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HOW THE MARRIAGE ADVANTAGE IN INFANT HEALTH OUTCOMES INTERSECTS WITH FAMILY-OF-ORIGIN, PRENATAL, AND NEIGHBORHOOD ENVIRONMENTS

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ABSTRACT

In recent decades, health disparities have gained increased attention among sociological audiences. Implicit in much of this literature is an emphasis on social stratification processes that are produced and reproduced through interactions between individuals and social structures such as families and neighborhoods. Families play a potentially large role in both the development and reproduction of health disparities across generations. However, sociological exploration into the impact of families on one particular health disparity—infant health outcomes (such as low birth weight and preterm birth)—has been relatively minimal. Using multiple data sources, this dissertation provides an in-depth exploration of when and why family structure affects infant health outcomes.

This monograph begins by exploring a benefits-of-marriage hypothesis which contrasts two explanations of the marriage advantage: a life course or selection model (positing that the observed advantages are grounded in women's experiences in prior life stages such as childhood and adolescence) and a mediation model (positing that marriage leads to positive prenatal health characteristics, which in turn lead to better infant health outcomes). Findings indicate that the marriage advantage is diminished but not eradicated with the inclusion of a rich set of childhood environment characteristics. Subsequent exploration using fixed-effects models demonstrates the salience of the marriage advantage between married and single women within a recent, nationally-representative sample of households, but finds no difference between married and cohabiting women. The married-single disparity is partially explained by increased rates of prenatal smoking among single women. Results for two other measures of infant health—low birth weight and preterm birth—indicate no evidence of a marriage advantage within a fixed-effects framework. In sum, the results demonstrate greater support for a life course or selection approach although it is clear that these processes do not account for the entire advantage.

Second, this monograph explores a different dimension of the marriage advantage: Are risky neighborhood environments more weakly related to infant health outcomes among married women compared with cohabiting or single women? Drawing upon fundamental cause theory and the buffering hypothesis, multilevel regression results indicate that mother-father relationship status is one type of interpersonal resource that differentially buffers women from the effects of living within stressful social environments. In neighborhoods characterized by high levels of violent and serious property crimes, cohabitation (and perhaps singlehood) are more risky (compared with marriage) than in neighborhoods with relatively low levels of crime—and this disadvantage exists above and beyond measures of a host of human capital, sociodemographic, family background, and pregnancy characteristics.

Third, this monograph addresses why single mothers have historically exhibited poorer infant health outcomes by examining intergenerational (mother-daughter) transmissions of infant health risk. Structural equation models indicate that previously-documented mother-daughter similarities in birth weight may be at least partly spurious in that intergenerational transmissions of educational attainment and sociobehavioral modeling accounted for half of the mother-daughter similarity in the risk of low birth weight when subgroups of non-poor and poor women were compared, and partially accounted for the mother-daughter similarity in birth weight (adjusted for preterm birth status). Furthermore, the effect of education on birth weight and the risk of low birth weight operated indirectly through nonmarital birth status. Findings demonstrate the importance of including this broader intergenerational context in future investigations of infant health outcomes—especially with respect to

research that intends to inform policies related to preventing infant health risk and reducing infant health disparities.

In sum, this dissertation contributes to both health disparities and family sociology literatures by producing theoretical, methodological, and policy-oriented insights related to the formation of infant health disparities that affect long-term human development and social investment.

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CHAPTER 1: INTRODUCTION

In recent years, sociological and demographic audiences have witnessed an upsurge of interest in studies linking social environments to the formation of health disparities. While much of this research focuses on health outcomes that manifest themselves within individuals over the life course (such as obesity, asthma, or heart disease), a much smaller body of work traces the impact of poor health from one generation to the next through women's health outcomes at the time of a birth (such as having a low birth weight, preterm, or small for gestational age baby). Yet we know that women in poor health exhibit higher rates of low birth weight and preterm birth, and in turn, these infants are more likely to experience subsequent decrements in physical and social well-being across the life course including Type 2 diabetes, obesity, heart disease, poor bone density, cerebral palsy, deafness, impaired cognitive ability, poorer neuromotor functioning, and lower educational attainment (Chomitz et al. 1995; Conley & Bennett 2000; Reichman 2005; Goldenberg et al. 2008).

Together, these findings suggest that: (1) there are numerous social and health consequences of poor infant health that reverberate across the life course, (2) infant health is one source of health risk that can transmit poor health across generations, and (3) the highest levels of intergenerational risk are likely concentrated in subpopulations that exhibit high levels of intergenerational poverty (or conversely, low levels of intergenerational mobility). These preliminary conclusions portend the importance of expanding our understanding intergenerational transmissions of health before we can adequately address associations between social environments and health.

Prior research has shown that poor infant health outcomes are not randomly distributed in the population. Rather, stratification and inequality processes play a central role in explaining differential incidence and risk factors. Women who exhibit poor infant health outcomes are more likely to be poor, unmarried, non-Hispanic Black (vs. non-Hispanic White or Hispanic), as well as live in impoverished neighborhoods and report poor health status (Chomitz et al. 1995; Goldenberg et al. 2008). Consequently, sociologists—and family sociologists in particular—are in a unique position to advance this area of research. For example, prior research has demonstrated that marriage confers many benefits to individuals (e.g., Waite 1995; Amato & Booth 1997); individual-, family- and neighborhood-level characteristics affect health risk (e.g., Link & Phelan 1995; Berkman & Kawachi 2000; Sampson, Morenoff, & Gannon-Rowley 2002); and social (and health) inequality is often reproduced through the family unit (whether through persistent poverty or through sociobehavioral modeling) (e.g., Amato & Booth 1997; Palloni 2006). However, much of the extant research on infant health outcomes has failed to capitalize on these potential contributions from family research, particularly those relating to the role of family structure.

In this dissertation, I will provide an in-depth examination of the ways in which family structure impacts infant health outcomes, drawing upon theoretical frameworks from both health disparities and broader sociological literatures. I address the following three areas:

(A) Benefits of Marriage: Is the marital disparity in infant health outcomes best conceptualized through a life course model (positing that the observed advantages are grounded in women's experiences in prior life stages such as childhood and adolescence) or a mediation model (positing that marriage leads to positive prenatal health characteristics, which in turn lead to better infant health outcomes)?

(B) The Role of Resources: Are risky neighborhood environments more weakly related to infant health outcomes among married women compared with cohabiting or single women?

(C) Intergenerational Transmission: Is the previously-documented intergenerational link between mother-daughter infant health outcomes explained by other processes such as intergenerational poverty (i.e., socioeconomic status) or parent-child sociobehavioral modeling (i.e., marital status at birth, pregnancy wantedness, and/or prenatal health behaviors)?

In the following sections, I first provide an overview of the literature document marriage advantages in infant health, move on to a discussion of how recent changes in family demographic trends impact the evaluation of infant health outcomes, discuss the theoretical underpinnings of this dissertation and the role of selection processes in these analyses, and conclude with an overview of the unique contributions of this work.

What is the "Marriage Advantage"?

Much prior research has documented that women who are unmarried at the time of a birth are more likely to experience preterm birth (Goldenberg et al. 2008) and low birth weight (e.g., Albrecht et al. 1994; Bennett 1992; Bennett et al. 1994; Chomitz et al. 1995). Generally speaking, infant health outcomes among married women exceed those of single women, while the outcomes of cohabiting mothers are somewhere in between married and single women (Bird et al. 2000; Luo, Wilkins, & Kramer, 2004). Evidence of this "marriage advantage" has even been cited in nations such as Canada (Luo, Wilkins, & Kramer, 2004) and Finland (Raatikainen, Kaisa, Nonna Heiskanen, & Seppo Heinonen, 2005) where (a) cohabitation is much more prominent and (b) access to healthcare is less stratified by socioeconomic status (compared with the United States for example).

There is some evidence to suggest that the marriage advantage in the United States may not be uniform across all sociodemographic groups. For example, some work has found different patterns by race/ethnicity. Using data from births in North Carolina between 1963 and 1988, Bennett (1992) cites evidence of a higher risk of low birth weight among unmarried White women compared with married White women. The disparity in low birth weight between married and unmarried Black women however was much smaller. Regardless of being married or unmarried, Bennett also argues that Black women have historically exhibited higher risks overall. Other research documents similar evidence related to the risk of preterm birth for Black women (Goldenberg et al. 2008). However, it is important to note that these differences do not emerge in all studies. For example, Bird and colleagues (2000) found no racial/ethnic differences in the risk of low birth weight between non-Hispanic White, non-Hispanic Black, and Hispanic women who were married versus cohabiting.

Other research focuses on the intersection of marital status and age. Generally speaking, teen mothers and those approaching advanced maternal age (i.e., older than age 35 at birth) exhibit poorer outcomes than mothers between ages 20 and 35 (Reichman 2005; Goldenberg et al. 2008). However, some work finds that marriage among some at-risk subgroups may not be enough to protect against the risk of poor infant health. For example, Bennett (1992) finds that married teen mothers exhibit higher infant mortality rates than their unmarried counterparts which provides some evidence that marriage is not uniformally "protective" for all women.

Age and race/ethnicity are also related to infant health independent of marital status. For example, Geronimus (1996) argues that maternal age at birth is one type of a risk factor that differs between Black and White populations via psychosocial mechanisms that link inequality to health. Earlier births are more advantageous for Black women since they occur before years of the "weathering" associated with inequality have taken root. Thus, she hypothesized that maternal age at birth would have a differential impact on low birth weight for Black vs. White women. Indeed, she finds that the Black/White disparity in low birth weight increases with age and that this increase is most extreme for poor Black mothers (even relative to non-poor Black mothers). Taken together, this suggests that family demographic trends are closely linked with infant health trends.

Other work has focused on how associations of age and race/ethnicity also intersect with marital status. Bennett, Braveman, Egerter, and Kiely (1994) for example found a heightened risk of infant mortality among unmarried women increased with age, especially for Black women. However, these results should be noted with some caution. The authors used a dataset containing all singleton live births in the linked birth and death files for all 50 states from 1983-1985, which is advantageous in that it contains a large number (more than 10 million) births. However, this exploration is limited by several factors. The authors were forced to impute marital status for 9 states and maternal education for 3 states where the information wasn't included on the birth certificate. Furthermore, they were not able to measure financial capital (e.g., income) and were only able to contrast Black versus White women (without considering Hispanic ethnicity). The extent to which these same patterns would emerge in a more recent dataset, without imputations for critical variables such as marital status and education, with the inclusion of a measure of financial capital, and between Black, White, and Hispanic women remains uncertain.

Comparatively less research has examined marriage advantages for Hispanic women. One study however found that Hispanic women who were either married or cohabiting were more likely to receive adequate prenatal care and exhibited more advantageous infant health outcomes, and this advantage was stronger among Hispanic women than either Black or White women (Albrecht, Miller, & Clarke, 1994).

Despite the salience of a marriage advantage overall, relatively few studies have attempted to explain why this might occur. Some have postulated reasons such as greater economic distress among unmarried mothers (Bennett 1992) or higher levels of social support among married mothers (Landale & Oropesa 2001; see Bennett 1992 for an alternative perspective). With respect to smaller disparities among unmarried and married Black women, Bennett (1992) posits two potential explanations: smaller material gains made through marriage and greater social support via kin networks. Still the bulk of evidence simply cites correlations or unadjusted associations between marital status, explanatory factors, and infant health, or does not statistically address mediating pathways that could potentially explain these advantages (Bennett 1992; Bird et al. 2000). Other work does address such pathways but do not provide sufficient evidence of what factors might explain the associations (by presenting stepwise regression tables that add one set of variables at a time) (Bennett et al. 1994).

One important exception exists however. Kallen (1993) used data from the NSFG (1988) (and births from 1984 – 1988) to examine multiple pathways through which various factors (marital status, race/ethnicity, education, and age) were related to infant health outcomes. He considered intervening factors such as pregnancy wantedness, prenatal smoking, prenatal care, parity, prior low birth weight, and health status (i.e., hypertension, pelvic inflammatory disease, and diabetes). In short, he found that pregnancy wantedness and prenatal smoking were key “mediators” of marital status on one indicator of infant health (intra-uterine growth restriction), and that the marriage advantage was stronger for Whites than non-Hispanic Blacks (“mediators” is in quotation here since the study did not formally test for statistical mediation). While this study paves the way for future work in this area, it is uncertain the extent to which similar patterns would emerge using more recent data (i.e., births since 1988).

In sum, it is difficult to discern from past research the nature of the concurrent marriage advantage related to infant health, what factors explain this advantage (through a mediating perspective), or what factors combine with marital status to put women at greater or lesser risk of poor infant health (through a moderating perspective).

How Recent Changes in Family Demographic Trends Affect Infant Health

Despite the salience of the marriage advantage in infant health that has been demonstrated over time, substantial changes in the family over the past few decades potentially affect the continued relevance and accuracy of these findings. First, family demographic changes such as increasing proportions of nonmarital births across the population age structure may afford greater overall risk for population-level birth outcomes—particularly for White women. Second, as cohabitation becomes more prevalent overall, and particularly more common across various socioeconomic strata, it is important to investigate the effect of cohabitation on infant health outcomes using the most recently available, and nationally-representative data. Third, family demographers have cited delays in the timing of childbearing across the lifespan, and health research has shown that maternal age at birth is linked with low birth weight: women who have children at both younger and older ages are more at risk (Bennett 1992; Goldenberg et al. 2008). Yet, we know from prior work in family sociology that the risk of delaying the transition to parenthood isn’t evenly distributed across the population. Recent research suggests that more economically advantaged and highly educated women are leading this delay, whereas poorer minority women are lagging behind (and still having earlier first births) (e.g., McLanahan 2004). This suggests that greater proportions of the population—including those who both delay and initiate early childbearing—are at increased risk of poor infant health outcomes.

This increasing divergence has implications for birth outcomes as well. For example, Geronimus (1996) argues that maternal age at birth is one risk factor that differs in its implications for Black and White populations via psychosocial mechanisms that link inequality to health. Earlier births are more advantageous for Black women since they occur before years of the "weathering" associated with systematic inequality have taken root. Thus, she hypothesized that maternal age at birth would have a differential impact on low birth weight for Black vs. White women. Indeed, she finds that the Black/White disparity in low birth weight increases with age and that this increase is most extreme for poor Black mothers (even relative to non-poor Black mothers). Taken together, these findings suggest that changing family demographic trends are closely linked with infant health trends in the population.

Theoretical Pathways

Benefits of Marriage

The first portion of the dissertation addresses a "benefits of marriage" perspective by testing two competing hypotheses of why marriage advantages are observed with respect to infant health outcomes. First, a "marriage selection" perspective asserts that marriage advantages emerge because underlying selection processes affect the likelihood that women will both be married at the time of conception and exhibit positive infant health outcomes (e.g., Goldman 1993; Haas 2006; Haas 2008). These processes can be captured through either measured or unmeasured characteristics, and as a result, statistical approaches such as fixed-effects modeling (which control for all time-invariant unobserved characteristics) is a particularly important method to test the salience of a selection hypothesis. Along these same lines, life course theory posits that factors present within one stage of life are inevitably linked with processes observed in subsequent stages (Elder 1977; Elder 1998; Bengtson & Allen 1993; Elder, Johnson, & Crosnoe 2003). Therefore, taking into account measures across the life course (i.e., childhood, adolescence, *and* adulthood) guards against the possibility of overestimating any given pathway in the analysis due to omitted variable bias.

On the other hand, a “marriage protection” hypothesis asserts that marriage in and of itself offers individuals additional benefits –one of which is improved health outcomes (Waldron, Hughes, & Brooks 1996). Evidence along these lines is often supported by a social support argument. That is, married individuals receive higher levels of social support from their spouse which in turn is related to more advantageous health behaviors and outcomes (see Landale & Oropesa, 2001 for an example of how this process is specifically related to infant health outcomes).

Several factors are considered in the analysis that are plausibly indicative of both selection and protection hypotheses. These include marital status, pregnancy wantedness, prenatal health behaviors (i.e., smoking, prenatal care, and alcohol consumption) (Chomitz et al. 1995; Landale & Oropesa 2001; Oropesa, Landale & Davila 2001; Padilla & Reichman 2001; Teitler 2001; Martin et al. 2008; Warnecke et al. 2008). Both Warnecke et al. (2008) and Culhane & Elo (2005) discuss specific ways in which these factors are related to health disparities and will be discussed in more detail in the following chapter.

Role of Resources

The second portion of this dissertation draws upon several theoretical frameworks within the health disparities, family sociology, and broader sociological literatures. First, we know that health disparities are not randomly distributed within the population. Some individuals or more at risk of poor health outcomes than others and much research attributes these (dis)advantages to social stratification processes. Socioeconomic status and health share a long history of documented associations across a variety of outcomes, and this literature has evolved from a primary focus on a poor/non-poor dichotomy to one that recognized the gradient relationship of SES (Adler & Ostrove 1999).

Second, prior research has shown that individuals are not randomly distributed across social environments and that social context affects individuals in significant ways, such as through shaping norms, influencing social control, and facilitating behavior (e.g., Berkman & Kawachi 2000; Sampson, Morenoff, & Gannon-Rowley 2002). Both Warnecke et al. (2008) and Culhane & Elo (2005) acknowledge this important fact and include the effects of social environments within their frameworks. They are not the first to do so however. Much sociological research underscores the significance of social context, and has advanced our understanding of how context affects individuals by focusing on the role of *resources* within social environments.

Resources represent a fundamental concept throughout the history of sociology, dating back to social theorists such as Marx and Weber, and have been conceptualized as the element linking neighborhood structure and process to individual social and health outcomes. For example, Link and Phelan (1995) argue that social conditions are “fundamental causes of disease” and that researchers should focus on social conditions that put people at risk of developing poor health outcomes. They particularly emphasized that social context “conditions access” to resources that may be used to prevent disease or treat a disease after it has been diagnosed. In their work, resources were defined quite broadly as, “money, knowledge, power, prestige, and the kinds of interpersonal resources embodied in the concepts of social support and social network” (p. 87). Since that time, the importance of resource acquisition has been widespread in the literature. In an edited volume entitled, “Social Determinants of Health,” Marmot (2005) emphasized unequal access to resources along with material deprivation as key determinants of health disparities. Furthermore, both structural components (i.e., poverty, residential segregation) and functional components (i.e., crime rates, social cohesion) of neighborhoods influence health outcomes and act independently of one another (Leventhal & Brooks-Gunn 2000; Adler & Newman 2002; Morenoff 2003; Warnecke et al. 2008).

Stress processes have also been implicated in the link between neighborhoods and individuals. For example, Pearlin (1989) argues that stress is often a byproduct of a specific social context or environment—especially those that relate to elements of social stratification such as socioeconomic status or race/ethnicity. He argues, “To the extent that these systems embody the unequal distribution of resources, opportunities, and self-regard, a low status within them may itself be a source of stressful life conditions” (p. 242). Specifically with respect to infant health, stressful neighborhood environments (indicated by high levels of violent crime for example) are linked with poor infant health outcomes above and beyond a host of individual- and neighborhood-level characteristics including poverty (Morenoff 2003). Thus far, each of these frameworks exhibit two common notions: that the social environment plays an important role in the formation of health disparities and that the resources available to individuals within the surrounding environment have the potential to mitigate health risk.

Third, we know that social stratification processes provide opportunities for and induce constraints on individual choices regarding residential mobility, and that these processes do not operate in a vacuum. Rather, they are produced and reproduced largely through interactions with social structures such as the family. Family structure is tightly linked with individual-level socioeconomic status (e.g. McLanahan & Booth 1989), neighborhood residence (e.g., Leventhal & Brooks-Gunn 2000), as well as increased health risks such as unintended injuries and childhood asthma (Chen, Martin, & Matthews 2006). Furthermore, the family environment can either buffer or exacerbate the effects of social conditions on individuals. For example, children growing up in stable two-parent families in poor neighborhoods are at lower risk of engaging in risky behaviors in adolescence such as delinquency and early sexual initiation than their counterparts in single- or step-parent families in the same poor neighborhood (e.g., Wu and Martinson 1993; Amato & Booth 1997; Wu 1996; Wu & Thompson 2001). Thus, family structure is an important predictor of a child's risk of growing up within a given socioeconomic status, of residing within a poorer (or richer) neighborhood, and of developing poorer health outcomes over the life course.

Together these frameworks provide a compelling, more comprehensive portrait of how we might expect families to affect infant health outcomes, and how these associations may operate at both the individual- and neighborhood-levels.

Intergenerational Transmission

The third portion of this dissertation addresses the intergenerational transmission of birth outcomes between mothers and daughters (documented by Conley & Bennett 2000, 2001 and Currie & Morietti, 2007, among others), and tests a theoretical model that explains this association by accounting for other mother-daughter similarities in characteristics related to infant health outcomes (such as educational attainment at the time of birth and nonmarital birth status).

Building upon behavioral genetics research which has documented that less than half of the similarity in birth weight and the risk of low birth weight between parents and offspring can be explained by genetic factors (Magnus et al. 1984; Vlietinck, Derom, Neale, Maes, van Loon, Derom, & Thiery 1989; Magnus, Bakketeig, & Skjaerven, 1993; Magnus, Gjessinb, Skrondala, & Skaervenb 2001; Lunde et al. 2007), this research seeks to explain the remaining association through a social-environmental perspective.

Grounded in a sociological approach, this perspective suggests that social stratification processes provide opportunities for and induce constraints on individual choices (e.g., Grusky 2008). Specifically, stratification processes related to educational attainment and nonmarital birth status may be particularly salient to this examination. Mothers and daughters often exhibit similar levels of educational attainment at pregnancy (e.g., Oreopoulos, Page, & Huff Stevens 2003) and age at first birth (Barber, 2001; Card, 1981; Furstenberg, Levine, and Brooks-Gunn, 1990; Hardy et al. 1998; Horwitz, Klerman, Kuo, and Jekel 1991; Kahn and Anderson, 1992; Manlove, 1997), and are similar with respect to marital status at the time of a first birth (e.g., Furstenberg, Levine, & Brooks-Gunn 1990).

Each of these factors is related to infant health: lower levels of educational attainment, teen births, and nonmarital births are all associated with a higher risk of low birth weight and preterm birth (Bennett 1992; Bennett et al. 1994; Bird et al. 2000; Chomitz 1995; Reichman 2005; Goldenberg et al. 2008). Therefore, it is plausible that these associations—when modeled simultaneously—account for the remaining proportion of the mother-daughter similarity in infant health outcomes that genetic similarities cannot explain.

The Role of Selection

It is important to note the potential confounding effect of selection processes when discussing associations between family structure and infant health outcomes. Based on research on marriage market opportunities, we know that marriage is a resource that is differentially available to individuals of low vs. high SES, and to individuals of Black vs. Other racial groups (Lichter et al. 1992; Lichter et al. 2003; Harknett & McLanahan 2004). Thus, I would expect the effect of relationship status on infant health outcomes to diminish once the confounding effect of selection is taken into account. Health disparities research has acknowledged this potential bias. For example, one study found that marriage exerts its protective influence through higher SES (Sheehan 1998). However, current SES is only a rough measure of selection. Much more information is needed about the childhood and family background of the individual in order to more fully address selection processes. Therefore, to address the potential selection effects within this dissertation, I employ a series of variables from the respondent's family background including maternal and paternal education, maternal age at first birth, and family structure at age 14. While this is by no means an exhaustive list of potential selection variables, it represents an improvement upon past research in that I employ the best available (and most recent) data which provide information on family history, romantic relationship history, and birth outcomes at the population-level.

Unique Contributions of this Dissertation

In sum, this dissertation will make several unique contributions to both sociological and health disparities literatures. First, I will measure infant health outcomes in three ways: a binary measure of low birth weight, a continuous measure of birth weight adjusted for gestational age, and a binary measure of preterm birth (see Figure 1 for a conceptual diagram relating these three outcomes). Surprisingly, the majority of studies of infant health outcomes have used only a binary measure of low birth weight (e.g., Geronimus 1996; O'Campo et al. 1997; Gorman 1999; Conley & Bennett 2000; Padilla & Reichman 2001; Teitler 2001; Rauh, Andrews & Garfinkel 2001; Finch et al. 2007). Although this binary measure has been widely utilized in the public health literature over the past several decades, it has also been criticized for the fact that it does not explain why being born small may lead to higher infant mortality (Wilcox 2001). On the other hand, "small for gestational age" (or, a continuous measurement of birth weight adjusted for gestational length) and preterm birth are both associated with specific medical conditions that are directly linked with higher infant mortality and morbidity. Only a handful of studies exploring the role of families have incorporated a continuous measure of birth weight (e.g., Pearl, Braveman & Abrams 2001; Buka et al. 2003; Morenoff 2003; Subramanian et al. 2006; Moiduddin & Massey 2008) or have considered preterm birth (e.g., El-Bastawissi et al. 2007; Culhane & Elo 2005; Messer et al. 2006; O'Campo et al. 2008).

Second, this dissertation will utilize nationally representative samples of women from two different datasets (one longitudinal and one cross-sectional), and will link spatially located data on neighborhood environments with individual survey records. Several studies have documented the relationships between family structure, socioeconomic status and birth outcomes using local or regional level data (within Baltimore, O'Campo et al. 1997; within Chicago, Morenoff 2003; within Massachusetts, Subramanian et al. 2006; within California, Currie & Moretti 2007; Pearl, Braveman & Abrams 2001; or within 4 states, Messer et al. 2006, O'Campo et al. 2006, O'Campo et al. 2008), but not at the national-level. Third, many studies have not utilized multilevel regression modeling strategies to analyze the individual- and neighborhood-level effects on birth outcomes (O'Campo et al. 1997; Gorman 1999) which results in inflated standard errors and significance tests due to correlated error terms across individuals within the same level-2 unit.

Fourth, this dissertation will incorporate two measures of individual-level socioeconomic status—current and childhood measures—both of which likely contribute to infant health outcomes. Surprisingly, sophisticated composites of both measures have not yet been incorporated into studies of infant health outcomes. Some recent work has encouraged researchers to consider the role of lifetime socioeconomic status in addition to current socioeconomic status (e.g., Lynch & Kaplan 2000). Pickett & Pearl (2001) surveyed the literature on SES and general health disparities and argued that across studies, lifetime SES mattered more than current SES. Moreover, theoretical models suggest the importance of both (e.g., Lu & Halfon, 2003; Culhane & Elo, 2005). In sum, this dissertation will provide a nuanced perspective of associations between family structure and infant health that can be used to inform future policies on prevention/intervention strategies aimed at reducing infant health disparities in the population.

CHAPTER 2: The 'Marriage Advantage' in Infant Health Outcomes: Evidence of Spuriousness, or Risky Behavior?

INTRODUCTION

Improving infant health outcomes is an important goal of health disparities research. Targeted prevention efforts aimed at decreasing the incidence of low birth weight (weighing less than 2500 grams) and preterm birth (a birth occurring less than 37 weeks of gestational age) have been plentiful, and for good reason. Preterm birth has been identified as the leading cause of infant mortality in the US, accounting for at least 1/3 of all infant deaths (Callaghan et al. 2006). Furthermore, both preterm birth and low birth weight are associated with a variety of poor cognitive and health-related problems that manifest across the life course (Chomitz et al. 1995; Conley & Bennett 2000; Goldenberg et al. 2008), making both outcomes of substantial interest to policymakers and practitioners alike. Prior research has also shown that poor infant health outcomes are not randomly distributed in the population. Poor, non-Hispanic Black, and some Hispanic women are more likely to exhibit poor infant health, as are women who are unmarried at the time of a birth—which is the focus of this study (Chomitz et al. 1995; Goldenberg et al. 2008).

'Marriage advantages' have garnered substantial attention within multiple literatures spanning physical and mental health outcomes and have been widely cited in the infant health literature (e.g., Waite 1995; Bennett 1992; Goldenberg et al. 2008). Yet comparatively little research examines *how* these advantages operate with respect to infant health or if they are salient to particularly stringent tests of selection bias. This study provides such an examination. Using a female subsample of the most recently available population-level data (NSFG 2006-2008), this study tests two potential explanations of the marriage advantage: a *life course* approach (positing that observed advantages are grounded in women's experiences in prior life stages such as childhood) and a *mediation* approach (positing that marriage leads to positive prenatal health characteristics which in turn lead to better infant health). A visual conceptualization of these approaches is provided in Figure 2. Analyses incorporate three different indicators of infant health—low birth weight, preterm birth, and continuous birth weight adjusted for gestational age (which approximates intra-uterine growth restriction or small-for-gestational age)—and employ multilevel and fixed-effects regression strategies to adjudicate between these explanations.

BACKGROUND

Current estimates suggest that approximately 8% of all infants are low birth weight and 12% are delivered preterm (Goldenberg et al. 2008). In line with a broader literature citing various benefits of marriage for women (such as improved physical health and psychosocial well-being, Waite 1995), married women exhibit better infant health outcomes than their unmarried counterparts (Bennett 1992; Martin et al. 2007; Paneth 1995; Reichman 2005). Yet we still don't understand why these 'marriage advantages' persist.

Studies spanning multiple disciplines have identified (positive) selection processes that guide healthier people into marriages. A "marriage selection" perspective posits that these processes (relating to both observed and unobserved characteristics) explain why married men and women exhibit better mental and physical health outcomes, attain higher levels of education, and accumulate greater wealth over the life course (e.g., Goldman 1993; Haas 2006; Haas 2008). Therefore, it is not the marriage itself which confers benefits but rather it is the underlying selection processes that produce spurious associations. This perspective is often contrasted with a "marriage protection" perspective which alternatively suggests there is something about marriage in and of itself that explains why married individuals exhibit better outcomes (Waldron, Hughes, & Brooks 1996). The evidence adjudicating between these perspectives is mixed. Some find more evidence of health selection (e.g., Goldman 2003) while others find evidence of both (e.g., Murray, 2000). One particularly compelling test of both hypotheses used a rich longitudinal dataset (NLSY79) and found little evidence of health selection processes among married women (although found some evidence of health selection among those who were unemployed; Waldron, Hughes, & Brooks, 1996).

Life course theory further illuminates a marriage selection perspective by positing that experiences in prior life stages affect behavior observed at a later date (Elder 1977; Elder 1998; Bengtson & Allen 1993; Elder, Johnson, & Crosnoe 2003). By accounting for the sequencing of life transitions, a life course perspective guards against the possibility that factors co-occurring with the pregnancy (such as social support, or prenatal health attitudes and behaviors) are spurious.

Life Course or "Marriage Selection" Perspective

A marriage selection perspective in the case of birth outcomes would suggest that healthier women are more likely to get married, exhibit higher levels of human and financial capital, and undertake healthy behaviors during pregnancy—all of which are linked with advantageous birth outcomes. Along these lines, previous attempts to explain the marriage advantage have often focused on higher (average) levels of socioeconomic status among married women that is linked with dual incomes of husbands and wives (e.g., Sheehan 1998). However, this factor alone has been shown to be an insufficient explanation with respect to infant health.

Broader literatures relating socioeconomic status to health outcomes emphasize the importance of incorporating life course measures of SES rather than just concurrent SES (Lynch & Kaplan 2000; Pickett, & Pearl, 2001), which may provide a more stringent test of selection. Similarly, research on marriage market opportunities suggests that marriage is a resource that is differentially available to individuals of different socioeconomic status, family background, and spatial location (Lichter et al. 1992; Lichter et al. 2003; Harknett & McLanahan 2004) which further supports the relevance of including family background characteristics or life course measures of SES. Yet prior research on marriage advantages in infant health outcomes has largely excluded these potentially important factors—in part due to a lack of sufficient data on women's family background and infant heath outcomes. No research that I know of has linked a rich set of experiences within women's prior life stages (such as childhood) to marriage advantages, yet the two are quite plausibly related. With respect to infant health outcomes in particular, there are several potentially spurious factors that are plausibly related to both the risk of being married, cohabiting, or single at the time of conception and the risk of poor infant health. Such factors may include childhood socioeconomic status (i.e., household income, parental education, parental employment, maternal age at first birth, if the woman was herself born out of wedlock) and childhood family structure (e.g. McLanahan & Booth 1989).

An underlying assumption of this discussion thus far is that all potentially spurious factors from prior life stages are measured, observed, and available for inclusion in the analysis. This assumption is not met with the use of any data source—no matter how rich the depth and breadth of measures are. But, some modeling strategies such as fixed-effects models can be used to account for these unobserved characteristics that may confound the marriage advantage and are utilized here.

In sum, evidence of a life course/selection approach would emerge if the inclusion of observed variables relating to women's childhood environment and unobserved characteristics (through the use of fixed-effects models for example) diminish the direct effect of marriage on infant health in both size and significance. No research I know of has directly tested the marriage advantage within this type of framework, but a few studies have applied these techniques to the effects of mother's income on infant health. For example, Conley and Bennett (2000) found that, within a fixed-effects framework, mother's income did not portend greater infant health risk. A subsequent study by these same authors suggested that income may matter—but only for children who are at greatest risk of being low birth weight (Conley & Bennett 2001).

