MIGRATION AND INFANT DEATH: ASSIMILATION OR SELECTIVE MIGRATION AMONG PUERTO RICANS?

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Using pooled origin/destination data from the Puerto Rican Maternal and Infant Health Study, we examine the implications for infant mortality of migration from Puerto Rico to the United States. An analysis restricted to the U.S. mainland shows that children of migrants have lower risks of infant mortality than do children of mainland-born Puerto Rican women. A critical question is whether this pattern indicates that maternal exposure to U.S. culture undermines infant health or whether it is largely a result of the selective migration of healthier or more advantaged mothers to the United States. Our findings show that mother's duration of U.S. residence is positively related to infant mortality among the children of migrants, suggesting that a process of negative assimilation is occurring. However, inclusion of Puerto Rico in the analysis demonstrates the importance of selective migration in explaining the U.S. mainland pattern: Infant mortality is substantially lower among recent migrants to the mainland than it is among nonmigrant women in Puerto Rico. The roles of socioeconomic status, cultural orientation, health habits, and health care utilization in accounting for differences in infants' survival chances by maternal migration status are assessed.

THE persistence of racial and ethnic differences in health provides evidence of the tenacity of inequality in the United States. Although exceptions have been documented, disadvantaged minority groups continue to have lower life expectancies and higher rates of chronic disease than do non-Latino whites (Feinstein 1993; Hayward and Heron 1999; Williams and Collins 1995). Prevailing explanations of this pattern emphasize racial and ethnic disparities in socioeconomic status. Because racial and ethnic minorities are often of low socioeconomic position, they may lack the resources required to lead a healthy lifestyle and to obtain high-quality medical care (Krieger et al. 1993; Sorlie, Backlund, and Keller 1995; Williams and Collins 1995).

Research on racial and ethnic differences in infant health is consistent with the broader health literature in its emphasis on socioeconomic resources. In fact, Rowley et al. (1993) argue that a paradigm of poverty has been central to the public health agenda for maternal and infant health throughout the century. Yet, the viability of socioeconomic explanations of racial and ethnic disparities in birth outcomes is increasingly called into question. Studies of the black/white difference in birth outcomes show that, while so-

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cioeconomic status is positively related to favorable birth outcomes among both blacks and whites, the black disadvantage persists at every socioeconomic level (Krieger et al. 1993). At the same time, the birth outcomes of Mexican-origin women are as favorable as those of non-Latino whites, despite a much poorer socioeconomic profile (Guendelman 1995).

These striking inconsistencies with the paradigm of poverty have led to a search for alternative explanations for racial and ethnic disparities in birth outcomes. In particular, the better-than-expected birth outcomes of Mexican-origin women have attracted attention. The leading explanation of this pattern (called the "epidemiological paradox") emphasizes the protective influence of Mexican culture and the loss of that influence with assimilation into U.S. society. Another explanation is that Mexican immigrants are unusually healthy or resourceful because of selective migration. This "healthy immigrant effect" could potentially reduce the risk of poor birth outcomes in the Mexican-origin population as a whole and account for the perplexing finding that foreign-born Mexican-origin women have better birth outcomes than do their U.S.-born counterparts (Guendelman 1995).

Interest in the epidemiological paradox has stimulated considerable recent research, but several issues remain unresolved. First, recent studies based on vital records show that foreign-born mothers have better birth outcomes than do native-born mothers in a number of ethnic groups (Hummer et al. 1999; Landale, Oropesa, and Gorman 1999). However, the extent to which explanations drawn from studies of Mexicans are applicable to other groups is unknown. Second, although numerous studies have addressed the effects of assimilation on pregnant women's health behavior, only a few studies have examined the potentially important role of selective migration (e.g., Weeks, Rumbaut, and Ojeda 1999). This omission is largely a result of data limitations. The impact of selective migration cannot be determined without data that allow for comparisons between nonmigrants in the origin country and migrants in the receiving country. Finally, studies based on vital records or general health surveys typically lack data on key explanatory factors (e.g., immigration history, cultural orientation, social support, stress) that are identified in speculations about how assimilation affects pregnant women's lifestyles. Understanding the role of such factors in promoting or impeding healthy behavior during pregnancy is critical to ascertaining the circumstances under which immigrant women can achieve positive birth outcomes in spite of low socioeconomic status.

We advance the literature on infant health among Latinos by examining the implications of migration to the United States for infant mortality among Puerto Ricans. Although Puerto Ricans have received little attention in studies of migration and infant health, they are an important group to examine because they are one of the three U.S. minority groups with the poorest infant health outcomes.[1] Using pooled origin/destination data from the Puerto Rican Maternal and Infant Health Study (PRMIHS), we compare the risks of infant mortality among the offspring of first- and second-generation women on the U.S. mainland with those of the offspring of women in Puerto Rico. An important focus of our study is the role of selective migration in producing the generational pattern of infant mortality observed in the United States. We also assess the implications of the duration of the mother's exposure to U.S. society for infant health as well as the mechanisms through which exposure may exert an effect.

MIGRATION AND INFANT MORTALITY

The paucity of studies on infant health among Puerto Ricans requires that we draw on the well-developed literature on Mexican Americans to guide our analysis. Two features of the pattern of infant health among Mexican Americans are of interest. First, Mexican Americans and non-Latino whites have similar rates of low birth weight and infant mortality (Guendelman 1995; Scribner

[1] The U.S. Public Health Service identifies Puerto Ricans, Native Americans, and African Americans as groups needing special attention with regard to infant health (U.S. Department of Health and Human Services 1991).

and Dwyer 1989). Second, foreign-born Mexican-origin mothers typically have better birth outcomes than do native-born Mexican-origin mothers (Collins and Shay 1994; Scribner and Dwyer 1989). Although the first observation pertains to intergroup differences and the second to intragroup variation, a single set of explanations has been applied to both phenomena.

The most common explanation is that a Mexican cultural orientation is a protective factor that overrides the negative consequences of socioeconomic disadvantage for infant health (Cobas et al. 1996; Collins and Shay 1994; Guendelman 1995; Scribner and Dwyer 1989; Scribner 1996; Zambrana et al. 1997). Extending this argument, one would expect the offspring of mothers who are most attuned to traditional beliefs and practices to be the most protected. Thus, first-generation immigrants are expected to have especially favorable birth outcomes, which should worsen over time with assimilation to U.S. values and behaviors (Guendelman and English 1995). While the cultural argument is generally silent on the issue of how migrants to the United States compare with nonmigrants at the origin, it implies that children of women in the origin country will also have relatively low infant mortality.[2]

Following this logic, we focus on intragroup differences in infant mortality within the Puerto Rican population to evaluate the cultural argument vis-à-vis other arguments in the literature. Consistent with prior research, we first restrict our attention to Puerto Ricans living in the continental United States. We then extend our analysis to women and children in Puerto Rico to address the selectivity argument and to evaluate the viability of conclusions drawn from data on the mainland population alone.

THE ROLE OF SOCIOECONOMIC STATUS

Although the epidemiological paradox was defined as such because it is contrary to a socioeconomic model, the socioeconomic paradigm remains central to efforts to understand and improve maternal and infant health (Centers for Disease Control and Prevention 1995; Institute of Medicine 1985). Consequently, we discuss potential links between socioeconomic status and infant mortality before considering arguments regarding conditions under which the influence of socioeconomic position may be attenuated.

Numerous studies demonstrate that maternal education is associated negatively with the risk of infant death (Cramer 1987; Eberstein, Nam, and Hummer 1990; Hummer 1993; Landale et al. 1999). The role of income has been studied less extensively because most available data sources (e.g., vital records-based files) lack information on individual or family income. However, a few investigations show the expected negative relationship between income and infant mortality (Centers for Disease Control and Prevention 1995; Gortmaker 1979).

