal age helps to cast the epidemiologic paradox within the conceptual framework of weathering, which suggests that the cumulative impact of social inequality (i.e., repeated experience with social, economic, or political exclusion) is an important source of variability in health outcomes across populations in the United States. Although the most specific focus has been on African-American women, it seems likely that the conceptual framework of weathering is equally applicable to other socially-disadvantaged and marginalized populations—in particular to the Mexican American and Mexican immigrant populations.

This paper uses the pooled NCHS linked birth- infant death files from 1995-2002 to re-examine the paradox of lower rates of infant mortality in specific populations relative to US-born non-Hispanic whites (NHW-US). The most relevant focal groups for the purposes of the evaluating the epidemiological paradox are US-born Mexican origin (MO-US) and Mexican immigrant (MO-FB) women, as they tend to be compositionally similar to US-born non-Hispanic blacks (NHB-US) on a number of important risk factors, yet exhibit rates of infant mortality similar to US-born non-Hispanic whites. By contrast, US-born non-Hispanic blacks exhibit rates that are over twice as high. We also examine foreign-born NHW (NWH-FB) and foreign-born and US-born NHB (NHB-FB, NHB-US) infant mortality for comparison.

Data and Methods

This analysis uses the National Center for Health Statistics (NCHS) linked birth and infant death cohort files for the years 1995-2002. These data include all infants born alive to non-Hispanic white, non-Hispanic black, and Mexican-origin women who were residents of the United States during those years (*N* = 28,057,362). As is customary in this literature, we use maternal identification reported on the birth certificate to ascertain the race and ethnicity of the infant; we exclude cases with missing identification information.

Between 98 to 99 percent of the recorded infant deaths are successfully matched to their birth certificates in the 1995-2002 cohort data (National Center for Health Statistics 1995-2002). One percent of infant deaths in the 2002 birth cohort file were unable to be linked to the matching birth certificate. However, the match rates vary considerably by state, with 23 states successfully linking all of their infant deaths to a matching birth certificate. The two states with the largest Mexican-origin populations, California and Texas, successfully matched 97.8% and 96.7% of their infant deaths to birth certificates, respectively (National Center for Health Statistics 2002, Documentation Table 1) . For the present analysis, the number of deaths in the linked file is weighted to equal the sum of the linked plus unlinked infant deaths by state. The assigned weights for infant deaths ranged from 1.0, for a 100% match rate, to 1.04 depending on the state of residence of the mother.

Results

Our central aim is to compare the Mexican American (MO-US) and Mexican immigrant (MO-FB) populations to US-born non-Hispanic whites (NHW-US). Other comparison groups of interest are US and foreign-born African Americans (NHB-US and NHB-FB), in addition to foreign-born Non-Hispanic whites (NHW-FB). We begin by examining the maternal age-distribution for all births and first births.

Maternal Age Distribution

The maternal age distribution is very different for non-Hispanic whites and Mexican Americans due to different population age structures and other factors. This difference could mask important maternal age-specific infant mortality patterns. Panel A of Table 1 shows the age distribution of mothers from the 1995-2002 NCHS data. We see that US-born non-Hispanic whites have a more protracted childbearing experience when compared to Mexican-origin populations and to US-born non-Hispanic blacks, but have similar age patterns of fertility when compared to foreign-born whites and blacks. The maternal age dynamics are such that 59% of the births to US-born Mexican-origin (i.e., Mexican American) and 43% of foreign-born Mexican-origin (i.e., Mexican immigrant) women occur under the age of 25, compared to 31% of the births to US-born non-Hispanic whites. Panel B of Table 1 shows similar patterns for primiparous women. In particular, whereas about 45% of first births occur before age 25 to US-born non-Hispanic whites, between 60% and 78% of first births occur to Mexican-origin women at these ages. The age profile of first births among Mexican-origin women is similar to that of US-born blacks, where 75% of first births occur before age 25.

[Table 1 about here]

Maternal Age-Specific IMRs

The maternal age specific IMRs (per 1,000 live births) in Panel A of Table 1 show the typical U-shaped pattern for all populations (i.e., initially high rates that decrease through prime childbearing years and increase at higher ages). It is useful to compare the maternal age-specific patterns to the overall rates. We see that Mexican Americans have higher overall rates and

Mexican immigrants have lower overall rates than non-Hispanic whites. These patterns are very similar for primiparous women (Table 1 Panel B). The lowest overall IMRs are exhibited by foreign-born whites and Mexican immigrants. However, the maternal age-specific patterns tell a quite different story. For the Mexican-origin population, there is a clear crossover from an infant survival advantage at ages younger than 30 with an increasing survival disadvantage at later ages relative to US-born whites. For Mexican Americans, this crossover occurs after age 24, while for Mexican immigrants the crossover occurs after age 29, as shown in Panels A and B of Figure 1. Therefore, the relatively smaller number of Mexican-origin women giving birth at age 30 or older comprise a higher risk group relative to non-Hispanic whites at those ages, while young Mexican-origin women are a much lower risk group when compared to younger whites.

[Figure 1 about here]

Table 2 shows the maternal age-specific IMR ratios (rate ratios) for each group relative to US-born whites. We see that the rate ratios for US-born blacks are uniformly higher at all maternal ages when the estimates are precise enough. The rate ratios in Table 2 quantify the excess mortality risk for Mexican-origin infants born to older mothers. Specifically, infants born to Mexican American women 25 and older face a 9 to 41 percent higher risk of dying when compared to their US-born white counterparts, while infants born to Mexican immigrants age 30 or older have risks that are 4 to 36 percent higher.

[Table 2 about here]

Standardization Analysis

The sensitivity of these findings can be gauged by fitting multivariate models that adjust for risk factors and permit the risk factors and their effects to vary by maternal age. Before conducting such an analysis, we carry out a standardization that considers the maternal age distribution of births and the maternal age-specific infant mortality rates as the sole sources of the difference in crude IMRs between the Mexican-origin and non-Hispanic white populations. Of central interest to us is the question: What would be the overall IMR in the Mexican-origin population if they were characterized by the maternal age structure of US-born non-Hispanic whites? We consider a hypothetical scenario based on the maternal age-specific rates and the maternal age distribution of births given in Table 3 and apply direct standardization to evaluate the overall infant mortality rates in selected populations under alternative maternal age distributions (Kitagawa 1955).

Formally, this approach denotes the IMR in population j and maternal age category k as r_{jk}. The overall IMR in population j under the maternal age distribution of population j' can be expressed as $p_{jj'} = \sum_k r_{jk} a_{j'k}$, where $a_{j'k}$ denotes the proportion of births in maternal age category k in population j'. The standardization is most effectively carried out using matrix operations, where $\mathbf{R}$ denotes the 2×7 matrix of maternal age-specific infant mortality rates for two populations and $\mathbf{A}$ denotes the 7×2 matrix denoting the respective maternal age distributions. Then, via direct standardization, the overall standardized and unstandardized rates are the elements of $\mathbf{P} = \mathbf{RA}$.

A standardization based on the US-born Mexican-origin (i.e., Mexican American) and US-born non-Hispanic white populations gives:

$$\mathbf{P} = \begin{pmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{pmatrix} = \begin{pmatrix} 5.78 & 6.74 \\ 6.12 & 6.22 \end{pmatrix}.$$

The diagonal entries are the overall IMRs for US-born non-Hispanic whites (p_{11}) and Mexican-Americans (p_{22}) shown in Table 1 (Panel A). We consider the elements of $\mathbf{P}$ to be point estimates subject to sampling variability (see, e.g., Brillinger 1986) and construct interval estimates of the IMRs according to the methods described in Mathews and MacDorman (2008).[2] The first off-diagonal entry p_{12} = 6.74 (95% CI 6.63, 6.84) is interpreted as the Mexican-American IMR subject to the US-born non-Hispanic white maternal age-specific mortality rates.[3] The interval estimates fall outside those for Mexican American infants (p_{22} = 6.22, 95% CI 5.93, 6.51). Mexican American infants would therefore be expected to face a survival disadvantage if they were characterized by the US-born non-Hispanic white maternal age-specific mortality rates.

The 2nd off-diagonal entry p_{21} = 6.12 (95% CI 5.79, 6.45) is the Mexican-American IMR under the US-born non-Hispanic white maternal age distribution.[4] The interval estimates imply that under the white maternal age distribution, Mexican American infants would face neither a survival advantage nor a disadvantage if characterized by the US-born non-Hispanic white maternal age structure.[5] Further analysis of these components reveals that 77% of the Mexican-American-non-Hispanic white differential in crude IMR can be attributed to differences in maternal age-specific mortality rates, with the remainder owing to population differences in the maternal age distribution.[6]

A standardization based on the Mexican immigrant and US-born non-Hispanic white populations gives:

$$\mathbf{P} = \begin{pmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{pmatrix} = \begin{pmatrix} 5.78 & 6.07 \\ 4.99 & 4.92 \end{pmatrix},$$

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[2] Asymptotic variances computed under alternative distributional assumptions yielded nearly identical interval estimates.