Mediation or "Marriage Protection" Perspective

Alternatively, a second explanation suggests that the direct effect of marriage on infant health can be explained through the following pathway: married women exhibit more positive prenatal attitudes and behaviors, and in turn these more positive attitudes and behaviors lead to better infant health outcomes. In contrast to a selection perspective, this perspective emphasizes a specific causal pathway through which marriage exerts protection.

Theoretical and empirical research cites the importance of various individual-level characteristics that may potentially mediate marriage advantages in infant health including social support (i.e., father involvement, emotional support, and stress reduction) (Chomiz 1995; Culhane & Elo 2005; Landale & Oropesa 2001; Padilla & Reichman 2001; Teitler 2001; Martin et al. 2008; Warnecke et al. 2008), pregnancy wantedness and prenatal health behaviors (i.e., smoking, alcohol consumption, nutrition, prenatal care, and maternal weight gain) (Chomitz et al. 1995; Oropesa, Landale & Davila 2001; Warnecke et al. 2008). Some work has addressed these separate pathways (of the effect of marriage on prenatal health, and prenatal health on birth outcomes) although very little has considered both within a mediating framework.

With respect to smoking, prior research has shown that marriage formation and smoking cessation go hand-in-hand, although not for all demographic subgroups. Non-Hispanic Black and Hispanic women (regardless of the age at which they marry) and White women who marry later in life are more likely to quit smoking when they enter a marriage. On the other hand, the converse was found in White women who married earlier (Weden & Kimbro 2007). This suggests greater evidence of a marriage protection perspective—that it is something about marriage itself (for most subgroups) that aids individuals in successful smoking cessation. In turn, it may also be true that married women make different choices when it comes to health behaviors during pregnancy. For example, one study found that married women engaged in significantly different prenatal behaviors (i.e., less smoking, earlier initiation of prenatal care, and less government-assisted health insurance used to pay for prenatal care) than women in cohabiting or “other” relationships (Bird et al. 2000). In turn, other studies have shown that smoking and later initiation of prenatal care are risk factors for both preterm birth (Goldenberg et al. 2008) and low birth weight (Chomitz et al. 1995) as are heavy alcohol consumption, using drugs, poor nutrition, and lower pregnancy weight gain (although these latter effects are only sometimes significant in previous literature; Chomitz et al. 1995).

Social support is a probable explanation for more advantageous health behaviors among married women. With respect to prenatal smoking in particular, some work has found lower rates of smoking cessation among married women whose partners also smoked which provides some evidence for a social support model (Lemola & Grob, 2009). Although social support may be varied in its effect on infant health. One particularly relevant study found that social support did not directly impact birth outcomes directly. Rather, it acted indirectly through co-residence with the father, receiving adequate emotional support, receiving adequate instrumental assistance, and reducing the amount of stress during pregnancy (Landale & Oropesa, 2001).

Pregnancy wantedness is another potential mediator. One prior study using 1995 NSFG data tested the mediating effect of pregnancy wantedness and found that married women were more likely to report a pregnancy was wanted or intended than unmarried women and, in turn, pregnancy wantedness was associated with more positive birth outcomes (Bird et al. 2000). However, the extent to which this pathway would remain salient with the addition of other mediating pathways (or family background characteristics) remains uncertain. Such an examination is an important addition to this literature since researchers, policymakers, and practitioners alike have relied on such studies to inform prevention efforts aimed at decreasing the incidence of poor infant health outcomes.

Furthermore, the majority of previous studies relating marital status to pregnancy wantedness have been based on a simple measure of whether the birth was timed correctly or whether the mother wanted a baby at any time. More sophisticated measures of wantedness are now available that encompass these dimensions in addition to others (i.e., if the mother was taking deliberate steps to prevent pregnancy, if the mother wanted a child with that particular partner, if that partner wanted a child, and if the mother and partner wanted a child at that time). These more comprehensive measures of wantedness allow researchers to observe greater heterogeneity within wantedness among married vs. unmarried women, which in turn may reveal new dimensions of these associations. For example, it may be that only married women with the highest levels of pregnancy wantedness exhibit a positive health benefit, whereas married women with average or below average levels of pregnancy wantedness exhibit infant health outcomes more similar to unmarried women. This study will explore these possibilities.

Prenatal health behaviors may operate in this same way. In the past, it was assumed that married women exhibited greater prenatal health behaviors because they had a live-in partner with whom they could share the experiences of pregnancy as well as to whom they are socially accountable (for heavy smoking or drinking throughout a pregnancy for example). However, cohabiting partners may serve some of the same functions within pregnancy and thus, it is possible that new associations will emerge with respect to prenatal health behaviors as cohabitation patterns have changed dramatically in the population. The same argument of heterogeneity applies once again: since we can now observe greater heterogeneity within mother-father relationship status, it is possible that only women in a residential union (married *or* cohabiting) exhibit positive prenatal health behaviors, and thus more beneficial infant health outcomes.

Each of these characteristics discussed thus far are also plausibly related to each other. Prenatal smoking for example is related to late receipt of prenatal care (e.g., Pagnini and Reichman 2000) and factors such as wantedness, a “taste” for risky behavior” and maternal health characteristics are associated with behaviors such as prenatal smoking and late prenatal care receipt as well as birth weight outcomes (Reichman, Corman, Noonan, & Dave, 2006). Therefore, taking into account all variables at once is an important guard against overestimating the effects of any given factor due to omitted variable bias.

In sum, a mediating perspective would be most supported if the inclusion of prenatal health attitudes and behaviors were significantly related to both marriage and infant health, and their inclusion fully mediated the direct effect rendering it non-significant.

A “Hybrid” Approach

The extent to which factors such as prenatal smoking and late prenatal care receipt may be considered entirely selective or entirely causal is a source of some debate in both economic and public health literatures. Thus, a simple distinction between these two perspectives might be overly simplistic. A third, “hybrid,” approach is considered here as well.

Several studies have used strategies such as instrumental variables approaches to test whether or not the association between prenatal care receipt and infant health can be accurately characterized as causal

(Rosenzweig & Schultz, 1983; Corman, Joyce, & Grossman, 1987). Both of these studies found evidence of a salient link between prenatal care and birth weight while other work (capitalizing on natural experiments and samples with a uniquely rich set of pregnancy-related covariates) has shown that prenatal care receipt is unrelated to infant health (Conway & Deb, 2005; Reichman & Teitler, 2005; Reichman, Corman, Noonan, & Dave, 2006). Still other research finds evidence of a different pattern—adverse self-selection. That is, women with “low health endowments” are more likely to receive earlier and more prenatal care, and are also much more likely to exhibit low birth weight (Wehby et al., 2009).

Findings related to prenatal smoking document no evidence of unobserved heterogeneity and generally find salient effects on birth weight outcomes (Rosenzweig & Schultz, 1983; Lien & Evans, 2005; Reichman, Corman, Noonan, & Dave, 2006). In fact, one recent study used an instrumental variables approach capitalizing on genetic markers related to smoking behavior and found that prenatal smoking was even more consequential for birth weight once the endogeneity of prenatal smoking was taken into consideration (compared for example with OLS estimation; Wehby et al. 2011).

Contributions of This Study

Taken together, both life course and mediating hypotheses are plausible explanations of the marriage advantage yet past research has not yet fully tested either one—particularly within the same model which is important in order to avoid omitted variable bias. Moreover, much of the research on marriage advantages in infant health reflects somewhat dated trends (i.e., 1960s to the 1990s). Recent population-level rises in cohabitation across all socioeconomic strata, rises in nonmarital childbearing, and delayed ages at first marriage and childbirth indicate important compositional differences among contemporary subpopulations of women unmarried at the time of a birth. These changes are both substantive and empirical in nature. That is, not only is the meaning of nonmarital and delayed childbirth changing, but the size of the population at risk of a nonmarital birth at any given time has shifted as well. In light of prior research which has highlighted the important role in marriage advantages played by maternal age at conception (teen births, birth to women age 20-34, and births to women ages 35+) (e.g., Bennett 1992; Bennett et al. 1994), it is quite plausible that sweeping demographic changes such as delayed age at childbearing among contemporary cohorts of women impact marriage advantages. Furthermore, very little research has subdivided the group of unmarried women into cohabiting and single subgroups (see Bird et al. 2000 for an exception), which provides little insight into current trends among unmarried women. Overall, how contemporary women's reproductive health intersects with mother-father relationship status in light of these wide-reaching demographic changes, or the mechanisms through which marriage advantages may operate in the current context, remains to be examined.

DATA AND METHODS

This study employs data from the most recent wave (2006-2008) of the National Survey of Family Growth, a nationally representative sample of households containing adults ages 15-44. The analytic subsample consists of females who had at least one live birth (7,356 – 3,944 = 3,412) and who had at least one live birth in the five years prior to the interview (3,412 – 1,806 = 1,606). Within this subsample of 1,606 women, there were 2,930 births reported.

Since missing data was minimal (ranging from 1-2% on most variables), a single imputation (in Stata) was utilized. Supplementary analyses (available upon request) suggest that findings presented here are substantively and statistically similar to estimates from complete case analysis.

Variables

Infant Health. Three measures of infant health are included. First, low birth weight is indicated by a value of 1 if the infant was less than 2500 grams or 5 ½ pounds at the time of birth, and value of 0 if the infant was 5 ½ pounds ore more. Second, a continuous measure of birth weight (in ounces) adjusted for gestational length approximates the outcome "small-for-gestational age," or SGA (*range = 13 – 208*). Third, preterm birth is indicated by a value of 1 if the infant was born less than 37 weeks of gestational age and a value of 0 if the infant was born at 37 weeks or more. As previously mentioned, observing all three outcomes is important since each are conceptually and empirically distinct. Results relating to low birth weight are most closely comparable to prior literature since most work has been based on this measure, whereas results relating to preterm birth and the approximation of SGA provide unique information to inform future prevention strategies aimed at reducing infant mortality.

Mother's Relationship Status at the Time of Conception is represented by a series of binary variables: married (the reference group), cohabiting, or non-romantic non-residential—hereafter termed "single." Including relationship status at conception is a substantial advantage over prior work which is typically based on mother's relationship status at the time of a birth. With the rise of cohabitation, divorce, and nonmarital childbearing in recent decades, it is plausible that these two measures are becoming increasingly divergent. There is evidence in these data that the two are not synonymous: 13% of mother-father relationships changed status between conception and birth. The most common transitions were from single to cohabiting (representing 4.7% of women), cohabiting to married (3.4%), and cohabiting to single (2.3%). Including relationship status at conception is also advantageous in that it (a) provides more relevant information regarding the prenatal environment and (b) is not endogenous to marriage advantages in infant health (since it is measured causally prior to, instead of concurrent with, birth outcomes).

Family Background. Another key innovation of this study is the inclusion of a rich set of characteristics describing mother's family background or childhood environment. These include grandmother's and grandfather's education (1 = *less than high school*, 4 = *Bachelor's degree or higher*), if the mother herself was born out-of-wedlock (*1=yes*), grandmother's age at first birth (1 = *less than 18 years old*, 5 = *30+ years old*), mother's family structure in adolescence (0 = *living with two biological parents at age 14*, 1 = *living with single or step-parents*), and if the grandmother worked during the mother's childhood (0 = *didn't work at all for pay*, 1 = *worked part- or full-time*).

Pregnancy Wantedness measures draw upon extremely rich data that encompass several questions: if the respondent wanted a pregnancy at any time in the future, if she wanted a pregnancy at that time (and if too soon, how much too soon did it come), if she wanted a pregnancy with that partner, a 10-point scale of happiness about that pregnancy, if the father of her baby wanted a pregnancy at any time in future, and if he wanted a pregnancy at that time. An exploratory factor analysis (based on Principal Components Analysis) revealed two distinct factors consistent with prior literature (Hummer, Hack & Raley 2004; Gipson et al. 2008): whether the respondent and her partner (1) did not want the pregnancy, and (2) felt the pregnancy was mistimed. High factor scores indicate high levels of unwantedness and mistiming. (Factor loadings are not shown but available upon request.)

Prenatal Health Behaviors. Three indicators of prenatal health are considered. First, if the respondent ever smoked during the pregnancy (*1 = yes*) since prior research has shown that any amount of smoking during a pregnancy can be harmful (Marsiglio & Mott 1988). Accessing medical care during the pregnancy is another important component of prenatal health. Analyses include if the respondent ever initiated prenatal care throughout the entire pregnancy (*1 = never*), and among mothers who did receive prenatal health care, if the respondent initiated prenatal health care in the first trimester (*1 = yes*).

Sociodemographic and Pregnancy Characteristics. Prior research emphasizes the importance of including several covariates of infant health including: race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic Other), nativity status (0 = *native born*, 1 = *foreign born*), mother's age at conception (less than 20, between 20 and 34, 35+ years old), parity (1 = *first born*, 9 = *ninth born*), child gender (*1 = male*), what party paid for the delivery (0 = *private insurance or personal income*, 1 = *Medicaid, government, or other public assistance*), and a proxy of human capital—if the mother had her first child before completing high school (*1 = yes*). Models predicting the continuous indicator of birth weight also include gestational length (*range = 22 – 45 weeks*).

Analytic Strategy

Since the analytic subsample contains multiple births for some women, the assumptions of single-level regression are violated (for example, that ε_1 is uncorrelated with ε_2 and ε_i do not systematically covary). Thus, multilevel models identifying births (level-1) nested within women (level-2) were used. Multilevel (linear) regression models were estimated for the continuous indicator of birth weight (in ounces) based on the following equations (for child *i* nested within mother *j*):

Level-1: $Y_{ij} = \beta_{0j} + \Sigma\ \beta_{1\text{-}13}\ X_{ij} + r_{ij}$

Level-2: $\beta_{0j} = \gamma_{00} + \gamma_{01\text{-}11} + \mu_{0j}$

$\beta_{1j} = \gamma_{10} \ldots \beta_{13j} = \gamma_{130}$,

where β_{0j} indicates the sum of the mother-level intercept (γ_{00}) and mother-level characteristics ($\gamma_{01\text{-}11}$) along with a mother-specific residual (μ_{0j}). $\Sigma\ \beta_{1\text{-}13}\ X_{ij}$ indicates the sum of all infant-level characteristics and r_{ij} indicates a child-specific residual. Mother-level characteristics including race/ethnicity, nativity status, family background, and human capital; infant-level characteristics include relationship status, pregnancy characteristics, pregnancy wantedness, and prenatal health behavior.

Hierarchical generalized linear models were estimated for the binary outcomes—low birth weight and preterm birth—using a similar equation but were instead based on the Bernoulli distribution. The probability model is Prob(Y=1|β)=P, and the link function is $\mu_i=\exp(\eta_i)/1+(\exp(\eta_i))$ or the inverse expressing the linear model as a function of the value for the probability model, $\eta_j = \log_n(\mu_i/(1\text{-}\mu_i)$. The link function transforms η into a form that is more appropriate to assume a linear model, resulting in log odds which are unbounded at either end (upper and lower) (Raudenbush & Bryk 2002).

When using multilevel modeling techniques, it is important to check the assumptions of the model. The most simplistic multilevel regression model assumes that the effect of level-1 variables on the outcome do not vary across level-2 units. This is sometimes referred to as a “random intercept” model. However, this assumption may or may not be accurate. One can test this assumption by comparing goodness-of-fit statistics between these simplistic (random intercept) models and more complex models which allow the effects of level-1 variables to vary across level-2 units (often referred to as “random coefficient” or “random slope” models).

However, when using generalized hierarchical linear models in HLM (as is the case for low birth weight and preterm birth), this procedure cannot be performed since the program is based on restricted maximum likelihood and penalized quasi-likelihood algorithms (Raudenbush & Bryk 2002). Instead, Raudenbush and Bryk recommend using LaPlace iterations to produce deviance statistics that can be compared using chi-square tests. In accordance with their recommendation, this alternative procedure was used to determine if the addition of any random coefficients improved goodness-of-fit (results not shown but available upon request). Overall, these comparisons (and the traditional deviance comparison tests from the linear models) suggested that the random intercept models were the best fit of the data. In addition, there is no theoretical justification in the literature that suggests the effects of the infant-level characteristics on birth weight may vary across mothers. As a result, random intercept models were used throughout the analysis. All models were also estimated using appropriate survey weights to adjust for the complex and stratified survey design of the NSFG. Sobel mediation tests were calculated to identify explanatory variables which performed significant mediation.

Subsequent analyses addressing the selection hypothesis employed sibling fixed-effects regression models. This technique facilitates the comparison of infant health outcomes for two (or more) siblings when the mother's relationship status differs for each child. For example, a woman who was unmarried at the time of her first birth but married at the time of her second birth would be retained in the analysis. This comparison informs our assumptions about the marriage advantage in infant health outcomes within a very stringent context since these models implicitly account for all selection factors—observed and unobserved—that do not change between the two time points (such as race/ethnicity, personality traits, income, genetic contributions, etc.) and where the survey sampling criteria is not a function of the dependent variable (Johnson 2005). One assumption of these models is that all time-varying indicators that are relevant to the study at hand are explicitly included in the model, which may or may not be satisfied (Allison 2009). To buttress support for this assumption, these models include several time-varying (or in this case, child-specific) explanatory indicators: mother's age at conception, parity, child gender, health insurance status, gestational length, pregnancy unwantedness, pregnancy mistiming, smoking behavior, prenatal healthcare receipt.

These findings will contribute to the analysis in ways that are unique from the multilevel random intercept models. As previously discussed, multilevel models offer the advantage of estimating both level-1 and level-2 effects on the outcome which is a more efficient way to estimate variance (compared with fixed-effects models). By design, fixed-effects models perfectly account for all group-level variance by estimating an exhaustive list of group-specific constants. This means that only level-1 variance can contribute to the estimate of the beta coefficients and also that the model estimates are based on this specific set of cases. While this approach is extremely powerful, this highlights two important limitations. First, this approach produces less efficient estimates of the beta coefficients (in using up numerous degrees of freedom) which are reflected in larger (inflated) standard errors. Second, the fixed effects approach produces a solution that is unique to the group of cases included here; thus, the results cannot be generalized to a broader population (Johnson 1995).

Descriptive Analysis

Table 1 provides a summary of the appropriately weighted descriptive statistics for both infant- and mother-level characteristics. (A weighted correlation matrix is also provided for reference in Appendix A for reference.[1]) Recall that the analytic subsample includes only births occurring in the five years prior to the 2006-8 survey. Due to the shifting incidence of infant health outcomes over the past few decades, limiting the sample to births occurring within the bounds of a specific period in time is advantageous. The average pregnancy in this sample ended in 2005. Similar to estimates from the National Vital Statistics Report for births in 2005, the incidence of low birth weight and preterm birth in this sample is 7% and 11% respectively (compared with 8% and 11% respectively, Martin et al. 2007). Babies born in this sample weighed an average of 117 ounces (or, 7 pounds 5 ounces) at birth.

More than half of infants (63%) were born to married mothers whereas substantially fewer infants were born to cohabiting or single mothers (21% and 16% respectively). Over half the sample is non-Hispanic White (60%), with smaller proportions in other subgroups (22% Hispanic, 12% non-Hispanic Black, and 6% non-Hispanic

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[1] Although the pairwise correlation between grandmother's and grandfather's education is moderately high (r = .59), a preliminary analysis compared the results from models that included and excluded the latter measure. No differences arose and as a result, both variables were included in all analyses.

Other). Around one-fifth of mothers are foreign-born (19%) and just over a quarter transitioned into motherhood before completing high school (28%). The average parity in this sample is just over 2 children (2.08) and almost half of mothers reported that public insurance paid for at least some portion of the cost of delivery (44%). Relatively few mothers ever smoked during pregnancy (12%) or never received prenatal care throughout the entire pregnancy (2%). Nearly all mothers who received prenatal care at some point did so in the first trimester (91%).

Family background characteristics included in this survey provide rich detail about the childhood environment of the mothers in this sample. Nearly a third of mothers were living in a single- or step-family at age fourteen (30%) and sixteen percent were themselves born out-of-wedlock. Grandmothers and grandfathers completed, on average, more than a high school degree (a value of 2 in the categorical scale) but less than some college (a value of 3). Grandmother's age at first birth was more than 18-19 years old (a value of 2 in the categorical scale) but less than 20-24 years old (a value of 3). Also, nearly three quarters of women in this sample reported that the grandmother was employed at least part-time outside of the home at some point during her childhood (70%).

Table 2 compares sample characteristics across three groups of infants: those born to mothers who were married, cohabiting, and single at the time of conception. As expected, infants born to married mothers were significantly advantaged: they experienced less risky infant health outcomes whereas their mothers exhibited lower rates of teen pregnancy, more advantageous family backgrounds, lower levels of public insurance utilization, lower levels of pregnancy unwantedness and mistiming, lower rates of prenatal smoking, and higher rates of early initiation of prenatal care. Together, these findings suggest that marriage advantages in infant health are prevalent at the bivariate level and are likely linked with a variety of explanatory processes.

The multivariate results in the section below are presented as follows: the multilevel model estimates for one outcome, birth weight, are presented first, followed by the results for low birth weight and preterm birth. Each series of models begins by estimating the total effect of mother's relationship status on infant health and then adding each block of covariates one at a time to subsequent models. Consistent with a life course perspective, factors that are more distal to the birth are added first (sociodemographic characteristics), followed by those that are more proximate (family background and human capital, followed by pregnancy characteristics). Next, the two groups of potential mediators—pregnancy wantedness and prenatal health behaviors—are added separately to the model. Finally, a full model is estimated including all covariates and mediators.

FINDINGS

Table 3 presents the results from the multilevel regression models estimating birth weight (in ounces), adjusting for gestational length. Model 1 indicates that, on average, infants born to cohabiting mothers weigh nearly 3 ounces less than infants born to married mothers (b = -2.74, p < .001). Their counterparts born to single mothers weigh 6 ounces less (b = -6.28, p < .001). Including demographic and family background characteristics (in Models 2 and 3) reduces these coefficients slightly, but the effects of relationship status are still relatively sizable and significant. As anticipated, infants born to non-Hispanic Black mothers weigh less than their counterparts born to non-Hispanic White mothers. Interestingly, in these data there are no significant differences between infants born to Hispanic and non-Hispanic White mothers. With respect to family background characteristics, in preliminary analyses (not shown), I explored the data by adding each factor, one at a time, to the model. In this context, each exhibited a significant association with birth weight in the expected direction. However when all family characteristics were included simultaneously (shown in Model 3), only one retained a unique and significant effect: mother's nonmarital birth status. Infants born to mothers who were themselves born out-of-wedlock weigh 3 ounces less on average then their counterparts whose mothers were born within a marital union (b = -3.03, p < .01).

Adding the measures of human capital (in Model 4) reduces the cohabiting-married disparity to non-significance, whereas the single-married disparity is reduced only in size. Infants born to single mothers weigh nearly 4 ounces less than their counterparts born to married mothers. Having a child before finishing high school is not significantly related to birth weight but the proxy of poverty status—using public health insurance (i.e., Medicaid) to pay for the birth is inversely related to birth weight, as expected. The addition of pregnancy characteristics (in Model 5) reduces the married-single disparity in both size (by almost half) and significance. The covariates added here operate in the expected directions: higher parity infants and male infants exhibit higher birth weight. Models 2 thru 5 have considered various categories of variables related to life course and selection factors. Comparing the married-single disparity net of the full set of characteristics in Model 5 (-2.3) with its correlate in Model 1 (-6.28) demonstrates that almost two-thirds (63%) of the disparity is accounted for by life course/selection factors.

Thus far, the findings indicate no difference in birth weight among infants born to cohabiting versus married mothers or cohabiting versus single mothers (net of a host of important covariates spanning the mother's life course), but a significant disparity between infants born to single versus married mothers. Next the potential mediators are considered. Despite the richness of the pregnancy unwantedness and mistiming variables, neither is significantly related to birth weight (Model 6), net of all other factors. Consistent with prior research however, smoking during pregnancy is related to lower birth weight (Model 7) and its effect remains salient in the full model (Model 8). Ever receiving prenatal care and early receipt of prenatal care (in the first trimester) are related to birth weight (at the $p < .10$ level) in the intermediate model, but are not significant in the full model. Sobel-Goodman mediation tests demonstrate that prenatal smoking behavior is a significant mediator of the married-single disparity in both models (Model 7: $t = -2.56$, $p = .01$; Model 8: $t = -2.31$, $p = .02$).

Supplementary analyses (not shown but available upon request) explored a single-cohabiting disparity by rotating the reference group. Results demonstrate that infants born to single mothers weighed less than their counterparts born to cohabiting mothers by nearly 3 ounces. This difference persisted in size and significance with the addition of demographic characteristics, family background measures, and human capital. However, once pregnancy characteristics were included the disparity became non-significant.

Next I repeat this same series of models for the other two infant health outcomes: low birth weight and preterm birth. The results are presented in Tables 4 and 5. Converting the logit coefficients presented here to odds ratios (e^{β}), we see that the odds of low birth weight are 55% higher among infants born to cohabiting mothers ($e^{\beta} = e^{.44} = 1.55$) and 116% higher among infants born to single mothers ($e^{.77} = 2.16$). (The cohabiting-single disparity was never significant.) These effects are reduced in size once demographic characteristics are included and the married-cohabiting disparity is no longer significant when family background factors are added. The married-single disparity remains significant however (odds ratio = 1.46, $p < .05$). Notable covariates include non-Hispanic Black race/ethnicity (which is associated with a 116% increase in the odds of low birth weight), grandmother's age at first birth (higher values on the categorical scale are associated with lower odds of low birth weight), and mother's nonmarital birth status (which is associated with a 45% increase in the odds of low birth weight). The addition of human capital reduces the married-single disparity to non-significance. Having a child before finishing high school is unrelated to the risk of low birth weight but using public insurance to pay for the birth is positively associated with this risk.

This suggests that the observed advantages among married women with respect to the risk of low birth weight are grounded in mother's experiences in prior life stages (i.e., childhood environment), demographic differences (i.e., race/ethnicity), and human capital (health insurance status). (Although the marriage advantage in low birth weight is fully explained, it is interesting to note that pregnancy unwantedness and never receiving prenatal care are both associated with increased odds of low birth weight in the final model.)

The results for preterm birth are similar. The odds of preterm birth are 55% higher among infants born to single mothers, but there are no differences between infants born to cohabiting and married mothers. Including demographic and family background characteristics reduces the married-single disparity to non-significance. Important covariates of preterm birth in these models include non-Hispanic Black race/ethnicity, single or stepparent family structure in adolescence, utilization of public insurance to pay for the birth, lower parity births, and pregnancy unwantedness—each are associated with increased odds of preterm birth in final model.

Thus far, the results for all three outcomes lend support to the life course hypothesis in that the addition of (causally prior) family background characteristics account for much, and sometimes all, of the observed marriage advantage. The results for birth weight also lend support to the mediation hypothesis in that smoking is a significant mediator of the married-single disparity. However, the married-single disparity remains marginally significant in the final model predicting birth weight which suggests that these two explanations do not fully explain differences among infants born to married versus single women. Evidence along these lines is indicated by comparing the direct effect of singlehood on birth weight from Table 3, Model 8 (-1.64) with the total effect from Table 3, Model 1 (-6.28) which reveals that the sum of variables included in the final model together explain about 74% of the association between relationship status and infant health outcomes ((total effect – direct effect)/total effect). We can also calculate the proportion of total level-1 and level-2 variation explained by the model to examine a different dimension of this association. The following equations provide the basis for these comparisons.

$R^2_{\text{level-1}} = (\sigma^2_{\text{null}} - \sigma^2_{\text{model}}) / \sigma^2_{\text{null}}$

$R^2_{\text{level-2}} = (\tau_{\text{null}} - \tau_{\text{model}}) / \tau_{\text{null}}$

$R^2_{\text{total}} = (\sigma^2_{\text{null}} + \tau_{\text{null}}) - (\sigma^2_{\text{model}} + \tau_{\text{model}}) / (\sigma^2_{\text{null}} + \tau_{\text{null}})$

Following these calculations using statistics provided in the footnote of Table 3, we can see that the full model accounts for 30% of the infant-level variation in birth weight and 42% of the mother-level variation in birth weight. Together, the burden of proof suggests that there is more to this story than we have examined so far.

Next I turn to sibling fixed-effects models to explore the possibility that unobserved characteristics associated with both relationship status and infant health outcomes (the selection hypothesis) lends increased explanation. Table 6 summarizes these results. Model 1 indicates that infants born to mothers who were single at the time of one birth but married at the time of another birth exhibit significantly different birth weight outcomes. Infants born to single mothers are on average 7 ounces lighter than their siblings born within a marital union. Recall that these models implicitly adjust for all time-invariant characteristics—both measured and unmeasured—that are correlated with the independent and dependent variables. Interestingly, there are no differences between infants born to cohabiting and married mothers in this framework.

Adding (child-specific) human capital and pregnancy characteristics reduces the married-single disparity by 2 ounces although it remains significant at the $p < .05$ level. Important covariates here include both parity and infant gender but interestingly, not public insurance utilization. Pregnancy unwantedness and mistiming are not significantly related to birth weight but smoking during pregnancy and never receiving prenatal care are negatively associated with birth weight. The married-single disparity remains significant in the final model: infant born to single mothers remain 5 ounces lighter than their counterparts born within a marital union.

Subsequent analyses explored fixed-effects models for the other two outcomes— low birth weight and preterm birth—but did not find evidence of a marriage advantage for any group of infants in the bivariate context. In sum, this series of models supports the existence of a salient advantage of married women over single women with respect to birth weight, but no difference between married and cohabiting women, and no salient marriage advantage in any contrast with respect to low birth weight or preterm birth.

DISCUSSION AND CONCLUSIONS

This study investigates the mechanism through which marriage advantages in infant health outcomes operate. Drawing from a rich sociohistorical perspective within family sociology and demography literature, analyses reconcile changes in family formation trends (such as rising rates of nonmarital childbearing, delayed age at first marriage, and delayed childbearing) with women's reproductive health outcomes observed at one point in time. To that end, analyses compare and contrast two potential explanations of the marriage advantage: a life course model (positing that the observed advantages are grounded in women's experiences in prior life stages such as childhood) and a mediation model (positing that marriage leads to positive prenatal health characteristics, which in turn lead to better infant health outcomes).

This study is among the first to apply a rich set of family background *and* pregnancy-related characteristics to this examination and the first to estimate the marriage advantage within a fixed-effects context—together providing a particularly stringent test of the life course and mediation hypotheses. Furthermore, results explore three different mother-father relationship statuses at the time of conception (married, cohabiting, and single) and compare findings across three different indicators of infant health: low birth weight, preterm birth, and birth weight measured in ounces and adjusted for gestational length (to approximate intrauterine growth restriction or small-for-gestational age). The results from models predicting low birth weight situates this analysis within previous literature (since most prior research is based on this measure) and the results from the preterm birth and birth weight models inform future prevention strategies aimed at reducing infant mortality.

In sum, results from multilevel models (where infants are nested within mothers) demonstrate that the marriage advantage for one indicator of infant health—birth weight—is diminished but not eradicated with the inclusion of a rich set of family background characteristics. Intergenerational transmissions of health risk are also apparent—infants whose mothers were born out-of-wedlock were lighter on average than their counterparts whose mothers were born within a marital union. Subsequent exploration using fixed-effects models demonstrate the salience of the marriage advantage between married and single women but show no difference between married and cohabiting women. Furthermore, in both multilevel and fixed-effects models, the married-single disparity is partially explained by poorer prenatal health characteristics (i.e., smoking during pregnancy) among single women. While somewhat surprising that no other prenatal characteristics (i.e., prenatal care receipt) mediated this association, these findings are consistent with work by Reichman and Teitler (2005) suggesting that prenatal care often offers “too little, too late” with respect to birth outcomes. In sum, the results for birth weight demonstrate some support for both hypotheses with respect to birth weight.

On the other hand, the findings for the other two indicators of infant health were quite different. There was no evidence of a marriage advantage for preterm birth (even at the bivariate level), and the advantage of married mother over single mothers with respect to low birth weight was diminished once family background characteristics were included. When tested within a fixed-effects framework, there was no evidence of a marriage advantage for either outcome. This is particularly surprising given previously-demonstrated advantages of married women over both cohabiting and single women with respect to low birth weight (Bird et al. 2000), although the current findings reflect more recent pregnancies which are situated within a much different family demographic landscape than was observed in past research.

Taken together, results from this study are consistent with marriage advantages observed with respect to other physical and mental health outcomes in that a large proportion (though not all) of the advantage is due to the confounding effect of selection processes (e.g., Booth & Amato, 1991). However, there is no difference between married and cohabiting women in terms of one indicator of child well-being, infant health, which stands in contrast to a host of literature on poor child well-being outcomes among cohabiting parents (e.g., Brown 2004; Manning & Lichter 1996). On one hand, if poor child well-being occurs partly as a result of the *experience* of living with cohabiting parents, this would not extend to infant health outcomes since (by definition) they don't include the same level of exposure. Alternatively, this may also indicate a growing convergence in well-being between children living within marital and cohabiting unions as the diversity within family types in the U.S. grows. More research is needed to adjudicate between these explanations.