A fundamental issue is how these relationships occur. Clearly, socioeconomic position affects exposure to and vulnerability to risk factors for poor infant health. While some of these risk factors may be social, others must be directly linked to biological processes that compromise survival chances. In the words of Paneth (1995), "Poverty must alter health through biological mechanisms, and much of the work of epidemiology consists of decoding the 'biological expression of social stratification'" (p. 31). In short, socioeconomic position must be linked to infant health through a set of proximate determinants (Eberstein 1989; Mosley and Chen 1984). These proximate determinants include: (1) maternal health, (2) maternal lifestyle, (3) maternal knowledge, and (4) access to medical care (Chomitz, Cheung, and Lieberman 1995; Cramer 1995; Hughes and Simpson 1995; McLean et al. 1993; Rowley et al. 1993; Shiono and Behrman 1995; Shiono et al. 1997; Williams and Collins 1995). Specifically, low socioeconomic status is associated with health problems, such as chronic hypertension, diabetes, and sexually transmitted diseases, that may compromise infant health (Institute of Medicine 1985; Williams and Collins 1995). In addition, disadvantaged women often experience difficult life circumstances that may influence their lifestyles during pregnancy.

[2] In the Mexican case, other factors clearly contribute to differences in infant mortality between migrants and nonmigrants. Infant mortality is considerably higher in Mexico than it is among first-generation Mexicans in the United States.

For example, high levels of stress contribute to poor health behaviors that directly affect the growth and development of the fetus. Examples of such behaviors include inadequate nutrition, smoking, and drinking (Chomitz et al. 1995).

Limited knowledge may further exacerbate the elevated risks of poor birth outcomes among disadvantaged women. Clearly, education increases knowledge about general health practices (e.g., hygiene, nutrition) and healthy behavior during pregnancy. Education also increases women's ability to access information and is associated with autonomy in making decisions regarding appropriate actions (Caldwell and Caldwell 1993; Cleland and van Ginneken 1988).

Education and income are also related to prenatal care.[3] Many studies demonstrate that low-income women face significant barriers to prenatal care (Brown 1989; Guendelman and Witt 1992; Harvey and Faber 1993; Kalmuss and Fennelly 1990; Lia-Hoagburg et al. 1990; McDonald and Coburn 1988; Oropesa et al. 2000). Programs like Medicaid provide access to medical care for those without adequate resources, but Medicaid recipients typically enter prenatal care later and receive fewer prenatal visits than do women with private health insurance (Joyce and Grossman 1990; McDonald and Coburn 1988; St. Clair et al. 1990; Zambrana, Dunkel-Schetter, and Scrimshaw 1991). Still, women with more education are likely to be better able to navigate the system and overcome obstacles to prenatal care.

The socioeconomic argument implies that maternal education and family income are negatively related to infant mortality. Moreover, differences in socioeconomic status may play a key role in explaining variation in infant mortality by maternal migration status. Nonetheless, a woman's socioeconomic position does not necessarily determine her children's destiny. The unexpectedly low rates of low birth weight and infant mortality among Mexican Americans show that positive birth outcomes can be achieved in the face of socioeconomic disadvantage.

[3] However, the empirical evidence supporting a relationship between prenatal care and birth outcomes is equivocal (Alexander and Korenbrot 1995).

Migration, Lifestyle, and Health Habits

The explanations of the Mexican pattern that have received the most research attention stress connections between maternal migration status, assimilation, lifestyle, and health behavior.[4] The central hypothesis is that immigrant mothers (especially recent arrivals) are protected against the adverse effects of socioeconomic disadvantage on infant health because they retain healthy aspects of the origin-country lifestyle and avoid unhealthy behaviors. The negative lifestyle factors that have been emphasized include cigarette smoking, alcohol consumption, and the use of illicit drugs (Collins and Shay 1994; Guendelman 1995; Guendelman and Abrams 1995; Guendelman and English 1995; Landale et al. 1999; Rumbaut and Weeks 1996; Scribner and Dwyer 1989; Zambrana et al. 1997). Dietary intake may also play a role, but the empirical research on this topic is relatively scant (but see Cobas et al. 1996; Guendelman and Abrams 1995).

A related argument is that Latino families lose some of their strengths as assimilation occurs. Traditionally, Latinos have had strong family networks that provide material and social support to those in need. Family support helps pregnant women maintain a healthy lifestyle and avoid harmful behaviors (e.g., smoking and drug use), despite the hardships associated with low income. To the extent that the family becomes less cohesive as its members spend more time in the United States, assimilation may lead to lower levels of social support and poorer health behavior during pregnancy. Examples of a loss of family cohesion include higher rates of single motherhood and less family extension.

Overall, these arguments suggest a process of negative assimilation in which protective influences are lost as immigrants spend time

[4] Alternative explanations of the low infant mortality rate among Mexican Americans, given their socioeconomic status, include the underreporting of infant deaths, ethnic misclassification on the birth and death certificates, and the elimination of weaker fetuses prior to live birth via excess fetal deaths (Guendelman 1995). To date, there is little support for any of these explanations.

in the United States. Understanding this process requires attention to how the values, situations, and behaviors of immigrant groups change with duration of residence and generational succession.

Selective Migration

An alternative perspective focuses on the role of selective migration in the positive birth outcomes of immigrants. Migration is selective on demographic and socioeconomic characteristics, but the nature of the selection process varies across origin countries and over time (Borjas 1990; Massey 1993). Migration may also be selective on traits that are less often measured in surveys, such as general health status, resourcefulness, and motivation to succeed. If immigrants are positively selected on measured or unmeasured attributes that are related to infant health, then migration selectivity may at least partially account for the generational pattern of infant health observed in the United States.

Some scholars acknowledge the potential importance of selective migration for nativity differences in infant health (Guendelman 1995; Guendelman and English 1995; Markides and Coreil 1986; Rumbaut and Weeks 1996), but there is little empirical research on the issue because of a lack of appropriate data (but see Weeks et al. 1999). Understanding the role of selective migration requires pooled origin/destination data with comparable information for nonmigrants in the origin country and for migrants to the United States. Using such data, the infant health outcomes of U.S. migrants can be compared with those of nonmigrants in the origin country. Initial support for the selective migration thesis would be found in a pattern of better birth outcomes among recent U.S. migrants than among women remaining in the origin country. If such a pattern is found, the role of measured characteristics in explaining the finding can be assessed.

The Case of Puerto Ricans

While debates about the health advantages of infants of immigrants have focused on the Mexican-origin population, a few recent studies provide information that places Puerto Ricans in comparative perspective. The socioeconomic disadvantage of mainland Puerto Ricans, relative to both non-Latino whites and other Latino groups, is well documented (e.g., see Bean and Tienda 1987). Unlike the case of Mexican Americans, the infant health outcomes of mainland Puerto Ricans are consistent with their socioeconomic position: Puerto Ricans have higher rates of low birth weight and infant mortality than do non-Latino whites, Mexican Americans, Cuban Americans, and Central/South Americans (Albrecht et al. 1996; Becerra et al. 1991; Collins and Shay 1994; Hummer, Eberstein, and Nam 1992; Landale et al. 1999). However, Puerto Ricans' rates of low birth weight and infant mortality are lower than those of African Americans, although they are roughly comparable to African Americans on a variety of socioeconomic characteristics.

A key aspect of the Mexican pattern is that infants of foreign-born mothers have better health outcomes than do infants of U.S.-born mothers. The extent to which a similar pattern is expected for Puerto Ricans depends in part on one's assessment of the appropriate framework for understanding the experience of Puerto Rican migrants to the U.S. mainland. Because Puerto Rico is a commonwealth of the United States, Puerto Ricans are U.S. citizens with unrestricted movement between the island and the U.S. mainland. Island-to-mainland migration is therefore classified as internal migration. At the same time, Puerto Rican migrants are Spanish-speaking, frequently lack proficiency in English, and are culturally distinct from the U.S. mainstream. These characteristics contribute to a migration experience that entails a significant process of assimilation subsequent to arrival on the mainland. Most prior research regards the experience of Puerto Rican migrants as more akin to that of international migrants than that of internal migrants. Consistent with this viewpoint, we believe that expectations developed from the Mexican case may be applicable to Puerto Ricans.