[3] It is also interpreted as the non-Hispanic white IMR subject to the Mexican-American maternal age distribution. Here we note that the expected IMR of non-Hispanic whites would be statistically higher than the observed IMR under the Mexican-American maternal age distribution.

[4] This is also interpreted as the US-born non-Hispanic white IMR when subjected to the maternal age-specific mortality of Mexican Americans. Here we note that expected mortality of whites would be not significantly different under this scenario.

[5] Similarly, non-Hispanic white infants would have an insignificant survivor advantage if they were to experience the maternal age-specific infant mortality rates of Mexican Americans.

[6] The total differential is $p_{11}-p_{22}$. The component due to different age structures is $p_{11}-p_{21}$ and the component due to difference in age specific rates is $p_{21}-p_{22}$, where $p_{jj'}$ (j = 1,2 j' =1,2) is the corresponding element in **P**.

where the elements of **P** are interpreted as before. Here we would expect to find a much higher overall IMR (6.07 vs. 4.92) among Mexican immigrant infants if their maternal age-specific mortality equaled that of US-born non-Hispanic whites (p_{12} = 6.07, 95% CI 5.98, 6.16). We would also expect to find a somewhat higher IMR in the Mexican immigrant population if they were characterized by the maternal age distribution of US-born non-Hispanic whites (p_{21} = 4.99, 95% CI 4.78, 5.21). However, interval estimates of the standardized rates lie within the unstandardized Mexican immigrant interval estimates (p_{22} = 4.92, 95% CI 4.72, 5.12). A component analysis reveals that about 92% of the Mexican-immigrant-non-Hispanic white IMR differential can be attributed to differences in maternal age-specific mortality rates, with the remainder due to differences in the maternal age distributions.

Although it seems plausible to attribute the relatively lower IMR in the Mexican-origin population as a whole to the younger age composition of their births, the overwhelming contribution to the IMR *differential* between US-born non-Hispanic whites and the Mexican-origin groups is attributable to differences in the maternal age-specific *rates*, with only a small contribution owing to population differences in maternal age distributions. Evidence thus far suggests that differences in maternal age-specific mortality account for the difference in overall infant mortality between Mexican-origin and non-Hispanic whites and that overall IMR differences are not simply an artifact of differences in the maternal age distributions.

<u>Multivariate Models: Risk Factors and Model Specification</u>

<u>Risk Factors</u>

It remains to be seen if observed patterns in maternal age-specific IMRs persist after adjustment for maternal health risks and sociodemographic characteristics. In particular, are the observed maternal age crossovers adjusted away if we account for risk factors that have differing impacts by age? Here we investigate how the age-specific infant mortality patterns respond to adjustment for risk factors using a multivariate analysis.

When building the analytic model we consider an array of risk factors including clinically recognized maternal health and biological factors that can be viewed as proximate determinants of birth outcomes and infant mortality, in addition to demographic and socioeconomic risk factors. The goal is to examine the adjusted maternal age specific rates and rate ratios after controlling for risk factors. We present results for all race/ethnic/nativity categories, but focus mainly on comparisons between the Mexican-origin and US-born non-Hispanic white infants. The analytic model includes a binary variable *maternal morbidity*, coded 1 (0 otherwise) for a positive response to the presence of any of the following: anemia, cardiac disease, acute or chronic lung disease, diabetes, genital herpes, hydramnios/oligohydramnios, hemoglobinopathy, chronic hypertension, hypertension (pregnancy-associated), eclampsia, incompetent cervix, previous infant weighing 4000 grams or more, a birth to a previous preterm or small-for-gestational-age infant, renal disease, Rh sensitization, uterine bleeding, and other medical risk factors. A binary variable *labor complications* is constructed in a similar manner, and is coded 1 (0 otherwise) for a positive response to any of the following: febrile (>100 degrees F or 38 degrees C), meconium, moderate/heavy, premature rupture of membrane (>12 hours), abruptio placenta, placenta previa, other excessive bleeding, seizures during labor, precipitous labor (<3 hours), prolonged labor (>20 hours), dysfunctional labor, breech/malpresentation, cephalopelvic disproportion, cord prolapsed, anesthetic complications, fetal distress, and other complications of labor and/or delivery.

Additional risk factors include adequate-plus prenatal care (i.e., possibly indicating maternal health problems during pregnancy; see Kotelchuck [1994]), inadequate prenatal care (i.e., indicating fewer than expected number of prenatal care visits)[7], 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), a plural birth (i.e., non-singleton), maternal smoking (i.e., tobacco use during pregnancy and in the 3 months prior to pregnancy), being unmarried, low maternal education (i.e., having less than a high school education), first birth, and high parity (i.e., 4 or more previous births). We consider sociodemographic risk factors as analytically distinct from—but not necessarily independent of— maternal/biological risk factors, which is consistent with the social-conditions of health conceptual framework outlined by Link and Phelan (1995).

Table 3 shows the distribution of risk factors as they vary by population and maternal age. The distribution of these factors varies by age in a predictable way. We find the highest prevalence of maternal health problems at any age occur among whites and blacks, with foreign born women generally exhibiting fewer such problems. However, when we examine differences in the percentage of women with risk factors associated with maternal morbidity and labor complications, we find a narrowing gap between US-born non-Hispanic white and Mexican-American women after age 25. In contrast, the percentage of women with adequate-plus prenatal care is higher for Mexican Americans compared to whites over age 30, and the proportion receiving inadequate prenatal care is higher at all ages. Foreign born women are more highly represented among the proportion receiving inadequate prenatal care. We also find a higher representation of Mexican immigrant and non-Hispanic black women among the low-educated

[7] This is also called the Adequacy of Prenatal Care Utilization (APNCU) Index. To classify the adequacy of received services, the number of prenatal visits is compared to the expected number of visits for the period between when care began and the delivery date. The expected number of visits is based on the American College of Obstetricians and Gynecologists prenatal care standards for uncomplicated pregnancies and is adjusted for the gestational age when care began and for the gestational age at delivery. A ratio of observed to expected visits is calculated and grouped into 4 categories. The 1st category (adequate-plus prenatal care) is considered an indicator of problem pregnancy, whereas the 4th category represents inadequate prenatal care.

and in the high parity group. Mexican-origin and non-Hispanic black women are also less likely to be married at the time of the birth compared to other groups.

[Table 3 about here]

Multivariate Adjustment

We specify a multivariate model that permits the effects of risk factors to vary across subpopulations by maternal age. This allows prediction of the maternal age-specific infant mortality rates that would prevail in each subpopulation if risk factors were eliminated. The purpose of the model is to adjust for, rather than interpret, the effects of risk factors, all of which are expected to operate in predictable ways. We specify separate models for each subpopulation in reference to US-born non-Hispanic whites. The resulting log rate ratios and their standard errors are used for significance testing using a general specification for the log probability of mortality for the *i*th infant each of 5 maternal age categories: <20, 20-24, 25-29, 30-34, and >34. We use a broader age classification than was used with the descriptive statistics in order to maximize statistical precision of the maternal age effects in the multivariate models. The model is specified as a generalized linear (loglinear rate or log probability) model in log p_i, where $p_i = \Pr(d_i = 1)$, and $d_i = 1$ denotes infant death and $d_i = 0$ denotes survival.[8] Specifically,

$$\log p_i = a_{1j} R_{ij} M_{i1} + \ldots + a_{5j} R_{ij} M_{i5} + \sum_k b_{1jk} R_{ij} X_{ik} M_{i1} + \ldots + \sum_k b_{5jk} R_{ij} X_{ik} M_{i5}, \qquad (1)$$

where R_j is a factor denoting a specific maternal race/ethnicity/nativity category $j \in \{\text{NHW-US, other}\}$, and where "other" denotes one of the 5 other race/ethnic/nativity comparison groups. X_k denotes the *k*th of *K* risk factors and M_1-M_5 denote the 5 maternal age categories. This model is estimated by evaluating two populations at a time. Specifically, we

[8] This specification allows the coefficients to be interpreted as logs of rates or differences in log rates and the exponentiated coefficients are interpretable as rates and rate ratios. In the parlance of generalized linear models, the log function links the conditional mean binomial probability to the linear predictor.

construct models in which each "other" group is contrasted with US-born non-Hispanic whites. This yields a total of 5 separate models. The model makes no constraints on the proportionality of effects and thus allows for maximum variation in the effects of risk factors by race/ethnicity, nativity, and maternal age. As a consequence of this specification, the number of parameters (i.e., the total number of *a*'s and *b*'s in Eq. (1)) is 10 and 125 in Model 1 (the baseline model) and Model 2 (the full model), respectively. To maintain identical samples across models and to maximize the amount of data used, we include dummy variable for missing information on maternal education (pct. missing =1.29%), maternal morbidity (pct. missing=1.19%), and smoking (pct. missing = 16.3%).[9] All other maternal risk and sociodemographic factors consisted of less than 1% missing data. In addition to including the missing indicators, we recoded risk factors to 0 (the reference category) in the case missing data. Given a data set of over 28 million births and over 195 thousand infant deaths, the statistical precision of all estimates is very high. This model provides a flexible specification to yield the *risk-adjusted* maternal age-specific IMRs and rate ratios for each group relative to US-born non-Hispanic whites, which are reported in Table 4.