As with any other study, there are several limitations of this work. In order to include prenatal health behaviors and attitudes, the analytic subsample could only contain women who had a live birth in the five years prior to the survey interview. This was an advantage in terms of (a) reducing potential period effects on marriage advantages that may arise from sweeping family demographic changes in the past several decades, and (b) informing trends among more recent births in the U.S. However, the results cannot inform trends among births that occurred before 2001. It may be that these processes operate differently among previous cohorts of women. Future work could compare these processes across different time points (i.e., births grouped by decade) to tease out potential period effects and to address the changing nature of marriage advantages over time. Limiting the scope of the analysis to births occurring in the five years prior to the interview was also consequential in terms of retaining a relatively smaller number of births in the analysis. Given that low birth weight and preterm birth are relatively rare occurrences it is possible that future analyses using larger subsamples of women may produce different results with greater statistical power. However, this survey is unique in its inclusion of a rich set of family background, sociodemographic, and pregnancy characteristics. Larger datasets (such as electronic birth certificates) often do not offer the same level of rich description across the life course. Lastly, there has been some debate in the literature about the extent to which respondents may apply a "revisionist history" to questions about pregnancy wantedness (see Miller & Jones 2009 for a review of the literature on the construct validity of pregnancy wantedness). With respect to this study in particular, the consequences of revision are less consequential if including only recent births (in the last five years) reduces this bias. On the other hand, if revision tends to occur at any point after the birth, then the benefit of using recent births is negated. Using measures that are asked during (or before) pregnancy would be optimal and could be used in future research as a way to further test these associations.

In sum, results from this study demonstrate more support for a selection perspective in terms of shaping marriage advantages in infant health but it is clear that these do not entirely explain the 'marriage advantage'—even within a fixed-effects framework. Future work should consider other factors that may explain the remaining advantage, such as neighborhood environments. A large literature suggests social environments affect both social behaviors and health outcomes (e.g., Sampson, Morenoff, & Gannon-Rowley, 2002; Leventhal & Brooks-Gunn 2000). Therefore, it is quite possible that the inclusion of neighborhood characteristics may further illuminate the marriage advantage in infant health outcomes. The results from this study also accentuate the conceptually and empirically distinct nature of the three outcomes considered here. Future research in this area should continue to examine a wide variety of infant health outcomes in order to produce the most germane findings to inform future policy on reducing infant health disparities at the population-level.

Figure 1. Conceptual Framework Linking Life Course and Mediation Hypotheses with Infant Health Outcomes

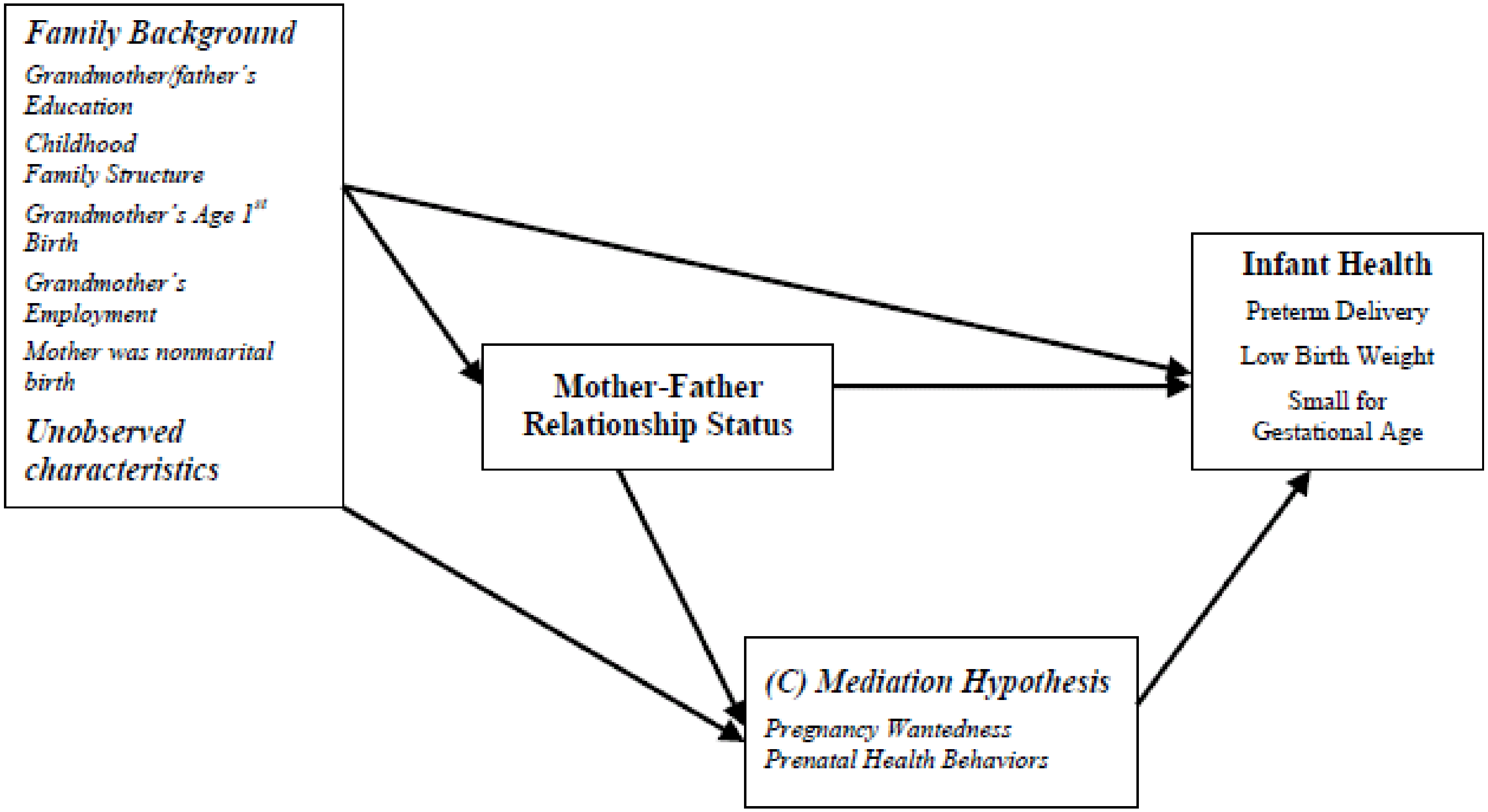

Table 1. Weighted Descriptive Statistics: Life Course versus Mediation Hypotheses

	Min.	**Max.**	**Mean or Proportion**	**Standard Deviation**	**Standard Error**
Infant Health Outcomes					
Low Birth Weight	0	1	0.07		0.09
Preterm Birth	0	1	0.11		0.01
Birth Weight (ounces)	13	208	117.52	21.90	0.62
Gestational Length	22	45	38.52	2.47	0.07
Relationship Status					
Cohabiting	0	1	0.21		0.01
Single (non-residential)	0	1	0.16		0.01
Married (*reference group*)	0	1	0.63		0.02
Demographic Characteristics					
Mother's Race/ethnicity					
non-Hispanic Black	0	1	0.12		0.02
Hispanic	0	1	0.22		0.04
non-Hispanic White (*reference group*)	0	1	0.60		0.04
non-Hispanic Other	0	1	0.06		0.02
35+ years old	0	1	0.12		0.02
non-Hispanic White (*reference group*)	0	1	0.60		0.04
Nativity status (*1 =foreign-born*)	0	1	0.19		0.02
Human Capital					
Had 1st child before exiting HS (*1 = yes*)	0	1	0.28		0.03
Public insurance paid for birth (*1 = yes*)	0	1	0.44		0.03
Pregnancy Characteristics					
Mother's age at time of conception					
Less than 20 years old	0	1	0.13		0.01
20-34 years old	0	1	0.75		0.02
Parity	1	9	2.08	1.17	0.05
Child gender (*1 = male*)	0	1	0.49		0.02
Family Background					
Single or stepparent family (*1 = yes*)	0	1	0.30		0.03
Grandmother's education	1	4	2.35	1.03	0.07
Grandfather's education	1	4	2.34	1.08	0.08
Grandmother's age at first birth	1	5	2.66	1.07	0.06
Mother born out-of-wedlock (*1 = yes*)	0	1	0.16		0.01
Grandmother employed (*1 = yes*)	0	1	0.69		0.04
Pregnancy Wantedness					
Birth was unwanted (factor score)	-1.17	4.34	-0.28	1.63	0.05
Birth was mistimed (factor score)	-1.12	2.96	-0.11	1.19	0.04
Prenatal Health Behaviors					
Ever smoked during pregnancy (*1 = yes*)	0	1	0.12		0.02
Never received prenatal care (*1 = never*)	0	1	0.02		0.00
Rec'd prenatal care in 1st trimester (*1 = yes*)	0	1	0.91		0.01

Note: N = 2,930 births nested within 1,606 women. Means and standard deviations are adjusted for weighting. Standard errors are adjusted for clustering, stratification, and weighting.

Table 2. Weighted Means (or Proportions), by Mother's Relationship Status at Conception

	Married	Cohabiting	Single	Significant Difference
Infant Health Outcomes				
Low Birth Weight	0.06	0.08	0.13	Married < Cohabiting < Single
Preterm Birth	0.10	0.11	0.14	Married < Single
Birth Weight (ounces)	119.27	116.78	111.50	Married > Cohabiting > Single
Gestational Length	38.53	38.54	38.42	Married > Single
Demographic Characteristics				
Mother's Race/ethnicity				
non-Hispanic Black	0.07	0.13	0.34	Married < Cohabiting < Single
Hispanic	0.18	0.34	0.22	Cohabiting > Married, Single
non-Hispanic Other	0.06	0.07	0.04	Single < Married, Cohabiting
non-Hispanic White (*reference group*)	0.69	0.46	0.40	Married > Cohabiting > Single
Nativity status (*1 =foreign-born*)	0.20	0.22	0.12	Single < Married < Cohabiting
Human Capital				
Had 1st child before exiting HS (*1 = yes*)	0.19	0.44	0.43	Married < Cohabiting, Single
Public insurance paid for birth (*1 = yes*)	0.27	0.71	0.73	Married < Cohabiting < Single
Pregnancy Characteristics				
Mother's age at time of conception				
Less than 20 years old	0.04	0.22	0.38	Married < Cohabiting < Single
20-34 years old	0.79	0.73	0.59	Married > Cohabiting > Single
35+ years old	0.16	0.05	0.03	Married > Cohabiting > Single
Parity	2.19	2.00	1.76	Married > Cohabiting > Single
Child gender (*1 = male*)	0.49	0.52	0.44	Cohabiting > Single
Family Background				
Single or stepparent family (*1 = yes*)	0.23	0.42	0.40	Married < Cohabiting, Single
Grandmother's education	2.47	2.12	2.19	Married > Cohabiting, Single
Grandfather's education	2.49	2.03	2.13	Married > Cohabiting, Single
Grandmother's age at first birth	2.80	2.35	2.51	Married > Cohabiting, Single
Mother born out-of-wedlock (*1 = yes*)	0.07	0.24	0.36	Married < Cohabiting < Single
Grandmother employed (*1 = yes*)	0.68	0.67	0.79	Cohabiting < Married < Single
Pregnancy Wantedness				
Birth was unwanted (factor score)	-0.63	-0.03	0.79	Married < Cohabiting < Single
Birth was mistimed (factor score)	-0.35	0.13	0.50	Married < Cohabiting < Single
Prenatal Health Behaviors				
Ever smoked during pregnancy (*1 = yes*)	0.09	0.15	0.20	Married < Cohabiting, Single
Never received prenatal care (*1 = never*)	0.01	0.03	0.03	Married < Cohabiting, Single
Rec'd prenatal care in 1st trimester (*1 = yes*)	0.94	0.89	0.83	Married > Cohabiting, Single

Note: N = 2,930 births nested within 1,606 women. Means are adjusted for weighting. "Single" refers to women who did not live with the father of their baby at the time of conception. Significant difference indicates $p < .05$.

Table 3. Multilevel Regression Coefficients Predicting Birth Weight (in ounces), from Mother's Relationship Status, Childhood Environment, Pregnancy Wantedness, and Prenatal Health Behaviors

	1	2	3	4	5	6	7	8
Relationship Status *(ref = Married)*								
Cohabiting	-2.74***	-2.49**	-1.98*	-1.21	-0.44	-0.23	-0.32	-0.19
	(0.83)	(0.84)	(0.86)	(0.91)	(0.91)	(0.93)	(0.91)	(0.93)
Single (non-residential)	-6.28***	-5.47***	-4.78***	-3.96***	-2.30*	-1.87†	-1.91†	-1.66†
	(0.90)	(0.95)	(0.97)	(1.01)	(1.05)	(1.12)	(1.05)	(1.12)
Demographic Characteristics								
Mother's Race/ethnicity								
non-Hispanic Black		-4.10***	-3.06**	-2.85*	-3.25**	-3.21**	-3.75**	-3.73**
		(1.10)	(1.17)	(1.17)	(1.16)	(1.16)	(1.18)	(1.18)
Hispanic		0.58	1.67	1.93	2.01†	1.99†	1.38	1.35
		(1.10)	(1.18)	(1.18)	(1.18)	(1.18)	(1.20)	(1.20)
non-Hispanic Other		-1.36	-1.08	-1.26	-1.68	-1.70	-1.86	-1.88
		(1.66)	(1.66)	(1.66)	(1.65)	(1.65)	(1.65)	(1.65)
Nativity status (*1 =foreign-born*)		-1.75	-1.46	-1.22	-0.89	-0.86	-1.19	-1.15
		(1.14)	(1.16)	(1.17)	(1.17)	(1.17)	(1.17)	(1.18)
Family Background								
Single or stepparent family (*1 = yes*)			-0.42	-0.14	-0.27	-0.26	0.15	0.16
			(0.81)	(0.83)	(0.82)	(0.82)	(0.83)	(0.83)
Grandmother's education			0.20	0.14	0.28	0.28	0.18	0.18
			(0.46)	(0.46)	(0.46)	(0.46)	(0.46)	(0.46)
Grandfather's education			0.46	0.32	0.37	0.36	0.41	0.40
			(0.44)	(0.44)	(0.44)	(0.44)	(0.44)	(0.44)
Grandmother's age at first birth			-0.13	-0.20	-0.04	-0.05	-0.05	-0.06
			(0.38)	(0.38)	(0.38)	(0.38)	(0.38)	(0.38)
Mother born out-of-wedlock (*1 = yes*)			-3.03**	-2.87**	-2.81**	-2.78**	-2.96**	-2.93**
			(1.06)	(1.07)	(1.06)	(1.06)	(1.06)	(1.06)
Grandmother employed (*1 = yes*)			1.25	1.03	1.06	1.08	1.18	1.19
			(0.84)	(0.84)	(0.83)	(0.83)	(0.83)	(0.83)
Human Capital								
Had 1st child before exiting HS (*1 = yes*)				0.00	-0.89	-0.81	-0.23	-0.17
				(0.96)	(0.98)	(0.99)	(0.99)	(1.00)
Public insurance paid for birth (*1 = yes*)				-2.37**	-2.66**	-2.71**	-2.24**	-2.31**
				(0.85)	(0.85)	(0.86)	(0.86)	(0.87)
Pregnancy Characteristics								
Mother's age at time of conception (ref = 20-34)								
Less than 20 years old					0.90	0.92	0.76	0.73
					(1.09)	(1.11)	(1.09)	(1.11)
35+ years old					2.15*	2.23*	2.05†	2.13†
					(1.11)	(1.11)	(1.11)	(1.11)
Parity					1.88***	1.96***	1.97***	2.02***
					(0.32)	(0.32)	(0.32)	(0.32)
Child gender (*1 = male*)					4.12***	4.08***	3.99***	3.96***
					(0.62)	(0.62)	(0.62)	(0.62)

Table 3. Multilevel Regression Coefficients Predicting Birth Weight (in ounces), from Mother's Relationship Status, Childhood Environment, Pregnancy Wantedness, and Prenatal Health Behaviors (Continued)

	1	2	3	4	5	6	7	8
Pregnancy Wantedness								
Birth was unwanted (factor score)						-0.30		-0.20
						(0.24)		(0.24)
Birth was mistimed (factor score)						0.02		0.08
						(0.30)		(0.30)
Prenatal Health Behaviors								
Ever smoked during pregnancy (*1 = yes*)							-3.80***	-3.78***
							(1.10)	(1.10)
Never received prenatal care (*1 = never*)							-4.11†	-3.98
							(2.45)	(2.46)
Rec'd prenatal care 1st trimester (*1 = yes*)							1.88†	1.79
							(1.08)	(1.09)
Gestational Length	5.10***	5.08***	5.08***	5.06***	5.02***	5.02***	5.02***	5.02***
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Intercept (γ_{00})	-77.69***	-76.04***	-78.30***	-76.30***	-82.01***	-82.24***	-83.34***	-83.36***
	-5.42	-5.44	-5.63	-5.69	-5.66	-5.66	-5.77	-5.77
Mother-Level Residual (μ_{0j})	135.08	132.49	129.76	129.76	128.14	128.40	128.30	128.48
Infant-Level Residual (r_{ij})	186.89	187.39	188.64	188.63	181.26	181.10	179.79	179.76
Deviance	25046.7	25019.7	25000.6	24996.0	24898.2	24898.2	24871.4	24872.2

Note: ****p* < .001, ***p* < .01, **p* < .05, †*p* < .10 (two-tailed). Total sample = 2,930 births nested within 1,606 women. Significance tests are based on robust standard errors. Null model results: intercept (γ_{00})= 116.87, mother-level residual (μ_{0j}) = 220.83, infant-level residual (r_{ij}) = 258.07, deviance = 26174.80, *df* = 2.

Table 4. Multilevel Logistic Regression Coefficients Predicting Low Birth Weight, from Mother's Relationship Status, Childhood Environment, Pregnancy Wantedness, and Prenatal Health Behaviors

	1	2	3	4	5	6	7	8
Relationship Status *(ref = Married)*								
Cohabiting	0.44*	0.35*	0.22	0.05	0.01	-0.10	-0.01	-0.11
	(0.17)	(0.18)	(0.18)	(0.19)	(0.20)	(0.20)	(0.20)	(0.20)
Single (non-residential)	0.77***	0.52**	0.38*	0.20	0.15	-0.05	0.14	-0.06
	(0.17)	(0.19)	(0.19)	(0.20)	(0.21)	(0.23)	(0.22)	(0.23)
Demographic Characteristics								
Mother's Race/ethnicity								
non-Hispanic Black		0.77***	0.57**	0.55**	0.58**	0.57**	0.58**	0.57**
		(0.19)	(0.21)	(0.21)	(0.21)	(0.21)	(0.22)	(0.21)
Hispanic		0.18	0.03	0.00	0.06	0.05	0.02	0.00
		(0.23)	(0.25)	(0.25)	(0.25)	(0.25)	(0.26)	(0.26)
non-Hispanic Other		0.00	-0.06	-0.03	0.03	0.02	0.01	0.00
		(0.35)	(0.36)	(0.36)	(0.36)	(0.36)	(0.36)	(0.36)
Nativity status (*1 =foreign-born*)		-0.06	-0.05	-0.11	-0.19	-0.18	-0.22	-0.22
		(0.23)	(0.24)	(0.25)	(0.25)	(0.25)	(0.25)	(0.26)
Family Background								
Single or stepparent family (*1 = yes*)			0.24	0.18	0.24	0.23	0.22	0.22
			(0.16)	(0.16)	(0.17)	(0.17)	(0.17)	(0.17)
Grandmother's education			0.17	0.18*	0.19*	0.20*	0.20*	0.21*
			(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Grandfather's education			-0.14	-0.10	-0.10	-0.11	-0.12	-0.12
			(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Grandmother's age at first birth			-0.16*	-0.15†	-0.16*	-0.15*	-0.16*	-0.15*
			(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Mother born out-of-wedlock (*1 = yes*)			0.37*	0.33†	0.34†	0.34†	0.33†	0.33†
			(0.19)	(0.19)	(0.19)	(0.19)	(0.19)	(0.19)
Grandmother employed (*1 = yes*)			-0.27	-0.22	-0.23	-0.26	-0.25	-0.27
			(0.17)	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)
Human Capital								
Had 1st child before exiting HS (*1 = yes*)				0.08	0.20	0.16	0.17	0.15
				(0.18)	(0.19)	(0.19)	(0.19)	(0.19)
Public insurance paid for birth (*1 = yes*)				0.47**	0.56**	0.56**	0.58**	0.59**
				(0.18)	(0.19)	(0.19)	(0.19)	(0.19)
Pregnancy Characteristics								
Mother's age at time of conception (ref = 20-34)								
Less than 20 years old					-0.27	-0.31	-0.27	-0.32
					(0.22)	(0.23)	(0.22)	(0.23)
35+ years old					0.32	0.29	0.31	0.27
					(0.26)	(0.26)	(0.26)	(0.26)
Parity					-0.18*	-0.21**	-0.18*	-0.21**
					(0.07)	(0.07)	(0.07)	(0.07)
Child gender (*1 = male*)					-0.17	-0.16	-0.18	-0.16
					(0.14)	(0.15)	(0.15)	(0.15)

Table 4. Multilevel Logistic Regression Coefficients Predicting Low Birth Weight, from Mother's Relationship Status, Childhood Environment, Pregnancy Wantedness, and Prenatal Health Behaviors (CONTINUED)

	1	2	3	4	5	6	7	8
Pregnancy Wantedness								
Birth was unwanted (factor score)						0.13**		0.13**
						(0.05)		(0.05)
Birth was mistimed (factor score)						0.04		0.05
						(0.07)		(0.07)
Prenatal Health Behaviors								
Ever smoked during pregnancy (*1 = yes*)							-0.05	-0.09
							(0.23)	(0.23)
Never received prenatal care (*1 = never*)							0.90*	0.82*
							(0.40)	(0.40)
Rec'd prenatal care 1st trimester (*1 = yes*)							-0.02	0.06
							(0.23)	(0.24)
Intercept (γ_{00})	-2.77***	-2.87***	-2.40***	-2.73***	-2.36***	-2.20***	-2.30***	-2.22***
	(0.10)	(0.12)	(0.31)	(0.33)	(0.38)	(0.38)	(0.45)	(0.45)
Mother-Level Residual (μ_{0j})	0.6	0.43	0.38	0.4	0.43	0.41	0.46	0.00

Note: ***p < .001, **p < .01, *p < .05, †p < .10 (two-tailed). Total sample = 2,930 births nested within 1,606 women. Significance tests are based on robust standard errors. Null model results: intercept (γ_{00})= -2.51***, μ_{0j} = 0.88.

Table 5. Multilevel Logistic Regression Coefficients Predicting Preterm Birth, from Mother's Relationship Status, Childhood Environment, Pregnancy Wantedness, and Prenatal Health Behaviors

	1	2	3	4	5	6	7	8
Relationship Status *(ref = Married)*								
Cohabiting	0.12	0.05	-0.01	-0.18	-0.23	-0.38*	-0.23	-0.38*
	(0.15)	(0.16)	(0.16)	(0.17)	(0.17)	(0.18)	(0.17)	(0.18)
Single (non-residential)	0.44**	0.28†	0.24	0.06	0.01	-0.27	0.00	-0.28
	(0.15)	(0.16)	(0.17)	(0.18)	(0.19)	(0.20)	(0.19)	(0.20)
Demographic Characteristics								
Mother's Race/ethnicity								
non-Hispanic Black		0.43*	0.38*	0.36*	0.37*	0.35†	0.40*	0.38*
		(0.17)	(0.19)	(0.19)	(0.19)	(0.19)	(0.19)	(0.19)
Hispanic		0.24	0.29	0.26	0.27	0.27	0.31	0.31
		(0.19)	(0.20)	(0.20)	(0.20)	(0.21)	(0.21)	(0.21)
non-Hispanic Other		-0.05	-0.04	0.00	0.04	0.02	0.07	0.05
		(0.31)	(0.31)	(0.31)	(0.31)	(0.31)	(0.31)	(0.31)
Nativity status (*1 =foreign-born*)		-0.33	-0.25	-0.31	-0.35	-0.36†	-0.33	-0.34
		(0.20)	(0.21)	(0.21)	(0.22)	(0.22)	(0.22)	(0.22)
Family Background								
Single or stepparent family (*1 = yes*)			0.31*	0.24†	0.26†	0.25†	0.25†	0.25†
			(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Grandmother's education			0.06	0.07	0.07	0.07	0.06	0.07
			(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Grandfather's education			0.03	0.07	0.06	0.06	0.07	0.07
			(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Grandmother's age at first birth			-0.10	-0.08	-0.09	-0.08	-0.09	-0.08
			(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Mother born out-of-wedlock (*1 = yes*)			-0.08	-0.13	-0.12	-0.13	-0.12	-0.13
			(0.17)	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)
Grandmother employed (*1 = yes*)			0.11	0.17	0.16	0.14	0.16	0.14
			(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
Human Capital								
Had 1st child before exiting HS (*1 = yes*)				0.10	0.19	0.14	0.19	0.15
				(0.16)	(0.17)	(0.17)	(0.17)	(0.17)
Public insurance paid for birth (*1 = yes*)				0.45**	0.49**	0.51**	0.48**	0.49**
				(0.15)	(0.16)	(0.16)	(0.16)	(0.16)
Mother's age at time of conception (ref = 20-34 years old)								
Less than 20 years old					-0.24	-0.26	-0.23	-0.25
					(0.20)	(0.20)	(0.20)	(0.20)
35+ years old					-0.12	-0.18	-0.12	-0.17
					(0.23)	(0.23)	(0.23)	(0.23)
Parity					-0.13*	-0.18**	-0.14*	-0.19**
					(0.06)	(0.06)	(0.06)	(0.06)
Child gender (*1 = male*)					-0.10	-0.09	-0.10	-0.07
					(0.12)	(0.12)	(0.12)	(0.12)

Table 5. Multilevel Logistic Regression Coefficients Predicting Preterm Birth, from Mother's Relationship Status, Childhood Environment, Pregnancy Wantedness, and Prenatal Health Behaviors (CONTINUED)

	1	2	3	4	5	6	7	8
Pregnancy Wantedness								
Birth was unwanted (factor score)						0.18***		0.18***
						(0.04)		(0.04)
Birth was mistimed (factor score)						0.03		0.03
						(0.06)		(0.06)
Prenatal Health Behaviors								
Ever smoked during pregnancy (*1 = yes*)							0.14	0.10
							(0.19)	(0.19)
Never received prenatal care (*1 = never*)							-0.50	-0.63
							(0.53)	(0.53)
Rec'd prenatal care in 1st trimester (*1 = yes*)							0.00	0.11
							(0.20)	(0.21)
Intercept (γ_{00})	-2.19***	-2.21***	-2.34***	-2.44***	-2.29***	-2.09***	-2.31***	-2.22***
	(0.08)	(0.09)	(0.26)	(0.28)	(0.33)	(0.33)	(0.39)	(0.39)
Mother-Level Residual (μ_{0j})	0.59	0.56	0.56	0.58	0.57	0.54	0.57	0.54

Note: ****p* < .001, ***p* < .01, **p* < .05, †*p* < .10 (two-tailed). Total sample = 2,930 births nested within 1,606 women. Significance tests are based on robust standard errors. Null model results: intercept (γ_{00})= -2.08***, μ_{0j} = 0.69.

Table 6. Summary of Fixed Effects Regression Analysis Predicting Birth Weight (in Ounces) From All Child-Specific Indicators

	1	2	3	4	5
Relationship Status (ref = Married)					
Cohabiting	-3.57	-2.76	-2.71	-3.17	-3.12
	(2.18)	(2.18)	(2.18)	(2.18)	(2.18)
Single (non-residential)	-7.04**	-5.09*	-4.81*	-5.20*	-4.98*
	(2.21)	(2.26)	(2.31)	(2.26)	(2.30)
Human Capital					
Public insurance paid for birth (*1 = yes*)		2.23	2.22	1.86	1.84
		(2.16)	(2.16)	(2.16)	(2.17)
Pregnancy Characteristics					
Mother's age at time of conception (ref = 20-24 yrs)					
Less than 20 years old		-0.56	-0.45	-0.28	-0.2
		(2.12)	(2.13)	(2.11)	(2.13)
35+ years old		3.93	3.9	4.01	3.98
		(3.12)	(3.12)	(3.11)	(3.11)
Parity		1.51*	1.62*	1.51*	1.60*
		(0.72)	(0.74)	(0.72)	(0.74)
Child gender (*1 = male*)		4.42***	4.42***	4.15***	4.15***
		(1.01)	(1.01)	(1.02)	(1.02)
Pregnancy Wantedness					
Birth was unwanted (factor score)			-0.26		-0.21
			(0.42)		(0.42)
Birth was mistimed (factor score)			-0.1		-0.05
			(0.49)		(0.49)
Prenatal Health Behaviors					
Ever smoked during pregnancy (*1 = yes*)				-4.83†	-4.75†
				(2.82)	(2.83)
Never received prenatal care (*1 = never*)				-9.19†	-9.12†
				(5.25)	(5.26)
Rec'd prenatal care 1st trimester (*1 = yes*)				-1.15	-1.18
				(1.69)	(1.69)
Gestational Length	4.44***	4.44***	4.45***	4.39***	4.40***
	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)
Intercept	-51.87***	-59.76***	-60.38***	-55.88***	-56.38***
	(10.44)	(10.63)	(10.69)	(10.75)	(10.82)
F value	94.01***	40.16***	32.1***	30.01***	25.34***

Note: ***$p < .001$, **$p < .01$, *$p < .05$, †$p < .10$ (two-tailed). Fixed-effects models are based on a subsample of 1,304 births nested within 610 women.

CHAPTER 3: How Neighborhood Environments Attenuate the 'Marriage Advantage' in Birth Outcomes among Women in the U.S.

INTRODUCTION

Differential incidence rates of poor birth outcomes (i.e., low birth weight, preterm birth, and small for gestational age) among women by factors such as socioeconomic status, marital status, and race/ethnicity represent a burgeoning area of scientific inquiry in both the public health and social science literatures. Poor infant health outcomes not only shape infant's immediate survival chances, but they also shape their longer-term life chances. Poor infant health at birth is associated with a variety of risk factors across the life course including physical conditions (such as cerebral palsy, deafness, Type 2 diabetes, obesity, and heart disease), lower levels of cognitive ability, poorer neuromotor functioning, and lower educational attainment (Chomitz et al. 1995, Conley & Bennett, 2000; Reichman 2005; Goldenberg et al. 2008).

Prior work has examined how local social conditions within neighborhood environments intersect with racial/ethnic disparities in infant health. A different disparity, however—marriage advantages in infant health—remains underexplored. It represents an increasingly important topic, given sweeping demographic changes in family formation across the population (such as rising rates of nonmarital births, cohabitation, divorce, and delays in marriage and childbearing; Smock 2000). While we know that marriage advantages exist for a variety of health outcomes including infant health (Sheehan 1998; Bennett 1992; Bennett et al. 1994; Bird et al. 2000), no study has explicitly examined how these interact with women's neighborhood environment.

This study contributes to this literature by examining how neighborhood environments mitigate infant health risk among married, cohabiting, and single women. The analyses are based on a data set that links individual-level data from the recently released 2006-08 National Survey of Family Growth (NSFG) with (restricted) data on women's *prenatal* neighborhood environment. The NSFG contains rich information on family background, relationships and fertility histories, and infant health outcomes—and the contextual data include measures such as structural poverty, housing quality, and violent and serious property crime rates. Analyses compare three different indicators of infant health (low birth weight, preterm birth, and birth weight adjusted for gestational length) and examine hypotheses about the role of resources: Are risky neighborhood environments more weakly related to infant health outcomes among married women compared with cohabiting or single women?

BACKGROUND

Poor infant health outcomes are more common in the United States than in other developed nations (Paneth 1995), which presents a unique problem for policymakers to tackle. In 2004 for example, the United States reported higher infant mortality, low birth weight, and preterm birth rates than most other developed nations (Matthews & MacDorman 2008). While the demographic, social, and economic factors contributing to the divergence of infant mortality across developed nations are not well understood, this higher rate is partly attributable to lower gestational age cut-offs used in the United States vs. other developed nations (Goldenberg et al. 2008). Although the difference in measurement accounts for some of the disparity, it is not likely the primary cause of the poor rankings of the United States (Matthews & MacDorman 2008).

Fortunately, infant mortality and low birth weight have decreased in the United States over the past few decades, largely as a result of higher survival rates of very small babies (Paneth 1995). On the other hand, preterm births are increasing (from 9.5% in 1981 to 12.7% in 2005, compared with 5-9% in Europe; Goldenberg et al. 2008). The CDC estimates that in 2009, the incidence of low birth weight in the United States was 8.2% and the incidence of preterm birth was 12.1% (Hamilton, Martin, & Ventura 2010).