The research is sparse, but several studies show that the health outcomes of Puerto Rican infants vary according to maternal nativity. For example, the offspring of U.S.-

born Puerto Rican mothers have a higher incidence of low birth weight than do the offspring of mothers born in Puerto Rico (Albrecht et al. 1996; Becerra et al. 1991; Engel, Alexander, and Leland 1995; Landale et al. 1999). In addition, there is some evidence that infants of U.S.-born Puerto Rican mothers have higher rates of intrauterine growth retardation (Engel et al. 1995), very short gestation (Engel et al. 1995), and infant mortality (Becerra et al. 1991; Landale et al. 1999) than do infants of island-born mothers. Nevertheless, the magnitude of the nativity differences in many of these outcomes is small, relative to those found in the Mexican-origin population (Landale et al. 1999).

These initial studies provide important baseline information, but significant gaps remain in our knowledge of the processes underlying the health outcomes of Puerto Rican infants (Lamberty and Garcia Coll 1994). Does the health advantage of the infants of island-born mothers result from lower maternal exposure to the U.S. social context or from the selective migration of healthier or more advantaged mothers from Puerto Rico to the U.S. mainland? What role do socioeconomic circumstances play in the health disparity between infants of migrant and native mothers? To what extent and through what mechanisms does a Latino cultural orientation protect infant health? The answers to these questions will not only contribute to our understanding of infant health among Puerto Ricans, they will also provide additional insight into the generalizability to other ethnic groups of findings based on Mexican Americans.

DATA, MEASURES, AND METHODS

DATA

Apart from data sets compiled from vital records, there are few representative data sources with which to examine the health of Puerto Rican infants.[5] Vital-records-based data are extremely useful because they include information on the full population of births to Puerto Rican women, but their utility for answering many questions is limited because vital records contain information on only a few social and economic variables. More detailed information is often available from clinic-based samples, but such samples are rarely representative of the larger population.

Our analysis overcomes these limitations by using data from the Puerto Rican Maternal and Infant Health Study (PRMIHS), a study of maternal and infant health outcomes among Puerto Ricans in the United States and Puerto Rico.[6] In-person interviews were conducted with 2,763 mothers of infants sampled from the 1994 and 1995 birth and infant death records of six U.S. vital statistics reporting areas (Connecticut, Florida, Massachusetts, New Jersey, New York City, and Pennsylvania)[7] and the Commonwealth of Puerto Rico. Infants in the United States were eligible for inclusion in the birth sample if the Hispanic ethnicity of the mother was designated as Puerto Rican on the birth certificate. Infants who died before their first birthday were eligible for inclusion in the U.S. death sample if they were identified as Puerto Rican on the death certificate or if their mother was classified as Puerto Rican on the birth certificate.[8]

[5] National health surveys appropriate for research on infant health have included too few Puerto Ricans to allow for the study of Puerto Ricans as a separate group.

[6] The data were collected by the Institute for Survey Research at Temple University under a subcontract from the Population Research Institute, Pennsylvania State University.

[7] The U.S. states included in the PRMIHS are those with the greatest number of births to Puerto Rican women each year. In 1994 and 1995, 72.3 percent of all births to mainland Puerto Rican women occurred in these six states.

The state of New York is divided into two separate vital statistics reporting areas, New York City and the remainder of the state. New York City granted permission to conduct the survey, but permission could not be obtained from the State of New York. New York cases are therefore restricted to births and deaths occurring in New York City only.

[8] Because death cases were included in the study based on the decedent's ethnicity (from the death certificate) *or* on the mother's ethnicity (from the birth certificate), there is a minor difference in the selection criteria used for birth and death cases in the U.S. states. An infant identified as Puerto Rican on the death certificate

Roughly two-thirds of the interviews (1,946) were with mothers of infants sampled from the computerized birth certificate files maintained by the states indicated and by Puerto Rico. The remaining 817 interviews were with mothers of infants drawn from death certificates for infant deaths.

Mothers of the sampled infants were located from the address information provided on the vital records and were asked to participate in a Computer Assisted Personal Interview (CAPI). All PRMIHS interviewers were bilingual, and the questionnaire was available in both Spanish and English. Response rates for the birth and death samples, respectively, were 79 percent and 74 percent.

The weighted birth sample is representative of 1994–1995 births to Puerto Rican women residing in the study areas. One limitation of representative samples of births, however, is that typically there are too few infant deaths to allow for the study of infant mortality. To overcome this limitation, the PRMIHS included all death cases in the study areas during the designated time frame. We use this oversample of infant death cases in our analysis of infant mortality.

MEASURES

Our dependent variable is *infant mortality*, a dichotomous measure of whether an infant died before his or her first birthday (1 = yes). Our analysis of infant mortality focuses on several key sets of predictors: mother's migration status, demographic background, socioeconomic position, social support, and cultural orientation. Also considered are more proximate variables through which the former predictors may operate: medical risk factors, health habits, lifestyle, use of medical care, and infant birth weight.

Previous research on the implications of migration for infant health emphasizes the roles of *maternal nativity* and *duration of U.S. residence* (among the foreign-born). In our analysis of infants born on the U.S. mainland, we integrate these approaches by including an indicator of maternal nativity (U.S. mainland versus Puerto Rico) and a measure of the mother's cumulative years of residence on the U.S. mainland.[9] The latter variable was constructed from two sources of information: (1) a question on the number of years each woman lived on the U.S. mainland before her tenth birthday, and (2) a complete migration history starting at age 10. Using the migration history, episodes of U.S. residence from age 10 to the conception of the focal child were cumulated to measure the total number of months of the mother's U.S. residence after her tenth birthday. After conversion to years, exposure from the tenth birthday forward was added to exposure before age 10, resulting in a measure of the total number of years in the United States. In addition, we include a variable measuring the total number of moves between the island and the mainland that the mother made between her tenth birthday and the conception of the focal child.

Parts of our analysis include infants born in Puerto Rico to island-resident mothers. The aforementioned migration variables are also relevant for understanding their mortality risks because many mothers in Puerto Rico have prior experience living in the United States. In addition, the pooled analysis of mainland-born and island-born infants includes the mother's place of residence when the infant was born (U.S. mainland versus Puerto Rico).

whose mother was not listed as Puerto Rican on the birth certificate was considered eligible for the study. Only 4 percent of U.S.-born infants included in the study had mothers who were not identified as Puerto Rican on the birth certificate. In addition, information on ethnicity is not included on the birth and death certificates in Puerto Rico because an extremely high percentage of island residents are of Puerto Rican descent. To avoid inclusion of non-Puerto Rican infants in the study, a question on whether the focal infant was of Puerto Rican descent was included to screen for eligibility. Mothers who answered that their infant was not of Puerto Rican descent were excluded from the study. This screening question was used in both Puerto Rico and in the U.S. states.

[9] The PRMIHS allows us to determine whether mainland-born women are second- or third-generation U.S. residents (i.e., whether their parents were born in the United States). The vast majority of the U.S.-born women in our sample (94 percent) belong to the second generation. Thus, the distinction between mainland-born and island-born women essentially captures generational status.

Demographic risk factors included in the analysis are maternal age, number of previous births, and whether the focal infant was a plural birth. Two measures of socioeconomic status are considered: educational attainment and household income. Education measures the highest grade of school completed by the woman. To measure household income, we asked women to indicate which of 13 categories best represented their total household income around the time the focal baby was conceived. We recoded the categories to their midpoints and treat income as a continuous variable.