[Table 4 about here]

Model 1 (the baseline model) in Table 4 includes only maternal age and therefore will exactly reproduce the observed maternal age-specific IMRs and rate ratios. Model 2 (the full model) includes all the aforementioned maternal health and sociodemographic risk factors, each of which is interacted with the dummy variables for race/ethnicity/nativity and maternal age. Focusing on the Mexican-origin/non-Hispanic white comparisons, we find that the crossover from a survival advantage among Mexican-origin infants of young maternal age to a survival

[9] Sensitivity analysis was carried out by estimating models that excluded the missing data. Excluding the missing data does not change the general patterns of predictions of rates and does not alter the conclusions.

disadvantage among older maternal ages persists after adjusting for risk factors. For Mexican Americans (MO-US), the rate ratios (RR) relative to US born whites (NHW-US) remain similar. The predicted maternal age specific rates (i.e., conditional on risk factors) are adjusted downward, with the extent of downward adjustment given by the percent reduction column labeled %Δ in Table 4. We find that the predicted, or risk-adjusted, rates for US-born whites are 60.3% to 75.4% lower after adjustment for risk factors, while the adjusted rates for Mexican Americans are 62.1% to 76.2% lower than the observed rates.

The cross-over from survival advantage to disadvantage among Mexican immigrant infants (MO-FB) is evident at older maternal ages (≥ 30) after adjusting for the effects of risk factors. For both Mexican Americans and Mexican immigrants the predicted IMRs for the youngest maternal age interval reflect a larger mortality decline when compared to US-born whites. In this case, eliminating risk factors would be expected to result in a moderately improved survival advantage for Mexican origin infants relative to US-born whites. The predicted IMRs for other maternal age intervals are not adjusted downward to a similar extent, with the exception of the predicted IMR for Mexican American infants born to 30-34 year old mothers. Thus, adjusting for risk factors has somewhat less impact on the mortality of infants born to older Mexican-origin women when compared to their younger counterparts and when compared to non-Hispanic whites.

Adjusting for risk factors has less impact on the reduction in mortality of US-born black infants born to teen mothers. However, rates are adjusted downward by 70.2 to 79.3 percent for infants born to older women, which lead to modest reductions in IMR ratios relative to non-Hispanic whites when compared to the empirical maternal age-specific IMRs. An interesting pattern is evident among foreign-born blacks (NHB-FB) where we find that the risk-adjusted maternal age-specific infant mortality rates are 70.0 to 82.9 percent lower than the observed rates. Moreover, these rates are not significantly different from those of non-Hispanic whites for women under the age of 30.

To gain further insight into infant mortality differences between the non-Hispanic white and Mexican-origin population, we construct the age-specific IMRs that would prevail in the Mexican-origin population if they would have experienced the same rate reduction in every maternal age interval as US-born whites in response to adjustments for risk factors. We constrain the reduction in the observed Mexican-origin rates to be equal to those of US-born whites at every maternal age, and refer to these as *hypothetical* rates, distinct from the *predicted* or expected rates under the model. The hypothetical and predicted rates are reported in Table 5. The a-superscript pertains to a group's hypothetical rate under the condition that they experienced the same proportionate reduction in maternal age-specific IMR as US-born whites. The b-superscript denotes the group's predicted rate from Model 2 in Table 4. The b/a rate ratios reflect the extent to which the predicted rate from Model 2 differs from the hypothetical rate (i.e., if rate-reductions followed the white pattern in each maternal age interval).[10]

[Table 5 about here]

The hypothetical rates for Mexican Americans do not differ significantly from those predicted under Model 2 over most of the maternal age range. The exception to this is at maternal ages > 34, where the predicted rate under Model 2 is 19% higher than the hypothetical rate, and thus reflects the excess risk accruing to Mexican American infants born to older

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[10] The rate ratios are cross-product ratios of the observed and expected rates for each group. For example, let O_W and O_M denote the observed maternal age-specific IMRs for US-born non-Hispanic whites and Mexican Americans and E_W and E_M denote the expected maternal age-specific IMRs under Model 2, then $(O_M E_W)/(O_W E_M)$ is the ratio of expected rates to the hypothetical rates under the model. This is equal to ratio of the estimated rate ratios for Mexican Americans from Model 2 and Model 1. Thus, interval estimates of rate ratios are readily obtained using the results of Model 1 and Model 2.

mothers after adjusting for covariates. For Mexican immigrants, the expected rates from Model 2 are adjusted downward from the observed rates by 64.5% to 73.6%, which is less downward adjustment than what is observed for US-born non-Hispanic whites. Table 5 shows that the expected rates are higher than the hypothetical rates (i.e., under the white pattern) for maternal ages 25 and older, although differences are significant only in the 25-29 and > 34 maternal age intervals. The departures of the predicted maternal age-specific IMRs from the IMRs if these groups were characterized by the same reduction in adjusted rates as US-born non-Hispanic whites provides modest evidence of the differential impact of risk factors at older maternal ages. Specifically, Mexican-origin—in particular Mexican immigrant—rates at older maternal ages are less responsive to adjustments for risk factors than are those of US-born non-Hispanic whites. This suggests a possible role of weathering insofar as risk factors other than those included in the multivariate models may underlie differences in infant mortality patterns at older maternal ages.

Differences within the Mexican Origin Population

A further comparison of Mexican American and Mexican immigrant rates is relevant in light of the weathering hypothesis. If weathering reflects prolonged exposure to socioeconomic disadvantage in the United States, then we should observe that the Mexican-American IMR ratios (relative to Mexican-immigrants) increase with maternal age. The results provided in Table 4, and in Figure 2, show that whereas the Mexican immigrant maternal age specific rates are 13 to 22 percent lower than Mexican American rates, there is no evidence that the maternal age-specific rate ratios increase with age. These patterns remain largely the same after adjusting for risk factors. In fact, there is a tendency toward a slightly decreasing gap in the adjusted rates between the Mexican-origin populations with age. In summary, while the maternal age-specific

IMR differentials between Mexican Americans and Mexican immigrants are significant, there is no evidence of an increase in the within-Mexican-origin disparity with age.

[Figure 2 about here]

Thus far, we have shown that a relative survival disadvantage for infants born to older Mexican-origin women remains after adjustment for selected risk factors, but that nativity differences within the Mexican-origin population are relatively constant over the maternal age range. Given the limits of our data which uses nativity as a gauge of cumulative exposure to U.S. social conditions, there is no evidence that Mexican-Americans experience a differential worsening with increasing maternal age—in terms of higher IMR relative to Mexican immigrants—as might be expected under a weathering hypothesis. Next we consider possible factors that can account for the higher IMRs of older Mexican-Origin women relative to non-Hispanic white women.

Relative Differences at Older Ages

Although the results comparing the Mexican-origin and US-born non-Hispanic white populations provide evidence of differential decline in infant survival with advanced maternal age, we might question if the overall observed and predicted patterns simply reflect the relatively lower infant mortality accruing to selectively-advantaged non-Hispanic white women who give birth at older ages. That is, the question becomes not whether Mexican-origin women are experiencing more unfavorable outcomes with age, but whether they are being fairly compared to the reference population.

We observe from Table 1 that non-Hispanic white women are more likely than their Mexican-origin counterparts to bear children at older ages. They are also more likely to be married when compared to Mexican-origin women of the same age (89% vs. 73%). Women in this age group also tend to be better educated, with 68% of US-born white women and 22% of Mexican-origin women in this age group completing 13 or more years of schooling. These better-educated married women represent an advantaged group who are considerably more likely to possess the socioeconomic resources to obtain adequate health care services and are likely to have additional sources of material and social support afforded by marriage. Given the existing socioeconomic disparities between the Mexican-origin and white populations in this age group, we might ask to what extent are the relative Mexican-origin versus white infant mortality differentials at older maternal ages an artifact of the differences in the socioeconomic composition of these groups, and in particular, the prevalence of relatively advantaged US-born non-Hispanic whites in this segment of the maternal age distribution?