There are two types of preterm births, and the difference between them is important in terms of understanding the rising trend. They can be either "indicated," which refers to early births resulting from "medical complications that necessitate iatrogenic prompt delivery" (p. 361) or "spontaneous," which refer to early births resulting from "spontaneous delivery, cervical failure, and premature rupture of membranes" (p. 361; Yogev & Langer, 2007). The increasing incidence of preterm birth has been attributed mostly to rising rates of "indicated" preterm births (Goldenberg et al. 2008). Some work has suggested that "indicated" preterm births are more common among socioeconomically advantaged women while "spontaneous" preterm births are more common among less advantaged women.

Similar to many other health outcomes, prior research also shows that poor infant health is more common among women who are poor, unmarried, non-Hispanic Black (vs. non-Hispanic White or Hispanic), and live in impoverished neighborhoods (Chomitz et al. 1995; Reichman 2005; Goldenberg et al. 2008). It is clear why reducing infant health disparities is an important goal of policymakers, practitioners and researchers alike, yet we still do not understand the mechanisms through which these disparities operate.

Examining differences by marital status and neighborhood context may be particularly important to the study of infant health disparities because it is possible that marriage may moderate the influence of neighborhood environments. For example, family scholars have shown that married women exhibit a wide range of social and health advantages (e.g., Waite 1995), but we also know that marriage is not a resource that is equally available to all women. Marriage market research has shown that factors including spatial location, place of employment, local sex ratios, race/ethnicity, and socioeconomic status affect one's probability of being married (Lichter et al. 1992; Lichter et al. 2003; Harknett &

McLanahan 2004). Thus, social context, spatial location, and the likelihood of being married are often related. This underscores the potential for marriage advantages to operate differentially across neighborhood environments.

Theoretical Framework

Socioeconomic status (SES) and health share a long history of documented associations across a variety of outcomes. This literature has evolved from a primary focus on a poor/non-poor dichotomy to one that recognized the gradient relationship of SES (Adler & Ostrove 1999). Both neighborhood- and individual-level socioeconomic status affect health outcomes and much work finds the two sources exert unique effects on health (Diez Roux, 2001; Leventhal & Brooks-Gunn, 2000) (see O'Campo, Xue, Wang, & Caughy, 1997 for an example of a study finding redundancy).

Stress is perhaps the most commonly invoked explanation of why individual- and neighborhood-level SES are related to health outcomes. Several studies have found that individuals who have fewer socioeconomic resources, lower financial capital, and/or live in poor neighborhoods exhibit significantly higher levels of stress than their more socioeconomically advantaged counterparts, and this stress in turn is a primary source of mortality and morbidity (Berkman & Kawachi 2000; Adler & Newman 2002; LaViest 2005). High-crime neighborhoods in particular induce more stress on individuals (Leventhal & Brooks-Gunn 2000; Morenoff 2003), and, on average, single mothers experience more stress within the home and in neighborhood environments than married mothers (e.g., McLanahan & Booth 1989). In turn, stress has been largely implicated as a central predictor of preterm birth (Rini et al. 1999; Wadhwa et al. 2001; Dunkel Schetter 2009) and low birth weight (Feldman et al. 2000). However, stress often remains unmeasured in research.

Above and beyond socioeconomic status, neighborhood environments in general are salient to the study of individual health outcomes. Social contexts affect individuals in significant ways—by shaping norms, influencing social control, and facilitating behavior (e.g., Berkman & Kawachi 2000;

Sampson, Morenoff, & Gannon-Rowley 2002). Warnecke et al. (2008) and Culhane & Elo (2005) have put forth theoretical frameworks detailing the development of infant health risk among women and include social context as a key factor.

These explorations beg the question however, *how* do neighborhood environments affect individuals? Resources have been identified as one key element linking neighborhood structure and process to individual social and health outcomes. Link and Phelan (1995) argue that social conditions are "fundamental causes of disease" and that researchers should focus on social conditions that put people at risk of developing poor health outcomes. They particularly emphasized that social context "conditions access" to resources that may be used to prevent disease or treat a disease after it has been diagnosed. In their work, resources were defined quite broadly as, "money, knowledge, power, prestige, and the kinds of interpersonal resources embodied in the concepts of social support and social network" (p. 87).

Building on this foundational study, subsequent research has found that both structural and functional resources within neighborhoods influence health outcomes, and that the two act independently of one another. "Structural" elements include poverty, racial/ethnic composition, residential stability, lead pollution, environmental exposure to toxins, residential segregation, housing quality, and built infrastructure whereas "functional" elements refer to crime rates, social organization, social cohesion, collective efficacy, social networks and social support (Leventhal & Brooks-Gunn 2000; Adler & Newman 2002; Morenoff 2003; Warnecke et al. 2008).

Both structural and functional resources can impact infant health independent of individual- or family-level SES (Culhane & Elo 2005). For example, neighborhood deprivation (as indicated by housing instability, severe material hardship, and high unemployment rates) and violent crime rates are associated with preterm birth (e.g., O'Campo et al. 2008; Goldenberg et al. 2008) and low birth weight (e.g., Morenoff 2003), above and beyond the effect of individual-level SES. Furthermore, these associations are typically explained through a stress argument. That is, individuals living in low-resource neighborhoods exhibit greater stress and as a result, also exhibit poorer infant health outcomes (Morenoff 2003).

However, marital status may moderate the influence of neighborhood environment. Consistent with the buffering hypothesis for example, it is possible that married women who live in poorer, crime ridden neighborhood environments experience better infant health outcomes than their cohabiting and single counterparts because the marriage acts as an interpersonal resource that buffers the women from experiencing the full effects of living in a stressful social environment (e.g., Thoits 1982; Cohen & Wills 1985; Bloom 1990). Along these same lines, marital status may not moderate the influence of all neighborhood characteristics in the same way. For example, prior research suggests that neighborhood-level indicators of stress processes (such as crime rates) are more causally proximate to infant health outcomes than measures of structural poverty, and some types of crime (i.e., violent crime) are more consequential for women's infant health outcomes than others (Morenoff 2003).[2]

On the other hand, an emphasis on the number of parents would suggest that just having a partner—marital or cohabiting—may protect women from the full effects of stressful environments. Evidence along these lines is widely cited in family sociology and demography. Much research has shown that children in two-parent homes exhibit more advantageous social, emotional, and behavioral outcomes than children in single-parent families (Amato 1993, 2000; Amato & Booth, 1997; Brown, 2006; Cavanagh & Huston, 2006, 2008; Cherlin et al., 1991; Fomby & Cherlin, 2007; Heard, 2007; Osborne & McLanahan, 2007; Wu, 1996; Wu & Martinson, 1993). These findings hold true with respect to any type of two parent home—including stepfamilies and two-biological parent families (e.g., Thomson, McLanahan, & Curtin, 1992), and are even salient when two parents exhibit high levels of

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[2] In order to test these possibilities in this analysis, one must necessarily assume that poverty is not highly correlated with violent or serious property crime rates which is supported in the data used here ($r_{\text{poverty : violent crime}} = 0.33$, $r_{\text{poverty : serious property crime}} = 0.23$.)

interpersonal conflict (Amato & Kane, 2011). Therefore, it is possible that another indicator of child well-being—infant health—operates similarly, yet little research has tested these possibilities.

The Current Study

Overall, it is clear that there is much to be learned about how marital status may moderate the influence of other types of resources on infant health. Analyses address two types of resources: those associated with individual-level human capital (education and poverty) and those associated with neighborhood-level “structure” and “function” (such as housing quality, poverty rates, unemployment rates, number of vacant houses, violent crime rates, and serious property crime rates). Figure 3 provides a conceptual framework depicting how the proposed processes may operate.

To that end, this study examines two hypotheses:

H_1: Neighborhood and individual resources directly affect infant health outcomes.

H_2: Neighborhood and individual resources also interact with relationship status (marriage, cohabitation, singlehood) to predict infant health outcomes.

Generally speaking, it is likely that observed ‘marriage advantages’ may reflect spurious associations or underlying selection processes (as indicated in Chapter 2). One potential source of spuriousness in this context is differential resource availability. Analysis will first examine whether women who have higher levels of human capital and live in wealthier, less crime-ridden neighborhood environments are both married and exhibit better infant health outcomes. If a marriage advantage remains, two potential explanations will be explored. First, a remaining advantage may reflect the fact that even in poor or crime-ridden neighborhood environments, partnered women are buffered from the full effects of stress (unlike unpartnered women) because living with another person affords greater feelings of safety or security. This “number of parents” approach would be supported if there were no differences found between infants born to cohabiting and married mothers, but differences found between infants born to single and married mothers.

On the other hand, the stability of marital unions (relative to cohabiting unions) may afford even greater feelings of protection from the ill effects of social conditions because married women may feel even more secure in the fact that their partner will be there throughout the pregnancy. Along the lines of the buffering hypothesis, this suggests that marriage is a more protective resource in terms of buffering the individual from the effect of stressful social environments than either cohabiting unions or singlehood because of the increased stability of marital unions. Evidence for this hypothesis would be indicated by significant differences between married and cohabiting women in addition to significant differences between married and single women. (It is important to note that these hypotheses assume that single women live alone or do not garner additional protection from the persons with whom they live, such as parents, which may or may not be true. This will be kept in mind when interpreting the results.)

DATA AND METHODS

This study pools data from two National Survey of Family Growth (NSFG) datasets: 2006-8 and 2002 (Cycle 6). Both are repeated cross-sectional surveys based on a nationally representative sample of households with adults ages 15-44 in the given survey year. I capitalize on the unique advantage of these datasets, which is that both can be linked with a restricted data file containing information on women's neighborhood environments. (Analyses were performed at the Restricted Data Center housed in the National Center for Health Statistics in Hyattsville, Maryland). Both surveys asked respondents (a) where they lived at the time of the survey, and (b) where they lived on April 1st, 2000.[3] Data based on

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[3] The fact that both cross-sectional surveys can be combined with the same Census survey (and not two different Census surveys such as 1990 and 2000) represents another unique advantage of pooling these

the 4/1/2000 location can be easily combined with information from the 2000 Census, which is the approach taken in this analysis. Neighborhood data for both surveys were measured at the county level. (The NSFG also tracks information at smaller units of analysis such as block groups, but due to the limited number of women surveyed in each block group, use of these data—even within the confines of the Restricted Data Center—was prohibited based on an unacceptable disclosure risk.)

In order to isolate the effect of neighborhood environments on pregnancy, the sample is restricted to (a) women who did not move between April 1st, 2000 and the time of the survey interview and had a birth since April 1st, 2000 (hereafter termed "stayers"), and (b) women who moved after April 1st, 2000 but had a birth in 2001 (hereafter termed "movers"). For the latter group of women, the sample is limited to women who were exposed to the given neighborhood throughout the entire gestational period. In cases where women had more than one birth in this time frame, only the most recent birth was included in the analysis. This retained a total analytic sample of 1,709 singleton births to women nested within 112 counties in the United States.

Variables

Pooling data from the 2006-8 and 2002 NSFG datasets is relatively seamless since both surveys ask many of the same questions, and ask these questions in the same manner. (Within the variable descriptions that follow, the reader may assume that both surveys ask identical questions except when the text explicitly mentions otherwise.)

Three dependent variables reflecting infant health are considered: a dichotomous measure of low birth weight indicating if the infant was less than 2500 grams or 5 ½ pounds at birth (*1 = less than 5 ½ pounds, 0 = 5 ½ pounds or more*), a continuous measure of birth weight (in ounces) that is adjusted for gestational length (*range = 13-198*), and a dichotomous measure of preterm birth indicating if the infant was born less than 37 weeks of gestational age (*1 = less than 37 weeks, 0 = 37 weeks or more*). The

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datasets. Combining across Census survey years would risk introducing error based on period differences in marriage advantages related to infant health outcomes.

binary indicator of low birth weight situates findings within previous literature (since most has been based on this measure), whereas the findings from models predicting the continuous measure of birth weight adjusted for gestational length and preterm birth provide additional information to inform future prevention strategies aimed at reducing infant mortality.

The independent variable, mother's relationship status includes three categories: married, cohabiting, and non-residential or "single" (included as binary indicators with married as the reference category). The NSFG 2006-8 survey asked mothers to report their informal relationship status at both conception and birth; here, "informal" refers to a set of options that includes "cohabitation" as a potential response. The NSFG 2002 survey however only asked mothers to report the formal relationship status at both time periods and their informal status at birth. Using relationship status at conception may be more desirable because it is measured causally (and temporally) prior to the prenatal period, although relatively few women switched relationship statuses between conception and birth in these data. Prior analyses (presented in Chapter 2) showed that 13% of women who had a birth in the last five years in the NSFG 2006-8 changed statuses, while a comparison of the formal status categories in NSFG 2002 shows that only 8.4% of women changed statuses. (Many of these transitions were to women who went from being (a) never married at conception to married at birth (6.3%), (b) married at conception to divorced, separated, or widowed at birth (0.9%), or (c) divorced at conception to married at birth (1%).) Because these transitions affected relatively few cases (8.4% of cases in the NSFG 2002 sample but only 3% of cases in the pooled dataset), relationship status at conception was imputed using a single imputation procedure in Stata. Covariates included relationship status at birth, birth weight, gestational length, human capital, family background characteristics, race/ethnicity, nativity status, maternal age at conception, and parity.

Two sets of explanatory variables are included: individual-level resources and neighborhood-level structural and functional resources. Individual-level resources are indicated by a measure of human capital—if the mother had her first birth before finishing high school (*1 = yes*)—and a proxy measure of financial capital—health insurance information reflecting who paid for the delivery (such as private insurance, Medicaid, government, or other public assistance). The latter is commonly used as a proxy for individual-level financial capital in research on birth outcomes (e.g., Kogan et al. 1994; Institute of Medicine 2003). Unfortunately, other measures of individual-level human and financial capital (e.g., the mother's education at the time of conception or birth; family income at the time of conception or birth) were not measured on a time-varying basis and therefore could not be included in the analysis.

Neighborhood-level structural resources (measured at the county-level)[4] include six indicators from the Census 2000 data: percent of families living below the poverty line, percent of 18+ year-olds with less than a high school education, percent of males who are unemployed, percent of households with no indoor plumbing, and the percent of vacant homes. Since each item reflects a percentage, an average score for each county was created by summing the values of all six indicators and dividing by six (*range = .04 - .21*; *α* = .79).[5] Neighborhood-level functional resources include three indicators of crime: violent crime (including crimes related to murder, rape, robbery, and assault), serious property crime (including crimes related to burglary, larceny, motor vehicle theft, and arson), and all crimes (both violent and serious property crimes combined). The log rates (log of the number of crimes reported per 100,000 individuals) were used in the analysis (*range of (log) violent crimes = 3.08 – 7.71, range of (log) serious property crimes = 3.77 – 9.85, and range of (log) total crimes = 4.18 – 9.95).* Crime statistics were taken from ICPSR's National Archive of Criminal Justice Data (NACJD) which is based on data compiled

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[4] The measurement of "neighborhoods" has been a source of contention in this literature. While county-level data are not the smallest unit of analysis preferable for neighborhood research, it was the only level-2 data available at this time from the National Survey of Family Growth. Census tract and block-group level data may be available in the future. Crime statistics were also available only at the county level.

[5] An exploratory factor analysis revealed that these six variables also loaded highly onto a single factor representing neighborhood structural resources. Preliminary analyses exploring both measures revealed similar findings using the two measures (*r* = .97). The average score was retained since it facilitates a more meaningful interpretation in regression analysis than a factor score.

from the Uniform Crime Reporting Program (UCR) at the Federal Bureau of Investigation. The distribution of each crime variable was examined using the ladder command in Stata. Results suggested that the identity approximated a normal distribution however, to be consistent with prior research (e.g., Morenoff 2003), log rates were used.

Several control variables were included due to their covariance with the independent and dependent variables (Chomitz et al. 1995; Paneth 1995; Reichman 2005; Goldenberg et al. 2008). Women's childhood environment was reflected by several measures such as grandmother's education (1 = *less than high school*, 4 = *Bachelor's degree or higher*), if the mother herself was born out-of-wedlock (*1=yes*), grandmother's age at first birth (1 = *less than 18 years old*, 5 = *30+ years old*), mother's family structure in adolescence (0 = *living with two biological parents at age 14*, 1 = *living with single or step-parents*), and if the grandmother worked during the mother's childhood (0 = *didn't work at all for pay*, 1 = *worked part- or full-time*). Mother's race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic Other) and nativity status (0 = *native born*, 1 = *foreign born*) were also included. Characteristics of the given pregnancy were reflected by a series of indicators including mother's age at conception (less than 20, between 20 and 34, 35+ years old), parity (1 = *first born*, 9 = *ninth born*), and child gender (*1 = male*). Models predicting the continuous indicator of birth weight also include gestational length (*range = 21 – 43 weeks*). Finally, the racial/ethnic composition of the neighborhood is reflected by two variables: percent non-Hispanic Black and percent Hispanic (with the reference category being the percent non-Hispanic White/Other).

Analytic Strategy

Two analytic strategies were explored. First, multilevel (linear) regression models were estimated for the continuous indicator of birth weight (in ounces) based on the following equations (for mother *i* nested within county *j*):

Level-1: $Y_{ij} = \beta_{0j} + \Sigma\ \beta_{1\text{-}17} X_{ij} + r_{ij}$

Level-2: $\beta_{0j} = \gamma_{00} + \gamma_{01\text{-}05} + \mu_{0j}$

$\beta_{1j} = \gamma_{10} \ldots \beta_{5j} = \gamma_{05}$,

where β_{0j} indicates the sum of the county-level intercept (γ_{00}) and the county-level characteristics ($\gamma_{01\text{-}05}$) along with a county-specific residual (μ_{0j}). $\Sigma\ \beta_{1\text{-}17} X_{ij}$ indicates the sum of all mother-level characteristics and r_{ij} indicates a mother-specific residual.

Multilevel generalized linear models were estimated for the binary outcomes—low birth weight and preterm birth—using a similar equation but were based on the Bernoulli distribution. The probability model is $\text{Prob}(Y=1|\beta)=P$, and the link function is $\mu_i=\exp(\eta_i)/1+(\exp(\eta_i))$ or the inverse expressing the linear model as a function of the value for the probability model, $\eta_j = \log_n(\mu_i/(1\text{-}\mu_i)$. The link function transforms η into a form that is more appropriate to assume a linear model, resulting in log odds which are unbounded at either end (upper and lower) (Raudenbush & Bryk 2002). Assumptions pertaining to the way in which the effects of level-1 variables vary or not across level-2 units were checked, but results showed that random-intercept models (which do not allow these effects to vary across level-2 units) were an optimal fit for the data.

Second, single-level regressions in Stata were examined where the neighborhood unit was defined as the primary sampling unit (using the svy command). This approach adjusts the estimated standard errors to account for clustering of women within neighborhoods but does not estimate a separate intercept for each level-2 unit as in multilevel modeling. This approach may be more optimal than multilevel modeling when the number of (level-1) women in each (level-2) neighborhood is relatively small, which is the case here. The NSFG survey design is such that relatively few individuals in a given neighborhood are interviewed, while a broader range of neighborhoods around the country are included. In these data for example, the number of women in each neighborhood ranges from 1 to 14 with a mean of 3.6. As a result, the complexity of multilevel modeling may not be necessary since, for many neighborhoods, the neighborhood-level characteristics are unique to a few woman. Preliminary analyses examined both approaches and the results were found to be substantively similar, although the single-level models were slightly more conservative. As a result, the estimates from the single-level models are presented.

Given the large number of covariates considered here (combined with the complexity of the model examined, the relatively small number of cases, and the relatively rare outcomes of low birth weight and preterm birth), steps were taken to simplify the final model by minimizing the number of covariates that were included. Preliminary analyses examined the addition of two sets of variables to the bivariate model, one at a time. First, sociodemographic characteristics (race/ethnicity, nativity, parity, and maternal age at conception) were included. Variables that were not significant were dropped (which in this case were nativity, parity, and maternal age). Then, family background characteristics were added. Only nonmarital birth status retained a significant effect; grandmother's education, employment, age at first birth, as well as mother's family structure in adolescence were not significant and were therefore dropped. This resulted in a smaller number of covariates that are presented in the final results. (However, parallel analyses were performed using the full range of covariates and the results were substantively similar in most ways.)

The analysis begins by estimating a model with only relationship status (and gestational length in the case of birth weight). Subsequent models add sociodemographic controls at the individual and neighborhood levels, and then individual- and neighborhood-level resources to explore the direct effects of resources on infant health outcomes. Next, each of the following interactions are added one at a time to the model: relationship status x human capital, relationship status x neighborhood structural resources, relationship status x neighborhood functional resources. Model fit indices are included:

deviance statistics for models predicting continuous outcomes, birth weight, and (-2 times) the log likelihood for models predicting binary outcomes (which approximates the deviance statistic). Comparatively smaller values of each indicate better model fit. Deviance comparison tests (for continuous outcomes) and likelihood ratio tests (for binary outcomes) are used to test the significance of adding each set of interaction terms to the full model. All analyses were weighted in accordance with NSFG recommendations to approximate population-level parameters.

Several sensitivity analyses were also performed. First, analyses were replicated using a larger subsample by including all births to stayers and movers rather than just one birth per woman. This increased the sample size from 1,709 infants to 1,947 infants. Ideally, this data structure requires the use of a three-level model in HLM (infants nested within mothers, nested within counties) with cross-level interactions between level-1 variables (relationship status) and level-3 variables (neighborhood context). This operation is not possible with HLM 6.0 software however, as cross-level interactions can only be separated by one level, such as level-1 x level-2 or level-2 x level-3. Using a two-level model would likely be demonstrably similar since most women had only one birth in the time period of interest (here, all mother-specific covariates would be reduced to infant-level covariates), although the standard errors would be at risk of being inflated. When the analysis was performed in this way (using a 2-level model of all births), the results were substantively identical to those presented here. Thus, the smaller subsample (with more reliable significance tests) was used.

Second, analyses examined the addition of 198 cases where the infant was exposed to a given neighborhood environment for only a portion of the gestational period (as opposed to the analytic subsample examined in the rest of the analyses in which the infant was exposed to the given neighborhood environment for the *entire* length of gestation). While this small increase in sample size may be desirable, the main findings with respect to moderations of the marriage advantage by neighborhood environment did not change. Therefore, this group was omitted.

Lastly, analyses also explored the inclusion of several additional characteristics such as grandfather's education, grandparent's education (the average of grandmother's and grandfather's education), percent foreign born in a given neighborhood, and percent "Other" race/ethnicity. The addition of either education variable made little difference to the results and were ultimately omitted. Percent foreign born was omitted due to its high correlation with percent Hispanic, and percent "Other" was subsumed under the reference category (which ultimately is reflected by percent White and Other) since it is a relatively small proportion in any given neighborhood.

FINDINGS

Table 7 provides a summary of the appropriately weighted descriptive statistics (means and standard deviations) by relationship status at time of conception—married, cohabiting, and single—along with a final column indicating significant differences across groups. (Weighted descriptive statistics and a weighted correlation matrix for the entire analytic sample are presented for reference in Appendices D and E, respectively.) As expected, statistics indicate higher rates of low birth weight and preterm birth, as well as lower birth weight (in ounces) among cohabiting and single women (relative to married women). Married women exhibit many other advantages as well such as higher levels of human and financial capital (or, lower rates of transitioning into motherhood before graduating high school and lower rates of public insurance utilization) and lower levels of (adolescent) family instability. They were less likely to report that they themselves were born out-of-wedlock, and their own mothers completed higher levels of education, delayed age at first birth, and worked outside the home at a lower rate. The neighborhoods in which married women lived during their pregnancy were also more advantageous with respect to lower levels of structural poverty and crime. It is important to note that the standard deviations for most variables do not vary a great deal across groups, suggesting it is unlikely that outliers exist within each specific group that would bias the results.

Lastly, differences between the two subgroups of women that comprise the analytic sample ("stayers" and "movers") were examined since the two groups have the potential to be different in a variety of ways that may be correlated with relationship status at conception and/or resource utilization. Statistics in Appendix F indicate that each subgroup contains a relatively heterogeneous group of women who do not differ significantly with respect to the majority of characteristics considered in this study. "Stayers" were advantaged in some ways (reported lower rates of preterm birth, higher levels of human capital, lower rates of growing up in single parent homes, higher ages at first birth among grandmothers, had fewer teen births, and exhibited more later age (35+) births), but were not advantaged in other ways (they were no different with respect to rates of low birth weight, gestational length, neighborhood poverty, neighborhood crime, race/ethnicity, nonmarital birth status, or grandmother's education and employment). A flag indicating stayer/mover status was added to all multivariate models but was never significant. Therefore, it is not presented in the tables.

Next, the multilevel regression results for birthweight are examined (see Table 8). First, birth weight is regressed on relationship status (and gestational length). Model 1 indicates that the difference between infants born to cohabiting and married mothers is only marginally significant ($p < .10$), but infants born to single mothers are 5.2 ounces lighter than their counterparts born to married mothers and this difference is highly significant ($p < .001$). When all individual- and neighborhood-level controls are added (Model 2), no difference between infants born to cohabiting and married mothers remains and the married-single disparity is reduced by almost half (to a 3.7 ounce difference) (although the point estimate remains significant at the $p < .01$ level). Infants whose mothers were themselves born in a marital union (versus out-of-wedlock), those who were born one week later, as well as male infants are all around 4 ounces heavier.

The individual-level resources are added in Model 3. Having a first birth before high school graduation is not related to birth weight although using public insurance to pay for the birth does exert a significant (direct) effect on birth weight. These infants are more than 6 ounces lighter than their counterparts whose births were paid for out-of-pocket or by private insurance. Together, these covariates further reduce the married-single disparity in both size and significance, although infants born to single mothers remain nearly 3 ounces lighter. No differences are evident for infants born to non-Hispanic Black and Hispanic mothers (versus non-Hispanic White mothers), although infants born to non-Hispanic Other mothers may be as many as 12 ounces lighter at birth (however this difference is only marginally significant). There are also no differences by the percent non-Hispanic Black or percent Hispanic residents within the neighborhood.

The potentially interactive effects of relationship status and resources on birth weight are examined next. First, relationship status x neighborhood structural poverty is added (Model 4). Deviance comparison tests (based on the chi-square distribution) show that these additional parameters do not significantly improve the fit (compared with the full model, 3) (χ^2 = 28.050, *df* = 22, *p* =.17) nor are the interactions significant. Models 5, 6, and 7 demonstrate similar results. Adding interaction terms for relationship status x violent crime, relationship status x serious property crime, or relationship status x total crime does not significantly improve model fit (violent crime: χ^2 = 9.99, *df* = 22, *p* =.99; serious property crime: χ^2 = 13.67, *df* = 22, *p* =.91; total crime: χ^2 = 13.38, *df* = 22, *p* =.92) nor are any of the interactions significant. (Note that here, only one crime rate is added to each model due to the high collinearity between violent and serious property crime rates.) Neither interaction term (for relationship status x human capital added in Model 8) is significant.

Results for low birth weight however are somewhat different. The findings are summarized in Table 9. Contrary to the results for continuous birth weight, likelihood ratio tests indicate that several of the additional interactions improved model fit.[6] There are no differences in the effects of neighborhood

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[6] Here, the chi-square parameter (χ^2) indicates two times the difference in the log likelihoods [2 * (LL_2 – LL_1)].

poverty by relationship status, but the effects of violent crime on the risk of low birth weight are significantly different for infants born to single and married mothers (LR Ratio test: χ^2 = 103.38, *df* = 22, *p* =.000). Similarly, the effects of serious property crime and total crime are significantly different for infants born to cohabiting versus single mothers (serious property crime: LR Ratio test: χ^2 = 108.32, *df* = 22, *p* =.000; total crime: LR Ratio test: χ^2 = 107.82, *df* = 22, *p* =.000). It is difficult to compare the strength of the coefficients for violent crime and serious property crime (even though both are measured in the same metric) because only one contrast is significant in each model, and it is the opposite contrast. If for instance the cohabiting-married contrast was significant in both models, it would be easier to directly compare these coefficients.

For ease of interpretation, Figure 3 portrays the predicted probability of low birth weight for each of the three crime-related interactions (evaluated at the grand mean of all variables except those contributing to the interaction). Only slopes that are significant are graphed; point estimates represent predicted probabilities evaluated at the mean, +/- 1 standard deviation, and +/- 2 standard deviations of the independent variable for married, cohabiting, and single women. No values outside of this range are graphed. As expected, we see that the predicted probability of low birth weight for infants born to single mothers increases slightly as the level of violent crime increases, and the predicted probability of low birth weight for infants born to cohabiting mothers increases markedly as the level of serious property crime and total crime increases. Overall, these results suggest that cohabitation and perhaps singlehood are increasingly risky for infants of mothers living in high-crime neighborhoods during the prenatal period. The findings for preterm birth are similar to continuous birth weight. None of the resource x relationship status interactions are significant and therefore none are examined further.

DISCUSSION AND CONCLUSIONS

Infant health disparities are an important population health problem facing policymakers, practitioners, and researchers, yet we still don't understand the full range of factors that put some women at higher risk than others. This literature has been advanced by a focus on women's neighborhood environments, but little work has examined how social conditions differentially impact mothers who are married at the time of conception, versus their cohabiting and single counterparts. Such an examination is increasingly relevant given widespread demographic changes in family formation across the population.

In line with fundamental cause theory and the buffering hypothesis, the results demonstrate that mother-father relationship status is one type of interpersonal resource that differentially buffers women from the effects of living within stressful social environments. In neighborhoods characterized by high levels of violent, serious property, and total crime, cohabitation and perhaps singlehood are more risky (compared with marriage) than in neighborhoods with relatively low levels of crime—and this disadvantage exists above and beyond a host of measures related to human and financial capital, sociodemographic characteristics, women's family background, and pregnancy characteristics. However, this pattern is documented within only one outcome considered: the risk of low birth weight. Results for the other two outcomes (continuous birth weight and the risk of preterm birth) indicated no significant differences for married, single, and cohabiting women living in various neighborhood environments. Taken together, these results indicate the *potentially* risky nature of cohabitation and singlehood for infants in high-crime environments, but more research is needed to determine the exact nature of these associations. The "number of parents" approach was only somewhat supported in that the general pattern indicated that cohabitation and singlehood were each uniquely different from marriage.

Evidence in these analyses also suggests that these effects are not an artifact of socioeconomic advantage among married women. Even though married women were more likely to have high levels of human capital and live in wealthier, less crime-ridden neighborhoods, evidence of a marriage advantage remained in the multivariate context after the inclusion of a rich set of individual- and neighborhood-level controls.

Consistent with prior research (Morenoff 2003), proxy indicators of stress processes (such as crime rates) were generally more consequential for women's infant health outcomes than indicators of structural poverty, although it was difficult to determine if violent crime exerted a stronger moderation on the relationship status-infant health link compared with serious property crime (as evidenced by larger beta coefficients). There was only some evidence of direct effects of individual-level and neighborhood-level resources in these data (contrary to Culhane & Elo 2005 for example), although this was largely restricted to a direct effect of public insurance utilization on birth outcomes. However, the lack of any significant direct effects of neighborhood resources on birth outcomes is consistent with the propositions of fundamental causes theory and the buffering hypothesis which place greater emphasis on moderation than on direct effects of social context on health outcomes. Also, both public insurance utilization and neighborhood poverty were salient predictors of low birth weight and preterm birth which is consistent with prior literature suggesting individual- and neighborhood-level measures of poverty can have unique effects when simultaneously included (i.e., consistent with Diez Roux, 2003 and Leventhal & Brooks-Gunn 2001, while contrary to O'Campo, Xue, Wang, & Caughy, 1997).

As with any study, this is not without its limitations. While this paper draws upon a uniquely rich dataset by linking women's birth histories, relationship histories, and family background with geospatial indicators of their neighborhood environment, the number of women for whom a *prenatal* neighborhood environment could be determined was relatively small. Larger samples based on electronic birth records for example could ameliorate this limitation, but are less advantageous in that they do not provide the rich set of covariates provided by NSFG. Future work should replicate these analyses however using larger samples to test the salience of the findings. Modeling relatively rare outcomes such as low birth weight and preterm birth with a relatively small sample puts the analysis at risk of statistically overemphasizing a small numbers of cases which may lie at the extreme tails of the distribution (i.e., married women living in very high crime neighborhoods). However, a comparison of (weighted) standard deviations for all variables by relationship status (in Table 7) shows little in the way of large differences in variance across groups—particularly with respect to neighborhood poverty and crime rates. This suggests that outliers or small groups of outlying cases are not dominating the patterns documented in this analysis. Future work should seek to replicate this work using different datasets. Contrasting differences in how marriage advantages and neighborhood environments intersect over time (i.e., comparing a repeated cross-sectional survey over various time periods) may be one interesting approach.