Four variables measure the availability of *social support during the pregnancy*. Union status indicates whether the woman resided with a partner at the beginning of the pregnancy and the legal status of the union at that time. The variable was coded into three categories: not living with a partner, living with a partner informally, and living with a partner to whom she was legally married. In addition, each woman provided information on all other individuals living with her at the beginning of the pregnancy. From this household roster, we created a measure of whether extended family members lived in the household. The women also were asked how long it would have taken various relatives to travel from their homes to the woman's home during the months she was pregnant. Relatives included in this set of questions were the respondent's mother, father, and brothers/sisters, as well as her partner's mother, father, and brothers/sisters. To measure the density of social support potentially available from relatives living nearby, we constructed a measure of the number of these relatives reported to be living within one-half hour's distance of the respondent. Finally, the mothers were asked whether there was anyone they could rely on for emotional support or advice during the pregnancy. Our measure of emotional support codes yes responses as 1 and no responses as 0.

A *Latino cultural orientation* also has been identified as potentially protective of pregnant women. To indicate the extent to which respondents were embedded in Latino culture, we include three indirect measures. The first is an additive index constructed from three questions regarding the respondent's use of English versus Spanish at home, with friends, and when watching TV. The responses to each question (English most of the time, Spanish and English about equally, Spanish most of the time) were coded from 1 to 3, with 3 indicating the dominance of Spanish language use. Although it does not directly gauge cultural content, Spanish language use is considered an important component of ethnic identity and attachment to the origin culture (Fishman 1966; Garcia et al. 1988; Sole 1980). Cultural orientation is also linked to social networks (Hammel 1990). Culture is both created and reinforced by communication networks comprised of actors who are engaged in discourse. Because interaction with others of like ethnicity provides opportunities for reinforcement of cultural content (Pollak and Watkins 1993), those with a high proportion of Latino friends and neighbors are likely to have a stronger Latino cultural orientation than others. Hence, we include measures of the ethnic composition of the respondents' friends and neighborhoods. Responses range from 1 to 5, with 1 indicating "all non-Latinos" and 5 indicating "all Latinos."

More proximate determinants of infant health include the *woman's reproductive history and health status*, as well as her health habits and lifestyle during the focal pregnancy. Using a complete fertility history, we constructed indicators of whether the mother ever had a miscarriage and whether she had ever given birth to a low-birth-weight infant. Another measure indicates whether the mother had any of the medical risk factors for the focal pregnancy listed on the birth certificate (excluding previous preterm or small-for-gestational-age infant, which is covered by the aforementioned item).[10]

Our measures of *maternal health habits and lifestyle* include indicators of whether the mother ever smoked or drank alcoholic

[10] The medical risk factors reported on the birth certificate include anemia, cardiac disease, acute or chronic lung disease, diabetes, genital herpes, hydramnios/ oligohydramnios, hemoglobinopathy, chronic hypertension, pregnancy-associated hypertension, eclampsia, incompetent cervix, previous infant weighing 4,000 grams (8.8 pounds) or more, renal disease, Rh sensitization, uterine bleeding, or "other" medical risk factor.

beverages during the focal pregnancy. An additional dichotomous variable indicates inadequate weight gain, which is defined as a gain of less than 22 pounds. Because prior studies indicate that maternal weight must be controlled to properly assess the effect of weight gain during pregnancy (Kramer 1987), we control for the Body Mass Index when examining the effect of inadequate weight gain.[11] Furthermore, we include an *index of stressful life events* as a measure of mothers' lifestyles. Each mother was asked a series of questions about whether she had experienced the following situations *during* the focal pregnancy: (1) "someone very close to you had a bad problem with drinking or drugs," (2) "your husband or partner went to jail," (3) "you were homeless," (4) "you lost your job even though you wanted to go on working," (5) "you had a lot of bills you couldn't pay," (6) "you were involved in a physical fight," and (7) "your husband or partner hit you or physically hurt you." On each of these questions, a no response was coded 0, and a yes response was coded 1. Responses were summed to construct an index with scores that range from 0 to 7. Because of the sensitive nature of the information on stressful life events, smoking, and drinking, the questions on these topics were answered privately using a self-administered questionnaire.

Another set of variables describes the *medical care received* during the focal pregnancy. The timing of prenatal care is measured with an indicator of whether the woman initiated prenatal care during the first trimester. We also asked the mothers a series of questions about specific prenatal care services. The respondents indicated whether a medical professional took a complete family health history and a complete personal health history, as well as whether the respondent received a physical examination, a pelvic examination, a Pap smear, and an ultrasound. An additive index was constructed to measure the number of these services received by the woman during the focal pregnancy. In addition, the mothers indicated whether their prenatal health care provider offered advice about vitamins, nutrition, breast-feeding, drug use, and weight gain during pregnancy. Dichotomous measures of whether the woman received advice on each of these topics were summed to create a prenatal advice index. Furthermore, we include a dichotomous measure of whether the woman participated in the Women, Infants, and Children (WIC) Program during the focal pregnancy. WIC provides both nutritional supplementation and advice/referrals to pregnant women. It is thus an important source of medical information and support for low-income populations.

A final consideration is the close relationship between infant mortality and the *health status of an infant at birth*. An important indicator of compromised infant health at birth is low birth weight. Because low birth weight is a very proximate biological determinant of infant death, most of our models of infant mortality do not include infant birth weight as a predictor. However, we address the role of low birth weight in a final model of infant death to shed light on its importance as a mechanism through which other predictors operate. An infant is considered low birth weight if he/she weighs less than 2,500 grams (5.5 pounds) at birth.

STATISTICAL ANALYSIS

The analysis consists of a series of logistic regression models of infant mortality. The first set of models is restricted to mainland-born infants and documents differences in infants' mortality risks by maternal nativity and duration of U.S. residence. Explanations based on socioeconomic status, social support, cultural orientation, lifestyle, health care utilization, and other factors are assessed. A second component of the analysis focuses on the role of selective migration in producing the migration status differentials. Pooled origin/destination data are utilized to compare the mortality experience of infants of migrants on the mainland to that of infants of nonmigrants in Puerto Rico.

The PRMIHS was based on a complex sample design that involved stratification by state, month, and birth outcome. Low-birth-weight infants were oversampled in the birth sample, and a separate death sample included the full population of

[11] The Body Mass Index is measured as weight in kilograms divided by the square of height in meters.

deaths. Consequently, we estimate our models of infant mortality with SUDAAN, which adjusts coefficients and standard errors to take the sampling design into account. All models are based on weighted data, using the final birth and death sample weights. The weights were adjusted to retain the original sample size.

Cases with missing data are *not* excluded from the analysis. This avoids erroneous inferences that can stem from the rejection of cases in which data are not missing completely at random. Instead, Bayesian procedures for the multiple imputation of missing data are employed (Schafer 1997, 1998).[12] Five imputations were made to generate plausible values for missing data, and the five imputed data sets were then analyzed with standard complete-data methods. The results were combined to yield estimates, standard errors, and p-values that incorporate uncertainty about missing data.

RESULTS

U.S.-Born Infants

Columns 1 and 2 of Table 1 show means and percentages for the predictors included in the analysis of infant mortality among U.S.-born infants, broken down by maternal nativity. Columns 3 and 4 provide parallel information for infants born in Puerto Rico. Focusing on the U.S. sample, several differences between island-born and mainland-born mothers are noteworthy. As expected, U.S.-born mothers have lived in the United States longer and have had fewer island-mainland moves than Puerto Rican-born mothers. U.S.-born mothers also are less likely to be in the oldest age group (35 years and older) and have had fewer births. There is a striking difference between the nativity groups in union status: Fully 38 percent of mainland-born mothers were single at the time of conception, compared with only 23 percent of island-born mothers. Because they are more likely to be single, mainland-born mothers are also more apt to reside with extended family members (42 percent) than are Puerto Rican-born mothers (32 percent). Most often, this represents continued residence in the parental home, which presumably provides some protection for the mother and infant. Differences between the two groups in education and family income are not statistically significant.