Although the NCHS data lack detailed measures of socioeconomic status, it is possible to partially address this issue by treating maternal education as a proxy for socioeconomic status and compare overall infant mortality for women 25 and older with different marital statuses and levels of education. Table 6 shows IMRs and rate ratios for women age 25 and older by marital status and years of schooling. Among married women with 12 or fewer years of schooling, the IMR among Mexican Americans is statistically equal to that of US-born non-Hispanic whites (RR=1.019, 95% CI 0.968, 1.073), whereas the Mexican-immigrant IMR is 19% lower (RR=0.815, 95% CI 0.788, 0.841). Among married women with 13 or more years of schooling, the Mexican-immigrant IMR is statistically equal to that of US-born non-Hispanic whites (RR=1.068, 95% CI 0.992, 1.150), but is nearly 15% higher (RR=1.146, 95% CI 1.079, 1.216) among Mexican Americans. The mortality of infants born to married women for all levels of schooling are about 18% higher for Mexican Americans (RR=1.176, 95% CI 1.131, 1.233) and 4% higher for Mexican immigrants (RR=1.04, 95% CI 1.011, 1.070) relative to US-born non-

Hispanic whites. These results suggest that the Mexican-origin relative disadvantage at older maternal ages can be explained in part by compositional differences in maternal education across groups. That is, non-Hispanic white mothers in this age range are drawn disproportionately from a pool of higher-educated women whose infants face a much lower risk of death.

Infants born to unmarried women in general face a greater overall risk of dying within the first year. However, the mortality disadvantage associated with low education and single motherhood is considerably less in the Mexican-origin population when compared to whites. In particular, infant mortality among unmarried women with 12 years of schooling or less is 17% lower among Mexican Americans (RR=0.834, 95% CI 0.781, 0.891) and is 42% lower among Mexican immigrants (RR=0.577, 95% CI 0.549, 0.606) relative to their US-born non-Hispanic white counterparts, a finding that is consistent with earlier research (National Center for Health Statistics 2000). Among higher-educated unmarried mothers we find statistically equal IMRs for Mexican Americans (RR=1.018, 95% CI 0.903, 1.147) and IMRs that are 15% lower among Mexican immigrants (RR=0.845, 95% CI 0.732, 0.976) relative to US-born non-Hispanic whites.[11]

These results suggest that the overall *relative* survival advantage of Mexican-origin infants among unmarried mothers reflects the higher mortality of infants born to less-educated, unmarried US-born non-Hispanic white mothers. In general, we find that Mexican origin infants are not penalized by low maternal education and single motherhood to the same extent as US-born non-Hispanic whites; nor are they advantaged by higher maternal education and marriage to the same extent as US-born non-Hispanic whites, a finding which is consistent with research on birth outcomes (Scribner and Dwyer 1989; James 1992). We can speculate that the lack of an observed negative effect of low maternal education and single motherhood may be due to

[11] We caution that this estimate is based on 198 deaths occurring among 35,759 births.

offsetting factors, and in particular, by other mechanisms of social support and/or healthy behavior in Mexican-origin communities.

Discussion

This research examines infant mortality by maternal age by race/ethnicity using vital-statistics data from the NCHS. Age-specific fertility patterns differ among the six sub-populations considered in this research, with the distribution of births skewed towards younger maternal ages in the Mexican-origin and the US-born non-Hispanic black populations. An analysis of maternal age-specific infant mortality rates reveals a distinct survival advantage for infants born to younger mothers in Mexican-origin populations relative to US-born non-Hispanic whites, which is consistent with the Hispanic epidemiological paradox. However, at older maternal ages, the Mexican-origin population experiences a distinct survival disadvantage relative to non-Hispanic whites, which appears consistent with a weathering explanation. In particular, we find that the crossover from a survival advantage to a survival disadvantage relative to whites occurs for Mexican-American infants born to mothers age 25 or older, and to infants born to Mexican-immigrant mothers over age 29. We also showed that differences in the population composition on key socioeconomic dimensions of marriage and education may partially explain this crossover.

Given the association between infant survival and maternal health, differential infant survival within the Mexican-origin population suggests that longer exposure to social conditions in the U.S. undermines the health of mothers who, in general, seem to have more favorable health endowments than their US-born white counterparts as evidenced by the relatively lower rates of infant mortality at younger ages. In the subsequent analysis, we adjusted maternal age-specific mortality rates using a model that allows the effects of a large number of known risk factors to vary by race/ethnicity, nativity, and maternal age to yield the predicted mortality rates for hypothetical low-risk populations, which are then compared across subgroups. We find that the maternal age Mexican-origin crossover pattern in infant mortality rates described above persists after adjusting for risk factors.

Our findings are consistent with the conceptual framework of weathering (Geronimus 1992) insofar as: (1) relatively higher mortality is experienced by Mexican-Americans compared to Mexican immigrants over the entire maternal age range, (2) the fitted mortality rates for infants born to older Mexican-origin women are not adjusted downward to the extent of those of US-born whites, which suggests that factors not measureable with our current data are responsible for the relative survival disadvantage of these infants, and (3) foreign-born Mexican women tend to have a lower prevalence of maternal risk factors at older ages than US-born Mexican women. On the other hand, we find no evidence of a growing within-Mexican-origin gap in IMR with increasing maternal age, which provides somewhat less support for a weathering explanation of infant mortality differences. Data limitations preclude any definitive conclusions about the actual impact of exposure on maternal health and infant mortality. An important area of further research will be to inform about the possible factors contributing to the relatively lower survival rates of infants born to older Mexican-origin women when compared to non-Hispanic whites. The NCSH data contain limited measures of socioeconomic status, acculturation, and other important factors. However different data sources may be able to provide additional insight into the possible mechanisms underlying the apparent erosion of the Mexican-origin survival advantage at older maternal ages, perhaps by focusing on birth outcomes as proximate determinants.

The Hispanic infant mortality paradox has been the subject of a great deal of debate, with explanations that focus on immigrant selectivity (Franzizi et al. 2001; Markides and Eschbach 2005), the positive role of Hispanic culture (Franzizi et al. 2001; Scribner 1996), and data quality (Palloni and Morenoff 2001; Hummer et al. 2007). While it is not possible to evaluate all of these explanations with the limited measures available in the NCHS data, recent research using these data provides strong evidence against the data-quality explanation (Hummer et al. 2007). This leaves positive selection and positive cultural characteristics as possible explanations for the lower IMR of Mexican Americans and Mexican Immigrants at lower maternal ages. The protective cultural attributes of Mexican-origin people that have been identified in past research include, lower rates of smoking and alcohol use, better nutrition, and stronger family ties when compared to non-Hispanic whites (Williams 1986). Past research has found support for the acculturation hypothesis (Cobas, et al. 1989) in the Hispanic Health and Nutrition Examination Survey (HHANES). In particular, this research found that Mexican-origin women who maintained Mexican-oriented cultural values, beliefs, practices, and lifestyles, experienced lower rates of low birth weight (infant birth weights < 2500g) than their counterparts with a US-orientation. Other studies have found that nativity status is associated with low-weight birth rates within the Hispanic population (Williams 1986; Becerra et al. 1991), with Mexican Americans facing higher rates than Mexican immigrants.

In contrast to past studies, we provide detailed comparisons of maternal age-specific infant mortality. The finding that Mexican Americans and Mexican immigrants have consistently lower IMRs than US-born whites and blacks at younger maternal ages is a new pattern and is suggestive of the importance of selectivity and/or culture as explanations for their lower rates relative to other groups. Our finding of distinct patterns for Mexican Americans and

Mexican immigrants is consistent with past findings regarding the possible role of acculturation. An important area of future research will be to understand what the specific mechanisms are, and why younger Mexican-origin women have such positive outcomes in the context of their risk profiles, which, in turn, could provide important clues regarding the reduction of infant mortality among non-Hispanic whites and non-Hispanic blacks.

Bibliography

Abraido-Lanza, A.F., B.P. Dohrenwend, D.S. Ng-Mak, and J.B. Turner. 1999. "The Latino mortality paradox: A test of the "salmon bias" and healthy migrant hypotheses." *American Journal of Public Health* 89(10): 1543-1548.

Albrecht, S.L., L.L. Clarke, M.K. Miller, F.L. Farmer. 1996. "Predictors of Differential Birth Outcomes Among Hispanic Subgroups in the United States: The Role of Maternal Risk Characteristics and Medical Care," *Social Science Quarterly*, 77: 407-433.