The analytic sample was also limited to women who had births between 2001 and 2006-8. This imposes two additional limitations. First, the findings cannot inform trends that may have been present among cohorts who had a birth before 2001, and second, the inclusion of neighborhood indicators from the 2000 Census necessarily assumes that neighborhood environments did not change a great deal between 2000 and the time of the birth. While many neighborhood environments change little over time, some work suggests that large changes can occur in a relatively short period of time (Sampson, Morenoff, & Gannon-Rowley 2002). However, this is the first study that has been able to identify prenatal neighborhood environments for women across the United States (rather than in just one city) which advances our understanding of the population-level processes at work in the intersection of social environments and infant health.

Lastly, defining neighborhood environments at the county-level is less than ideal. Unfortunately these data do not allow for any other choice of level-2 unit at this time. However, it is notable that much work uses administratively-defined neighborhood environments such as census tracts, counties, or zip codes to produce multilevel models that portray how social environments affect health risk. These are often criticized however for being only a proxy of the social spaces in which individuals actually encounter on a daily basis (e.g., Galster 2001). Some scholars acknowledging this fact have suggested a focus on multiple levels and various contexts may be useful (Diez Roux 2003). Others (such as Sampson and colleagues) have worked to overcome these limitations by defining Chicago neighborhoods along different criteria, although other researchers continue to argue that census tracts—which are nested within counties—may in fact be appropriate units of measurement given that they are selected by the U.S. Census Bureau to be relatively homogenous across a variety of sociodemographic characteristics (Wooldredge 2007). (Census tracts are not used here because crime rates are only available at the county level.) Despite the administrative convenience of using counties or census tracts, it is clear that future work should continue to move beyond these spatial definitions in order to model dynamic ways in which individuals interact with their broader social environment (i.e., Matthews 2008).

Overall, this study documents a new dimension of marriage advantages in birth outcomes and highlights a new subgroup of women at particularly high risk of poor infant health: cohabiting (and perhaps single) women living in high-crime neighborhoods. Findings lend greater contextualization and explanatory power to persistent marriage advantages observed in public health research and highlight the influential role of social environments in “getting under the skin” to impact infant health outcomes for married, cohabiting, and single women.

Figure 2. Conceptual Framework Linking Mother-Father Relationship Status, Individual- and Neighborhood-Level Resources, and Infant Health Outcomes

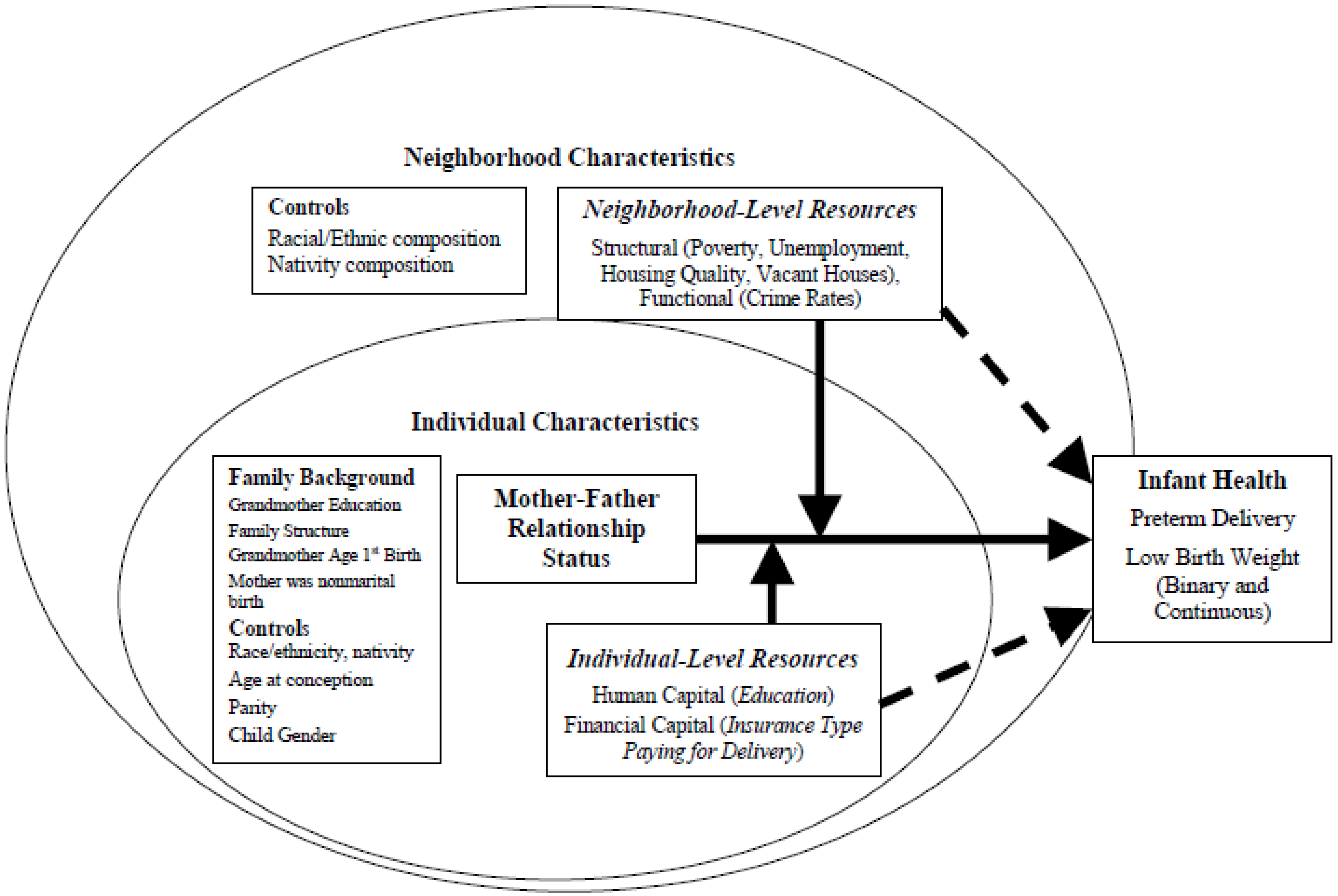
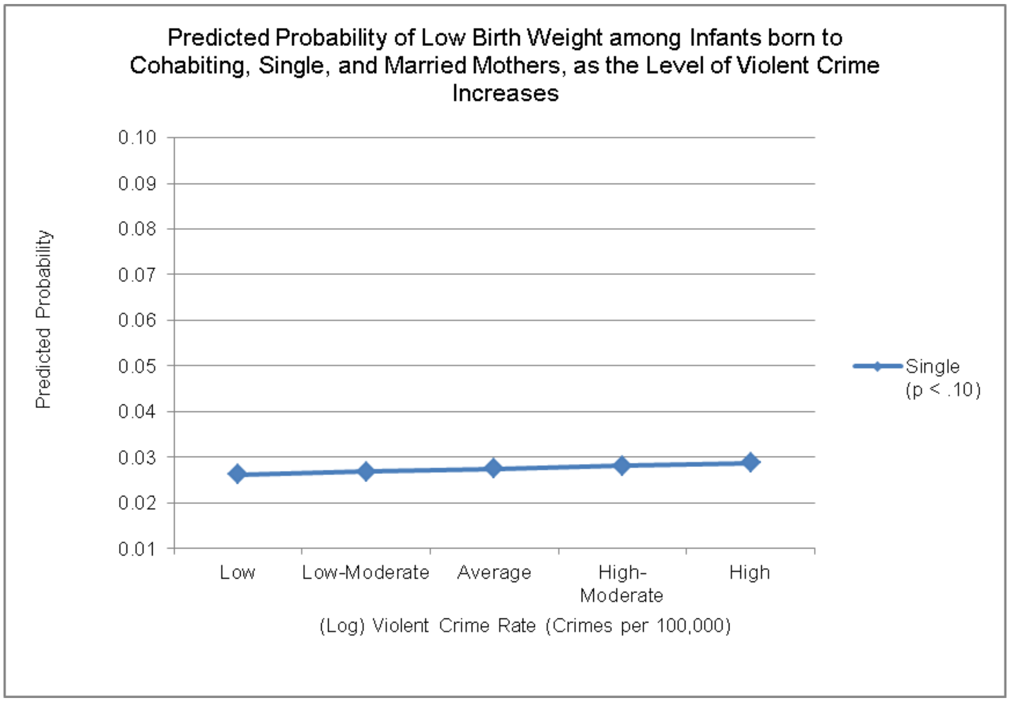
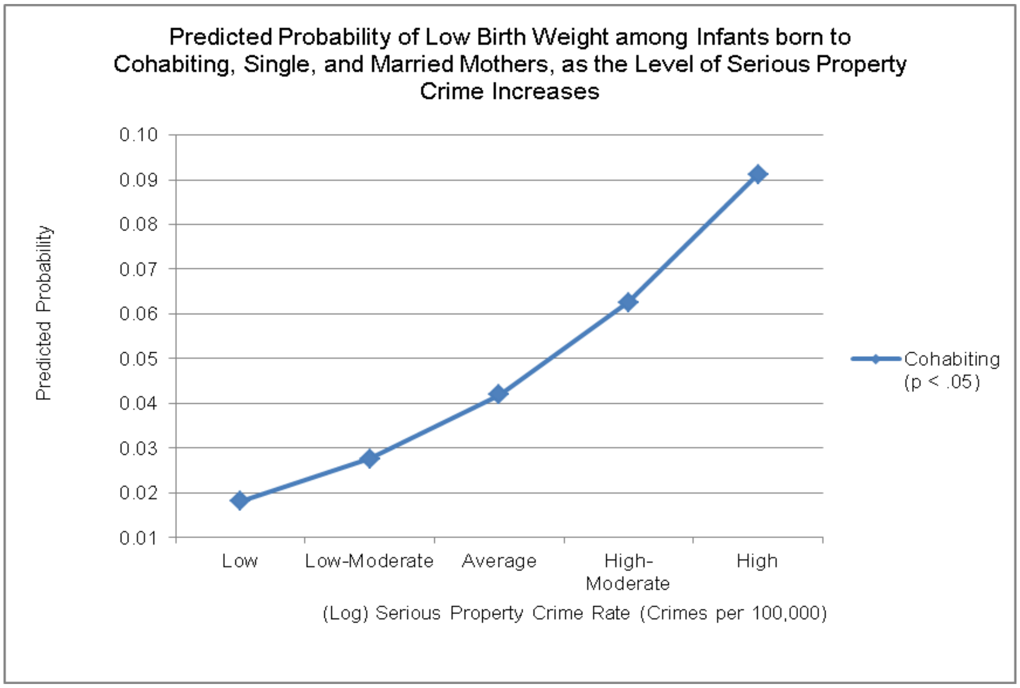


Figure 3. Graphs Representing Predicted Probability of Low Birth Weight for Moderations by Neighborhood Violent Crime, Serious Property Crime, and Total Crime





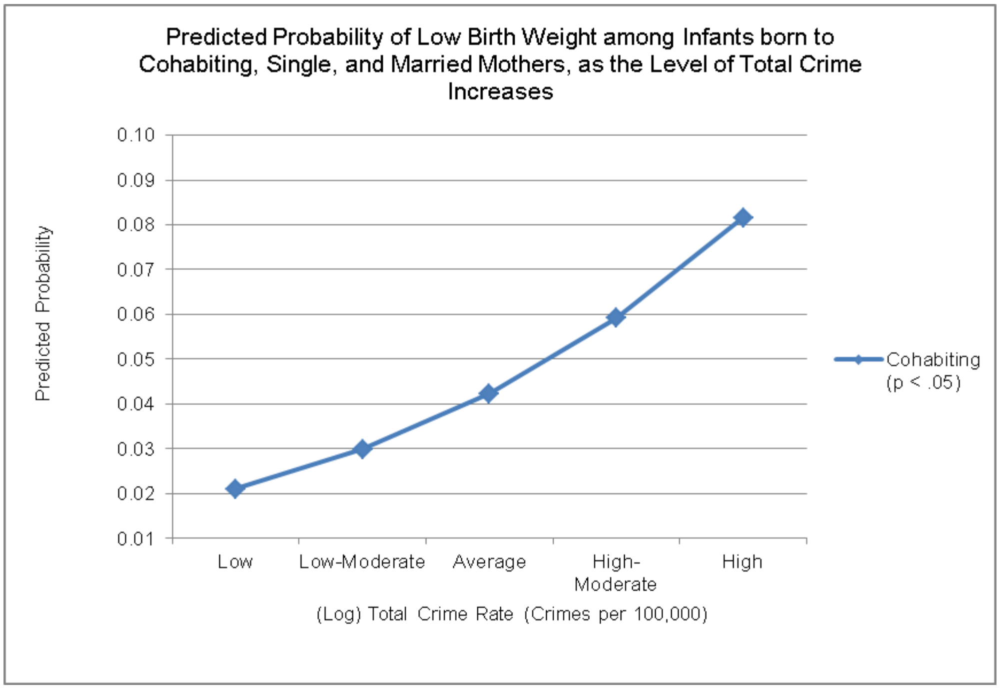

Predicted Probability of Low Birth Weight among Infants born to Cohabiting, Single, and Married Mothers, as the Level of Total Crime Increases

Table 7. Weighted Descriptive Statistics, by Relationship Status at Time of Conception

	Married	**Cohabiting**	**Single**	**Significant Differences**
Low Birth Weight (*1 = yes*)	0.05	0.10	0.07	Married < Cohabiting, Single
	(0.23)	(0.30)	(0.26)	
Preterm Birth (*1 = yes*)	0.10	0.13	0.14	Married < Cohabiting, Single
	(0.30)	(0.33)	(0.34)	
Birth Weight (*ounces*)	120.76	115.45	114.46	Married > Cohabiting, Single
	(19.96)	(25.23)	(20.85)	
Resources -- Individual-Level				
Human capital (Had 1st Birth before HS Grad; *1 = yes*)	0.16	0.49	0.45	Married < Cohabiting, Single
	(0.37)	(0.50)	(0.50)	
Public Insurance Paid for Birth (*1 = yes*)	0.17	0.70	0.71	Married < Cohabiting, Single
	(0.38)	(0.46)	(0.46)	
Resources -- Neighborhood-Level				
Average Neighborhood Poverty	0.09	0.10	0.10	Married < Cohabiting, Single
	(0.03)	(0.04)	(0.03)	
(Log) Violent Crime Rate (# Crimes per 100,000 people)	5.90	6.05	6.17	Married < Cohabiting, Single
	(0.82)	(0.77)	(0.83)	
(Log) Serious Property Crime Rate (# Crimes per 100,000 people)	8.11	8.14	8.12	Married < Cohabiting
	(0.59)	(0.48)	(0.75)	
(Log) Total Crime Rate (# Crimes per 100,000 people)	8.22	8.28	8.27	Married < Cohabiting
	(0.59)	(0.48)	(0.73)	
Controls -- Individual-Level				
Family Background				
Single or Step-Family Structure at Age 14 (*1 = yes*)	0.23	0.48	0.43	Married < Cohabiting, Single
	(0.42)	(0.50)	(0.50)	
Grandmother's Education	2.38	1.90	2.16	Married > Single > Cohabiting
	(1.05)	(0.94)	(1.04)	
Grandmother's Age at First Birth	2.73	2.29	2.43	Married > Cohabiting, Single
	1.04	(1.08)	(1.11)	
Mother was a Nonmarital Birth (*1 = yes*)	0.07	0.22	0.28	Married < Cohabiting < Single
	(0.26)	(0.42)	(0.45)	
Grandmother Employed during Mother's Childhood (*1 = yes*)	0.66	0.70	0.77	Married < Single
	(0.47)	(0.46)	(0.42)	

Table 7. Weighted Descriptive Statistics, by Relationship Status at Time of Conception (CONTINUED)

	Married	**Cohabiting**	**Single**	**Significant Differences**
Mother's Race/Ethnicity (*ref = non-Hispanic White*)				
non-Hispanic Black	0.06	0.20	0.40	Married < Cohabiting < Single
	(0.24)	(0.40)	(0.49)	
Hispanic	0.17	0.34	0.19	Cohabiting > Married, Single
	(0.38)	(0.47)	(0.39)	
non-Hispanic Other	0.07	0.08	0.04	Single < Married, Cohabiting
	(0.25)	(0.28)	(0.20)	
Mother's Nativity Status (*1 = foreign born*)	0.19	0.19	0.12	Single < Married, Cohabiting
	(0.39)	(0.39)	(0.33)	
Mother's Age at Conception *(ref = 21-34 years old*)				
Less than 20 years old	0.03	0.19	0.34	Married < Cohabiting < Single
	(0.17)	(0.39)	(0.48)	
More than 35 years old	0.18	0.04	0.09	Married > Cohabiting, Single
	(0.38)	(0.19)	(0.28)	
Infant's Birth Order	2.14	2.02	1.92	Married > Cohabiting > Single
	(1.14)	(1.24)	(1.16)	
Infant Sex (*1 = male*)	0.50	0.53	0.49	ns
	(0.50)	(0.50)	(0.50)	
Gestational Length	38.76	38.28	38.58	Married > Cohabiting
	(2.19)	(3.33)	(2.82)	
Mover (*1 = yes*)	0.30	0.37	0.52	Married > Cohabiting, Single
	(0.46)	-0.48		
Controls -- Neighborhood-Level				
Racial Composition (*ref = Percent non-Hispanic White*)				
Percent non-Hispanic Black	0.11	0.12	0.18	Married < Cohabiting < Single
	(0.12)	(0.12)	(0.15)	
Percent Hispanic	0.15	0.18	0.14	ns
	(0.18)	(0.24)	(0.18)	
Percent non-Hispanic Other	0.14	0.16	0.13	Cohabiting > Single
	(0.12)	(0.16)	(0.13)	
Percent Foreign Born	0.12	0.13	0.11	ns
	(0.11)	(0.12)	(0.12)	
Subsample Size	*976*	*305*	*428*	

Note: Statistics are based on sample of 1,709 births to mothers located within 112 counties. Means and (standard deviations) are weighted; means are also adjusted for clustering in the survey design. Significant differences indicate p < .05.

Table 8. Multilevel Regression Coefficients Predicting Birthweight from Marital Status, Human Capital, and Neighborhood Resources

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Relationship Status (ref = Married)								
Cohabiting	-2.91†	-2.45	-1.64	-5.39	-10.56	23.09	17.89	-1.36
	(1.66)	(1.65)	(1.75)	(3.68)	(11.82)	(31.25)	(30.78)	(2.19)
Single (non-residential)	-5.2***	-3.73**	-2.71†	-4.32	-5.09	17.84	14.38	-1.93
	(1.27)	(1.37)	(1.54)	(3.56)	(9.12)	(26.5)	(25.83)	(1.8)
Relationship Status x Resources								
Neighborhood Poverty x Cohabiting				41.17				
				(31.47)				
Neighborhood Poverty x Single				17.49				
				(37.04)				
Violent Crime x Cohabiting					1.51			
					(1.97)			
Violent Crime x Single					0.4			
					(1.57)			
Serious Property Crimes x Cohabiting						-3.03		
						(3.77)		
Serious Property Crimes x Single						-2.51		
						(3.27)		
Total Crimes x Cohabiting							-2.36	
							(3.66)	
Total Crimes x Single							-2.06	
							(3.15)	
Human Capital x Cohabiting								-0.91
								(3.43)
Human Capital x Single								-1.96
								(2.35)
Resources -- Individual-Level								
Human capital (Had 1st Birth before HS Grad)			-2.01	-1.99	-2.02	-2.08	-2.06	-1.29
			(1.35)	(1.36)	(1.35)	(1.38)	(1.37)	(1.87)
Public Insurance Paid for Birth (*1 = yes*)			-6.13***	-6.21***	-6**	-6.34***	-6.32***	-6.31***
			(1.91)	(1.92)	(1.91)	(1.96)	(1.96)	(1.94)
Resources -- Neighborhood-Level								
Neighborhood Structural Poverty				-5.17	-4.9	-5.12	-4.39	-4.45
				(15.86)	(15.5)	(15.43)	(15.45)	(15.41)
(Log) Violent Crime Rate					-0.58			
					(0.74)			
(Log) Serious Property Crime Rate						0.26		
						(1.6)		
(Log) Total Crime Rate							-0.01	
							(1.53)	
Sociodemographic Controls -- Individual-Level								
Mother was a Nonmarital Birth		-4.03*	-3.37*	-3.37*	-3.35*	-3.39*	-3.39*	-3.33**
		(1.59)	(1.48)	(1.43)	(1.47)	(1.49)	(1.48)	(1.46)

Table 8. Multilevel Regression Coefficients Predicting Birthweight from Marital Status, Human Capital, and Neighborhood Resources (CONTINUED)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Mother's Race/Ethnicity (*ref = non-Hispanic White*)								
non-Hispanic Black		-1.67	-2.42	-2.45	-2.39	-2.28	-2.28	-2.54
		(2.4)	(1.67)	(1.67)	(1.66)	(1.65)	(1.65)	(1.68)
Hispanic		1.15	1.94	1.82	1.96	2.04	2.07	1.76
		(1.61)	(1.51)	(1.58)	(1.53)	(1.52)	(1.53)	(1.54)
non-Hispanic Other		-8.64†	-12.02†	-11.97†	-12.58†	-12.2†	-12.2†	-11.97†
		(5)	(6.58)	(6.62)	(6.6)	(6.63)	(6.63)	(6.62)
Infant Sex (*1 = male*)		4.29***	4.09***	4.12***	4.1***	4.07***	4.06***	4.1***
		(1.11)	(1.01)	(1)	(1)	(1.01)	(1)	(1)
Gestational Length	4.83***	4.77***	4.8***	4.79***	4.8***	4.8***	4.8***	4.8***
	(0.3)	(0.29)	(0.3)	(0.29)	(0.3)	(0.3)	(0.3)	(0.3)
Sociodemographic Controls -- Neighborhood-Level								
Racial Composition (*ref = Percent non-Hispanic White*)								
Percent non-Hispanic Black		-1.99	-9.72	-9.63	-0.932	-9.87	-9.87	-9.63
		(7.87)	(6.84)	(6.85)	(6.91)	(7.03)	(7.03)	(6.85)
Percent Hispanic		9.22	9.53	9.47	9.87†	9.7†	9.7†	9.47
		(6.35)	(5.82)	(5.88)	(5.92)	(5.81)	(5.81)	(5.88)
Intercept	-66.24***	-65.76***	-66.58***	-65.96***	-63.37***	-68.76***	-66.54***	-66.68***
Deviance statistic	14,201.60	14,149.55	14,075.54	14,047.49	14,065.55	14,061.87	14,062.16	14,067.67
df	2	20	22	22	22	22	22	22

Note: ****p* < .001, ***p* < .01, **p* < .05, †*p* < .10 (two-tailed). Total sample = 1,709 births to women nested within 112 counties. Significance tests are based on robust standard errors. (Log) crime rates indicate (log) number of crimes per 100,000 people. Mother's race/ethnicity and education are included as random coefficients.

Table 9. Multilevel Logistic Regression Coefficients Predicting Low Birth Weight and Preterm Birth from Marital Status, Human Capital, and Neighborhood Resources

	Low Birth Weight				**Preterm Birth**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Relationship Status (ref = Married)								
Cohabiting	-0.16	0.41	-8.62*	-8.01*	-0.07	1.53	-2.61	-1.99
	(1.08)	(2.34)	(3.82)	(3.98)	(0.82)	(2.31)	(4.95)	(5.09)
Single (non-residential)	-1.33†	-2.86*	-2.24	-2.58	0.67	0.68	-1.53	-1.01
	(0.81)	(1.42)	(2.03)	(2.13)	(0.89)	(1.55)	(2.64)	(2.62)
Relationship Status x Resources								
Neighborhood Poverty x Cohabiting	-0.01				-1.32			
	(9.42)				(7.28)			
Neighborhood Poverty x Single	5.99				-7.59			
	(7.15)				(8.46)			
Violent Crime x Cohabiting		-0.1				-0.29		
		(0.39)				(0.38)		
Violent Crime x Single		0.37†				-0.13		
		(0.2)				(0.25)		
Serious Property Crimes x Cohabiting			1.03*				0.29	
			(0.47)				(0.61)	
Serious Property Crimes x Single			0.2				0.17	
			(0.25)				(0.33)	
Total Crimes x Cohabiting				0.95*				0.21
				(48)				(0.61)
Total Crimes x Single				0.24				0.11
				(0.26)				(0.32)
Resources -- Individual-Level								
Human capital (Had 1st Birth before HS Grad)	-0.23	-0.18	-0.23	-0.22	0.15	0.18	0.14	0.14
	(0.32)	(0.31)	(0.32)	(0.32)	(0.27)	(0.26)	(0.27)	(0.27)
Public Insurance Paid for Birth (*1 = yes*)	1.38***	1.32***	1.36***	1.36***	0.68**	0.67**	0.72**	0.72**
	(0.35)	(0.35)	(0.36)	(0.36)	(0.26)	(0.26)	(0.26)	(0.26)
Resources -- Neighborhood-Level								
Neighborhood Structural Poverty	6.24	7.45*	6.74†	6.85†	8.64*	7.15*	7.02*	7.01*
	(5.45)	(3.73)	(4.01)	3.99)	(4.29)	(3.17)	(3.32)	(3.31)
(Log) Violent Crime Rate.		-0.34				-0.07		
		(0.2)				(0.19)		
(Log) Serious Property Crime Rate			-0.3				0.04	
			(0.18)				(0.23)	
(Log) Total Crime Rate				-0.33				0.04
				(0.19)				(0.23)
Sociodemographic Controls -- Individual-Level								
Mother was a Nonmarital Birth	0.42	0.49	0.42	0.42	-0.01	0.03	0.01	0.01
	(0.34)	(0.33)	(0.35)	(0.35)	(0.29)	(0.3)	(0.31)	(0.31)

Table 9. Multilevel Logistic Regression Coefficients Predicting Low Birth Weight and Preterm Birth from Marital Status, Human Capital, and Neighborhood Resources (CONTINUED)

	Low Birth Weight				**Preterm Birth**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Mother's Race/Ethnicity (*ref = non-Hispanic White*)								
non-Hispanic Black	0.91*	0.89*	0.9**	0.91*	0.24	0.22	0.22	0.22
	(0.36)	(0.36)	(0.36)	(0.36)	(0.35)	(0.35)	(0.35)	(0.35)
Hispanic	-0.44	-0.38	-0.46	-0.46	-0.48	-0.45	-0.51	-0.51
	(0.38)	(0.38)	(0.37)	(0.37)	(0.38)	(0.38)	(0.39)	(0.39)
non-Hispanic Other	0.89	1.07	1.03	0.95	0.99†	1.17†	1.11†	1.09†
	(0.99)	(1.1)	(1.08)	(1.05)	(0.59)	(0.65)	(0.65)	(0.65)
Infant Sex (*1 = male*)	-0.4	-0.43†	-0.41	-0.41	-0.25	-0.24	-0.24	-0.24
	(0.26)	(0.26)	(0.26)	(0.26)	(0.25)	(0.24)	(0.25)	(0.25)
Sociodemographic Controls -- Neighborhood-Level								
Racial Composition (*ref = Percent non-Hispanic White*)								
Percent non-Hispanic Black	2.93**	2.43*	3.14**	3.1**	-1.5	-0.07	-1.63†	-1.64†
	(1.07)	(1.07)	(1.08)	(1.07)	(0.98)	(0.19)	(0.96)	(0.95)
Percent Hispanic	0.48	1.3	0.79	0.81	0.66	1.07	0.58	0.58†
	(1.34)	(1.54)	(1.4)	(1.42)	(1.16)	(1.02)	(1.13)	(1.11)
Intercept	-3.42***	-1.72†	-1.06	-0.83**	-2.9***	-2.42*	-3.08	-3.09
(-) 2 Log Likelihood	747.98	743.04	743.54	744.12	1,708.08	1,166.68	1,168.26	1,168.98

Note: ****p* < .001, ***p* < .01, **p* < .05, †*p* < .10 (two-tailed). Total sample = 1,709 births to women nested within 112 counties. Significance tests are based on robust standard errors. *-2 Log Likelihood* results for full model: low birth weight = 851.36, preterm birth = 1,171.8.

CHAPTER 4: Do Mother-Daughter Similarities in Human Capital and Nonmarital Birth Status Explain Intergenerational Linkages in Infant Health Outcomes?

INTRODUCTION

In the U.S., infant health disparities relating to rates of low birth weight or preterm birth are the subject of much attention in policy and research circles given that poorer outcomes are often concentrated among economically disadvantaged populations, unmarried women, as well as non-Hispanic Black and some Hispanic women, and are simultaneously linked with a variety of subsequent decrements in physical and psychosocial outcomes (e.g., Reichman 2005). While most research focuses on disadvantages within these domains, some studies have explored a different dimension: infant health risk concentrated within families over time. This literature has documented a similarity in low birth weight among mothers and daughters (Conley & Bennett, 2000, 2001; Currie & Morietti, 2007; Lunde et al., 2007; Magnus, 1984; Magnus, Berg, Bjerkedal, & Nance, 1984; Magnus, Bakketeig, & Skjaerven, 1993; Magnus, Gjessinb, Skrondala, & Skaervenb 2001; Vlietinck et al. 1989), and has shown that (a) heritability explains less than half of the association, and (b) (low) maternal income is not a risk factor for poor infant health once mother's own birth weight is included.

However, no study has yet attempted to examine social-environmental pathways that may explain these mother-daughter similarities. Yet, sociological and demographic research has widely demonstrated that mothers and daughters are similar in a myriad of other ways including socioeconomic status, educational attainment, and sociobehavioral characteristics (i.e., marital status at birth, age at first birth) (e.g., Amato 1996; Amato & DeBoer 2001; Barber 2001; Furstenberg, Levine, & Brooks-Gunn 1990; Grusky 2008). These characteristics are in turn related to birth outcomes (e.g., Reichman 2005) which suggest that, together, they may provide a social-environmental explanation for the previously-documented similarity in birth outcomes. No research has yet tested this possibility. This study examines this question by applying structural equation modeling to a linked mother-daughter data file from the National Longitudinal Survey of Youth (NLSY) 1979 cohort and the Children of the NLSY79.

BACKGROUND

A foundational concept in sociological research, social stratification processes provide opportunities for and induce constraints on individual choices (e.g., Grusky 2008). It is widely held that these processes do not operate randomly within societies. Rather, they are produced and reproduced largely through interactions with social structures. The family unit is one particularly important social structure that shapes individual choices and experiences. For example, family structure is tightly linked with individual-level socioeconomic status (e.g. McLanahan & Booth 1989), neighborhood residence (e.g., Leventhal & Brooks-Gunn 2000), as well as increased health risks such as unintended injuries and childhood asthma (Chen, Martin, & Matthews 2006). Furthermore, the family environment can either buffer or exacerbate the effects of social conditions on individuals. For example, children growing up in stable two-parent families in poor neighborhoods are at lower risk of engaging in risky behaviors in adolescence such as delinquency and early sexual initiation than their counterparts in single- or step-parent families in the same poor neighborhood (e.g., Wu and Martinson 1993; Amato & Booth 1997; Wu 1996; Wu & Thompson 2001). Thus, family structure and the family environment as a whole are important predictors of a child’s risk of growing up within a given socioeconomic status, of residing within a poorer (or richer) neighborhood, and of developing poorer health outcomes over the life course. As a result, accounting for one’s family background is an important component in social sciences and public health research alike.

With respect to infant health disparities in particular, many disadvantages have been linked to marital status at conception and/or birth (Sheehan 1998; Bennett 1992; Bennett et al. 1994; Bird et al.

2000; Chomitz et al. 1995; Reichman 2005). Only a handful of studies however have focused on the role of the family through a different lens: environmental sources of intergenerational risks of poor infant health outcomes that are passed along from mother to daughter.

Biological or genetic similarities are a likely explanation of mother-daughter similarities in birth outcomes. However, behavioral genetics research has estimated the heritability of birth weight to be relatively low. For example, one particularly compelling study observed mother-child and father-child correlations of birth weight using Norwegian birth registry data between 1967 and 1998. They estimated the heritability of birth weight to be 0.25 (Magnus, Gjessinb, Skrondala, & Skaervenb 2001). In another study using the same dataset, Magnus and colleagues found very little evidence of an intergenerational correlation of gestational age and/or preterm birth suggesting any similarities may be limited to birth weight alone (Magnus, Bakketeig, & Skjaerven, 1993). In fact, they conclude that gestational age is not largely affected by genetics. A more recent study also using the Norwegian birth registry (from 1967 to 2004) found similar, though slightly different results. Maternal genetic characteristics accounted for 22% of the variance in birth weight and 14% of the variance in gestational age (Lunde et al. 2007).