Two of the measures of Latino cultural orientation exhibit a pattern that is consistent with our expectations: the language-use index and the measure of the ethnic composition of the respondent's friends. On both measures, U.S.-born women exhibit a weaker orientation toward Latino culture than do migrant women. In addition, mainland- born women experience a greater number of stressful life events during pregnancy than do island-born women. They also receive slightly fewer prenatal care services and slightly less prenatal advice, and are substantially less likely to participate in the WIC program.

Overall, the results in Table 1 for the U.S. sample suggest that education and income are unlikely to play key roles in explaining nativity differences in infant mortality. Risk factors that exhibit greater variation by maternal nativity hold more promise as explanatory factors. For example, U.S.-born women are more likely to be single and to experience difficult life events during pregnancy. Further, to the extent that Spanish language use and association with Latinos reinforce cultural values that contribute to healthy behavior, mainland-born women are less protected than are island-born women.

Table 2 provides results from logistic regression models for Puerto Rican infants born in the United States. The first column presents odds ratios from bivariate models of infant mortality. Model 1 incorporates all of the migration-related variables. An interaction term representing the multiplicative interaction between mother's birthplace and years of U.S. residence is included in Model 1 (and all subsequent models) because the relationship between maternal exposure to the U.S. social context and infant mortality differs by maternal nativity. The remaining models introduce, in turn, the various sets of

[12] The percentage of cases with missing data ranged from 0 percent for infant mortality and a number of predictors (e.g., mother's birthplace, mother's place of residence, age, number of previous births, education) to 7.7 percent for the index of stressful life events. On most variables, fewer than 4.0 percent of cases were missing.

Table 1. Summary Statistics for Variables Used in the Analysis of Infant Mortality among Puerto Ricans, by Mother and Infant's Residence and Mother's Birthplace, 1994–1995

Variable	Mother and Infant are U.S. Residents		Mother and Infant are Residents of Puerto Rico	
	Mother Born in Puerto Rico	Mother Born in U.S.	Mother Born in Puerto Rico	Mother Born in U.S.
Years of U.S. residence (mean)	12.9	22.1***	.7***	8.0***
Number of moves (age ≥ 10) (mean)	.8	.3***	.2***	.7
Age (percent):				
< 20 years	23.0	26.4	20.8	19.4
20 to 34 years	66.1	67.9	72.7	78.5
≥ 35 years	10.9	5.7*	6.5*	2.1
Number of previous births (mean)	1.3	1.0*	1.1	1.2
Infant was a plural birth (percent)	1.2	1.0	1.7	1.3
Highest grade of school completed (mean)	11.4	11.7	12.0*	13.2***
Family income (mean)	$18,839	$20,849	$14,322**	$15,082
Union Status (percent):				
Single	23.0	38.3***	16.0*	23.5
Cohabiting	43.7	37.6	35.8	27.4*
Married	33.3	24.1*	48.2***	49.1*
Extended family in household (percent)	31.9	42.3*	31.6	35.0
Number of relatives nearby (mean)	4.0	4.2	6.4***	5.3*
Emotional support (percent)	80.8	83.1	87.2	90.4
Language-use index (mean)	6.2	4.6***	—	—
Latino friends (mean)	3.7	3.4***	—	—
Latino neighbors (mean)	3.0	2.9	—	—
Previous miscarriage (percent)	25.2	24.7	18.0*	20.6
Previous low-birth-weight infant (percent)	15.2	8.0*	11.8	8.0
Medical risk factors (percent)	30.3	23.8	14.7***	17.1
Smoked during pregnancy (percent)	11.9	16.8	4.2**	10.7
Drank alcohol during pregnancy (percent)	4.3	4.1	6.3	7.0
Body mass index (mean)	24.8	25.0	24.1	23.0*
Low weight gain (< 22 lb.) (percent)	36.1	27.3	34.9	25.7
Stressful life events index (mean)	.8	1.2***	.8	.9
Early prenatal care (percent)	73.2	75.4	78.3	69.1
Prenatal care services index (mean)	5.6	5.4*	5.5	5.5
Prenatal advice index (mean)	4.5	4.3**	4.6	4.6
WIC program participant (percent)	75.4	66.4*	85.5**	79.3
Infant low-birth-weight (percent)	9.4	10.1	10.1	9.7
Number of cases	221	776	585	84

Note: The summary statistics are based on the birth sample. Significance tests indicate whether the group mean (or percentage) is significantly different from that for Puerto-Rican born mothers living in the United States (column 1).

*$p < .05$ **$p < .01$ ***$p < .001$ (two-tailed t-tests)

Table 2. Odds Ratios from Logistic Regressions of Infant Mortality on Selected Independent Variables: Puerto Rican Infants Born in the United States, 1994–1995

Independent Variable	Bivariate	Model 1	Model 2	Model 3	Model 4	Model 5
U.S.-born	1.16	2.67***	1.95*	1.95*	1.75	1.71
Years of U.S. residence	1.01	1.02*	1.04**	1.04***	1.04**	1.03*
U.S.-born × Years of U.S. residence	—	.95***	.96*	.96**	.97*	.97*
Number of moves (age ≥ 10)	.86*	.89	.91	.93	.93	.94
Age:						
< 20 years	1.67***	—	1.77***	1.71**	1.69**	1.44*
20 to 34 years	—	—	—	—	—	—
≥ 35 years	1.12	—	.86	.75	.79	.83
Number of previous births	.99	—	1.00	.84**	.84**	.93
Infant was a plural birth	6.30***	—	6.63***	6.64***	6.78***	1.41
Highest grade of school completed	.92***	—	.95	.93*	.78**	.80**
Family income	1.00	—	1.00	1.00	1.01*	1.01
Union Status:						
Single	—	—	—	—	—	—
Cohabiting	1.07	—	1.17	1.13	1.25	1.45
Married	.78	—	1.01	.89	1.39	1.28
Extended family in household	1.15	—	.87	.83	.80	.86
Number of relatives nearby	.98	—	.96*	.97	.97	.97*
Emotional support	.79	—	.81	.98	1.00	1.17
Language-use index	.97	—	1.04	1.08	.78	.79
Latino friends	.99	—	.94	.94	.93	.97
Latino neighbors	1.10*	—	1.12*	1.19**	1.17**	1.10*
Previous miscarriage	1.58***	—	—	1.58**	1.59**	1.49**
Previous low-birth-weight infant	1.94***	—	—	2.13***	2.12***	.99
Medical risk factors	1.98***	—	—	1.88***	1.88***	1.26
Smoked during pregnancy	1.57**	—	—	1.34	1.33	1.31
Drank alcohol during pregnancy	1.57	—	—	1.29	1.33	1.56
Body mass index	.98	—	—	.97*	.97*	.99
Low weight gain (< 22 lb.)	2.16***	—	—	2.25***	2.29***	1.31*
Stressful life events index	1.09	—	—	1.04	1.03	.97
Early prenatal care	.88	—	—	1.01	1.02	.96
Prenatal care services index	.80***	—	—	.95	.95	.97
Prenatal advice index	.77***	—	—	.84**	.84**	.88*
WIC program participant	.78*	—	—	.72*	.68**	.72*
Infant low-birth-weight	19.93***	—	—	—	—	16.90***
Interactions:						
Income × cohabiting	—	—	—	—	.99	.99
Income × married	—	—	—	—	.98**	.98*
Education × language-use index	—	—	—	—	1.03*	1.02
Intercept	—	.32***	.35	.87	5.75	1.94
Number of cases	1,607	1,607	1,607	1,607	1,607	1,607

*$p < .05$ **$p < .01$ ***$p < .001$ (two-tailed tests)

explanatory factors and test for key interactions identified in the preceding sections.