Becerra, J., C. Hogue, H. Atrash, and N. Perez. 1991. "Infant Mortality among Hispanics: A Portrait of Heterogeneity." *Journal of the American Medical Association* 265: 217-221.

Brillinger, D.R, 1986. "The Natural Variability of Vital Rates and Associated Statistics." *Biometrics* 42: 693-734.

Cho, YT., W.P Frisbie, R.A. Hummer, and R.G. Rodgers. 2004. "Nativity, Duration of Residence and the Health of Hispanic Adults in the United States," *International Migration Review*, 38: 184-221.

Cobas, J.A., H. Balcazar, M.B. Benin, V.M. Keith, and Y. Chong. 1996. "Acculturation and Low-Birthweight Infants among Latino Women: A Reanalysis of HHANES Data with Structural Equation Models," *American Journal of Public Health*, 86: 394-396.

Elo, I.T., and S.H. Preston. 1997. "Racial and Ethnic Differences in Mortality at Older Ages." Chapter 2 (pp. 10-42) in *Racial and Ethnic Differences in the Health of Older Americans*, edited by L.G. Martin and B.J. Soldo. Washington, DC: National Academy Press.

Elo, I.T., C.M. Turra, B. Kestenbaum, and B.R. Ferguson. 2004. "Mortality among elderly Hispanics in the United States: Past evidence and new results." *Demography* 41(1): 109-128.

Elo, I.T., 2006. "The Impact of Salmon Bias on the Hispanic Mortality Advantage: New Evidence from Social Security Data." Population Aging Research Center Working Paper Series, WPS06-06, Population Studies Center, University of Pennsylvania.

Forbes, D. and W.P. Frisbie. 1991. "Spanish Surname and Anglo Infant Mortality: Differentials Over a Half-Century." *Demography* 28(4): 639-660.

Franzini, L., J.C. Ribble, and A.M. Keddie. 2001. "Understanding the Hispanic Paradox." *Ethnicity and Disease* 11: 496-518.

Freide, A., W. Baldwin, P. Rhodes, et. al. 1987. "Young Maternal Ages and Infant Mortality: The Role of Low Birth Weight." *Public Health Reports*," 102: 192-199.

Frisbie, W.P., D. Forbes, and R.A. Hummer. 1998. "Hispanic Pregnancy Outcomes: Additional Evidence," *Social Science Quarterly*, 79: 149-169.

Geronimus, A.T. 1986. "Effects of Race, Residence, and Prenatal Care on the Relationship of Maternal Age to Neonatal Mortality." *American Journal of Public Health*, 76: 1461-1421.

Geronimus, A.T. 1992. "The Weathering Hypothesis and the Health of Aftrican-American Women and Infants: Evidence and Speculations," *Ethnicity and Disease* 2: 207-221.

Geronimus, A.T. 1993. "Maternal Youth or Family Background? On the Health Disadvantages of Infants with Teenage Mothers," *American Journal of Epidemiology* 137: 213-225.

Geronimus, A.T. 2001 "Understanding and Eliminating Racial Inequalities in Women's Heath in the United States: The Role of the Weathering Conceptual Framework," *JAMWA*, 25: 133-136.

Gordon, M.M. 1996. *Assimilation in American Life.* Oxford: Oxford University Press.

Guendelman, S. 2000. "Immigrants May Hold Clues to Protecting Health During Pregnancy." Pp. 222-257 in *Promoting Human Wellness: New Frontiers for Research, Practice, and Policy*, edited by M.S. Jamner and D. Stokols. Berkeley, CA: University of California Press.

Hummer, Robert A., Daniel A. Powers, Starling G. Pullum, Ginger L. Gossman, and W. Parker Frisbie 2007. "Paradox Found (Again): Infant Mortality among the Mexican Origin Population in the United States." *Demography* 44: 441-457.

Hummer, R.A., M. Benjamins, and R.G. Rogers. 2004. "Race/Ethnic Disparities in Health and Mortality among the Elderly: A Documentation and Examination of Social Factors." Chapter 3 (pp. 53-94) in *Critical Perspectives on Racial and Ethnic Differences in Health in Late Life*, edited by N. Anderson, R. Bulatao, and B. Cohen. Washington, DC: National Research Council.

Hummer, R.A., M. Biegler, P. DeTurk, D. Forbes, W.P. Frisbie, Y. Hong, and S.G. Pullum. 1999. "Race/Ethnicity, Nativity, and Infant Mortality in the United States." *Social Forces* 77(3): 1083-1118.

James, S.A. 1993. "Racial and Ethnic Differences in Infant Mortality and Low Birth Weight: A Psychosocial Critique," *Annals of Epidemiology*, 3:130-136.

Jasso, G., D.S. Massey, M.R. Rosenzweig, and J.P. Smith. 2004. "Immigrant Health: Selectivity and Acculturation." Pp. 227-266 (chapter 7) in *Critical Perspectives on Racial and Ethnic Differences in Health in Late Life*, edited by N.B. Anderson, R.A. Bulatao, and B. Cohen. Washington, D.C.: National Academies Press.

Kitagawa, E.M. 1955. "Components of a Difference between Two Rates," *Journal of the American Statistical Association*, 50: 1168-1194.

Kotelchuck M. 1994.. "An Evaluation of the Kessner Adequacy of Prenatal Care Index and a Proposed Adequacy of Prenatal Care Utilization Index." *American Journal of Public Health* 84: 1414-1420.

Landale, N.S., R.S. Oropesa, and B.K. Gorman. 2000. "Migration and Infant Death: Assimilation or Selective Migration among Puerto Ricans." *American Sociological Review* 65: 888-909.

Link B.G., and J. Phelan. 1995. "Social Conditions as Fundamental Causes of Disease." *Journal of Health and Social Behavior,* 35(extra issue): 80-94.

Markides, K.S., and J. Coreil. 1986. "The Health of Hispanics in the Southwestern United States: An Epidemiologic Paradox." *Public Health Reports* 101: 253-265.

Markides, K.S., and K. Eschbach. 2005. "Aging, Migration and Mortality: Current Status of Research on the Hispanic Paradox." *Journals of Gerontology: Series B*: 60B (Special Issue II): 68-75.

Mathews, T.J. and MacDorman M.F. 2008. "Infant Mortality Statistics from the 2005 Period Linked Birth/Infant Death Data Set." National Vital Statistics Reports; Vol. 57 no 2. Hyattsville, MD: National Center for Health Statistics.

Massey D.S. 2001. "Residential Segregation and Neighborhood Conditions in US Metropolitan Areas", In Smelser, N.J., W.J Wilson, and F. Michell, eds. *America Becoming*: *Racial Trends and Their Consequences*. Washington DC: National Academy Press

National Center for Health Statistics. 2002. 2002 Birth Cohort Linked Birth/Infant Death Data Set and Documentation. NCHS CD-ROM Series 20, No. 20a, issued January 2006. Washington, DC: U.S. Department of Health and Human Services.

National Center for Health Statistics. 2001. 2001 Birth Cohort Linked Birth/Infant Death Data Set and Documentation. NCHS CD-ROM Series 20, No. 19a, issued January 2005. Washington, DC: U.S. Department of Health and Human Services.

National Center for Health Statistics. 2000. 2000 Birth Cohort Linked Birth/Infant Death Data Set and Documentation. NCHS CD-ROM Series 20, No. 18a, issued January 2004. Washington, DC: U.S. Department of Health and Human Services.

National Center for Health Statistics. 2000. Health, United States, 2000, with adolescent health chartbook. Washington, DC: U.S. Government Printing Office.

National Center for Health Statistics. 1999. 1999 Birth Cohort Linked Birth/Infant Death Data Set and Documentation. NCHS CD-ROM Series 20, No. 17a, issued May 2003. Washington, DC: U.S. Department of Health and Human Services.

National Center for Health Statistics. 1998. 1998 Birth Cohort Linked Birth/Infant Death Data Set and Documentation. NCHS CD-ROM Series 20, No. 16a, issued April 2002. Washington, DC: U.S. Department of Health and Human Services.

National Center for Health Statistics. 1997. 1997 Birth Cohort Linked Birth/Infant Death Data Set and Documentation. NCHS CD-ROM Series 20, No. 15a, issued August 2000. Washington, DC: U.S. Department of Health and Human Services.

National Center for Health Statistics. 1996. 1996 Birth Cohort Linked Birth/Infant Death Data Set and Documentation. NCHS CD-ROM Series 20, No. 14a, issued September 1999. Washington, DC: U.S. Department of Health and Human Services.

National Center for Health Statistics. 1995. 1995 Birth Cohort Linked Birth/Infant Death Data Set and Documentation. NCHS CD-ROM Series 20, No. 12a, issued November 1998. Washington, DC: U.S. Department of Health and Human Services.

