Social Disparities and Breastfeeding in the United States

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CHAPTER ONE: INTRODUCTION

Background

Breastfeeding is considered the best source of nutrition for infants, and support of breastfeeding is a goal of US and international health organizations, including the American Academy of Pediatrics, the American Dietetic Association, and the World Health Organization. Notably, breastfeeding is considered a superior form of nutrition in the US and other more developed countries, where the alternatives to breastmilk are more readily available and of better quality than in less developed contexts.

Health organizations have established breastfeeding guidelines that mothers are encouraged to follow in order to provide their infants with the best possible nutrition. The American Academy of Pediatrics (AAP) recommends that children are exposed to at least a year of breast milk, including 6 months of exclusive breastfeeding in which the child is given no liquids or solids other than breastmilk (with the exception of medicines and vitamins) followed by another 6 months of breastfeeding supplemented with iron enriched solid foods (AAP 1997; Gartner et al. 2005). The World Health Organization recommends an even longer duration of breastfeeding, with 6 months of exclusive breastfeeding, followed by supplemented feeding until the child is at least *two years* old (http://www.who.int/nutrition/topics/infantfeeding_recommendation/en/index.html).

The benefits of breastfeeding are considered extensive enough that the US Department of Health and Human Services has incorporated breastfeeding objectives as

part of its Healthy People goals, a health promotion and disease prevention initiative, which is aimed at increasing the length and quality of life, as well as reducing health disparities among the US population (http://www.healthypeople.gov/default.htm).

Benefits of Breastfeeding

Why is breastfeeding so widely supported among health organizations? Research findings indicate that breastfeeding is associated with superior general health and improved growth and development for children. Reported advantages of breastfeeding include a decrease in the incidence and severity of infectious diseases, lower infant mortality, and lower incidence of sudden infant death syndrome among infants (Gartner et al. 2005). For older children and adults who were breastfed as infants, breastfeeding is associated with reductions in diabetes, lymphoma, leukemia, Hodgkin disease, obesity, and asthma (Gartner et al. 2005). This improved health translates into cost savings in health expenditures at the individual and population levels (Montgomery and Splett 1997; Ball and Wright 1999; Weimer 2001). Breastfeeding has been linked to health benefits for mothers, including post-pregnancy weight loss and reduced risk of breast and ovarian cancer (Gartner et al. 2005). Some research also indicates that breastfeeding is related to improved cognitive development and higher IQ scores among children (Anderson et al. 1999; Drane and Logemann 2000); however, results of this research are inconclusive, and recent research tends to question this conclusion (Rey 2003; Ip et al. 2007).

Breastfeeding in Historical Perspective

Although current medical guidelines strongly recommend breastfeeding, historically breastfeeding has moved in and out of fashion, with child rearing experts

alternatively claiming that breastfeeding was best, inferior, or had no impact on a child's health. Not surprisingly, breastfeeding initiation levels in the United States have varied quite substantially over the last century. Figure 1.1 shows historical trends in breastfeeding in the US, beginning in the 1930s. In the early to mid 1930s breastfeeding rates were quite high, with nearly 75% of mothers initiating breastfeeding (Hirschman and Butler 1981). This rate fell dramatically over the first half of the twentieth century, and by 1970 only about one-quarter of mothers initiated breastfeeding (Hirschman and Butler 1981; Ryan et al. 1991). Breastfeeding initiation levels began to rise in the early to mid 1970s, to about 60% in 1982 (Ryan et al. 1991). Rates rose again in the early 1990s, and as of 2003 about 66% of newborns received at least some breast-milk (Ryan et al. 2006).

The most recent reports suggest that breastfeeding is currently at historic highs. With the Centers for Disease Control and Prevention (CDC) reporting that 74% of mothers breastfed their children in the early postpartum period in 2005, breastfeeding initiation nearly meets and in some states exceeds the US government's Healthy People 2010 goals. Nonetheless, most mothers breastfeed for short intervals and breastfeeding duration still lags behind goals. Estimates from the CDC report that in 2005 some 43% of women breastfeed for 6 months, with only 21% breastfeeding for at least a full year (http://www.cdc.gov/breastfeeding/data/NIS_data/index.htm). Exclusive breastfeeding rates were even lower, with only 32% of mothers breastfeeding exclusively for 3 months and 12% of mothers breastfeeding exclusively for 6 months, falling short of the Healthy People 2010 goals of 40% and 17%, respectively. Moreover, significant disparities exist between demographic groups, with most disadvantaged groups (e.g., younger, less

educated, poor, African American) having lower breastfeeding rates than more advantaged groups, with the exception of Hispanic mothers, who tend to have low income and education but high breastfeeding rates (http://www.cdc.gov/breastfeeding/data/NIS_data/index.htm).

Why is breastfeeding important to study?