Parameter estimates from the bivariate models suggest that infant mortality is not associated with the migration-related variables, with the exception of the number of moves the mother made after age 10. However, as noted above, maternal birthplace and years of U.S. residence must be examined jointly. Thus, we postpone consideration of these variables until Model 1 is introduced.

The bivariate models show elevated risks of infant mortality among the children of young mothers (less than age 20) and mothers with relatively low educational attainment. In contrast, household income is only marginally related, at best, to infant mortality (p = .09).[13] Thus, education appears to be more important than income in determining infant survival in the mainland Puerto Rican population.

We find little evidence in the bivariate models that social support is related to infant mortality, although being married (p = .07) and having a source of emotional support (p = .10) *may* be protective factors. In addition, there is no indication in the bivariate models that a Latino cultural orientation is protective for Puerto Rican women. Of the three measures of cultural orientation, only having a high proportion of Latino neighbors is related to the risk of infant death. In contrast to our expectations, those who live in a predominantly Latino neighborhood have higher risks of infant mortality than others. Interpretation of this relationship is complicated by the fact that predominantly Latino neighborhoods are often impoverished. It may be that living in a disadvantaged environment, rather than contact with other Latinos, elevates the risk of infant death.

The variables most closely related to infant mortality in the bivariate models are those measuring the mother's reproductive history, health habits, and prenatal care—and the infant's plurality and birth weight. The odds of infant mortality are 58 percent higher for infants whose mothers had a previous miscarriage than for infants whose mothers did not. Similarly, the odds of death are twice as high for infants born to mothers with a prior low-birth-weight infant or with one or more medical risk factors during the focal pregnancy. As is amply documented in prior studies, smoking and low weight gain during pregnancy are also significant risk factors for infant mortality.

In contrast to other studies, we measured the *content* of prenatal care in addition to its timing. Both the prenatal-care-services index and the prenatal-advice index are negatively related to infant mortality, suggesting that screening and advice obtained during prenatal care influence infant health outcomes. In addition, participants in the WIC program have a significantly lower rate of infant mortality than do nonparticipants. As expected, the odds of infant mortality are substantially higher for plural births (odds ratio = 6.3) and for low-birth-weight infants (odds ratio = 19.9).

Model 1 provides information on the nature of the relationships between maternal birthplace, exposure to the U.S. social context, and infant mortality. The odds ratios indicate that the risk of death is higher for infants of mainland-born mothers than it is for infants of island-born mothers, but the magnitude of the difference depends upon duration of U.S. residence. For migrant women, the implications of length of residence are shown in the main effect for years of U.S. residence, which indicates that their risk of infant mortality rises with additional years spent in the United States (odds ratio = 1.02). For U.S.-born mothers, the relationship between duration of residence and infant mortality must be determined by considering both the main effect and the interaction term (odds ratio = 1.02 × .95 = .97). The relatively high risk of infant mortality for children of U.S.-born mothers declines with duration of residence (which is closely linked to age for the U.S.-born group).

To illustrate these relationships, Figure 1 shows the relative odds of infant mortality implied by Model 1 for migrant women with varying durations of exposure to the U.S. social context and for U.S.-born women.

[13] The odds ratio for income is .9952 prior to rounding. We also constructed a measure of whether family income was below the poverty line, as defined by the U.S. Bureau of the Census. The results for this dichotomous measure of poverty status were essentially the same as those for the continuous measure of income.

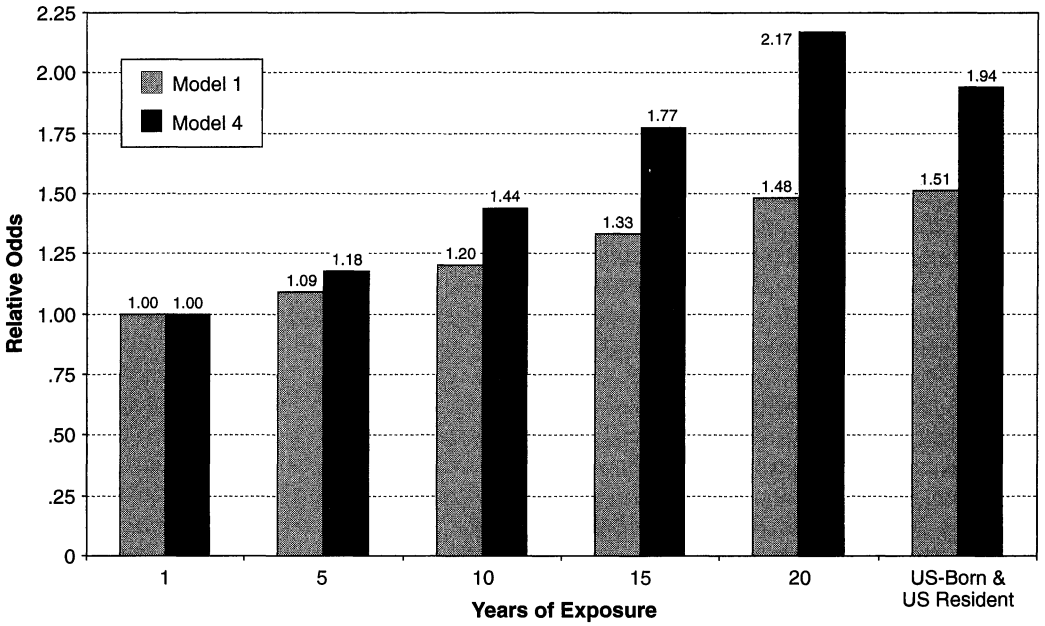

Figure 1. Relative Odds of Infant Mortality: Models 1 and 4, Table 2

(The figure also provides results for Model 4.) For illustrative purposes, the value for migrant women with one year of residence in the United States is set to 1.0. The relative odds for migrant women with 5, 10, 15, and 20 years of U.S. residence and for U.S.-born women (assuming 20 years of U.S. residence) are presented.

The relative odds implied by Model 1 (gray bars) show that the odds of infant mortality are 9 percent higher for infants born to migrants who have lived in the United States for 5 years than for infants born to migrants who have lived in the United States for 1 year. For infants of migrants with 10 and 15 years of U.S. residence, respectively, the odds are 20 percent and 33 percent higher. Infants born to migrants with 20 years of U.S. residence have roughly the same odds of dying before age one as infants of U.S.-born Puerto Rican women (about 50 percent higher than the odds for migrants with 1 year of U.S. residence). Thus, although infants of migrant women from Puerto Rico generally have lower mortality risks than do infants of native-born mothers, there is strong evidence that infant mortality risks rise with years of exposure to U.S. society.

The subsequent models in Table 2 assess the extent to which this pattern can be explained by the sets of factors we measured. Model 2 includes demographic characteristics, socioeconomic status, social support, and cultural orientation. Inclusion of these variables decreases substantially the odds ratio for infant mortality among U.S.-born Puerto Rican mothers compared with island-born mothers, while slightly increasing the odds ratio for years of U.S. residence (for migrant women). As was the case for the bivariate models, significant risk factors for infant mortality include plurality, young maternal age, and maternal residence in a predominantly Latino neighborhood. Protective factors include maternal education (marginally significant at $p = .07$) and having a relatively large number of relatives living nearby.

Model 3 adds reproductive history, medical risk factors, health habits, stressful life events, and the timing and content of prenatal care. Many of these factors are strongly related to infant mortality, but the results for the migration variables do not change when they are added to the model. As expected, a prior history of poor reproductive outcomes, medical risks during the focal pregnancy, and low weight gain increase the risks of infant mortality. Receipt of prenatal advice and participation in the WIC program are negatively

related to infant death. Note that education remains significant net of health care utilization indicators. This suggests that education influences infant mortality through mechanisms other than the better ability of well-educated mothers to access medical care.