Palloni, A. and E. Arias. 2004. "Paradox Lost: Explaining the Hispanic Adult Mortality Advantage." *Demography* 41(3): 385-415.

Palloni, A. and J.D. Morenoff. 2001. "Interpreting the Paradoxical in the Hispanic Paradox." *Annals of the New York Academy of Sciences* 954: 140-174.

Portes, A. 1995. "Children of Immigrants: Segmented Assimilation and its Determinants," Pp. 248-279, In A. Portes, Ed., *The Economic Sociology of Immigration: Essays on Networks, Ethnicity, and Entrepreneurship*, New York, NY: Russell Sage

Portes, A. and M. Zhou 1993. "The New Second Generation: Segmented Assimilation and its Variants among Post-1965 Immigrant Youth," *Annals of the American Academy of Political and Social Science,* 530: 75-98.

Poston, D.L.J. and Dan, H. 1996. "Fertility Trends in the United States," Pp. 85-100, In D.L. Peck and J.S. Hollingsworth, Eds. *Demographic and Structural Change: The Effects of the 1980s on American Society*, Westport, CT: Greenwood.

Rogers, R.G. 1989. "Ethnic Differences in Infant Mortality, Fact or Artifact?" *Social Science Quarterly* 70: 642-649.

Rogers, R.G., R.A. Hummer, and C.B. Nam. *Living and Dying in the U.S.A.: Behavioral, Health, and Social Differentials in Adult Mortality*. San Diego, CA: Academic Press.

Rosenbaum, E., S. Friedman. 2001. "Differences in the Locational Attainment of Immigrant and Native Born Households with Children in New York City," *Demography* 38: 337-348.

Rosenberg, H.M., J.D. Mauer, P.D. Sorlie, N.J. Johnson, M.F. MacDorman, D.L. Hoyert, J.F. Spitler, and C. Scott. 1999. "Quality of Death Rates by Race and Hispanic Origin: A Summary of Current Research." *Vital and Health Statistics* 2(128): National Center for Health Statistics.

Saenz R. 1997. "Ethnic Concentration and Chicano Poverty: A Comparative Approach," *Social Science Research*, 26: 205-228.

Singh, G.K., and M. Siahpush. 2001. "All-cause and cause-specific mortality of immigrants and native born in the United States." *American Journal of Public Health* 91(3): 392-399.

Singh, G.K., and M. Siahpush. 2002. "Ethnic-immigrant differentials in health behaviors, morbidity, and cause-specific mortality in the United States: An analysis of two national data bases." *Human Biology* 74(1): 83-109.

Singh, G.K., and S.M. Yu. 1996. "Adverse Pregnancy Outcomes: Differences Between U.S.- and Foreign-Born Women in Major U.S. Racial and Ethnic Groups." *American Journal of Public Health* 86(6): 837-843.

Smith, D.P., and B.S. Bradshaw. 2006. "Rethinking the Hispanic Paradox: Death Rates and Life Expectancy for US Non-Hispanic White and Hispanic Populations." *American Journal of Public Health* 96(9): 1686-1692

Wildsmith, E.M. 2002. "Testing the Weathering Hypothesis Among Mexican-Origin Women," *Ethnicity and Disease*, 12: 470-479.

Williams, R.L. 1986. "Pregnancy Outcomes among Spanish Surname Women in California," American Journal of Public Health, 76: 378-391.

Table 1: Infant Mortality Rates by Maternal Age and Nativity for Non-Hispanic White, Mexican-Origin, and Non-Hispanic Black Women: 1995-2002 Linked Files

A															
All Parities	**Maternal Age**	**NHW US**		**NHW FB**		**MO US**		**MO FB**		**NHB US**		**NHB FB**		**OVERALL**	
		%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR
	<15	0.1	18.0	0.0	12.3 †	0.7	12.9	0.2	11.5	0.8	18.5	0.1	7.6 †	0.24	16.8
	15-19	9.2	9.3	3.5	7.9	24.8	7.1	12.1	5.8	21.8	13.8	6.0	10.9	12.05	9.9
	20-24	22.3	6.8	15.9	5.0	33.8	5.8	30.4	4.6	33.0	13.4	18.7	8.6	25.07	7.8
	25-29	28.0	5.0	28.8	4.3	22.2	5.5	29.7	4.4	22.1	13.4	27.0	8.9	26.97	6.1
	30-34	25.9	4.6	31.3	4.3	12.5	5.8	18.3	4.8	14.1	14.1	28.1	10.0	22.87	5.6
	35-39	12.1	5.3	16.7	5.0	5.1	7.5	7.6	6.1	6.7	14.7	16.2	11.4	10.66	6.5
	40+	2.3	6.7	3.7	7.1	0.9	8.6	1.7	9.1	1.4	15.8	3.9	14.5	2.13	8.1
	Total	100.0	5.8	100.0	4.8	100.0	6.2	100.0	4.9	100.0	13.7	100.0	9.9	100.00	7.0
	Deaths	104,200		4,774		10,192		13,229		58,039		4,724		195,158	
	Births	18,021,839		1,001,622		1,638,104		2,689,077		4,229,098		477,622		28,057,362	
B															
First Births	**Maternal Age**	**NHW US**		**NHW FB**		**MO US**		**MO FB**		**NHB US**		**NHB FB**		**OVERALL**	
		%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR	%	IMR
	<15	0.2	17.4	0.1	13.0 †	1.6	12.4	0.6	10.8	2.0	17.8	0.28	7.8 †	0.58	16.2
	15-19	18.3	8.3	6.9	7.3	45.3	6.4	27.6	5.4	41.8	12.0	12.82	10.7	23.51	8.8
	20-24	26.9	5.7	22.0	4.4	31.4	5.5	40.8	4.5	31.4	12.8	28.39	7.9	28.74	6.7
	25-29	27.4	4.5	31.9	4.0	13.3	5.8	20.9	5.0	13.5	15.2	29.10	9.3	24.28	5.5
	30-34	18.9	4.7	26.2	4.2	6.0	6.1	7.5	5.9	7.6	17.7	20.23	13.3	15.91	5.8
	35-39	6.9	6.1	10.7	6.0	2.0	9.0	2.2	8.6	3.1	18.9	7.72	16.6	5.84	7.5
	40+	1.3	6.7	2.2	7.4	0.3	9.5	0.4	8.4	0.6	17.2	1.46	22.8	1.13	8.0
	Totals	100.0	5.7	100.0	4.7	100	6.2	100	5.1	100	13.5	100	10.6	100.00	6.9
	Deaths	42,770		1,959		4,076		4,617		21,650		1,945		77,017	
	Births	7,462,601		418,744		661,038		904,990		1,604,902		182,635		11,234,910	

† Estimate is based on fewer than 50 deaths.

Table 2: Rate Ratios Relative to US Born Non-Hispanic Whites by Maternal Age and Nativity: All Births and First Births, 1995-2002 Linked Files

All Births

Maternal Age	**NHW FB**	**MO US**	**MO FB**	**NHB US**	**NHB FB**
<15	0.69 †	0.72 *	0.64 *	1.03	0.42 †
15-19	0.86 *	0.76 *	0.63 *	1.49 *	1.18 *
20-24	0.73 *	0.86 *	0.67 *	1.96 *	1.27 *
25-29	0.87 *	1.09 *	0.89 *	2.67 *	1.77 *
30-34	0.94 *	1.28 *	1.04 *	3.07 *	2.19 *
35-39	0.93 *	1.41 *	1.15 *	2.75 *	2.14 *
40+	1.07 *	1.29 *	1.36 *	2.37 *	2.18 *
Overall	0.82 *	1.08 *	0.85 *	2.37 *	1.71 *

First Births

Maternal Age	**NHW FB**	**MO US**	**MO FB**	**NHB US**	**NHB FB**
<15	0.75 †	0.72 *	0.62 *	1.02	0.45 †
15-19	0.88 *	0.77 *	0.65 *	1.45 *	1.29
20-24	0.77 *	0.95 *	0.78 *	2.24 *	1.37 *
25-29	0.90 *	1.30 *	1.11 *	3.40 *	2.08 *
30-34	0.88 *	1.29 *	1.26 *	3.74 *	2.82 *
35-39	0.98 *	1.47 *	1.40 *	3.09 *	2.71 *
40+	1.10 *	1.41	1.25	2.55 *	3.40 *
Overall	0.82 *	1.08 *	0.89 *	2.35 *	1.86 *

† Estimate is based on fewer than 50 deaths in the comparison group.
* Significantly different from 1.0 ($p < 0.05$ two tailed test)