While it seems fairly safe to conclude that some studies have found the heritability of birth weight to be relatively low, it is important to note that this literature is not without its critics. Behavioral genetics research has been criticized by social scientists for producing results that do not illuminate behavioral or developmental pathways for example (Gottleib 2003), although these studies are unique in their ability to isolate estimates of genetic versus shared and non-shared environmental characteristics. More recently however, genetic researchers have begun focused on a different dimension of genetic contributions such as epigenetic influences and biosocial interactions. Epigenetic processes refer to another way to measure genetic contributions where the emphasis is on DNA methylation that can allow or suppress the expression of a specific part of the genome (e.g., Mabry, Olster, Morgan, & Abrams 2008). These changes can be induced by a variety of factors including environmental context and physiological stress. Biosocial interactions on the other hand focus on how genetic expression varies across environmental contexts (i.e., a genetic predisposition towards aggression may only express itself if one also grew up within a stressful home environment) (e.g., Booth, McHale, & Landale 2011).

Along these lines, Magnus and colleagues in another series of papers attempted to measure both fetal and maternal genetic contributions to birth weight, rather than simply a heritability estimate. Again using a subsample of the Norwegian birth registry data, they found that more than half of the variation in birth weight (60%) could be attributed to fetal genetic influences, and none of the variation could be explained by maternal genetic influences (Magnus 1984). A follow-up study however revealed a larger proportion of maternal genetic influence (12%) (Magnus et al. 1984). Building on this work, Vlietinck, Derom, Neale, Maes, van Loon, Derom, and Thiery (1989) were able to separate the heritability estimate of birth weight from factors such as gestational age and maternal age that may be correlated with both mother's and child's birth weight. This more nuanced technique estimated the heritability to be around 39%.

Taken together, it is clear that mother-daughter similarities in birth weight are partly biological in nature, but that environmental explanations can potentially explain a large proportion (i.e., more than half) of this association as well. Such explanations could relate to social or environmental characteristics that are similar between mothers and daughters, such as educational attainment, socioeconomic status, marital status at birth, or age at birth. However, we do not yet know if these associations provide a social-environmental explanation for associations in mother-daughter birth weight.

Social scientists have paved the way for such an examination by documenting the role of individual socioeconomic status on infant health in a within-family context. For example, Conley and Bennett (2000) found a significant intergenerational relationship of low birth weight between mothers and daughters based on data from the Panel of Income Dynamics (1968-1992). Interestingly, they found that mothers who were low birth weight themselves were twice as likely to have low birth weight babies and that including this intergenerational transmission eliminated the oft-cited effect of parental income on birth weight (net of maternal education, age, race/ethnicity, as well as child sex and birth order), yielding a potentially spurious association between low birth weight and income previously cited in the public health and social epidemiology literatures.

In 2001, Conley and Bennett examined the persistence of their findings using (sibling) fixed-effects models and a better measure of low birth weight: a continuous variable of child's birth weight (in ounces) as opposed to a dichotomous variable of low birth weight (although they were forced to rely on a dichotomous variable of low birth weight for the mother due to data limitations). They found income persisted in its effect when the mother was herself low birth weight, and interpreted this as evidence that income matters for those children who are at greatest risk of being low birth weight. They also found that this moderating effect (between income and maternal low birth weight) persisted into young adulthood—specifically, that low birth weight children with high income-to-needs ratios were "protected" against typical educational decrements associated with being low birth weight (i.e., they were more likely to complete high school on time than low birth weight children with less income advantage).

The impact of Conley and Bennett's findings was not inconsequential. These studies provided some evidence that the oft-cited link between socioeconomic status and health did not universally apply to infant health outcomes—as least in one data source. However, the PSID sample has some notable limitations (i.e., more than half of the original sample has died; McDonough et al. 1997) that preclude the ability to generalize to recent, population-level samples. It is also a relatively small dataset with which to examine a rare outcome such as low birth weight that occurs in only 7-10% of the population in any given year. Due to data limitations, they also could not examine other infant health outcomes of interest such as small-for-gestational age or preterm birth, even though both of these outcomes are more closely linked with subsequent morbidity and mortality than a binary indicator of low birth weight (Paneth 1995; Reichman 2005; Goldenberg et al. 2008; Sheehan 1998;).

Several years later, another study (Currie & Moretti, 2007) further tested the intergenerational association of low birth weight using a larger, but less geographically representative dataset: California birth records. They too found support for a positive intergenerational transmission of low birth weight (even in fixed-effect models) although they estimated that mothers who were low birth weight were only 50% more likely to have a low birth weight baby (as opposed to Conley and Bennett's estimate of being twice as likely). This relationship was also stronger for poor mothers in their sample than non-poor mothers. Overall, they concluded that intergenerational transmission of poverty may be partly accounted for by intergenerational trends in low birth weight.

However, there are a few aspects of this study that detract from its demographic generalizability. First, household or individual-level income measures are not available in birth certificate data. Therefore, the authors relied on median income levels of zip codes of residence as well as zip codes of the hospital in which the birth took place. While this is standard practice in research using birth certificate data and certainly useful in some ways, it does not capture the effects of individual socioeconomic status (which varies a great deal within a given zip code) on individual health outcomes. Second, cases were included if both the mother and child were born in California—a criteria which may have undercounted more transient individuals (either low or high income) and Hispanics who may have moved out of California to other destination cities during recent out-migration flows (e.g., Perry 2003).

More importantly, as previously mentioned, no prior study has directly addressed the *mechanisms* through which poor infant health outcomes may be linked across generations. For example, it is plausible that this link can be explained by mother-daughter transmissions of other behaviors that contribute to birth weight such as the likelihood of being married at the time of first birth, or educational attainment.

Strong empirical research supports the intergenerational cycles of poverty (and wealth) (e.g., Grusky 2008) as well as specific associations between mothers and children with respect to similarities in educational attainment across the life course (e.g., Oreopoulos, Page, & Huff Stevens 2003). Similarly, research within family sociology has shown that marital instability is linked across generations (e.g., Amato 1996; Amato & DeBoer 2001) and that daughters who are unmarried at the time of their first birth are likely to have mothers who made the same choice (Furstenberg, Levine, & Brooks-Gunn 1990). Research also documents similarities between age at first pregnancy or birth, specifically related to early fertility such as teen births (Barber, 2001; Card, 1981; Furstenberg, Levine, and Brooks-Gunn, 1990; Hardy et al. 1998; Horwitz, Klerman, Kuo, and Jekel 1991; Kahn and Anderson, 1992; Manlove, 1997).

In turn, prior research has shown that each of these characteristics are related to birth outcomes. Higher levels of socioeconomic status and/or educational attainment at birth, as well as lower maternal age at birth, and being married (versus unmarried) at the time of birth are each associated with a lower risk of poor infant health (Bennett 1992; Bennett et al. 1994; Bird et al. 2000; Chomitz 1995; Reichman 2005; Goldenberg et al. 2008; Paneth 1995). Together, these pathways represent a plausible social-environmental explanation of why we expect mother-daughter birth outcomes to be associated.

The Current Study

This study links data from mothers within the National Longitudinal Survey of Youth (1979 cohort) and daughters within the Children of the NLSY79 cohort to address the following questions:

1) Is there a (significant) intergenerational association for low birth weight, birth weight (in ounces, adjusted for gestational length), and preterm birth within a larger, population-level sample of women?
2) Are other intergenerational associations significant, such as mother-daughter similarities in marital status at the time of birth, age at first birth, and human capital? Does each factor significantly impact birth outcomes? If so, do these pathways together partially or fully mediate the intergenerational association of infant health outcomes?
3) Are differences between poor and non-poor women observed?

Based on prior research, I expect to find a significant intergenerational effect for two infant health outcomes (birth weight and low birth weight) as well as educational attainment, age at first birth, and marital status at birth. In the full model, I expect that intergenerational transmissions of marital status at birth and socioeconomic status will be strong and salient mediators of the total effect (of mother-daughter similarity in birth outcomes) and that the overall associations will be stronger for poor women than non-poor women.

DATA AND METHODS

This study links data from the National Longitudinal Survey of Youth 1979 cohort (NLSY79) and the Children of the National Longitudinal Survey of Youth 1979 (CNLSY79). The NLSY79 is a longitudinal survey of over 12,000 male and female participants collected annually from 1979 to 1994 and biennially from 1996 to the present. The CNLSY79 is a longitudinal survey of the children of this cohort. Because children in this survey vary in age from birth to age 30+ (by 2008) the Bureau of Labor Statistics administers two surveys based on the age of the child: one to children (or mothers of children) ages 0-14, and one to young adults ages 15 and up. This study uses information from the young adult survey which has been collected biennially since 1994. After selecting females (5,624 young women from the full sample of 11,494 young adults) who ever had a child by 2008 (dropped an additional 4,280), the sample size was 1,344 mother-daughter pairs. For the sake of simplicity, hereafter I will refer to mothers as "G_1" generation, daughters as "G_2" generation, and infants as "G_3" generation.

Variables

Endogenous Variables. The same three infant health outcomes are measured for G_2 and G_3: low birth weight (*1 = less than 5 ½ pounds at birth, 0 = 5 ½ pounds ore more*), preterm birth (*1 = less than 37 weeks, 0 = 37 weeks or more*), and birth weight in ounces (*range = 3-185*). When adjusted for gestational length, this final measure approximates intrauterine growth restriction or small-for-gestational age which is more closely linked with mortality and morbidity than the binary indicator of low birth weight. Unfortunately these data do not contain information on gestational length in weeks for G_3 (although they do contain gestational length in weeks for G_2). For the sake of consistency, the indicator of preterm birth for both G_2 and G_3 is used here as a proxy for gestational age, and is added to the structural equation model predicting continuous birth weight.

Next, the same set of variables from the mother (G_1) and daughter (G_2) data files were included to measure two explanatory processes: human capital (G_1 years of completed education at the time of pregnancy: *range = 1-16*, G_2 years of completed education at the time of pregnancy: *range = 1-20*) and whether G_1 and G_2's first birth was nonmarital (*1 = yes*). Age at first pregnancy was considered as a third pathway but preliminary analysis revealed that it did not significantly improve the fit of the model.[7]

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[7] This analysis revealed that the path between G_1 and G_2 age at first pregnancy was not significant, nor was the path from age at first pregnancy to birth weight or low birth weight (in either G_1 and G_2). Education consistently predicted age at first pregnancy however. This model also revealed poorer model

Therefore only nonmarital status and human capital were retained in the analysis. It would have been ideal to also consider a measure of financial capital but, unfortunately, daughter's household income at pregnancy was not consistently measured across all CNLSY79 surveys. In earlier waves, it was not asked at all (presumably because most children were still living with their family-of-origin) while in later waves, it was asked (presumably because most children had formed independent households by then). Other ways of including a measure of financial capital were considered, such as using mother's reported household income or mother's household poverty status in survey years when daughters were not asked, but were not used in the final analysis since these measures differed systematically from daughter's own household income/poverty (i.e., mothers were older at the time of measurement and were more likely to have a larger household size than daughters). Preliminary analyses also explored the addition of several additional explanatory pathways including mother-daughter similarity in prenatal smoking behavior, early prenatal care receipt, and pregnancy wantedness. However, just as was the case with age at first pregnancy, the addition of these variables did not result in significantly better model fit and thus were not retained in the final analysis.[8]

Exogenous Variables. Several sociodemographic characteristics were included based on their covariance with infant health outcomes (Chomitz et al. 1995; Paneth 1995; Reichman 2005; Goldenberg et al. 2008). G_1 race/ethnicity was indicated by a series of dummy variables (non-Hispanic Black and Hispanic, with non-Hispanic White/Other serving as the reference category). G_3 gender (*1 = male*) and parity (*range = 1 – 7*) were also included. Other measures reflecting G_1 childhood environment (such as grandmother's (G_0) education, grandfather's education, G_0 employment, G_1 family structure in

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fit. For example, the BIC for birth weight was 34,743.18 (compared with a value of 22,466.36 for the final model used in the analysis) and the BIC for low birth weight was 35,483.49 (compared with a value of 23,207.68 for the final model used in the analysis).

[8] Model fit indices for this model included: χ^2 = 518.9, *df* = 25, CFI = .64, TLI = .35, RMSEA = .12, and BIC = 28,361.81.

adolescence) were also considered but were ultimately not retained since they did not add sufficient explanatory power to justify the increased complexity they added to the model.

Analytic Strategy

Structural equation models were used to estimate the intergenerational associations in the analysis (see Figure 7 for a conceptual diagram of the proposed associations). Each infant health outcome (low birth weight, preterm birth and birth weight) is estimated as a separate model. Structural equation models are ideal for these types of analyses for two reasons. First, they are based on maximum likelihood (ML) estimation which has several advantages over ordinary least squares regression (OLS). While OLS minimizes the sum of squared errors, $\Sigma\varepsilon_i^2$, and ensures the best linear unbiased estimator, ML minimizes the difference between the observed and predicted variance/covariance matrix by maximizing the probability of having observed a given sample, given (a,b).

Second, structural equation models simultaneously estimate multiple regression equations outlined in a path diagram. In this analysis, these equations include: (1) G_3 infant health outcomes regressed on (a) G_2 infant health outcomes and (b) G_2 sociobehavioral characteristics (relationship status at conception and human capital), (2) G_2 infant health outcomes regressed on the same series of (G_1) sociobehavioral characteristics, and (3) G_2 sociobehavioral characteristics regressed on the parallel measures among G_1.

Just as in other types of regression, residuals are calculated for all endogenous variables in structural equation models and capture everything that remains unexplained by the model. In within-family models, there is presumed to be some level of genetic relatedness that bears on intergenerational associations. In this specific case, there is likely to be an unmeasured genetic or biological similarity between G_2 and G_3 infant health (and perhaps sociobehavioral) outcomes that is retained in the residuals. Thus, residuals between G_2 and G_3 infant health outcomes were explicitly correlated with one another in this model, and correlations between the residuals of mother's and daughter's sociobehavioral indicators were examined for potential significance. This technique, championed by Heckman (1977), represents not only a way to model genetic similarities but also a way to model underlying selection processes that inherently exist in the data. Due to this imposed structure, this model provides an extremely stringent test of multiple intergenerational pathways that may explain the mother-daughter similarity in birth outcomes by accounting for both sociobehavioral and biological similarities.

All models were estimated in Mplus which provides superior estimation of dichotomous endogenous variables (such as low birth weight and preterm birth). Other programs (such as AMOS) use algorithms which assume all endogenous variables are continuous and thus, are not ideally suited for this analysis. Several goodness-of-fit statistics are provided for each model. Since the sample size is somewhat large, the chi-square statistic (which compares the observed and predicted covariances, testing the null hypothesis that the model fits the data perfectly) fails to provide the best measure of model fit. Therefore, I present various alternative statistics. First, the Confirmatory Fit Index (CFI) compares model fit between the given model and (baseline) null model (Bentler 1990). This statistic tends to range between 0 and 1 with higher scores conferring better model fit; scores of 0.90 are required to accept the model as a good fit for the data. Similarly, the Tucker-Lewis Index (TLI) compares model fit between the given model and the independence model, and performs well for large sample sizes in addition to adjusting for model complexity. A score of 0.90 is required to confer good model fit. Third, I reference the Root Means Square Error of Approximation (RMSEA) which adjusts for error in the population, thus making it ideal for use with large population-level samples. Scores less than 0.05 indicate adequate approximation. Lastly, I include the Bayesian Information Criterion (BIC), both unadjusted and adjusted for sample size. Lower scores confer better model fit (in nested models) (Curran et al. 2003).

To fully accept the proposed theoretical model as an adequate characterization of the social-environmental pathways related to intergenerational association in birth weight, two criteria must be met. First, the direct effect of G_2 infant health on G_3 infant health would be smaller than the total effect and reduced in significance. It would potentially be non-significant if the model fully explained this association. Second, all three of the following paths would also have to be significant: (using nonmarital births as an example) G_1 nonmarital birth to G_2 infant health, G_2 nonmarital birth to G_3 infant health, and G_1 nonmarital birth to G_2 nonmarital birth status. The case of education may differ based on the model. That is, in the analysis, education is modeled to have a direct effect on nonmarital birth status as well as infant health. Therefore, evidence for this explanation could be similar to the nonmarital birth example, or could be shown by the effect of education on infant health operating through nonmarital birth status. In other words, education may retain no significant direct effect on infant health but instead have a significant effect on nonmarital birth which in turn significantly influences infant health.

Prior methodological research has shown that the application of survey weights in regression analysis is undesirable when the factors that were used to calculate the survey weight are a function of the independent variables in the regression model (Winship & Radbill, 1994). That is the case in these data and as a result, all analyses remain unweighted with the exception of the descriptive statistics which are weighted as follows: G_1 characteristics are weighted using a G_1 weight, and G_2 characteristics are weighted using the G_2 weight (both weights were provided by the Bureau of Labor Statistics).[9]

Descriptive Statistics

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[9] The choice to not weight the data was also informed by the substantive complexity of weighting intergenerational data such as these. For example, in the case of the NLSY79 mother-daughter pairs, one must first decide which set of weights to use (custom weights based on mother's survey data or daughter's survey data) and then consider what the substantive application of these weights would indicate for one group (i.e., mother's coefficients) if the other group's weights (i.e., daughter's weights) were used.

Table 10 presents descriptive statistics for the analytic sample. (Weighted descriptive statistics by poverty status and weighted correlation matrices for G_1 and G_2 characteristics are available for reference in Appendices G, H, and I, respectively.) Generally speaking, infant health outcomes (of G_2) and sociobehavioral characteristics (of G_1) are similar to national averages for births in 1980, the average year in which mothers in these data had their first birth. Although in some ways, this subsample is more disadvantaged than the national average. G_2 rates of low birth weight and preterm birth are 8% and 10% respectively which is similar although slightly higher than the national average for births in 1980: 7% and 9% respectively (NCHS Monthly Vital Statistics Report, 1982). Nonmarital birth rates in this sample were also similar but slightly different: 24% of White mothers and 81% of Black mothers in these data had a first nonmarital birth, whereas 18% and 83% of unmarried all-parity mothers had a birth in 1980. (Recall that around 1980, the nonmarital birth rate among White women began rising at the population-level; NCHS Monthly Vital Statistics Report, 1982).[10] G_1 age at first pregnancy in these data is nearly 18 years of age, slightly younger than the national average of 20 years of age at first birth (or, around 19 years of age at first pregnancy). Mothers (G_1) reported a median household income of $11,961 (mean = $14,360) and completed nearly 11 years of schooling at the time they became pregnant with the daughter (G_2) represented in this sample. The median level of education for mothers (including all parities) in 1980 was 12.6. Since there are more first-parity mothers represented in this sample, it is logical that their level of education would be slightly lower. G_1 rates of prenatal (ever) smoking and drinking (more than one drink per month) were 10%, and 74% of mothers received prenatal care in the first trimester of pregnancy (which is extremely comparable to the national average of 76%).

Because the majority of daughters (G_2) in this sample who have already had a live birth are in their 20's, this subgroup is, on average, younger and more disadvantaged than a cross-section of all-

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[10] Statistics related to nonmarital births represent post-1980 procedures for calculating this statistic.

parity mothers in 2002—the average year of daughter's first birth in this sample. For example, G_2 average age at first pregnancy was 19 years old which is lower than the national average (25). 10% of G_3 infants were low birth weight and 18% were preterm which are similar to but higher than national averages for births in 2002 (8% and 10% respectively; Martin et al. 2003). The preterm birth rate is particularly high, although these differences may reflect a higher proportion of teen births among the subsample. Similarly, more than three quarters of G_2 first births were nonmarital (84%) which is substantially higher than the national average in 2002 (34%).

(G_2) daughters completed an average of 11 years of schooling before their first birth, compared with a median 12.9 years of schooling for all-parity mothers in 2002. Risky behaviors such as prenatal smoking and drinking were much lower among the G_2 generation (about 10% for both) than among G_1 (about 1% for both), and the proportion of G_2 receiving prenatal care in the first trimester was 84%--identical to the national average in 2002. Lastly, more than half of the sample was non-Hispanic White/Other (61%), 29% were non-Hispanic Black and 10% were Hispanic.

In sum, compared with population-level data, (G_1) mothers in this sample were disadvantaged in some ways while (G_2) daughters were younger and disadvantaged in many ways. These findings will be kept in mind when interpreting the findings.

FINDINGS

Table 11 presents the results from the structural equation models of mother-daughter similarity in birth weight (Panel A) and low birth weight (Panel B). (A model exploring mother-daughter similarity in preterm birth found there to be no significant intergenerational association, and thus, was not examined further.[11]) In a model including only control variables (results not shown), the total effect of

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[11] A structural equation model including only sociodemographic characteristics (and not explanatory pathways) revealed that the direct effect of G_2 preterm birth on G_3 preterm birth was not significant (b = .07, p = .341).

G_2 birth weight on G_3 birth weight was positive and significant ($b = .19$, $p < .001$). In the full model shown here, the direct effect of G_2 birth weight on G_3 birth weight is reduced slightly but remains highly significant ($b = .15$, $p < .001$) which suggests the proposed explanatory pathways account for only a small proportion (21%) of this association [(total effect – direct effect)/total effect]. Some of the explanatory pathways operate as expected, but not all do. For example, consistent with prior literature, the intergenerational pathways between $G_1$and G_2 education and $G_1$and G_2 nonmarital birth status are salient and significant, as is the path from education to nonmarital birth status among both generations. However, education only impacts birth weight among the G_1 generation (not G_2) and nonmarital birth status only influences birth weight among the G_2 generation (not G_1).

Preliminary analyses examined the inclusion of two additional paths: from G_2 infant health outcomes to G_3 nonmarital birth status and education, and from G_2 nonmarital birth status and education to G_3 infant health outcomes. The first path tests the salience of long-term consequences of low birth weight among the G_2 generation. That is, G_2 daughters who were themselves low birth weight or lighter at birth may be at increased risk of nonmarital births or lower educational attainment. Conversely, the second path explicates a way in which G_1 characteristics (such as education) can influence G_3 infant health outcomes—two generations later. However, examination of the model results including both pathways revealed few significant direct associations. The single exception was that G_2 (lighter) birth weight was associated with G_2 delayed age at first pregnancy. Interestingly, G_2 birth weight did not influence G_2 educational attainment in this sample.

In terms of sociodemographic characteristics, race/ethnicity—and non-Hispanic Black race/ethnicity in particular—retains a significant direct effect on birth weight, education, and nonmarital birth status for both G_1 and G_2. Preterm birth and gender are also highly significant in their direct effect on birth weight. Finally, model fit indices indicate acceptable fit for birth weight: the CLI and TLI are above .90 (and are .97 and .95, respectively) although the RMSEA is slightly high (.06). (See Figure 8 for a graphical representation of the main findings for birth weight.)

As a whole, this provides only partial support for the proposed hypothesis. That is, intergenerational transmissions of human capital (education) and nonmarital births are evident, but the pathways from each explanatory variable to birth weight are not consistently significant. The effect of G_2 education on G_3 birth weight operates entirely through nonmarital birth status (and doesn't retain a significant direct effect). The same can't be said for G_1 however; only the path from education to nonmarital birth status is significant.

The results for low birth weight are fairly similar (Table 11, Panel B). In a preliminary model including only control variables (results not shown), the total effect of G_2 low birth weight on G_3 low birth weight (*b*) was .76 ($p < .01$). The main intergenerational association in the full model remains significant ($b = .69$, $p < .01$), indicating that the proposed model explains only a small proportion (9%) of the association. The intergenerational pathways between G_1 and G_2 educational attainment and G_1 and G_2 nonmarital birth status are significant however. Also, education retains a significant direct effect on nonmarital birth status among both generations. However, in this model, there is even less support for the proposed explanatory pathways than in the previous model. Nonmarital birth status and education (either directly or through nonmarital birth status) have little impact on the risk of low birth weight in either generation. Non-Hispanic Black race/ethnicity retains a significant direct effect on the risk of low birth weight, educational attainment, and nonmarital first birth status while Hispanic race/ethnicity is only directly related to educational attainment. Model fit indices again indicate acceptable fit: CFI is above .90 (.91), TLI is nearly .90 (.89), and RMSEA is below .05 (.03). (See Figure 9 for a graphical representation of the main findings for low birth weight.)

In sum, despite the numerous intergenerational pathways demonstrated thus far, the full model does little to diminish the effect of G_2 infant health on G_3 infant health. Next, a multiple group analysis was performed comparing poor versus non-poor mother-daughter pairs to see if this contrast provides greater explanatory depth. Findings are summarized in Table 12. Panel A shows that the intergenerational association of birth weight is similar in strength for poor ($b = .15$, $p < .001$) and non-poor women ($b = .17$, $p < .01$). A preliminary model including only control variables indicated the following associations for each group: poor women ($b = .20$, $p < .001$) and non-poor women ($b = .18$, $p < .001$). This is consistent with the findings from the full group analysis in that the proposed model explains only a small proportion of the main intergenerational association, although it is notable that a greater proportion is explained for poor versus non-poor women (25% and 6%, respectively). For non-poor women, we see similar findings as in the full model: the effect of education on birth weight operates through nonmarital births, although here this is largely true for both G_1 and G_2 generations (instead of just G_2). In other words, the path from education to nonmarital births is significant for both generations, and the path from nonmarital births to birth weight is significant for G_1 ($b = -.017$, $p < .05$) and just outside the 90% confidence interval for G_2 ($b = -.016$, $p = .163$). Similarly, paths between G_1 and G_2 educational attainment and G_1 and G_2 nonmarital birth status are highly significant.

For poor women on the other hand, intergenerational transmissions of birth weight, educational attainment, and nonmarital birth status are evident but very few explanatory pathways are significant and none in a systematic way. For example, the path from education to nonmarital births is significant for G_2 ($b = -.09$, $p < .05$) but not G_1 ($b = .02$, $p = .57$). The paths from nonmarital births and education to birth weight are never significant for either generation. Model fit indices however are acceptable: although the chi-square statistic is significant ($\chi^2 = 74.81$, $df = 32$), the CLI is above .90 (.93), TLI is nearly .90 (.89) and RMSEA is .05.

With respect to the risk of low birth weight, the main intergenerational association is only marginally significant for non-poor women (*b* = .19, *p* = .07) and not significant for poor women (*b* = .18, *p* = .11). The corresponding coefficients in the preliminary model including only control variables (representing the total effect) were .41 for non-poor women (*p* = .05) and .38 for poor women (*p* = .05). Unlike the full group analysis, this indicates that a larger proportion of the main intergenerational association is explained by the model when a poor/non-poor distinction is imposed. The full model explains 54% of the association for poor women and 53% of the association for non-poor women. In terms of other pathways, the path from education to nonmarital births is significant for G_1 in both groups but is only significant for G_2 among non-poor women. In turn, nonmarital births are not associated with the risk of low birth weight in either generation. Model fit indices here are again acceptable: the chi-square statistic is significant ($\chi^2 = 71.73$, *df* = 20) but the CLI is .91, the TLI is .89, and the RMSEA is .05.

Finally, the full models for birth weight and low birth weight were re-estimated with the inclusion of a correlation term between G_2 infant health and G_3 infant health. However, the estimate of the main intergenerational association did not change although the standard error increased such that it was no longer significant. Because the magnitude of the path coefficient was not reduced, I concluded that these results did not add substantial explanatory depth to the model and were thus excluded from the final analysis.

DISCUSSION AND CONCLUSIONS

Prior research has identified population-level infant health disparities that have persisted over several decades. Higher risk of low birth weight and preterm birth for example are concentrated among subgroups of poor, unmarried, non-Hispanic Black, and some Hispanic women yet we still don't understand the full range of factors that explain this increased risk. Some work has examined a different dimension of infant health disadvantage, mother-daughter similarities in birth weight (Lunde et al., 2007; Magnus, 1984; Magnus, Berg, Bjerkedal, & Nance, 1984; Magnus, Bakketeig, & Skjaerven, 1993; Magnus, Gjessinb, Skrondala, & Skaervenb 2001; Vlietinck et al. 1989), although heritability estimates of birth weight and low birth weight have been shown to be relatively low. This suggests that environmental factors likely play a stronger role in explaining this similarity than genetic or biological factors. Work in the social sciences has also observed this similarity but has yet to provide a social-environmental explanation (Conley & Bennett, 2000; Conley & Bennett, 2001; Currie & Morietti, 2007). Drawing upon prior work in family sociology and demography, this study proposes that widely-documented intergenerational similarities in educational attainment and nonmarital birth status may provide the missing piece to this puzzle. These explanations have the potential to either reduce the main intergenerational effect (at best) or indicate an entirely spurious relationship (at worst).

Using a sample of 1,344 mother-daughter pairs from the NLSY79 and CNLSY79 cohorts, this study examined intergenerational associations of infant health, poverty, and sociobehavioral modeling. Consistent with prior research, results from structural equation models indicate that the intergenerational association of infant health outcomes existed for birth weight and low birth weight but not preterm birth (Conley & Bennett 2000; Conley & Bennett 2001; Currie & Morietti 2007; Magnus, Bakketeig, & Skjaerven, 1993). However, support for the proposed theoretical model was not generally provided since all three of the explanatory pathways were not significant. The non-significance of one path (G_1 nonmarital birth to G_2 infant health) precluded the acceptance of the theoretical model for birth weight, and the non-significance of two paths (G_1 nonmarital birth to G_2 infant health and G_2 nonmarital birth to G_3 infant health) precluded the acceptance of the model for low birth weight.

However, the results extend prior literature in several interesting ways. First, they demonstrate that about one-fifth of the association between mother's and daughter's birth weight was explained by an effect of education on birth weight operating through nonmarital birth status. That is, higher educational attainment is related to lower risk of nonmarital birth, which in turn is related to higher birth weight. This finding was well-documented for daughters (G_2) although less well-documented for mothers (G_1). This is largely consistent with Conley and Bennett's work (2000 and 2001) which found that maternal education and income were never significant (direct) predictors of daughter's infant health.

Unlike previous studies (i.e., Currie & Morietti 2007), this study did not find evidence that intergenerational associations of low birth weight were stronger for poor versus non-poor women. The path coefficient for the main intergenerational association was .41 for non-poor and .38 for poor women (in the preliminary model). Similarly, the corresponding path coefficients for birth weight were .18 for non-poor and .20 for poor women. Results also demonstrate that the pattern relating to education on birth weight (operating through nonmarital birth status) was evident among non-poor women only. Among poor women, only the path from education to nonmarital births was significant (and not the path from nonmarital births to birth weight). Since nonmarital births were more common among poor women, this may indicate that nonmarital births are generally more consequential for infant health among the sub-population in which it is a rarer event.

However, consistent with the logic of their study, findings also show that the explanatory pathways examined in this analysis accounted for a larger proportion of the main intergenerational association when the group is subdivided into poor and non-poor women. That is, more than half of the total effect of G_2 infant health on G_3 infant health was explained for the risk of low birth weight among both poor and non-poor women (54% and 53% respectively). In the full model, only 9% is explained.

Consistent with prior literature (Oreopoulos, Page, & Huff Stevens 2003), intergenerational transmissions of human capital (or, educational attainment at the time of pregnancy) and nonmarital birth status were salient in both contexts (birth weight and low birth weight) and in both contrasts (poor versus non-poor women). However, mother's age at first pregnancy did not retain a significant direct effect on daughter's age at first pregnancy as has been shown in prior work (Barber, 2001; Card, 1981; Furstenberg, Levine, and Brooks-Gunn, 1990; Hardy et al. 1998; Horwitz, Klerman, Kuo, and Jekel 1991; Kahn and Anderson, 1992; Manlove, 1997). It may be that these two characteristics are related between mothers and daughters, but the direct path did not retain significance once transmissions of education and nonmarital birth status were included. Similarly, adding mother-daughter similarities in prenatal smoking behavior, early prenatal care receipt, and pregnancy wantedness did not significantly improve model fit even though exploratory analyses revealed significant direct effects between $G_1$and G_2 prenatal smoking and $G_1$and G_2 prenatal care.

The analysis also examined the full model under one additional constraint: that the error terms for G_2 infant health and G_3 infant health were correlated. This is supported by the assumption that unmeasured characteristics that affect G_2 infant health may be, and likely are, related to unmeasured characteristics that affect G_3 infant health. Substantively, these unmeasured characteristics may include factors such as genetic predispositions towards poor infant health that are expressed in both mothers and daughters. Evidence along these lines has been cited in past research (e.g., Magnus et al. 1984; Vlietinck et al. 1989) which justifies its inclusion from a theoretical standpoint. From a measurement perspective, not including this correlation can result in biased and imprecise path coefficients due to omitted variable bias.

However, in this analysis, including this constraint did not substantially improve the explanatory power to the model. The magnitude of the main intergenerational association did not change (unlike what we would expect to see if omitted variable bias were a significant problem) while the standard error increased such that it was reduced to non-significance (indicating only a reduction in precision).

