FINAL COMPREHENSIVE REPORT

R40 MC 07837A0
Birth Outcomes and Early Health Trajectories

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A. Executive Summary

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Statement of the Problem

Health disparities are known to emerge as early as infancy. Infants born to socially disadvantaged parents are at increased risk for adverse birth outcomes that affect not only an infant’s chance of survival, but future health prospects. In fact, the effect of adverse birth outcomes is known to persist well into adulthood. Thus, not only might early disparities contribute to adult health disparities, but, the double jeopardy of being born premature or small for gestational age and being born into adverse socio-economic conditions may lead to further health detriments. This study examined whether various dimensions of socio-economic status can alter the well-established trajectories linking adverse birth outcomes to adverse child health. Using two nationally representative, longitudinal data sets with rich survey data and birth certificate data, we investigated the interactions between distinct birth outcomes and socio-economic conditions in childhood (ages 1-6) and how they produce disparities in child health. We also focused on how these interactions helped to explain racial/ethnic disparities in child health.

Research Objectives

In particular, we sought to answer the following general questions: 1) Do adverse birth outcomes overwhelm socio-economic predictors of child health and development or can an advantaged socio-economic status buffer some of the subsequent health effects of adverse birth outcomes? and 2) How much does the interaction between disadvantaged socio-economic status and adverse birth outcomes contribute to observed childhood health disparities?

Study Design and Methods

Our study relied on secondary data analyses of two longitudinal data sets that all contain data regarding birth outcomes from actual birth certificate data, social conditions of the family and household at various time-points, and assorted measures of child health and development. The basic study design was to interact variables that are measured at different points in time to predict childhood health and development.

All of our analyses were conducted with data sets that are publicly available and currently being collected by various NIH agencies. Thus, all of our proposed hypotheses were tested via secondary data analysis. We used two longitudinal data sets to achieve our primary aims; each of these data sets carries with it a specific set of health measures not always available in the other. The two longitudinal data sets include: the Early Childhood Longitudinal Study—
Kindergarten Cohort (ECLS-K) and the National Health and Nutrition Examination Survey III—Youth Data and Natality Supplement (NHANES III-NS).

Various types of regression models were specified that would allow us to test each of our specific aims, and results of the subsequent manuscripts are currently under various stages in the writing and review process.

Findings

Our findings are as follows, using our specific aims as a guide for presentation:

Aim 1. Assessing the extent of a biosocial interaction between birth outcomes and socio-economic conditions in early childhood:

- Birth outcomes remain the primary determinant of early childhood health. Although several birth outcomes have more precise etiological relationships with particular child health measures, simple measures of birthweight and gestation length remain the strongest empirical predictors of future health.
- Socio-economic status remains a strong determinant of childhood health, net of birth outcomes. Resources and knowledge accrued with educational attainment of mothers remain a significant predictor of childhood health as does familial income and the material resources afforded families who are more socio-economically advantaged.
- Birth outcomes and socio-economic status are independently related to childhood health. Disadvantages accrued to infants with compromised birth outcomes are generally not modifiable in a more advantaged socio-economic context. Further, disadvantaged socio-economic context does not exacerbate prior poor birth outcomes.

Aim 2. Assessing the importance of biosocial interactions as determinants of disparities in childhood:

- This aim is still under exploration, although it is clear that early birth disadvantages are modifiable for Black infants such that height advantages are observed for Black children, net of their socio-economic status and birth advantages. In short, early disadvantages can be overcome in resilient Black families, although the majority of Black children remain in disadvantaged environments which lead to continued disparities in the early life-course and beyond.
- A major advantage for Mexican-American infants is being born to a foreign-born mother. These advantages are maintained over time and also accrue for early childhood health. However, an additional advantage is conferred above-and-beyond birth advantages among foreign-born mothers that is largely the result of maintaining Spanish-language speaking. In short, as families acculturate, selective health advantages tend to deteriorate.

Recommendations

A continued focus on improving the birth-weight outcomes of all infants, regardless of race/ethnicity, is warranted. Our initial hypotheses suggested that special care may be needed
for birth compromised infants in poor and/or minority households, but our findings suggest otherwise. Birth-weight remains the single most important predictor of subsequent childhood health and race and socio-economic status are independently related to child health but do not modify the birth outcome/child health relationship. In short, current efforts towards improving birth outcomes, particularly birth-weight, should be accelerated towards the end of improving infant health and later childhood health.

**List of Products**

Please note: two of our papers have been published, while a third remains under review. The remaining three papers are being prepared for submission to various journals and our goal is to have them all submitted by June 2011.