Table 3: Distribution of Risk Factors by Maternal Age and Nativity[†]

Risk Factors	US Born Maternal Age <20	20-24	25-29	30-34	35+	Total	Foreign Born Maternal Age <20	20-24	25-29	30-34	35+	Total
maternal morbidity												
NHW	28.6%	27.9%	27.8%	28.8%	33.8%	29.0%	23.0%	21.4%	22.0%	24.0%	29.5%	24.1%
NHB	31.4%	31.2%	32.2%	34.5%	39.6%	32.6%	27.1%	25.9%	26.9%	29.8%	35.3%	29.2%
MO	22.2%	20.9%	22.3%	24.4%	30.1%	22.5%	19.3%	17.4%	18.0%	20.1%	25.1%	19.0%
Total	28.6%	28.0%	28.1%	29.3%	34.3%	29.2%	20.2%	18.7%	19.9%	22.8%	28.5%	21.4%
labor complications												
NHW	33.4%	33.0%	33.9%	34.3%	35.7%	34.0%	30.5%	30.7%	31.6%	32.4%	33.9%	32.2%
NHB	33.5%	32.3%	33.6%	36.0%	38.1%	33.8%	34.3%	35.6%	37.3%	37.9%	39.3%	37.4%
MO	24.9%	23.8%	24.3%	26.0%	28.1%	24.7%	27.2%	26.5%	25.7%	25.8%	27.3%	26.3%
Total	32.2%	31.9%	33.3%	34.2%	35.7%	33.3%	28.0%	27.9%	28.3%	29.7%	31.9%	28.9%
adequate-plus prenatal care												
NHW	27.4%	29.5%	31.1%	31.6%	33.7%	30.9%	23.0%	23.7%	25.8%	28.2%	30.8%	27.1%
NHB	25.5%	28.7%	32.3%	34.0%	35.7%	30.1%	19.5%	22.5%	24.9%	26.6%	28.9%	25.4%
MO	24.7%	27.0%	30.5%	33.0%	36.0%	28.5%	20.1%	20.9%	22.7%	25.1%	28.5%	22.8%
Total	26.5%	29.1%	31.2%	31.9%	34.0%	30.6%	20.3%	21.5%	23.7%	26.4%	29.4%	24.2%
previous loss												
NHW	11.1%	21.3%	25.3%	29.5%	38.2%	26.0%	9.3%	15.7%	20.1%	25.5%	34.2%	23.6%
NHB	12.5%	27.4%	36.4%	38.3%	41.0%	28.6%	13.9%	26.2%	30.1%	33.6%	39.0%	31.1%
MO	8.1%	17.5%	23.6%	27.4%	33.2%	18.7%	5.3%	10.2%	14.9%	19.4%	25.1%	14.1%
Total	11.1%	22.4%	26.8%	30.4%	38.3%	26.0%	6.3%	12.4%	17.8%	23.4%	30.9%	18.3%
plural birth												
NHW	1.4%	2.1%	3.0%	4.2%	5.2%	3.3%	1.3%	2.0%	2.8%	3.9%	5.1%	3.4%
NHB	2.0%	3.2%	3.8%	4.1%	4.1%	3.3%	1.7%	2.3%	3.0%	3.5%	3.9%	3.1%
MO	1.3%	1.8%	2.4%	3.0%	3.5%	2.1%	1.2%	1.5%	1.9%	2.3%	2.6%	1.8%
Total	1.6%	2.3%	3.1%	4.1%	5.1%	3.2%	1.2%	1.7%	2.2%	3.0%	3.8%	2.4%
smoking												
NHW	26.6%	22.1%	12.5%	8.9%	9.2%	14.5%	11.8%	7.7%	4.9%	4.1%	4.5%	5.3%
NHB	6.1%	8.9%	10.1%	12.3%	15.5%	9.6%	2.4%	1.8%	1.3%	1.1%	1.2%	1.4%
MO	3.2%	3.5%	3.0%	2.9%	3.4%	3.2%	0.4%	0.4%	0.5%	0.6%	0.8%	0.5%
Total	17.0%	17.3%	11.6%	9.0%	9.8%	12.9%	1.6%	1.6%	1.6%	1.8%	2.2%	1.7%
inadequate prenatal care												
NHW	20.3%	14.4%	8.9%	7.6%	8.9%	10.8%	28.0%	21.6%	15.6%	12.9%	13.8%	15.8%
NHB	32.2%	25.7%	21.1%	20.2%	22.1%	25.1%	39.4%	28.0%	23.5%	22.2%	22.2%	24.7%
MO	29.0%	22.9%	17.1%	14.7%	15.7%	21.7%	36.2%	29.8%	25.2%	23.2%	24.2%	27.5%
Total	25.2%	17.8%	11.2%	9.2%	10.6%	14.1%	35.7%	28.4%	22.7%	19.6%	20.0%	24.4%
unmarried												
NHW	72.5%	37.7%	14.1%	8.1%	9.3%	22.6%	51.1%	21.4%	9.2%	6.5%	7.9%	11.5%
NHB	96.0%	81.6%	59.8%	47.0%	44.9%	72.2%	87.9%	62.5%	38.7%	29.5%	29.3%	41.7%
MO	74.9%	48.6%	29.9%	22.2%	23.2%	46.3%	60.8%	41.9%	30.1%	24.5%	24.7%	35.9%
Total	80.2%	49.0%	21.8%	12.8%	13.8%	33.0%	61.9%	40.6%	26.0%	19.2%	19.3%	30.7%
less than HS education												
NHW	56.2%	18.8%	6.5%	3.4%	3.2%	12.6%	47.5%	17.0%	8.1%	5.4%	5.8%	9.6%
NHB	61.9%	23.1%	13.6%	10.5%	10.5%	27.0%	48.9%	18.1%	13.1%	11.6%	14.5%	16.1%
MO	68.1%	32.5%	21.2%	16.0%	16.5%	36.0%	80.2%	66.7%	62.6%	61.3%	67.1%	66.2%
Total	59.6%	21.1%	8.4%	4.6%	4.5%	16.8%	75.0%	55.2%	44.4%	35.6%	35.2%	46.8%
first birth												
NHW	82.4%	49.9%	40.5%	30.2%	23.6%	41.4%	82.9%	57.7%	46.3%	35.0%	26.4%	41.8%
NHB	73.6%	36.1%	23.1%	20.3%	17.5%	37.9%	82.4%	58.0%	41.2%	27.6%	17.4%	38.2%
MO	74.4%	37.5%	24.2%	19.3%	15.6%	40.4%	77.1%	45.2%	23.7%	13.8%	9.6%	33.7%
Total	78.5%	45.5%	37.0%	28.7%	22.7%	40.7%	78.0%	48.1%	30.9%	22.8%	17.2%	36.1%
high parity												
NHW	0.2%	3.4%	7.2%	10.9%	19.5%	8.4%	0.2%	2.8%	7.0%	10.5%	18.7%	9.6%
NHB	0.9%	11.1%	22.1%	26.3%	32.8%	15.1%	0.3%	3.5%	9.1%	16.3%	29.8%	13.7%
MO	0.5%	7.8%	18.1%	24.9%	33.8%	11.9%	0.4%	4.5%	15.4%	30.7%	49.8%	16.2%
Total	0.5%	5.6%	10.0%	13.1%	21.5%	9.9%	0.3%	4.2%	12.7%	21.9%	34.7%	14.3%
N	3,054,477	5,966,459	6,352,104	5,477,653	3,038,348	23,889,041	394,413	1,067,158	1,216,016	940,203	550,531	4,168,321

[†] Summary measures are calculated using non-missing data. *N*'s include all observations.