INTERACTION TESTING. A key hypothesis in the literature on the epidemiological paradox among Mexican Americans is that social and cultural resources buffer the negative effects of low socioeconomic status on infant health. To address this hypothesis, we tested for interactions between each of the socioeconomic variables (family income and education) and the measures of social support and cultural orientation. All interaction tests were conducted using Model 3 as the baseline model. Significant interactions were found between income and union status and between education and the language-use index (Model 4).

The interaction between income and union status reveals that income is positively related to infant mortality among single mothers (odds ratio = 1.01), but is not related to infant mortality among married mothers (odds ratio = 1.01 × .98 = .99).[14] The positive relationship for single mothers may be related to the complexities of their situations: About 68 percent of the single mothers in our sample lived with family members other than their partner or their children, compared with 32 percent of cohabiting women and 13 percent of married women. The single women living with other family members had substantially higher mean household incomes than did other single women (about $16,000 versus $11,000). If the single women with the highest risk profile are those *most* likely to reside with relatives (e.g., their parents), then negative selectivity into coresidence (and thus, higher income) may underlie the unexpected positive relationship between income and infant mortality among the single women.

The relationship between maternal education and infant mortality varies with Spanish language use. The results suggest that maternal education decreases the risk of infant mortality among mothers who use English most of the time (odds ratio = .78), but the effect of maternal education weakens as Spanish use increases. At the same time, Spanish language use is a protective factor among those with little education, but matters less among those with more education. In the context of this analysis, Spanish language use is considered a general indicator of the extent to which women are embedded in the Latino community. Thus, this interaction is consistent with the idea that low socioeconomic status (i.e., limited educational attainment) is less of a risk factor for poor infant health among women who retain aspects of traditional Latino culture.

The relative odds of infant mortality calculated from the migration variables in Model 4 are presented in Figure 1 (black bars). The migration status differentials implied by Model 4 are stronger than those implied by Model 1. This is largely because the positive coefficient for years of U.S. residence for migrant women is stronger in Model 4 than it is in Model 1, while duration of U.S. residence no longer has a negative effect on infant mortality among mainland-born women (odds ratio = 1.04 × .97 = 1.01). Net of all predictors, the odds of infant mortality are about twice as high for infants of migrants with 20 years of U.S. residence and for U.S.-born Puerto Rican mothers than they are for migrants with 1 year of U.S. residence.

Model 5 controls for low birth weight, a powerful proximate determinant of infant mortality. The pattern of results for the migration variables is essentially unchanged when low birth weight is added to the model. However, plurality, previous poor birth outcomes (miscarriage and low-birth-weight infant), and medical risk factors are no longer significant when low birth weight is controlled. Thus, these factors appear to influence infant mortality through their effects on low birth weight.

INFANTS BORN IN THE UNITED STATES AND PUERTO RICO

Overall, the results in Table 2 are consistent with the idea of negative assimilation—that

[14] When separate models of infant mortality are estimated for the women in each union status group (not shown), the coefficient for income is positive and significant in the model for single women and nonsignificant in the models for cohabiting women and married women.

Table 3. Odds Ratios from Logistic Regressions of Infant Mortality on Selected Independent Variables: Puerto Rican Infants Born in the United States and Puerto Rico, 1994–1995

Independent Variable	Bivariate	Model 1	Model 2[a]	Model 3[b]	Model 4[c]	Model 5[d]
U.S.-born	1.09	1.64**	1.56*	1.69**	1.70**	1.84***
U.S. resident	.89***	.72**	.59***	.50***	.50***	.59***
Years of U.S. residence	1.00	1.02*	1.02**	1.03**	1.03**	1.02**
U.S.-born × Years of U.S. residence	—	.97**	.97**	.97**	.97**	.96***
Number of cases	2,723	2,723	2,723	2,723	2,723	2,723

[a] Model controls for age, number of previous births, plural birth, highest grade of school completed, family income, union status, extended family in household, number of relatives nearby, and emotional support.

[b] Model controls for all variables in Model 2 and previous miscarriage, previous low-birth-weight infant, medical risk factors, smoked during pregnancy, drank alcohol during pregnancy, body mass index, low weight gain, stressful life events index, early prenatal care, prenatal care services index, prenatal advice index, and WIC program participant.

[c] Model includes controls for all variables in Model 3 and income × union status and income × emotional support.

[d] Model includes controls for all variables in Model 4 and infant low birth weight.

*$p < .05$ **$p < .01$ ***$p < .001$ (two-tailed tests)

is, exposure to conditions on the U.S. mainland contributes to deteriorating outcomes for Puerto Rican migrants. Although this interpretation concurs with explanations commonly offered in studies of the Mexican-origin population, an alternative perspective focuses on selective migration. Migrants from Puerto Rico to the U.S. mainland may be positively selected on health or other attributes related to health. Positive selectivity may at least partially account for the favorable birth outcomes of recent migrants, relative to mainland-born women. Differences in the mortality risks of infants of recent and earlier migrants may result from changes in migration selectivity over time or from the joint effects of selective migration and negative assimilation.

In Table 3, we use the pooled sample of Puerto Rican infants born in Puerto Rico and the United States to compare the mortality risks of infants of recent migrants with the mortality risks of infants in the origin population. We also assess the extent to which any difference is explicable in terms of measured characteristics. The odds ratios are derived from a series of models identical to those in Table 2 (Models 1 to 4) except that a measure of place of residence (the United States versus Puerto Rico) is included and the measures of Latino cultural orientation are excluded. The cultural orientation measures are excluded because the variables are not applicable to women in Puerto Rico, given the universality of Spanish language use and association with Latino friends and neighbors. Because of space limitations, the odds ratios for the explanatory variables are not shown. (They are available from the authors on request.)

Model 1 shows that infants of U.S.-born mothers have higher risks of dying before age one than infants of island-born mothers, but the effect of years of U.S. residence varies according to maternal nativity. Duration of U.S. residence is positively related to infant mortality among the island-born mothers (odds ratio = 1.02), but the relationship is negative and not significant for the native-born (odds ratio = 1.02 × .97 = .99). In addition, the odds of infant mortality are reduced by current residence in the United States (odds ratio = .72).[15]

Figure 2 depicts the joint effects of the migration-related variables in Model 1 (gray bars). The relative odds of infant mortality are shown for groups with various durations in the United States, again using migrant

[15] We also tested for an interaction between current place of residence and years of U.S. residence. The effect of experience in the United States does not differ for mainland-resident and island-resident women.

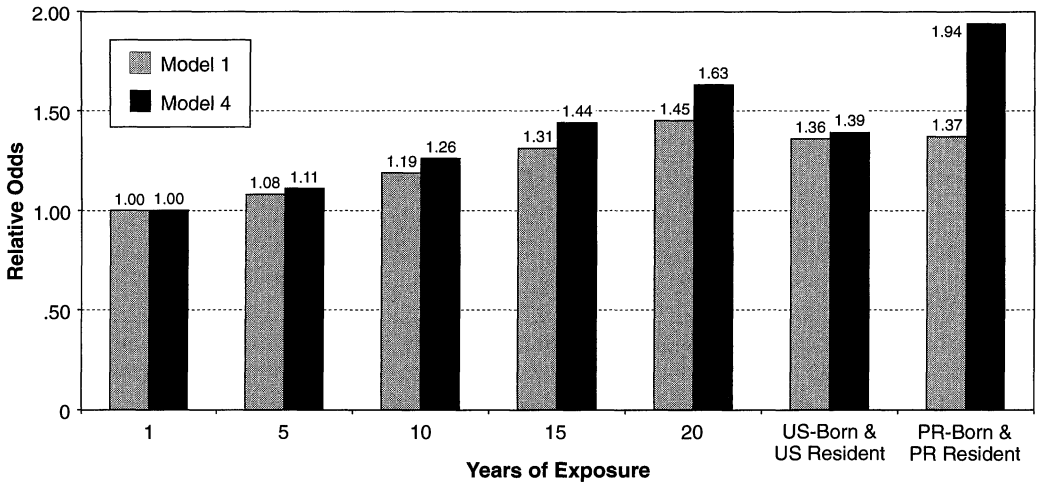

Figure 2. Relative Odds of Infant Mortality: Models 1 and 4, Table 3

women with one year of U.S. residence as the point of comparison (i.e., their value is set to 1.0). The relative odds of infant mortality for Puerto Rican-born women living in Puerto Rico (assuming no prior U.S. residence) are also shown.