B. Comprehensive Report

1. Introduction

a. Nature of the Research Problem

Social conditions are known to be a fundamental cause of population health and a key determinant of health disparities (Link and Phelan 1995). In fact, socioeconomic status (SES) is a key determinant of morbidity and mortality for virtually all ages of the life-course. Recent research has documented that these gradients and subsequent disparities emerge as early as infancy and childhood (Case, Lubotsky, and Paxson 2001; Finch 2000a; Finch 2000b) and persist throughout the life course (Elo and Preston 1992). Given the universality and persistence of health disparities, the study of infant and child health is crucial for several reasons: (1) pre-kindergarten age children rely almost exclusively on their external environment for their health and are generally (if not entirely) unable to modify their own health; (2) the origins of health disparities and social gradients emerge as early as infancy; and (3) poor childhood health increases the likelihood of illness and premature death in adulthood. Further, since the direction of causation between health and social conditions among adults is often in dispute (Smith 1999), the study of child health is especially conducive to capturing the extent to which social conditions are causally related to health because the socio-economic status into which infants are born were determined prior to their birth.

Therefore, we proposed to assess the extent to which adverse birth outcomes can be overcome by various socio-economic conditions in early life. Given that children with adverse birth outcomes (e.g., pre-maturity or fetal growth restriction) are at much higher risk for poor health in childhood, we propose to study the processes by which socio-economic conditions in early childhood may affect the well-established relationships between adverse birth outcomes and health disparities in very young children (ages 1-6). Thus, the core of our project was to identify key biosocial interactions between etiologically specific birth outcomes and early life socio-economic conditions and how they contribute to both the health of children and to early-life health disparities.

b. Purpose, Scope, and Methods of the Investigation

Knowledge of the extent to which early child health outcomes are dependent on birth outcomes and social conditions during childhood would enhance our understanding of health disparities among vulnerable populations. Although we are discovering increasingly more about the ways in which birth outcomes lead to health disparities, very little is known about whether these relationships overwhelm traditional relationships between SES and health and/or whether relationships between birth outcomes and later health are modified by SES. Additionally, understanding the salutary socio-economic conditions in early childhood that can potentially stave off the deleterious effects of adverse birth outcomes may provide an empirical foundation for early life interventions that reduce the financial toll of adverse birth outcomes.
on society. Most importantly, identifying key distal (i.e., upstream) and mediating (i.e., downstream) relationships between socio-economic conditions and health may help reduce the incidence of adverse birth outcomes and the toll that these outcomes have on infants and their families. Finally, modeling health trajectories for children of various racial and ethnic groups will help to improve our understanding of adult health disparities by observing the ways in which family characteristics lead to disparate birth outcomes and the ways in which these birth outcomes are translated into early child health via the influence of SES in both the family and community.

We employed secondary data analysis on two rich data sets to accomplish our project aims, including (1) the National Health and Nutrition Examination Survey III, Youth Data and Natality Supplement (NHANES III-NS), and (2) the Early Childhood Longitudinal Study-Kindergarten Cohort 1988-99 (ECLS-K). The ECLS-K data set contains a nationally representative sample of Kindergartners in 1988/89 while the NHANES III-NS retroactively collected birth certificate data for a large subset of children (aged 2 months and older) interviewed and examined for NHANES III—also a nationally representative sample of children. The size and specific strengths of each of these data sets allowed us to address our project aims with a wide range of objective health and developmental outcomes, while simultaneously specifying more detailed and etiologically specific birth outcomes than previous studies, through the use of birth certificate data rather than maternal reports.

For analysis of the two data sets, we employed conventional regression techniques in order to test the key interactions determining child health. Regression models were specific to each paper that we wrote and are as follows: a) linear regression analysis, b) multinomial logit regression, and c) linear growth curve modeling for panel data.

c. Nature of the Findings

Our infant mortality analyses suggest a rule of thumb for predicting infant mortality: when available, Apgar scores should always be included along with birth weight (or LBW status) and gestational age. Additionally, these findings argue for the continued study of low birthweight, gestational age, and Apgar scores as independently salient health outcomes.

Our analysis of childhood height suggests significant socio-economic gradients for both maternal education and family income, net of controls for confounders, including: birth weight, gestational age, family size, and parental heights. These results are in stark contrast to those from other developed countries that seem to indicate diminished or eliminated socio-economic disparities, net of known confounders. In the United States, it appears that socio-economic gradients have an effect on birth outcomes, and continue to have an additional direct and independent effect on height, even in early childhood.