While this procedure is clearly useful in some contexts (e.g., Heckman 1977), it has also been criticized. Jöreskog (1993) for example notes that this procedure essentially concedes that a given construct has not been measured accurately, which may pose a theoretical problem within a structural equation modeling framework where the purpose is to test a specific theory with a given model. Since these correlations also tend to improve the fit of a given model, he asserts this procedure is subject to "widespread misuse" and should be used with caution. Taken as a whole, it appears that, in this case, this addition was not as useful as it had the potential to be.

As with any study, this is not without its limitations. First and foremost, comparisons between the mother-daughter pairs with population-level data from 1980 and 2002 (the average years in which mothers and daughters in this sample gave birth) revealed that mothers in this sample were slightly disadvantaged and daughters were consistently disadvantaged. Differences with respect to nonmarital first birth status among daughters for example were particularly striking. While these differences are partially an artifact of the timing of the daughter's surveys (i.e., since the average age of the complete young adult sample in 2008 was 23.1 and average age at first birth in 2008 was 25.1; Martin et al. 2010), this limits the extent to which the findings from this study can be used to make generalizations about processes that we may expect to operate at the population-level. However, these findings may be more useful in informing our understanding of processes that may operate among more disadvantaged subpopulations who have earlier, nonmarital first births—the group in which much infant health risk is concentrated. Second, sociohistorical processes that may affects son's fertility outcomes are not explored in this study (since infant health data is asked only of women in these data) but remains an important group that should be studied in subsequent research.

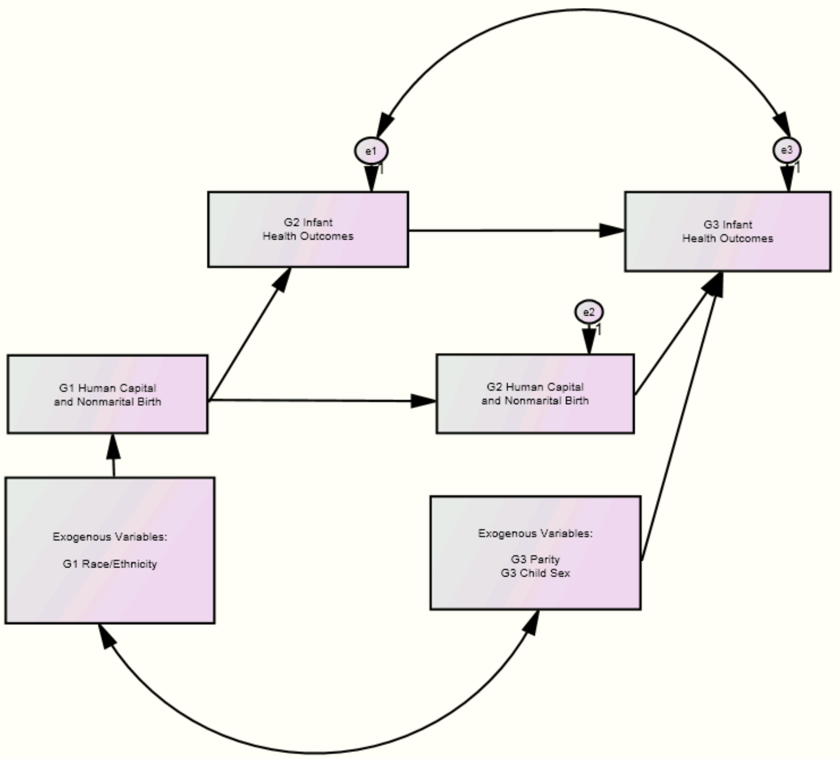
In sum, the results make several unique contributions to the literature. First, this study demonstrates that previously-documented intergenerational associations of infant health outcomes may be at least partly spurious in that intergenerational transmissions of educational attainment and sociobehavioral modeling accounted for half of the mother-daughter similarity in the risk of low birth weight when subgroups of non-poor and poor women were compared, and one fifth of the mother-daughter similarity in birth weight (adjusted for gestational length). Furthermore, these associations persisted net of the inclusion of sociodemographic and pregnancy-specific risk factors such as race/ethnicity, infant sex, and parity.

Second, results demonstrate that the effect of education on infant health (birth weight and the risk of low birth weight) operates through nonmarital birth status. This provides greater explanatory depth to prior studies focusing on intergenerational transmissions of education or nonmarital birth status in isolation of the other factor. Third, although maternal income never was never a significant predictor of daughter's birth weight in these data (as was demonstrated in Conley & Bennett's work), this provides further evidence of compounded, within-family disadvantage that exists across a variety of social and health outcomes. Fourth, within this broader intergenerational context, risk factors that have received much prior attention—such as prenatal smoking, late prenatal care receipt, and pregnancy unwantedness—retained few direct effects on infant health and did not significantly improve the fit of the model (even though mother-daughter similarities for smoking and prenatal care were documented). This may indicate that selection processes (related to educational attainment for example) may confound these risk factors. These two findings together make a compelling case to include broader intergenerational context in future investigations of infant health outcomes—especially in terms of research that intends to inform policies related to preventing infant health risk and reducing infant health disparities.

Lastly, despite a host of literature documenting long-term consequences of low birth weight for children across a variety of domains (Reichman 2005; Goldenberg et al. 2008), these findings suggest that these detrimental effects at least do not extend to some factors observed concurrently with pregnancy (such as educational attainment at the time of a given pregnancy, marital status at conception, prenatal smoking or drinking, early/late prenatal care receipt, pregnancy unwantedness or timing). Consequences of low birth weight likely include many other factors (such as lower levels of *completed* educational attainment and higher risk of obesity and Type 2 diabetes; Reichman 2005; Goldenberg et al. 2008). Overall however, these results provide more support for arguments suggesting that disadvantage associated with poor infant health is neither universal nor impervious to the potentially ameliorative effects of subsequent environments (Reichman 2005).

The relative disadvantage observed in these mother-daughter pairs though make it difficult to extend these findings to the population-level. Yet, these findings are most indicative of associations occurring within disadvantaged populations—the same subpopulation in which much infant health risk is concentrated. Future studies should seek to replicate this analysis using different intergenerational samples to further test the findings. In the short-term however, the findings highlight the importance of focusing on sociohistorical processes spanning women's life course rather than risky behaviors spanning women's prenatal period alone in terms of designing prevention/intervention programs to reduce infant health risk and infant health disparities.

Figure 5. Conceptual Framework of Proposed Intergenerational Associations of Infant Health, Human Capital, and Sociobehavioral Modeling



Note: Mother's and daughter's infant health outcomes include low birth weight, birth weight (in ounces), and preterm birth.

Figure 6. Model Presenting Path Coefficients for the Structural Equation Model Predicting Intergenerational Associations of Birth Weight, Human Capital, and Sociobehavioral Modeling

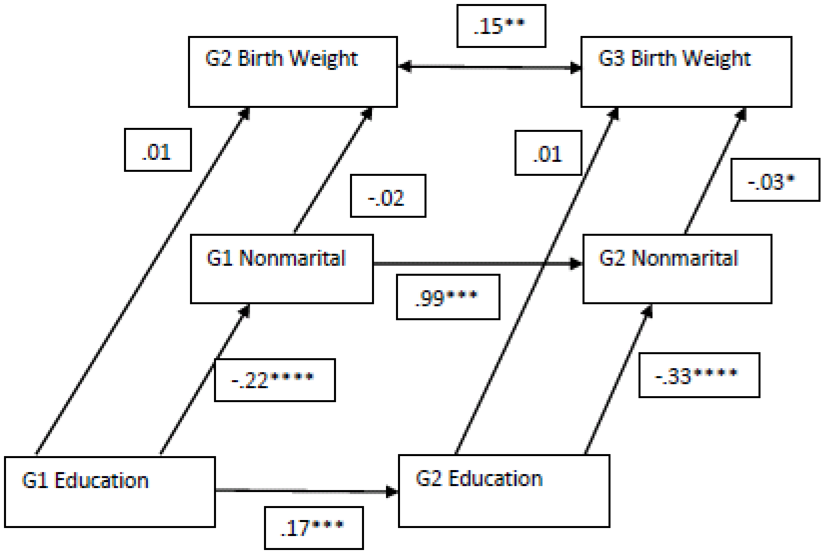


Figure 7. Model Presenting Path Coefficients for the Structural Equation Model Predicting Intergenerational Associations of Low Birth Weight, Human Capital, and Sociobehavioral Modeling

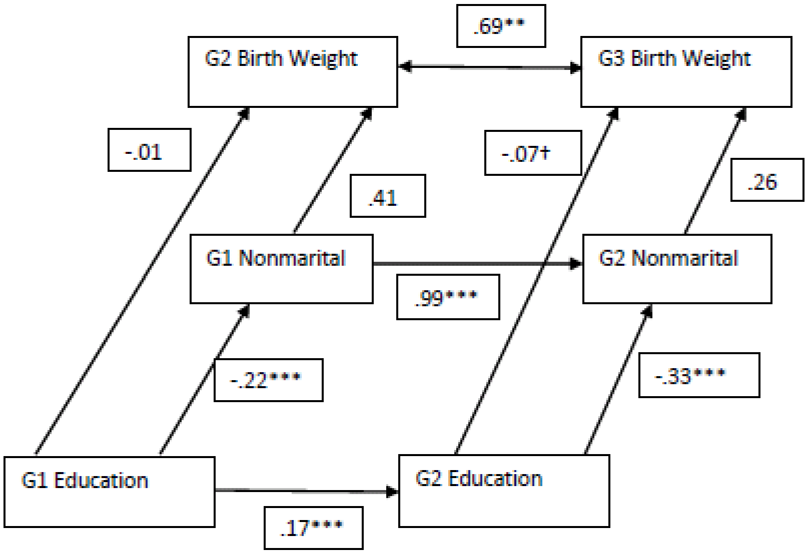


Table 10. Weighted Descriptive Statistics, Intergenerational Linkages

	Min	Max	Mean or %	Std Dev
Infant Health Outcomes				
G2 Low Birth Weight	0	1	0.08	
G2 Preterm Birth	0	1	0.10	
G2 Birth Weight (ounces)	8	198	113.39	18.51
G3 Low Birth Weight	0	1	0.10	
G3 Preterm Birth	0	1	0.17	
G3 Birth Weight (ounces)	3	185	112.02	21.80
Explanatory Characteristics				
Nonmarital First Birth				
G1 First Birth Nonmarital	0	1	0.42	
G2 First Birth Nonmarital	0	1	0.86	
Age at First Pregnancy				
G1 Age at 1st Pregnancy	10	31	17.71	2.60
G2 Age at 1st Pregnancy	11	30	18.81	3.12
Human and Financial Capital				
G1 Education at Pregnancy	1	16	10.84	1.77
G1 Household Income at 1st Pregnancy	0	75,001	14,360	11,703
G1 Household Poverty Status @ 1st Pregnancy	0	1	0.28	
G2 Education at Pregnancy	0	20	10.99	2.09
Prenatal Health Behaviors				
Smoking Behavior (Ever smoked during pregnancy; 1 = yes)				
G1 Prenatal Smoking	0	1	0.10	
G2 Prenatal Smoking	0	1	0.01	
Alcohol Use (Drank more than 1 drink/month during pregnancy; 1 = yes)				
G1 Prenatal Drinking	0	1	0.10	
G2 Prenatal Drinking	0	1	0.01	
Prenatal Care (Received prenatal care in the first trimester; 1 = yes)				
G1 Prenatal Care	0	1	0.74	
G2 Prenatal Care	0	1	0.83	
Pregnancy Wantedness (ref group = pregnancy was wanted)				
G1 Pregnancy was Unwanted	0	1	0.10	
G1 Pregnancy was Mistimed	0	1	0.41	
G1 Partner felt Pregnancy was Unwanted	0	1	0.13	
G1 Partner felt Pregnancy was Mistimed	0	1	0.28	
G2 Pregnancy was Unwanted	0	1	0.16	
G2 Pregnancy was Mistimed	0	1	0.48	
G2 Partner felt Pregnancy was Unwanted	0	1	0.12	
G2 Partner felt Pregnancy was Mistimed	0	1	0.32	

Table 10. Weighted Descriptive Statistics, Intergenerational Linkages (CONTINUED)

	Min	**Max**	**Mean or %**	**Std Dev**
Sociodemographic Characteristics				
G1 Race/ethnicity (reference = non-Hispanic White/Other)				
non-Hispanic Black	0	1	0.34	
Hispanic	0	1	0.12	
G3 Parity	1	7	1.79	1.03
G3 Gender (*1 = male*)	0	1	0.51	

Note: N = 1,344 births nested within 1,344 mother-daughter pairs.

Table 11. Unstandardized Regression Coefficients from Structural Equation Models Predicting Intergenerational Linkages of Birth Weight and Low Birth Weight

	Panel A: Birth Weight	**Panel B: Low Birth Weight**
Intergenerational Association of Birth Weight		
G2 Birth Weight --> G3 Birth Weight	0.15***	0.685**
	(0.029)	(0.25)
Explanatory (Intergenerational) Pathways		
Human Capital		
G1 Education --> G2 Education	0.168***	0.168***
	(0.036)	(0.036)
G1 Education --> G2 Birth Weight	0.001***	-0.012
	(0.003)	(0.054)
G2 Education --> G3 Birth Weight	0.004	-0.071†
	(0.003)	(0.042)
Nonmarital First Birth (1 = yes)		
G1 First Birth Nonmarital --> G2 First Birth Nonmarital	0.995***	0.995***
	(0.199)	(0.199)
G1 First Birth Nonmarital --> G2 Birth Weight	-0.021	0.405
	(0.013)	(0.265)
G2 First Birth Nonmarital --> G3 Birth Weight	-0.033*	0.256
	(0.016)	(0.351)
G1 Education --> G1 First Birth Nonmarital	-0.217***	-0.217***
	(0.048)	(0.048)
G2 Education --> G2 First Birth Nonmarital	-0.33***	-0.33***
	(0.047)	(0.047)
Pregnancy Characteristics		
G2 Preterm Birth --> G2 Birth Weight	-0.218***	x
	(0.021)	
G3 Preterm Birth --> G3 Birth Weight	-0.289***	x
	(0.017)	

Table 11. Unstandardized Regression Coefficients from Structural Equation Models Predicting Intergenerational Linkages of Birth Weight and Low Birth Weight (CONTINUED)

	Panel A: Birth Weight	**Panel B: Low Birth Weight**
Sociodemographic Characteristics		
G2 Parity --> G3 Birth Weight	-0.002	-0.182†
	(0.005)	(0.1)
G3 gender (*1 = male*)	0.047***	-0.223
	(0.01)	(0.182)
G1 Race/ethnicity (reference = non-Hispanic White/Other)		
non-Hispanic Black --> G2 Birth Weight	-0.067***	0.826**
	(0.013)	(0.305)
Hispanic --> G2 Birth Weight	-0.004***	0.308
	(0.015)	(0.317)
non-Hispanic Black --> G3 Birth Weight	-0.055***	0.498*
	(0.013)	(0.241)
Hispanic --> G3 Birth Weight	-0.018	0.331
	(0.013)	(0.269)
G1 non-Hispanic Black --> G1 Education	-10.386**	-11.169**
	(3.478)	(4.182)
G1 Hispanic --> G1 Education	-7.037***	-7.498**
	(2.059)	(2.466)
G1 non-Hispanic Black --> G1 First Birth Nonmarital	2.452***	2.452***
	(0.188)	(0.188)
G1 Hispanic --> G1 First Birth Nonmarital	0.214	0.214
	(0.213)	(0.213)
χ^2	120.13***	11.11*
df	15.00	5
CFI	0.97	0.91
TLI	0.95	0.89
RMSEA	0.06	0.03
Bayesian Information Criterion (BIC)	22,466.36	23,207.68
Bayesian Information Criterion (BIC), adjusted for sample size	22,310.71	23,093.33

Note: *** *p* <.001, ** *p* <.01, * *p* <.05, † *p* <.10 (two-tailed). Total sample = 1,344 mother-daughter pairs.

Table 12. Unstandardized Regression Coefficients from Structural Equation Models Predicting Intergenerational Linkages of Birth Weight and Low Birth Weight, Comparing Poor and Non-Poor Women

	Panel A: Birth Weight		**Panel B: Low Birth Weight**	
	Non-Poor	**Poor**	**Non-Poor**	**Poor**
Intergenerational Association of Birth Weight				
G2 Birth Weight --> G3 Birth Weight	0.165***	0.15***	0.193†	0.183
	(0.033)	(0.038)	(0.106)	(0.114)
Explanatory (Intergenerational) Pathways				
Human Capital				
G1 Education --> G2 Education	0.117***	0.2***	0.116***	0.199***
	(0.036)	(0.047)	(0.036)	(0.048)
G1 Education --> G2 Birth Weight	-0.001	0.001	-0.049	-0.003
	(0.004)	(0.005)	(0.054)	(0.053)
G2 Education --> G3 Birth Weight	0.003	-0.001	-0.047	-0.034
	(0.005)	(0.004)	(0.042)	(0.033)
Nonmarital First Birth (1 = yes)				
G1 First Birth Nonmarital --> G2 First Birth Nonmarital	0.39***	0.489***	0.375***	0.496***
	(0.081)	(0.12)	(0.078)	(0.119)
G1 First Birth Nonmarital --> G2 Birth Weight	-0.017*	-0.016	0.12	0.02
	(0.008)	(0.012)	(0.093)	(0.111)
G2 First Birth Nonmarital --> G3 Birth Weight	-0.016	-0.009	0.019	0.016
	(0.011)	(0.014)	(0.101)	(0.109)
G1 Education --> G1 First Birth Nonmarital	-0.192***	0.022	-0.188***	0.024
	(0.033)	(0.038)	(0.033)	(0.038)
G2 Education --> G2 First Birth Nonmarital	-0.24***	-0.085*	-0.239***	-0.087*
	(0.035)	(0.043)	(0.035)	(0.043)

Table 12. Unstandardized Regression Coefficients from Structural Equation Models Predicting Intergenerational Linkages of Birth Weight and Low Birth Weight, Comparing Poor and Non-Poor Women (CONTINUED)

	Panel A: Birth Weight		**Panel B: Low Birth Weight**	
	Non-Poor	**Poor**	**Non-Poor**	**Poor**
Pregnancy Characteristics				
G2 Preterm Birth --> G2 Birth Weight	-0.222***	-0.222***	x	x
	(0.017)	0.03		
G3 Preterm Birth --> G3 Birth Weight	-0.293***	-0.26***	x	x
	(0.015)	0.023		
Sociodemographic Characteristics				
G2 Parity --> G3 Birth Weight	-0.005	-0.001	-0.044	-0.14*
	(0.007)	(0.007)	(0.092)	(0.064)
G3 gender (*1 = male*)	0.051***	0.055***	-0.189	-0.196
	(0.009)	(0.008)	(0.189)	(0.185)
G1 Race/ethnicity (reference = non-Hispanic White/Other)				
non-Hispanic Black --> G2 Birth Weight	-0.028	-0.085**	0.238	0.642**
	(0.018)	(0.029)	(0.202)	(0.226)
Hispanic --> G2 Birth Weight	0.008	-0.03	-0.054	0.295
	(0.014)	(0.003)	(0.189)	(0.229)
non-Hispanic Black --> G3 Birth Weight	-0.028	-0.085*	0.023	0.339
	(0.018)	(0.04)	(0.155)	(0.241)
Hispanic --> G3 Birth Weight	-0.004	-0.054	0.094	0.27
	(0.019)	(0.044)	(0.159)	(0.234)
G1 non-Hispanic Black --> G1 Education	-6.862*	-13.936†	-10.271	-12.201*
	(3.479)	(7.382)	(6.804)	(6.047)
G1 Hispanic --> G1 Education	-3.796*	-12.72*	-5.258†	-11.035*
	(1.522)	(6.193)	(2.974)	(4.998)

Table 12. Unstandardized Regression Coefficients from Structural Equation Models Predicting Intergenerational Linkages of Birth Weight and Low Birth Weight, Comparing Poor and Non-Poor Women (CONTINUED)

	Panel A: Birth Weight		**Panel B: Low Birth Weight**	
	Non-Poor	**Poor**	**Non-Poor**	**Poor**
G1 non-Hispanic Black --> G1 First Birth Nonmarital	1.75***	1.296***	1.725***	1.24***
	(0.155)	(0.245)	(0.152)	(0.232)
G1 Hispanic --> G1 First Birth Nonmarital	0.147	0.041	0.129	-0.038
	(0.215)	(0.291)	(0.213)	(0.274)
χ^2	74.81***		71.73***	
df	32.00		20.00	
CFI	0.93		0.91	
TLI	0.89		0.89	
RMSEA	0.05		0.05	

Note: *** *p* <.001, ** *p* <.01, * *p* <.05, † *p* <.10 (two-tailed). Total sample = 1,344 mother-daughter pairs.

CHAPTER 5: CONCLUSION

While much research has cited evidence of a marriage advantage in infant health outcomes (Albrecht et al. 1994; Bennett 1992; Bennett et al. 1994; Bird et al. 2000; Chomitz et al. 1995; Goldenberg et al. 2008; Luo, Wilkins, & Kramer, 2004; Raatikainen, Kaisa, Nonna Heiskanen, & Seppo Heinonen, 2005)), only one study I know of has sought to explain specific pathways through which the two are related (Kallen 1993) and none have done so using data on births since the 1980's. Yet many important family demographic changes have occurred since that time. In the last few decades, widespread, population-level changes have been observed including increasing rates of cohabitation and nonmarital births as well as delays in age at first marriage and childbearing (Bianchi & Casper; Smock 2000). In sum, it is clear that the nature of marriage has changed substantially since the 1980's, yet we do not yet know how these changes have affected marriage advantages in infant health.

This dissertation set out to examine recent marriage advantages in infant health outcomes in a variety of ways: by taking into account women's sociohistorical family background; differential prenatal attitudes/behaviors and neighborhood environments among married, cohabiting, and single women; and intergenerational (mother-daughter) transmissions of human capital and sociobehavioral modeling. The results demonstrate that, within the more recent past, marriage advantages in infant health outcomes are multidimensional and contingent upon a variety of factors.

For example, married-single disparities remained in both multilevel and fixed-effects modeling frameworks although no disparity was observed between married and cohabiting women. This suggests that, net of selection processes that may affect women's risk of being married at the time of conception and women's risk of poor infant health outcomes, infants born to single mothers remain disadvantaged. Furthermore, even among women who were married at the time of one birth but unmarried at the time of another birth, a disparity remained. This provides strong evidence of a salient disadvantage exhibited by single mothers. Consistent with prior work (i.e., Kallen 1993), some of this disadvantage is explained by increased rates of prenatal smoking among single women but not all.

Importantly, this suggests that the children of single mothers are not only disadvantaged later on in life (i.e., in childhood and adolescence; Amato 2000), but that they also *begin* life with an important disadvantage that has the potential to affect subsequent physical well-being (i.e., increased risk of developmental and physical impairments) as well as decreased educational attainment. Much work in the family sociology literature for example focuses on family instability within early childhood and how these experiences affect later-life outcomes (Amato 1993, 2000; Amato & Booth, 1997; Brown, 2006; Cavanagh & Huston, 2006, 2008; Cavanagh, Schiller, & Riegle-Crumb, 2006; Cherlin et al., 1991; Fomby & Cherlin, 2007; Heard, 2007; Osborne & McLanahan, 2007; Wu, 1996; Wu & Martinson, 1993). The findings of this dissertation expand this research by demonstrating that exposure to family instability can begin in utero and should be measured as such when at all possible. Including prenatal exposure to single parenthood may enrich the explanatory and theoretical depth of this literature by introducing both a longer life course perspective for children as well as an intergenerational link between parent and offspring’s outcomes.

It was particularly striking finding to find no difference in the direct effect of marriage versus cohabitation on infant health, although some evidence emerged that cohabitation was more risky than marriage for infants when mothers lived in high-crime environments. This suggests that cohabitation may not be risky in and of itself—unless it is combined with other stressful conditions. This stands in contrast to multiple studies citing a marriage (versus cohabiting) advantage among infant health outcomes in the 1990’s (Bird et al. 2000; Luo, Wilkins, & Kramer, 2004; Raatikainen, Kaisa, Nonna Heiskanen, & Seppo Heinonen, 2005) as well as a host of literature citing poorer health and social outcomes in general for children living with a cohabiting union (e.g., Brown 2004; Manning 2000;

Manning & Lamb 2003; Manning & Lichter 2006). Prior literature in family sociology has explored if cohabitation more closely resembles singlehood or marriage (e.g., Bianchi & Casper 2000; Cherlin 2000; Smock 2000), but the lack of differences between infants born to married and cohabiting women here clearly indicates an interesting convergence between marriage and cohabitation among a recent sample of recent births. Since infants have yet to be exposed to these unions outside of the womb however, it would be interesting to compare the longer-term well-being of infants whose mothers were cohabiting versus married at conception. Given that this finding may reflect more recent trends, examining only children born since 2001 for example would likely produce the most relevant results.

The analyses also demonstrate the importance of examining poor infant health through a different dimension: intergenerational transmissions of health and social behaviors. For example, women who had a low birth weight infant were likely to have also been low birth weight themselves and this association was partially explained by a mother-daughter similarity in educational attainment, a mother-daughter similarity in nonmarital first birth status, and an effect of educational attainment on infant health that operated through nonmarital first birth status. In other words, these women were disadvantaged for a variety of reasons—some of which were related to mechanisms (such as intergenerational transmissions of human capital and sociobehavioral modeling) that are largely ignored in the literature on marriage advantages in infant health. Therefore, this work expands the current literature by documenting a disadvantage that spans multiple generations and multiple social dimensions (i.e., not simply a biological similarity in the risk of having a low birth weight infant).

This dissertation also demonstrated that the way in which infant health is measured matters. For the most part, findings were distinct across the three outcomes measured here: birth weight (in ounces), low birth weight, and preterm birth. For example, within the life course versus mediation framework, evidence of a salient married-single disparity emerged only with respect to birth weight while any initial disparities by marital status observed for low birth weight and preterm birth were captured by sociodemographic processes, measures of human capital, and childhood environment characteristics. With respect to differences by neighborhood environment, cohabiting (and sometimes single women) versus married women living in high-crime neighborhoods were significantly different with respect to the risk of low birth weight, but not for the other two outcomes. Lastly, intergenerational associations of infant health were somewhat similar for birth weight and low birth weight (although a higher proportion of the latter association was explained through social-environmental pathways than the former). Generally speaking, there was little evidence of a marriage advantage or intergenerational association with respect to preterm birth which may be indicative of the greater heterogeneity within this measure in that it encapsulates both spontaneous and indicated preterm births. This may also reflect that preterm birth is more strongly associated with health-related processes (i.e., hypertension or spontaneous rupture of the membranes) which are not captured by these analyses than the other two outcomes. Clearly, future research should continue to examine multiple outcomes when examining infant health disparities.

Another finding that persisted across all analyses was the salience of grandmother’s nonmarital birth status. This was both striking and unexpected. In other words, if a mother was herself born out-of-wedlock, she exhibited worse infant health outcomes than her counterparts born within a marital union. These associations persisted despite a host of factors relating to women’s childhood environment (i.e., grandmother’s education, grandmother’s employment, grandmother’s first birth, grandfather’s education, family structure in adolescence), sociodemographic characteristics (i.e., race/ethnicity, nativity), and local social conditions in the neighborhood environment. Why this disadvantage persists to the extent that it impacts infant health outcomes two generations later is an intriguing question to consider. The non-normative nature of nonmarital births among the grandmother’s generation is a likely possibility. So, this variable may be capturing a host of unmeasured characteristics that reflect underlying selection processes that affect marriage advantages in infant health. Or, perhaps this reflects the compounding disadvantage of early-life family instability on subsequent well-being. At the very least however, this highlights an intergenerational transmission of disadvantage that lies under the surface of many social processes touched upon in these analyses. Future research on infant health disparities should attempt to include this characteristic when at all possible.

Another interesting finding was that, across the board, infants born to teen mothers were not lower in birth weight or at greater risk of low birth weight and preterm birth after other characteristics were taken into consideration. Within the intergenerational context, mother's age at first pregnancy was related to daughter's birth weight but daughter's age at first pregnancy was not related to infant's birth weight (or risk of low birth weight). This latter finding is likely reflective of only births among disadvantaged daughters but, combined with the broader trend observed in the other analyses, may indicate a broader pattern emerging among more recent cohorts. This stands in contrast to much previous research documenting riskier infant health outcomes among teen mothers and has implications for extensive policies focused on reducing teen births. That is not to say that teen births may not be risky in other ways; they certainly may be. However, it is possible that the previously-documented link examined here may have been an artifact of other social processes related to women's childhood environment for example.

Lastly, generally speaking, prenatal health care, attitudes, and behaviors, did little to explain differences between married, cohabiting, and single women or intergenerational associations of infant health, and in many cases were not directly related to infant health outcomes after other factors (such as family background) were included. Although it is clear that prenatal characteristics are tangible factors that can be more easily targeted and measured in prevention/intervention strategies, the pay-off from investing in increased early prenatal care receipt or reduced heavy drinking during pregnancy may not be very high. The one exception to this trend is prenatal smoking. Enacting smoking cessation programs, particularly among single mothers, may produce dividends in terms of reducing differences between married and single women.

Taken together, this dissertation puts forth an interesting set of findings that may be useful for policymakers and practitioners to consider when designing future prevention/intervention strategies aimed at reducing infant health disparities. However, the difficulty in redirecting policy conversations towards a focus on risk factors within women's childhood environment and away from a focus on preventing teen births or increasing early prenatal care receipt is self-evident. At the very least though, these findings could further inform these conversations by expanding the focus to one that takes into account longer-term life course factors.

APPENDIX A: Weighted Correlation Matrix: Life Course and Mediating Hypotheses

	1	2	3	4	5	6	7	8	9	10	11	12
1. Low Birth Weight	1											
2. Preterm Birth	0.4779*	1										
3. Birth Weight	-0.6396*	-0.4489*	1									
4. Gestational Length	-0.5297*	-0.7462*	0.5571*	1								
5. Rel Status (Cohabiting)	0.0252	0.0001	-0.0259	-0.0046	1							
6. Rel Status (Single)	0.0784*	0.0557*	-0.1144*	-0.0206	-0.2536*	1						
7. Rel Status (Married)	-0.0830*	-0.0438*	0.1119*	0.0201	-0.6499*	-0.5704*	1					
8. M. Race (non-Hispanic Black)	0.1061*	0.0598*	-0.1310*	-0.0649*	0.016	0.2808*	-0.2342*	1				
9. M. Race (Hispanic)	-0.0007	0.001	0.0111	0.0111	0.1320*	0.0169	-0.1253*	-0.2209*	1			
10. M. Race (non-Hispanic Other)	-0.0135	-0.0188	-0.0121	0.0082	0.0101	-0.0448*	0.0267	-0.1029*	-0.1320*	1		
11. M. Race (non-Hispanic White)	-0.0690*	-0.0348	0.0902*	0.0333	-0.1269*	-0.1941*	0.2602*	-0.4822*	-0.6182*	-0.2881*	1	
12. Nativity status (foreign-born)	-0.0108	-0.0306	0.0055	0.0381*	0.0297	-0.0689*	0.0289	-0.1216*	0.5342*	0.1994*	-0.4552*	1
13. Birth before HS completion	0.0728*	0.0437*	-0.0989*	-0.0595*	0.1852*	0.1718*	-0.2923*	0.0104	0.3059*	-0.0513*	-0.2398*	0.2314*
14. M. Age (Less than 20 yrs)	0.0498*	0.0292	-0.0683*	0.0175	0.1167*	0.3142*	-0.3460*	0.0854*	0.0592*	-0.0466*	-0.0888*	-0.0528*
15. M. Age (20-34 yrs)	-0.03	0.0038	0.0075	-0.0106	-0.0198	-0.1657*	0.1470*	-0.0147	-0.005	0.0139	0.0082	0.0096
16. M. Age (35+ yrs)	-0.0141	-0.0380*	0.0661*	-0.0049	-0.1033*	-0.1216*	0.1832*	-0.0752*	-0.0593*	0.0328	0.0881*	0.0458*
17. Parity	-0.0194	-0.0235	0.0847*	0.0111	-0.0201	-0.1014*	0.0967*	-0.0114	0.0875*	0.0383*	-0.0833*	0.0635*
18. Child male	-0.018	-0.0127	0.0948*	-0.0026	0.0288	-0.0510*	0.0156	0.0319	-0.035	-0.0232	0.0175	-0.0275
19. Public ins. paid for birth	0.1062*	0.0804*	-0.1446*	-0.0725*	0.2761*	0.2709*	-0.4472*	0.1397*	0.2574*	-0.0587*	-0.2882*	0.1631*
20. Single or stepparent family	0.0759*	0.0623*	-0.0863*	-0.0517*	0.1597*	0.1372*	-0.2434*	0.1650*	-0.0717*	-0.0349	-0.0415*	-0.1408*
21. Grandmother's education	-0.0073	0.0078	0.0445*	0.0056	-0.1149*	-0.0836*	0.1631*	0.0084	-0.4268*	-0.0163	0.3599*	-0.3417*
22. Grandfather's education	-0.0495*	0.001	0.0594*	-0.002	-0.1405*	-0.0757*	0.1765*	-0.0095	-0.3847*	0.0437*	0.3070*	-0.2525*
23. Grandmother's age at first birth	-0.0688*	-0.0336	0.0447*	0.0123	-0.1261*	-0.0645*	0.1573*	-0.1020*	-0.2172*	0.0155	0.2479*	-0.1424*
24. Mother born out-of-wedlock	0.1078*	0.0396*	-0.1142*	-0.0182	0.0900*	0.2538*	-0.2755*	0.3399*	0.0729*	0.0121	-0.3104*	0.0082
25. Grandmother employed	-0.009	0.0349	0.0072	-0.021	-0.0403*	0.0772*	-0.0266	0.1511*	-0.2229*	-0.0156	0.0865*	-0.2727*
26. Pregnancy was unwanted	0.0874*	0.0960*	-0.0641*	-0.0299	0.1087*	0.3206*	-0.3443*	0.1304*	0.0779*	0.0011	-0.1592*	0.0334
27. Pregnancy was mistimed	0.032	0.0253	-0.0365*	-0.0026	0.0838*	0.2294*	-0.2514*	0.0682*	0.0466*	-0.0474*	-0.0655*	-0.0800*
28. Ever smoked during pregnancy	0.016	0.0344	-0.0855*	-0.034	0.0490*	0.0978*	-0.1184*	-0.0638*	-0.1506*	-0.0499*	0.1956*	-0.1729*
29. Never received prenatal care	0.0537*	-0.012	-0.0261	0.0065	0.0421*	0.0386*	-0.0661*	-0.0132	0.1177*	0.0193	-0.0984*	0.0925*
30. Rec'd prenatal care in 1st trimester	-0.0163	-0.0134	0.0410*	-0.013	-0.0849*	-0.1035*	0.1534*	-0.1326*	0.0102	-0.0207	0.0962*	-0.0037

Note: N = 2,930 births nested within 1,606 women. Correlations are weighted. Significant difference indicates $p < .05$.