Consistent with Figure 1, the results for Model 1 in Figure 2 show that infants of migrant women have higher risks of infant mortality the longer their mothers have lived in the United States. The mortality risks of infants of migrant mothers with 15 to 20 years of U.S. residence are roughly comparable to those of infants of U.S.-born mainland mothers. More important for understanding the potential effects of selective migration, however, is the contrast between recent migrants and nonmigrant women still living in Puerto Rico. If recent migrants are representative of the origin population, one would expect similar risks of infant mortality for these two groups. Model 1 of Figure 2 does not show such a pattern: The odds of infant mortality are 37 percent higher for infants of nonmigrant women in Puerto Rico than they are for infants of migrants with one year of U.S. residence.

In Models 2 through 4 (Table 3), a similar pattern persists for the migration variables, except that the relationship between U.S. residence and infant mortality is strengthened with the inclusion of additional controls. Model 4 of Figure 2 shows that the difference in mortality risks between recent migrants and nonmigrant women in Puerto Rico cannot be explained by the factors included in the model. In Model 4, the odds of infant mortality are almost two times greater for the offspring of nonmigrant women in Puerto Rico than they are for the offspring of recent migrants to the U.S. mainland. This pattern suggests that migration is selective on unmeasured characteristics related to infant health.[16]

CONCLUSIONS

Consistent with a growing body of research that demonstrates that assimilation does not always result in positive outcomes (Hernandez and Charney 1998), our analysis of Puerto Rican women on the U.S. mainland shows that those who have lived in the United States the longest have the poorest birth outcomes: Both mainland-born women and long-standing mainland residents born in Puerto Rico have higher rates of infant

[16] As in the mainland-only analysis, Model 4 in the pooled analysis includes all significant interactions between education and income—and the measures of social support. The interaction between union status and income is consistent with that presented in the mainland-only analysis. However, Model 4 in the pooled analysis also includes an interaction between income and emotional support. The interaction indicates that at low levels of income, the presence of emotional support is not related to infant mortality. At higher income levels, emotional support for mothers reduces the risk of infant mortality.

mortality than do recent migrants to the mainland. This pattern persists net of an extensive set of demographic and socioeconomic controls.

Most prior studies of migration and infant health have based their conclusions only on U.S. data. In contrast, our study placed the patterns found in the United States in a broader perspective by including comparisons with the area of origin. The use of pooled origin/destination data allows us to contrast the infant mortality experience of recent migrants with that of nonmigrant women living in Puerto Rico. Our analysis indicates that the risk of infant mortality is substantially lower among migrants with relatively few years of residence on the mainland than it is among women who remain in Puerto Rico. This is the case both before and after demographic and socioeconomic controls are included in the model. The striking difference in infant mortality between recent migrants and the population from which they came (Puerto Rican–born women living in Puerto Rico) suggests that selective migration contributes to the pattern observed in the United States. Migrant women appear to be self-selected on unmeasured characteristics related to the survival chances of their infants. These may include attributes such as general health, resourcefulness, and motivation to succeed.

Explanations of the favorable birth outcomes among immigrant women generally emphasize the protective aspects of their origin cultures. In our analysis of the mainland sample of Puerto Rican women, the pattern of differences in infant mortality by maternal migration status appears to be consistent with this cultural hypothesis. However, inclusion of the origin sample calls into question the logic underlying this explanation. If beliefs and practices drawn from the origin culture are central to the favorable birth outcomes of migrants living on the mainland, then nonmigrants at the origin should be similarly protected. Clearly, this is not the case. In the model restricted to the migration-related variables, the risk of infant mortality for nonmigrant women in Puerto Rico is roughly similar to that for U.S.-born mainland Puerto Rican women and considerably higher than that for recent migrant women. In the full model (excluding the low-birth-weight variable), the odds of infant mortality are considerably higher among nonmigrant women in Puerto Rico than they are among all groups of mainland women. While other differences between the mainland and island contexts may contribute to the relatively high rate of infant mortality in Puerto Rico,[17] the results from the pooled analysis are more consistent with an emphasis on selective migration than an emphasis on protective cultural content.

Nonetheless, we find some evidence that a strong orientation toward Puerto Rican culture does reduce the impact of low socioeconomic status on the health of the offspring of mainland women. In our analysis of infant mortality on the mainland, a significant interaction was found between maternal language use and maternal education. Among those with little education, Spanish language use is an important protective factor, but use of Spanish declines in importance as education rises. Education has a stronger impact on infant mortality among mothers who are predominantly English-speaking than among mothers who speak Spanish most of the time. In short, there is a weaker health disadvantage associated with low education among those who interact in Spanish than among those who do not.

A wide variety of important explanatory variables were included in our analysis: demographic risk factors, socioeconomic status, family circumstances, cultural orientation, stressful life events, social support, health habits, medical risk factors, and prenatal care. Still, we have been unable to determine why the health advantage of infants of recent migrants erodes as duration of U.S. residence increases. One possibility is that migration selectivity has changed over time so that recent migrants are more distinct from the origin population (on unmeasured characteristics) than are earlier migrants.

[17] For example, Becerra, Saliceti, and Smith (1989) suggest that there may be problems of access to or quality of neonatal intensive care in Puerto Rico. Consequently, high-risk newborns in the United States may be more likely than high-risk newborns in Puerto Rico to receive the medical interventions necessary to ensure their survival.

Rivera-Batiz and Santiago's (1996) analysis of 1980 and 1990 census data from Puerto Rico and the United States finds no support for the thesis that migrants to the mainland have become more positively selected over time. Nonetheless, further research on selectivity patterns in the island/mainland migration stream is needed, especially with regard to social psychological attributes that typically remain unmeasured.

Another possibility is that both selective migration and negative assimilation are operating—that is, migration may be selective on positive qualities that are then lost with exposure to life in the United States. Puerto Rican migrants often experience a set of circumstances that have been identified as major risk factors for negative assimilation (Portes and Zhou 1993; Zhou 1997). For example, they have relatively low educational attainment and limited economic resources (Bean and Tienda 1987; Rivera-Batiz and Santiago 1996). They tend to settle in central-city areas of large Northeastern cities, where they experience high rates of joblessness, discrimination, and exposure to negative influences of subcultures of native-born minorities. A more complete understanding of how such conditions affect the outlook and behavior of Puerto Rican migrants (and consequently, the health of their offspring) might be obtained by incorporating a longitudinal component into the origin/destination research framework.

In closing, we draw attention to the merits of using pooled data from origin and destination locales in the study of the implications of migration for infant health. Too often, research on this topic is based exclusively on U.S. data, and the processes of migration and assimilation are represented by a single variable for maternal nativity. Increasingly, studies demonstrate that migration and assimilation are complex processes. For example, migration is generally selective, individuals often migrate back and forth between origin and destination, and the outcomes experienced by migrants vary according to time in the destination. By drawing representative samples of births to Puerto Rican mothers in the United States and in Puerto Rico—and by collecting from the mothers detailed data on migration and other circumstances—we have been able to address the ramifications of some of these complexities for infant health. We hope that future studies of other migrant groups will adopt similar origin/destination frameworks. Only when we understand more fully how migration and assimilation influence women's lives can we begin to identify the mechanisms through which the migration process is linked to infant survival.

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