Our Mexican-American specific analysis suggests that not only is childhood health linked directly to prenatal health, but a portion of the health advantages transferred from mother to child among the Mexican-born are at least partially due to birth-weight differences. Finally, health advantages observed among children of Mexican-born mothers are largely due to
language differences as Spanish-speaking bestows advantages to children of both Mexican- and US-born mothers.

2. Review of the Literature

Numerous studies have established that birthweight is significantly associated with developmental outcomes, net of important social and economic controls. Increased risk for cognitive, educational, and behavioral impairments in school-aged children are found to be moderate for low birthweight children and significantly more pronounced for very low birthweight and preterm children (Agarwal & Lim 2003; Anderson & Doyle 2003; Boardman, Powers, et al. 2002; Schraeder & Hevery, et al. 1997; Hall & McLeod, et al. 1995; Lagerstrom 1991; Elgen & Sommerfelt 2002; Pharoah, Stevenson, et al.1994). Evidence on whether these deficits substantially decrease over time is mixed. Long-term follow up studies of very low birthweight infants have detected continuing and significant cognitive and educational underperformance, as well as height differences and visual and hearing impairments (Saigal 2000; Ericson & Kallen 1998). In contrast, other studies conclude that cognitive developmental impairments diminish with age and disappear as early as six years after birth (Ment & Vohr 2003; Miceli & Goeke-Morey, et al.2000; Piecuch & Leonard, et al. 1997; Lee & Barratt 1993).

In addition, prenatal social conditions have profound effects on birth outcomes while early childhood social conditions have profound effects on child health and development (Aber et al. 1996). Thus, while adverse birth outcomes often set a child on a trajectory towards poor health in later life, less is known as to whether these effects are independent of the social conditions into which a child is born or whether these social conditions modify the effects of birth outcomes on later health. In short, many of the observed relationships between childhood poverty and and poor health may actually reflect an unobserved (or uncontrolled for) relationship between adverse birth outcomes and later health, that are concentrated among the socio-economically disadvantaged. Evidence for a modifiable health trajectory is mixed at best. Some studies find that “biology is destiny” in the sense that the trajectory from adverse birth outcomes to poor child health is not malleable while other studies find that the often powerful effects of social conditions on child health have the ability to stave off potential deleterious effects of adverse birth outcomes. However, while many studies have parceled out the distinct sources of LBWT and looked at both the long-term effects on child health and development, very few have looked at whether or not these unique etiological effects (pre-maturity and fetal growth restriction as distinct phenomenon) are modifiable by the social conditions into which a child is born. This was the key focus of our proposal and of our analysis.

3. Study Design and Methods

a. Study Design

We employed secondary data analysis on two rich data sets to accomplish our project aims, including (1) the National Health and Nutrition Examination Survey III, Youth Data and Natality Supplement (NHANES III-NS), and (2) the Early Childhood Longitudinal Study-Kindergarten
Cohort 1988-99 (ECLS-K). The size and specific strengths of each of these data sets allowed us to address our project aims with a wide range of objective health and developmental outcomes, while simultaneously specifying more detailed and etiologically specific birth outcomes than previous studies, through the use of birth certificate data rather than maternal reports. For analysis of the two data sets, we employed conventional regression techniques in order to test the key interactions determining child health.

b. Population Studied

The ECLS-K data set contains a nationally representative sample of Kindergartners in 1988/89 while the NHANES III-NS retroactively collected birth certificate data for a large subset of children (aged 2 months and older) interviewed and examined for NHANES III—also a nationally representative sample of children.

c. Sample Selection

Given that the data were already collected, we did not engage in a formal sample selection. However, our data sets were nationally representative samples of a) children in the United States (NHANES III-NS) and b) children who were kindergartners in the United States in 1988/89 (ECLS-K).

d. Statistical Techniques Employed

The statistical techniques we employed to the secondary analysis of our data sets were wide and varied, depending upon the type of data and the structure of the dependent variable. We discuss each analysis in more detail, as they relate to each publication:

Ma and Finch 2010: We employed multivariate logistic regression (logit) models, for stratified gender- and race- specific populations, to assess the associations between each of the 14 key measures with the four outcomes (infant mortality, early neonatal, late neonatal, and postneonatal mortality), after accounting for the same set of covariates, including: parental characteristics (maternal age, maternal education, marital status, if mother was born in U.S., if father was unreported on birth certificates), maternal behaviors (adequacy of prenatal care, tobacco/alcohol use during pregnancy12), and child characteristics (parity). Deaths during other periods are excluded for each regression of postnatal period (i.e., analysis of early neonatal compares those who lived vs. neonatal deaths, but those who died during other time periods are excluded from the given analysis).