A life course perspective points to the potential importance of breastfeeding because of the significance of early childhood environments for later outcomes. Early childhood is widely believed to be a critical or sensitive period as advantages tend to accumulate and compound over the life course. Indeed, early childhood circumstances matter for later outcomes, and both early SES (Duncan et al. 1998; Wagmiller et al. 2006) and early health environments (Case et al. 2005; Black et al. 2007) have been linked to later health, academic, and labor market outcomes. Consequently, to the extent that breastfeeding provides benefits to children, breastfeeding is potential source of early childhood inequality. Combined with social group differences in breastfeeding, breastfeeding may be an additional source of disadvantage that children coming from already disadvantaged social groups are more likely to face.

However these same factors make breastfeeding difficult to study. Adverse exposures often clustered (Ben-Shlomo and Kuh 2002), and not breastfeeding is related to other forms of resource disadvantage, such as low income, low education, and poor parenting behaviors, as well as other forms of health disadvantage, such as low birth weight, smoking, and lack of adequate prenatal care. Furthermore, it is difficult and unethical to randomize children to breastfed and not breastfed, so research on breastfeeding is almost exclusively observational. Consequently, it is not easy to

disentangle any unique contribution of breastfeeding to positive child outcomes. Therefore, while breastfeeding may be a source of inequality in child nutrition, it may also be a reflection of other inequalities that children face. Indeed some question the scientific validity of research touting the benefits of breastfeeding given the small size of the associations and the impossibility of controlling for all plausible confounding variables, such as parental behavior (Wolf 2007). This points to the importance of studying social correlates of breastfeeding, and the extent to which these social correlates can account for beneficial outcomes related to breastfeeding.

However, it is imperative to be critical of seemingly objective medical recommendations—particularly those that reinforce social inequalities, such as the gendered division of housework and parenting. "Essential differences" between men and women are used to legitimate the gendered allocation of household tasks (West and Fenstermaker 1993). The ability of only biological mothers to provide breastmilk, combined with the medical recommendations that breastmilk is best for the baby, mean that breastfeeding becomes linked to conceptions of "good mothering" (Blum 1999) and thus serve to reinforce gender differences both inside and outside the household. Therefore, a critical examination of who breastfeeds and how much breastfeeding matters for child outcomes is essential for better understanding this highly political and controversial topic.

Why do mothers breastfeed?

Before considering factors that are related to breastfeeding, it is useful to consider why mothers might breastfeed in the first place. This dissertation takes a "rational/utilitarian" approach to understanding human behavior such as breastfeeding

(Collins 1994). A rational/utilitarian perspective sees society as comprised of the actions of individuals. In the case of breastfeeding, the individual actor of interest is the mother, who makes the decision about whether or not she will breastfeed (and for how long). Nonetheless, this does not mean that the mother is seen as simply a utility maximizing rational actor behaving exclusively in her own self interest. Instead, mothers are seen as individuals "boxed in by the constraints of social structures" (Collins 1984, p. 163), and thus acting within these constraints. This perspective also fits into the "social behaviorist" paradigm, in which individuals are seen to act within their environment in ways that are reinforced by their social environment (Ritzer 2001, p. 71). In other words, individuals tend to act in ways that are acknowledged with social approval (Collins 1994, p. 135). From the rational/utilitarian and social behaviorist perspectives, the health behaviors of individuals (such as breastfeeding), are highly influenced by the relationship between *individual agency* and *social structure* (Cockerham 2003).

Breastfeeding is a unique process because it requires action from one particular person—the child's mother. Therefore, it is individual mothers who must make the *choice* or decision about whether or not to breastfeed. However, because breastfeeding is, or at least can be, a long term behavior, in reality the choice to breastfeed must be made repeatedly until mother decides not to continue breastfeeding. Consequently, the desire and ability of an *individual* mother to breastfeed and to continue breastfeeding is largely shaped by the *social* circumstances and constraints she faces.

The decision to breastfeed is composed of two parts. First, a mother must have a desire to breastfeed. Second, a mother must have the ability to breastfeed. A mother's desire to breastfeed may be shaped by her ability to breastfeed, so these parts are not

necessarily independent. Moreover, both are highly shaped by a mother's social environment. A conceptual diagram of a mother's decision to breastfeed is presented in Figure 1.2.

A mother's desire to breastfeed is in part shaped by her knowledge and beliefs regarding breastfeeding. One factor that might contribute to a mother's desire to breastfeed is a belief in the benefits of breastfeeding. A human capital/investment perspective suggests that a mother will breastfeed her child if she feels that such an investment will be beneficial for her child's well-being (Becker 1981). If a mother believes that breastfeeding has such benefits, then that mother may be more likely to decide to breastfeed than a mother who does not think breastfeeding is beneficial for her child. However, a mother's beliefs regarding breastfeeding need not be child focused. A mother might believe breastfeeding is beneficial for her own health, or she might believe that the act of breastfeeding—for example the mother/child contact—is beneficial for her relationship with a child. These or other beliefs regarding the benefits of breastfeeding might also contribute to a mother's desire to breastfeed or not.