Table 4: Multivariate Models: Predicted IMR per 1000, Rate Ratios, and Percent Reduction in Predicted IMR from Observed IMR

Model 1[a]	NHW US			NHW FB			MO US			MO FB			NHB US			NHB FB		
Maternal Age	IMR	%Δ	RR	IMR	%Δ	RR	IMR	%Δ	RR	IMR	%Δ	RR	IMR	%Δ	RR	IMR	%Δ	RR
< 20	9.3	NA	1	8.0	NA	0.85 *	7.2	NA	0.77 *	5.9	NA	0.63 *	14.0	NA	1.50 *	10.8	NA	1.16 *
20-24	6.8	NA	1	5.0	NA	0.73 *	5.8	NA	0.86 *	4.6	NA	0.67 *	13.4	NA	1.96 *	8.6	NA	1.27 *
25-29	5.0	NA	1	4.3	NA	0.87 *	5.5	NA	1.09 *	4.4	NA	0.89 *	13.4	NA	2.67 *	8.9	NA	1.77 *
30-34	4.6	NA	1	4.3	NA	0.94 *	5.8	NA	1.28 *	4.8	NA	1.04 *	14.1	NA	3.07 *	10.0	NA	2.19 *
>34	5.5	NA	1	5.4	NA	0.97	7.7	NA	1.38 *	6.7	NA	1.20 †	14.9	NA	2.68 *	12.0	NA	2.17 *

Model 2[b]	NHW US			NHW FB			MO US			MO FB			NHB US			NHB FB		
Maternal Age	IMR	%Δ	RR	IMR	%Δ	RR	IMR	%Δ	RR	IMR	%Δ	RR	IMR	%Δ	RR	IMR	%Δ	RR
< 20	3.7	60.3%	1	2.9	63.5%	0.78	2.7	62.1%	0.74 *	2.1	64.5%	0.56 *	6.0	57.4%	1.60 *	3.2	70.0%	0.87
20-24	2.2	67.0%	1	1.8	64.2%	0.79 *	1.9	67.5%	0.84 *	1.5	67.0%	0.67 *	4.0	70.2%	1.76 *	1.9	77.8%	0.85
25-29	1.4	72.9%	1	1.2	71.8%	0.90	1.5	71.8%	1.14 *	1.3	70.8%	0.96	3.1	76.5%	2.30 *	1.5	82.9%	1.11
30-34	1.2	74.9%	1	1.0	75.8%	0.90	1.4	76.2%	1.21 *	1.3	73.6%	1.09 *	2.9	79.3%	2.52 *	2.0	80.0%	1.74 *
>34	1.4	75.4%	1	1.2	78.3%	0.85 *	2.2	70.7%	1.65 *	1.9	71.7%	1.38 *	3.6	75.7%	2.63 *	2.5	79.3%	1.82 *

[a] Maternal age only

[b] Maternal age and maternal risk factors: maternal morbidity, labor complications, adequate-plus prenatal care, previous loss, plural birth, smoking, first birth, high parity, inadequate prenatal care, unmarried, and less than 12 years of education. All risk factors are interacted with the dummy variables corresponding to maternal age categories with interactions varying by race/ethnicity and nativity. Models include indicator variables for missing data.

[*] Statistically different from 1.0 $p < 0.05$

[†] Statistically different from 1.0 $p < 0.10$

Table 5: Expected Maternal Age-specific Model-Adjusted IMRs and Rate Ratios Showing Expected Excess Mortality after Model Adjustment.

	Mexican American			Mexican Immigrant		
Maternal Age	**Hypothetical Rate[a]**	**Expected Rate[b]**	**Rate Ratio[c]**	**Hypothetical Rate[a]**	**Expected Rate[b]**	**Rate Ratio[c]**
< 20	2.9	2.7	0.95	2.3	2.1	0.89
20-24	1.9	1.9	0.99	1.5	1.5	1.00
25-29	1.5	1.5	1.04	1.2	1.3	1.08*
30-34	1.5	1.4	0.95	1.2	1.3	1.05
> 34	1.9	2.2	1.19*	1.6	1.9	1.15*

[a] Expected IMR if group experienced the same reduction in rates as US-born non-Hispanic whites.

[b] Expected IMR under Model 2 in Table 4.

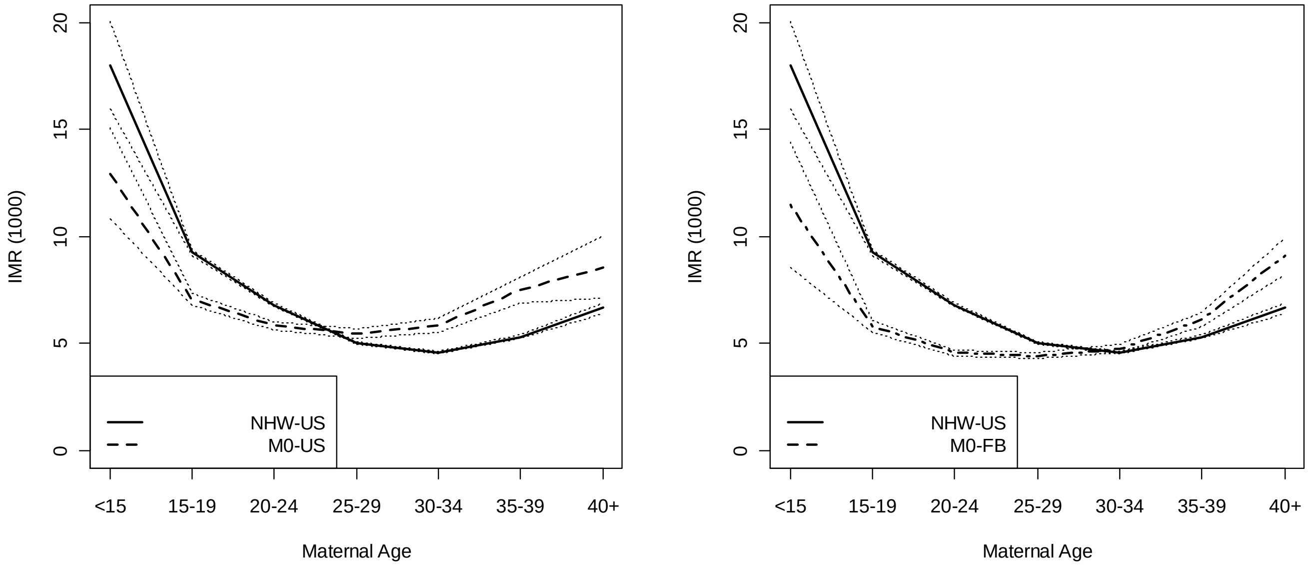
[c] The rate ratio is the ratio of the group's IMR from Model 2 in Table 4 to the expected group's IMR when subject to the reduction in IMR experienced by US-born non-Hispanic whites.

* Significantly different from 1.0 $p < 0.05$

Table 6: IMRs and Rate Ratios: Mothers Age 25 and Older by Education and Marital Status

		MO-US			MO-FB			NHW-US	
	Years of Schooling	**%**	**IMR**	**RR**	**%**	**IMR**	**RR**	**%**	**IMR**
Married	0-12 Years	38.7%	6.05	1.019	61.8%	4.83	0.814*	25.0%	5.93
	13+ Years	34.8%	4.63	1.146*	10.7%	4.32	1.068	64.2%	4.04
	All Levels	73.5%	5.38	1.176*	72.6%	4.76	1.040*	89.2%	4.57
Unmarried	0-12 Years	20.0%	7.63	0.834*	25.1%	5.28	0.577*	6.7%	9.14
	13+ Years	6.5%	6.67	1.018	2.3%	5.54	0.845*	4.1%	6.55
	All Levels	26.5%	7.39	0.906*	27.4%	5.30	0.650*	10.8%	8.15
	Overall	100.0%	5.91	1.192*	100.0%	4.90	0.989	100.0%	4.96
	N	667,548			1,540,659			12,325,121	

* Significantly different from 1.0 $p < 0.05$



(A) (B)

Figure 1: IMR (1,000): (A) Mexican American maternal age-specific IMRs compared to US-born non-Hispanic whites. (B) Mexican immigrant maternal age-specific IMRs compared to US-born non-Hispanic whites.

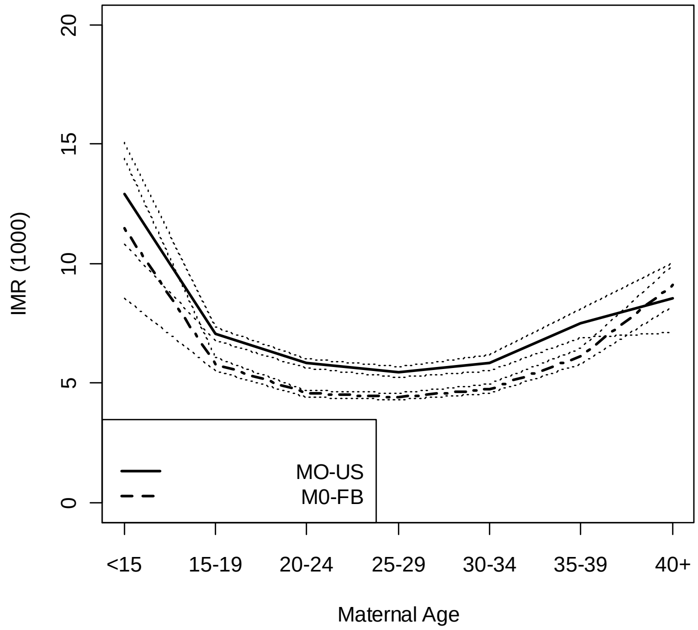


Figure 2: IMR (1,000): Mexican American maternal age-specific IMRs compared to Mexican immigrant