Finch and Beck 2011 & Finch under review: We specified a series of OLS regression models to test our key hypotheses.

Unpublished Manuscripts. As the data from ECLS-K were panel data, we created a person-wave file that contained multiple observations of each child over time. Due to this unique data
structure, we employed growth curve models (Singer and Willett 1999) to assess not only the effect of socio-economic status and birth outcomes (and their interaction) on various measures of child health and development, but also to assess the effect of these variables over time and whether or not they change in magnitude.

4. Presentation of the Findings

Birth outcomes remain the primary determinant of early childhood health. Although several birth outcomes have more precise etiological relationships with particular child health measures, simple measures of birthweight and gestation length remain the strongest empirical predictors of future health. Socio-economic status remains a strong determinant of childhood health, net of birth outcomes. Resources and knowledge accrued with educational attainment of mothers remain a significant predictor of childhood health as does familial income and the material resources afforded families who are more socio-economically advantaged. Birth outcomes and socio-economic status are independently related to childhood health. Disadvantages accrued to infants with compromised birth outcomes are generally not modifiable in a more advantaged socio-economic context. Further, disadvantaged socio-economic context does not exacerbate prior poor birth outcomes.

Early birth disadvantages are modifiable for Black infants such that height advantages are observed for Black children, net of their socio-economic status and birth outcomes. In short, early disadvantages can be overcome in resilient Black families, although the majority of Black children remain in disadvantaged environments which lead to continued disparities in the early life-course and beyond. On the other hand, a major advantage for Mexican-American infants is being born to a foreign-born mother. These advantages are maintained over time and also accrue for early childhood health. However, an additional advantage is conferred above-and-beyond birth advantages among foreign-born mothers that is largely the result of maintaining Spanish-language speaking. In short, as families acculturate, selective health advantages tend to deteriorate.

5. Discussion of the Findings

a. Conclusions to be Drawn from Findings

Our findings echo the view of prior scholars who talk about the primacy of birth-weight as the crucial outcome in infant health and child development. Birth-weight not only predicts infant mortality to a large degree (better than all measures but apgar scores for early mortality), but also overwhelmingly explains variation in key child health outcomes. This biological inheritance does not appear modifiable by social conditions. In other words, although socio-economic conditions independently affect child health, they cannot overcome poor birth-weight in determining later child health. Our findings once again buttress research which argues that continued emphasis should be placed on ensuring healthy birth outcomes and helping mothers to bear infants at healthy birth-weights.
b. Explanation of Limitations or Possible Distortion of Findings
One of the primary potential critiques of our findings is the notion that birth-weight is not causally related to our health outcomes, but is simply correlated with them. Wilcox has long argued that birth-weight is simply a very good proxy for other etiological processes and that attempts to solely modify birth-weight may be misguided and will not result in the improvement of infant health or the elimination of health disparities. Within the context of our analytical plan, there is no way to ensure that our results are causally linked. Thus, future studies should address causation and linkages between birth-weight and health and future interventions should assess the efficacy of attempts to modify birth-weight.

c. Comparison with Findings from Other Studies
Our findings represent a relatively unique application of data and theory and very few studies, save the handful mentioned above, have addressed these same bio-social interactions. However, if one blanket statement could be made from this research, it would be that “biology is, in fact, destiny” and efforts focused on improving birth outcomes should be continued as they will have both short term and long term implications.

d. Possible Application of Findings to Actual MCH Health Care/Delivery Situations
Given the linkage between prenatal conditions with birth-weight and the subsequent effect of birth-weight over the early life course, it is clear that prenatal care efforts need to remain at the forefront of MCH health care delivery. Although the linkages between current prenatal care efforts and improved birth outcomes are tenuous, new policies that encourage healthy living and improved birth outcomes should be developed and assessed.

e. Policy Implications
Our results support current efforts in encouraging prenatal care, encouraging healthy behaviors among women of child-bearing age, and supporting infants born with compromised birth outcomes. Some studies suggest a weakening of birth outcome effects over time which would imply that early-life interventions may still be needed to overcome early life disadvantage that is still disproportionately borne by those from racial/ethnic minority groups and socio-economically disadvantaged living circumstances.

f. Suggestions for Further Research
Future research should address causal linkages between birth-weight and health and should also address the potential modifiability of compromised birth outcomes and their strong linkages with later health and development. Also, future research should assess the efficacy of current and novel prenatal care interventions. The focus on fetal and infant health remains appropriate, although it should be extended.

6. List of Products


References