APPENDIX A: Weighted Correlation Matrix: Life Course and Mediating Hypotheses (CONTINUED)

	13	14	15	16	17	18	19	20	21	22	23	24
1. Low Birth Weight												
2. Preterm Birth												
3. Birth Weight												
4. Gestational Length												
5. Rel Status (Cohabiting)												
6. Rel Status (Single)												
7. Rel Status (Married)												
8. M. Race (non-Hispanic Black)												
9. M. Race (Hispanic)												
10. M. Race (non-Hispanic Other)												
11. M. Race (non-Hispanic White)												
12. Nativity status (foreign-born)												
13. Birth before HS completion	1											
14. M. Age (Less than 20 yrs)	0.3283*	1										
15. M. Age (20-34 yrs)	-0.1791*	-0.7017*	1									
16. M. Age (35+ yrs)	-0.1189*	-0.1451*	-0.6031*	1								
17. Parity	0.1831*	-0.2714*	0.1420*	0.1068*	1							
18. Child male	-0.0183	-0.0278	0.0017	0.0287	-0.0480*	1						
19. Public ins. paid for birth	0.4808*	0.2879*	-0.1106*	-0.1688*	0.1368*	-0.0351	1					
20. Single or stepparent family	0.2539*	0.1939*	-0.0409*	-0.1604*	0.0817*	-0.0025	0.2215*	1				
21. Grandmother's education	-0.2586*	-0.0544*	0.0710*	-0.0377*	-0.1109*	0.0212	-0.2940*	0.0041	1			
22. Grandfather's education	-0.3852*	-0.1319*	0.1179*	-0.0197	-0.1321*	0.0425*	-0.3500*	-0.0845*	0.5921*	1		
23. Grandmother's age at first birth	-0.2189*	-0.1054*	0.0603*	0.0339	-0.1136*	-0.0052	-0.2554*	-0.1099*	0.4141*	0.3729*	1	
24. Mother born out-of-wedlock	0.2225*	0.2092*	-0.0950*	-0.1024*	0.0175	0.0019	0.2274*	0.3066*	-0.0807*	-0.0917*	-0.1876*	1
25. Grandmother employed	-0.1873*	-0.0142	0.0132	-0.0023	-0.0929*	0.0454*	-0.1337*	0.0853*	0.2235*	0.1792*	0.0977*	0.0842*
26. Pregnancy was unwanted	0.2085*	0.1062*	-0.0898*	0.0058	0.1851*	-0.0552*	0.1946*	0.1212*	-0.1094*	-0.1265*	-0.1257*	0.1726*
27. Pregnancy was mistimed	0.0827*	0.2830*	-0.1173*	-0.1539*	-0.0886*	0.0047	0.2334*	0.0893*	-0.0296	-0.0302	-0.0223	0.0814*
28. Ever smoked during pregnancy	0.2115*	0.0630*	-0.0061	-0.0620*	0.1298*	-0.0748*	0.2151*	0.2421*	0.003	-0.0900*	-0.0324	0.0052
29. Never received prenatal care	0.1411*	0.0618*	-0.0451*	-0.0065	0.02	-0.0052	0.0675*	0.0495*	-0.0865*	-0.0476*	-0.0577*	0.0636*
30. Rec'd prenatal care in 1st trimester	-0.0922*	-0.1009*	0.0486*	0.0455*	-0.0174	-0.0359	-0.1156*	-0.0553*	0.0415*	-0.0084	0.0373*	-0.0500*

Note: N = 2,930 births nested within 1,606 women. Correlations are weighted. Significant difference indicates $p < .05$.

APPENDIX A: Weighted Correlation Matrix: Life Course and Mediating Hypotheses (CONTINUED)

	25	**26**	**27**	**28**	**29**
1. Low Birth Weight					
2. Preterm Birth					
3. Birth Weight					
4. Gestational Length					
5. Rel Status (Cohabiting)					
6. Rel Status (Single)					
7. Rel Status (Married)					
8. M. Race (non-Hispanic Black)					
9. M. Race (Hispanic)					
10. M. Race (non-Hispanic Other)					
11. M. Race (non-Hispanic White)					
12. Nativity status (foreign-born)					
13. Birth before HS completion					
14. M. Age (Less than 20 yrs)					
15. M. Age (20-34 yrs)					
16. M. Age (35+ yrs)					
17. Parity					
18. Child male					
19. Public ins. paid for birth					
20. Single or stepparent family					
21. Grandmother's education					
22. Grandfather's education					
23. Grandmother's age at first birth					
24. Mother born out-of-wedlock					
25. Grandmother employed	1				
26. Pregnancy was unwanted	0.0202	1			
27. Pregnancy was mistimed	0.0083	-0.0541*	1		
28. Ever smoked during pregnancy	0.0193	0.1036*	0.0639*	1	
29. Never received prenatal care	-0.0089	0.0936*	0.0104	0.0368*	1
30. Rec'd prenatal care in 1st trimester	0.0174	-0.1554*	-0.0934*	-0.0137	0.0443*

Note: *N* = 2,930 births nested within 1,606 women. Correlations are weighted. Significant difference indicates *p* < .05.

APPENDIX B: Weighted Descriptive Statistics: Individual- and Neighborhood Level Resources

	% or Mean	Std. Deviation	Minimum	Maximum
Low Birth Weight (*1 = yes*)	0.06		0	1
Preterm Birth (*1 = yes*)	0.11		0	1
Birth Weight (*ounces*)	118.79	21.20	10	224
Relationship Status at Conception (ref = Married)				
Cohabiting	0.16		0	1
Single	0.18		0	1
Resources -- Individual-Level				
Human capital (Had 1st Birth before HS Grad; *1 = yes*)	0.26		0	1
Public Insurance Paid for Birth (*1 = yes*)	0.35		0	1
Resources -- Neighborhood-Level				
Neighborhood Structural Poverty	0.09	0.04	0.04	0.21
(Log) Violent Crime Rate (# Crimes per 100,000 people)	5.97	0.82	3.08	7.71
(Log) Serious Property Crime Rate (# Crimes per 100,000 people	8.11	0.61	3.77	9.85
(Log) Total Crime Rate (# Crimes per 100,000 people)	8.24	0.60	4.18	9.95
Controls -- Individual-Level				
Single or Step-Family Structure at Age 14 (*1 = yes*)	0.30		0	1
Grandmother's Education	2.26	1.05	1	4
Grandmother's Age at First Birth	2.60	1.07	1	5
Mother was a Nonmarital Birth (*1 = yes*)	0.13		0	1
Grandmother Employed during Mother's Childhood (*1 = yes*)	0.69		0	1
Mother's Race/Ethnicity (*ref = non-Hispanic White*)				
non-Hispanic Black	0.15		0	1
Hispanic	0.20		0	1
non-Hispanic Other	0.07		0	1
Mother's Nativity Status (*1 = foreign born*)	0.18		0	1
Mother's Age at Conception (*ref = 21-34 years old*)				
Less than 20 years old	0.11		0	1
More than 35 years old	0.14		0	1
Infant's Birth Order	2.09	1.16	1	9
Infant Sex (*1 = male*)	0.50		0	1
Gestational Length	38.65	2.52	13	48
Mover (*1 = yes*)	0.32		0	1
Controls -- Neighborhood-Level				
Racial Composition (*ref = Percent non-Hispanic White*)				
Percent non-Hispanic Black	0.12	0.13	0	0.64
Percent Hispanic	0.15	0.19	0	0.88
Percent non-Hispanic Other	0.14	0.13	0.01	0.77
Percent Foreign Born	0.12	0.11	0	0.51

Note: Statistics are based on sample of 1,709 births to mothers located within 112 counties. Means and standard deviations are weighted; means are also adjusted for clustering in the survey design.

APPENDIX C: Weighted Correlation Matrix: Individual- and Neighborhood-Level Resources

	1	2	3	4	5	6	7	8	9	10
1. Low Birth Weight (*1 = yes*)	1									
2. Preterm birth (*1 = yes*)	0.4666*	1								
3. Birth Weight (*ounces*)	-0.6581*	-0.4828*	1							
4. Cohabiting	0.0335	0.0185	-0.0691*	1						
5. Single	0.016	0.0342	-0.1054*	-0.2237*	1					
6. Human capital (Had 1st Birth before HS Grad)	0.0021	0.0600*	-0.0652*	0.2176*	0.2301*	1				
7. Neighborhood Structural Poverty	0.1259*	0.1083*	-0.0933*	0.1374*	0.1133*	0.1727*	1			
8. Single or Step-Family at Age 14 (*1 = yes*)	0.0819*	0.0069	-0.1342*	0.2097*	0.1027*	0.1643*	0.0804*	1		
9. Grandmother's Education	-0.0519	-0.0800*	0.0800*	-0.1284*	-0.0383	-0.2920*	-0.2236*	-0.0529	1	
10. Grandmother's Age at First Birth	-0.0494	-0.0032	0.0497	-0.1148*	-0.0298	-0.1840*	-0.1414*	-0.1416*	0.4289*	1
11. Mother was a Nonmarital Birth	0.1454*	0.0622*	-0.2132*	0.1323*	0.1798*	0.2191*	0.1354*	0.4185*	-0.0992*	-0.1312*
12. Grandmother's Employment	-0.0308	-0.0277	-0.0022	0.0015	0.0628*	-0.0628*	-0.0294	0.1124*	0.1303*	0.0169
13. non-Hispanic Black	0.0944*	0.0518	-0.1185*	0.0844*	0.3339*	0.0722*	0.1429*	0.2495*	-0.0271	-0.0932*
14. Hispanic	0.0557	0.0537	-0.0373	0.1197*	0.0289	0.3440*	0.3217*	-0.0605*	-0.3987*	-0.1745*
15. non-Hispanic Other	0.0147	-0.0162	-0.1106*	0.1090*	-0.0742*	0.0205	0.1146*	0.0298	0.0396	0.0008
16. Mother's Nativity Status (*1 = foreign born*)	0.0422	0.0256	-0.0586	0.0317	-0.0444	0.2173*	0.0634*	-0.1134*	-0.2567*	-0.041
Mother's Age at Conception (ref = 21-34 yrs)										
17. Less than 20 years old	0.0107	0.0347	-0.0717*	0.0704*	0.4167*	0.3352*	0.1669*	0.1327*	-0.1019*	-0.1008*
18. More than 35 years old	-0.0958*	-0.0779*	0.1500*	-0.1526*	-0.0743*	-0.1495*	-0.0879*	-0.1839*	0.0303	-0.0126
19. Infant's Birth Order	-0.0074	-0.0217	0.0168	-0.019	-0.0802*	0.0988*	0.0518	0.0047	-0.2077*	-0.2014*
20. Infant Sex (*1 = male*)	-0.0885*	-0.0948*	0.1357*	0.0407	-0.0782*	-0.0549	0.0046	0.0325	0.029	-0.0281
21. Gestational Length	-0.5678*	-0.7341*	0.6330*	-0.0893*	0.0136	-0.033	-0.1553*	-0.0508	0.1179*	0.0285
Racial Composition (ref = Percent nH White)										
22. Percent non-Hispanic Black	0.0311	0.0059	-0.0701*	-0.0009	0.2577*	-0.015	0.2108*	0.1660*	-0.0537	-0.0421
23. Percent Hispanic	0.0448	0.0932*	-0.0095	0.0513	-0.0287	0.1575*	0.5985*	-0.0907*	-0.1988*	-0.059
24. Percent non-Hispanic Other	0.0124	-0.0225	0.0366	0.1078*	-0.0563	0.1144*	0.3866*	-0.0302	-0.0164	-0.0066
25. Percent Foreign Born	0.0337	0.0458	-0.0321	0.0388	-0.0132	0.1193*	0.2518*	-0.0669*	-0.0768*	0.0458
26. Neighborhood Violent Crime	-0.0416	-0.0315	0.0493	0.0049	0.1237*	0.1067*	0.3316*	0.1139*	-0.1115*	-0.0337
27. Neighborhood Serious Property Crime	-0.0215	0.0072	0.0184	-0.0143	0.0117	0.1149*	0.2326*	0.0707*	-0.0747*	0.0235
28. Stayer (vs. Mover)	-0.0188	-0.1102*	0.0261	-0.0012	-0.0755*	-0.0969*	0.0619*	-0.0900*	-0.0276	0.0189

APPENDIX C: Weighted Correlation Matrix: Individual- and Neighborhood-Level Resources (CONTINUED)

	11	12	13	14	15	16	17	18	19	20
1. Low Birth Weight (*1 = yes*)										
2. Preterm birth (*1 = yes*)										
3. Birth Weight (*ounces*)										
4. Cohabiting										
5. Single										
6. Human capital (Had 1st Birth before HS Grad)										
7. Neighborhood Structural Poverty										
8. Single or Step-Family at Age 14 (*1 = yes*)										
9. Grandmother's Education										
10. Grandmother's Age at First Birth										
11. Mother was a Nonmarital Birth	1									
12. Grandmother's Employment	0.03	1								
13. non-Hispanic Black	0.3285*	0.0657*	1							
14. Hispanic	0.0358	-0.1385*	-0.2093*	1						
15. non-Hispanic Other	0.0763*	-0.0659*	-0.1251*	-0.1460*	1					
16. Mother's Nativity Status (*1 = foreign born*)	0.0116	-0.2189*	-0.1409*	0.4640*	0.2644*	1				
Mother's Age at Conception (ref = 21-34 yrs)										
17. Less than 20 years old	0.1719*	0.0048	0.0869*	0.0859*	-0.0339	-0.0687*	1			
18. More than 35 years old	-0.1422*	0.0463	-0.0637*	-0.1148*	-0.0206	-0.0427	-0.1518*	1		
19. Infant's Birth Order	0.0447	0.0049	0.0223	0.0676*	0.0533	0.0689*	-0.2684*	0.1652*	1	
20. Infant Sex (*1 = male*)	-0.0603*	0.0069	-0.0684*	-0.0069	-0.0156	-0.0004	-0.0268	0.0123	-0.0094	1
21. Gestational Length	-0.1033*	-0.0039	-0.0479	-0.0832*	-0.0379	-0.0258	0.0004	0.0027	0.0058	0.0483
Racial Composition (ref = Percent nH White)										
22. Percent non-Hispanic Black	0.0936*	0.1490*	0.5195*	-0.1570*	-0.0853*	-0.057	0.0742*	-0.0326	-0.0528	0.0057
23. Percent Hispanic	0.0411	-0.1160*	-0.1458*	0.6126*	-0.0206	0.2629*	0.0861*	-0.0635*	0.0494	0.0103
24. Percent non-Hispanic Other	0.0815*	0.0098	-0.1483*	0.3214*	0.3771*	0.2483*	0.0528	-0.0295	0.0404	-0.0104
25. Percent Foreign Born	0.0691*	-0.0317	-0.0836*	0.5095*	-0.0096	0.3617*	0.0146	-0.0292	-0.0365	-0.0198
26. Neighborhood Violent Crime	0.0850*	0.0331	0.1745*	0.1929*	-0.0732*	0.1094*	0.0894*	-0.1393*	0.0527	0.0098
27. Neighborhood Serious Property Crime	0.0077	-0.0155	0.0761*	0.2131*	-0.1082*	0.1070*	0.0458	-0.1659*	0.0822*	-0.0366
28. Stayer (vs. Mover)	-0.0059	0.0793*	-0.0295	0.0292	0.0924*	0.0032	-0.1157*	0.1661*	0.0745*	0.0808*

APPENDIX C: Weighted Correlation Matrix: Individual- and Neighborhood-Level Resources (CONTINUED)

	21	22	23	24	25	26	27
1. Low Birth Weight (*1 = yes*)							
2. Preterm birth (*1 = yes*)							
3. Birth Weight (*ounces*)							
4. Cohabiting							
5. Single							
6. Human capital (Had 1st Birth before HS Grad)							
7. Neighborhood Structural Poverty							
8. Single or Step-Family at Age 14 (*1 = yes*)							
9. Grandmother's Education							
10. Grandmother's Age at First Birth							
11. Mother was a Nonmarital Birth							
12. Grandmother's Employment							
13. non-Hispanic Black							
14. Hispanic							
15. non-Hispanic Other							
16. Mother's Nativity Status (*1 = foreign born*)							
Mother's Age at Conception (ref = 21-34 yrs)							
17. Less than 20 years old							
18. More than 35 years old							
19. Infant's Birth Order							
20. Infant Sex (*1 = male*)							
21. Gestational Length	1						
Racial Composition (ref = Percent nH White)							
22. Percent non-Hispanic Black	0.0096	1					
23. Percent Hispanic	-0.1055*	-0.2234*	1				
24. Percent non-Hispanic Other	-0.0186	-0.2513*	0.5388*	1			
25. Percent Foreign Born	-0.0374	-0.0827*	0.7339*	0.5854*	1		
26. Neighborhood Violent Crime	0.0744*	0.3816*	0.3164*	0.1917*	0.3491*	1	
27. Neighborhood Serious Property Crime	0.0222	0.1696*	0.2837*	0.0308	0.1560*	0.7142*	1
28. Stayer (vs. Mover)	0.0115	-0.0323	0.0509	0.1303*	0.0455	-0.1444*	-0.2188*

APPENDIX D: Weighted Descriptive Statistics, Comparing "Stayers" versus "Movers"

	Stayers	**Movers**	**Significant Differences**
Low Birth Weight (*1 = yes*)	0.06	0.08	ns
Preterm Birth (*1 = yes*)	0.09	0.16	Stayers < Movers
Birth Weight (*ounces*)	119.25	117.83	ns
Resources -- Individual-Level			
Decreased human capital (Had 1st Birth before HS Grad)	0.24	0.33	Stayers < Movers
Public Insurance Used to Pay for Birth (*1 = yes)*	0.32	0.42	Stayers < Movers
Resources -- Neighborhood-Level			
Average Neighborhood Poverty	0.09	0.09	ns
(log) Violent Crime Rate (# Crimes per 100,000 people)	5.95	6.01	ns
(log) Serious Property Crime Rate (# Crimes per 100,000 people)	8.08	8.18	ns
(log) Total Crime Rate (# Crimes per 100,000 people)	8.21	8.30	ns
Sociodemographic Controls -- Individual-Level			
Single or Step-Family Structure at Age 14 (*1 = yes*)	0.27	0.38	Stayers < Movers
Grandmother's Education	2.24	2.31	ns
Grandmother's Age at First Birth	2.63	2.55	Stayers > Movers
Mother was a Nonmarital Birth	0.12	0.15	ns
Grandmother's Employment during Mother's Childhood	0.69	0.68	ns
Mother's Race/Ethnicity (*ref = non-Hispanic White*)			
non-Hispanic Black	0.14	0.15	ns
Hispanic	0.21	0.17	ns
non-Hispanic Other	0.07	0.05	ns
Mother's Nativity Status (*1 = foreign born*)	0.19	0.15	ns
Mother's Age at Conception *(ref = 21-34 years old*)			
Less than 20 years old	0.08	0.17	Stayers < Movers
More than 35 years old	0.17	0.06	Stayers > Movers
Infant's Birth Order	2.16	1.94	Stayers > Movers
Infant Sex (*1 = male*)	0.52	0.48	ns
Gestational Length	38.71	38.53	ns
Sociodemographic Controls -- Neighborhood-Level			
Racial Composition (*ref = Percent non-Hispanic White*)			
Percent non-Hispanic Black	0.12	0.12	ns
Percent Hispanic	0.16	0.14	ns
Percent non-Hispanic Other	0.14	0.12	Stayers > Movers
Percent Foreign Born	0.12	0.11	Stayers > Movers
Subsample Size	*1179*	*530*	

Note: Statistics are based on sample of 1,709 births to mothers located within 112 counties. Means and standard deviations are weighted; means are also adjusted for clustering in the survey design. Significant differences indicate p < .05.

APPENDIX E: Weighted Descriptive Statistics by Poverty Status

	Poor	**Non-Poor**	**Significant Difference**
Pregnancy Wantedness (ref group = pregnancy was wanted)			
Mother's Pregnancy was Unwanted	0.13	0.08	*ns*
Mother's Pregnancy was Mistimed	0.46	0.39	*ns*
Mother's Partner felt Pregnancy was Unwanted	0.16	0.12	*ns*
Mother's Partner felt Pregnancy was Mistimed	0.27	0.29	*ns*
Daughter's Pregnancy was Unwanted	0.21	0.13	Poor > Non-Poor
Daughter's Pregnancy was Mistimed	0.49	0.48	*ns*
Daughter's Partner felt Pregnancy was Unwanted	0.13	0.11	*ns*
Daughter's Partner felt Pregnancy was Mistimed	0.33	0.31	*ns*
Sociodemographic Characteristics			
Mother's Childhood Environment			
Mother's Family Structure at Age 14 (*1 = single or step parent family*)	0.59	0.30	Poor > Non-Poor
Grandmother's Education	9.19	10.60	Poor < Non-Poor
Grandmother Employed at Least Part-Time	0.49	0.58	Poor < Non-Poor
Race/ethnicity (reference = non-Hispanic White/Other)			
non-Hispanic Black	0.56	0.23	Poor > Non-Poor
Hispanic	0.15	0.11	*ns*
Infant gender (*1 = male*)	0.47	0.53	*ns*

Note: *N* = 1,344 births nested within 1,344 mother-daughter pairs. Means are adjusted for weighting. Significant difference indicates *p* < .05.

APPENDIX F: Weighted Correlation Matrix – Mother’s Characteristics

	1	2	3	4	5	6	7	8	9	10	11	12
1. Birth Weight	1											
2. Gestational Length	0.3867*	1										
3. Low Birth Weight	-0.6004*	-0.3616*	1									
4. Preterm Birth	-0.3474*	-0.7204*	0.3303*	1								
5. First Birth was Nonmarital	-0.1733*	-0.0666*	0.1291*	0.0164	1							
6. Age at 1st Pregnancy	0.1155*	0.0351	-0.0616*	-0.0733*	-0.3209*	1						
7. Early Prenatal Care Receipt	0.0084	-0.0179	-0.0037	-0.0098	-0.1578*	0.0849*	1					
8. Prenatal Drinking	-0.041	0.0267	0.0054	-0.0068	0.0592*	-0.0562*	-0.1134*	1				
9. Prenatal Smoking	-0.041	0.0267	0.0054	-0.0068	0.0592*	-0.0562*	-0.1134*	.5902*	1			
10. Mistiming	-0.0214	0.0535*	-0.0082	-0.0322	0.1908*	-0.1803*	-0.0004	0.0615*	0.0615*	1		
11. Uwantedness	-0.0465	-0.0916*	0.0493	0.0485	0.2109*	-0.1140*	-0.0162	-0.0218	-0.0218	-0.2709*	1	
12. H/P Mistiming	0.0434	0.0146	-0.0341	0.0006	0.0900*	-0.1188*	0.0172	0.0261	0.0261	0.5434*	-0.0984*	1
13. H/P Unwantedness	-0.0486	-0.0263	0.0688*	0.0183	0.2709*	-0.1637*	-0.0394	-0.0299	-0.0299	0.0272	0.5093*	-0.2489*
14. Education at Pregnancy	0.0799*	0.0275	-0.0262	-0.04	-0.2275*	0.4982*	0.1557*	-0.0153	-0.0153	0.0271	-0.0848*	0.0371
15. HH Income at Pregnancy	0.0518	0.0317	-0.0549*	-0.0297	-0.1857*	0.2337*	0.0258	-0.0841*	-0.0841*	-0.0433	0.0347	-0.0515
16. Poverty Status at Pregnancy	-0.0867*	0.0026	0.0835*	-0.0336	0.3084*	-0.1518*	-0.0726*	0.0809*	0.0809*	0.0637*	0.0781*	-0.0168
17. Family Structure	-0.0712*	-0.0542*	-0.0138	0.0259	0.1768*	-0.1185*	0.0167	-0.0127	-0.0127	0.0694*	0.0772*	0.0076
18. Grandmother's Education	0.0306	-0.0135	0.0051	0.0323	-0.1386*	0.1613*	0.1362*	0.0379	0.0379	0.0640*	0.0311	0.0932*
19. Grandmother's Employment	-0.0275	-0.0545*	0.0213	0.0267	-0.0419	-0.0058	0.0163	-0.025	-0.025	0.0447	0.0615*	0.0047

Note: Mother's characteristics weighted according to NLSY79 custom weight; *$p < .05$

APPENDIX F: Weighted Correlation Matrix – Mother's Characteristics (CONTINUED)

	13	14	15	16	17	18
1. Birth Weight						
2. Gestational Length						
3. Low Birth Weight						
4. Preterm Birth						
5. First Birth was Nonmarital						
6. Age at 1st Pregnancy						
7. Early Prenatal Care Receipt						
8. Prenatal Drinking						
9. Prenatal Smoking						
10. Mistiming						
11. Uwantedness						
12. H/P Mistiming						
13. H/P Unwantedness	1					
14. Education at Pregnancy	-0.0919*	1				
15. HH Income at Pregnancy	0.0539*	0.1485*	1			
16. Poverty Status at Pregnancy	0.053	-0.2156*	-0.4860*	1		
17. Family Structure	0.0537*	-0.0886*	-0.2179*	0.2696*	1	
18. Grandmother's Education	-0.0113	0.4270*	0.1655*	-0.2223*	-0.0492	1
19. Grandmother's Employment	0.0178	0.1164*	0.0489	-0.0751*	0.0919*	0.2108*

Note: Mother's characteristics weighted according to NLSY79 custom weight; *$p < .05$

APPENDIX G: Weighted Correlation Matrix – Daughter's Characteristics

	1	2	3	4	5	6	7	8	9	10	11	12
1. Birth Weight	1											
2. Low Birth Weight	-0.6669*	1										
3. Preterm Birth	-0.4956*	0.4547*	1									
4. First Birth was Nonmarital	-0.1040*	0.0576*	-0.0094	1								
5. Age at 1st Pregnancy	0.0688*	-0.0496	-0.0173	-0.3266*	1							
6. Early Prenatal Care Receipt	0.048	-0.0328	-0.02	-0.0898*	0.2131*	1						
7. Prenatal Drinking	-0.0396	0.0183	0.0092	-0.0179	-0.0188	-0.0235	1					
8. Prenatal Smoking	-0.0152	-0.0188	0.0851*	0.0229	-0.0319	-0.0650*	-0.0068	1				
9. Mistiming	-0.038	0.039	0.0301	0.1996*	-0.1939*	-0.0457	-0.0066	0.0281	1			
10. Uwantedness	-0.0274	-0.0077	-0.006	0.1209*	-0.1787*	-0.0656*	0.01	0.0185	-0.4150*	1		
11. H/P Mistiming	-0.0213	0.001	0.0438	0.1204*	-0.1497*	-0.0686*	0.0078	0.0504	0.5182*	-0.1791*	1	
12. H/P Unwantedness	-0.0322	-0.0141	-0.0055	0.0940*	-0.1505*	-0.0586*	0.029	0.0266	-0.1946*	0.5977*	-0.2534*	1
13. non-Hispanic Black	-0.1348*	0.0771*	-0.0288	0.2170*	-0.1362*	-0.1033*	-0.0139	-0.0411	0.0312	0.1367*	-0.0209	-0.001
14. Hispanic	0.0287	0.0126	-0.0327	-0.0064	-0.0217	0.0136	-0.0122	0.026	0.012	-0.0639*	-0.0373	-0.0319
15. White	0.1091*	-0.0815*	0.0489	-0.2019*	0.1436*	0.0892*	0.0213	0.0219	-0.0375	-0.0878*	0.0444	0.0219
16. Education at Pregnancy	0.0689*	-0.0393	0.0201	-0.2874*	0.6201*	0.1755*	-0.0648*	-0.0436	-0.1085*	-0.1372*	-0.0509	-0.1338*
17. Parity	-0.0223	-0.0263	-0.0469	0.1360*	-0.1974*	-0.0651*	0.0257	0.0194	-0.0107	0.0779*	-0.0234	0.0696*
18. Infant Gender	0.1319*	-0.0543*	0.0034	0.0203	-0.0012	0.0316	0.0067	-0.0275	-0.0068	-0.0024	-0.0013	-0.0491

Note: Daughter's characteristics weighted according to CNLSY79 custom weight; *$p < .05$

APPENDIX G: Weighted Correlation Matrix – Daughter's Characteristics (CONTINUED)

	13	14	15	16	17
1. Birth Weight					
2. Low Birth Weight					
3. Preterm Birth					
4. First Birth was Nonmarital					
5. Age at 1st Pregnancy					
6. Early Prenatal Care Receipt					
7. Prenatal Drinking					
8. Prenatal Smoking					
9. Mistiming					
10. Uwantedness					
11. H/P Mistiming					
12. H/P Unwantedness					
13. non-Hispanic Black	1				
14. Hispanic	-0.2685*	1			
15. White	-0.7728*	-0.4039*	1		
16. Education at Pregnancy	-0.031	-0.0483	0.0613*	1	
17. Parity	0.0622*	-0.005	-0.0558*	-0.2438*	1
18. Infant Gender	-0.0033	-0.0075	0.008	-0.0035	-0.006

Note: Daughter's characteristics weighted according to CNLSY79 custom weight; **p* < .05

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EDUCATION

Ph.D., Sociology and Demography, Pennsylvania State University, August 2011
Dissertation: How the Marriage Advantage in Infant Health Outcomes Intersects with Sociohistorical, Prenatal Health, and Neighborhood Factors

M.A., Sociology and Demography, Pennsylvania State University, 2008
Master's Thesis: A Closer Look at the Second Demographic Transition in the US: Evidence of Bidirectionality from a Cohort Perspective (1982-2006)

B.A., Sociology (Minors: Biology, Chemistry), Messiah College, 2001

SELECTED RESEARCH EXPERIENCE

2006 – 2011	Graduate Research Assistant to Drs. Paul Amato and Alan Booth, Pennsylvania State University. *Project*: Precursors to Early Family Formation
2005 – 2008	Research Consultant, Harvard University and University of Pennsylvania. *Projects*: (1) In-Kind Child Support from Non-Resident Fathers; (2) Survey Development: Measuring Changes in Learning of After School Program Staff
2005	Qualitative Fieldworker (for course credit), University of Pennsylvania. *Project*: Comparing Family Planning Service Delivery across Four Urban Health Resource Centers
2004 – 2006	Senior Research Coordinator, University of Pennsylvania. *Project*: Survey Development: Measuring Changes in Learning of After School Program Staff

JOURNAL ARTICLES AND BOOK CHAPTERS

Kane, Jennifer B. & Chun Bun Lam. 2011. "A Promising Approach to Future Biosocial Research on the Family: Considering The Role of Temporal Context." Pp. 247-264 in A. Booth, S.M. McHale, and N.S. Landale (Eds.) *Biosocial Foundations of Family Processes*.

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