While a mother's desire to breastfeed may be related to the perceived benefits of breastfeeding, a mother's desire to breastfeed does not necessarily come from an active cost/benefit analysis. For example, for some mothers a desire to breastfeed or not breastfeed may stem from beliefs regarding the role of a mother or woman, irrespective of direct benefits or costs. Individuals' ideas about appropriate mothering are shaped by their social background, including class, race, ethnicity, religion, political beliefs, workplace, place of residence, etc. (Hays et al. 1996), and these factors likely contribute

to a mother's desire to breastfeed. For example, some mothers may have the desire to breastfeed because they see it as an essential task of a "good mother" (Blum 1999).

If a mother wants to breastfeed, she will not be able to do so without the ability to implement this desire. A mother's ability to breastfeed is affected by the support, costs and constraints she faces. Mothers may be constrained by physical problems with breastfeeding or child characteristics (e.g., birth weight, age, personality) that make breastfeeding and continuing to breastfeed more difficult. The direct monetary costs of breastfeeding are thought to be low, particularly compared to infant formula. Consequently, the low cost of breastfeeding is often considered a factor that should encourage mothers to breastfeed. Indeed for some women it may be that the low monetary cost of breastfeeding contributes to the mother's desire to breastfeed in the first place. However, there are opportunity costs to breastfeeding, and the cost of breastfeeding increases substantially when you factor in the value of a mother's time. If mothers have to give up other activities in order to have the time and availability to breastfeed, then these factors should also be considered a cost of breastfeeding, and mothers deciding whether or not to breastfeed must weigh the perceived value and importance of breastfeeding against these costs. For example, the importance of work for survival combined with employers' abilities to set the conditions under which work and family are combined means that the structure of work often determines the structure of other activities in working mothers' lives (Jacobs and Gerson 2004). Because breastfeeding is a time intensive activity, some working mothers simply do not have the scheduling flexibility or consistency to breastfeed their child.

A mother's ability to breastfeed is not simply affected by monetary or opportunity costs. Mothers also face social constraints to breastfeeding. These social constraints may be physical. For example, married or cohabiting mothers may have an easier time breastfeeding because their partner can help support them financially and with other tasks inside and outside the home. However, social constraints are not simply related to the presence or absence of social figures in mothers' lives. Mothers are also constrained by differences in social values and expectations, which make it easier or harder for a mother to breastfeed.

Indeed, both a mother's *desire* and *ability* to breastfeed are likely influenced by social expectations and values. Mothers who choose to breastfeed or not to breastfeed must do so within the structure of the values and expectations of the social groups of which they are a part. These expectations help to shape a mother's core beliefs regarding the benefits (and costs) of breastfeeding and in turn her desire and ability to breastfeed. Mothers are connected to multiple social groups (e.g., family, classmates, workmates, etc.), and different groups may have more or less influence on an individual mother's breastfeeding decisions (desires and abilities). The act of mothering or fathering is by definition a "family" role, so for many parents, the expectations of family members likely play a large role in determining appropriate parenting, and mothering, behaviors. For example, a mother from a family that strongly believes in the importance of breastfeeding may have a difficult time not breastfeeding; while another mother from a family that feels breastfeeding is not important may have a harder time breastfeeding and continuing to breastfeed even if as an individual she would prefer to breastfeed her child. In addition to family, mothers confront other sources of social values and expectations. For example, a

mother that is part of a parenting group may feel pressure to conform to the group's expectations regarding how a mother should behave (of course she is more likely to join a parenting group with similar values). To make things more complicated, mothers may face conflicting expectations both between and within the various social groups in their lives. For example, a mother with a graduate degree may face pressure from highly educated peers to breastfeed in order to provide what they see as the best possible opportunities for her child; at the same time she may also face pressure from the *same peer group* to focus on her work and career. These conflicting expectations must be combined with the expectations and values of her family, neighbors, co-workers and all of the other groups in which she takes part to determine whether or not a mother wants or has the ability to breastfeed.

The decision to breastfeed is a complex and continuous process. The overarching perspective taken in this dissertation is that while the choice to breastfeed is the decision of an individual mother, this decision is largely shaped by the social environment in which she makes that decision. Indeed many *individual characteristics*—for example, education and place of birth, two individual characteristics of interest in this dissertation—can in part be understood as reflections of a mother's background and social environment. The goal of the first part of this dissertation is to better understand the relationship between some of these factors and breastfeeding.

Purpose of Study

The widespread medical support of breastfeeding combined with large scale social disparities in breastfeeding rates and the burden that breastfeeding recommendations place on mothers make breastfeeding an important topic of sociological

inquiry. In the current research I use of the Early Childhood Longitudinal Study Birth cohort (ECLS-B)—a recent, large, nationally representative cohort of children born in 2001—to examine the social disparities in breastfeeding in the United States. A series of analyses addresses the following questions: 1) What social and demographic factors are associated with breastfeeding initiation and duration? 2) How relevant are state level characteristics in explaining between state differences in breastfeeding prevalence? 3) Is breastfeeding related to higher cognitive scores in early childhood?

Analytic Framework

I break the analysis into four separate but related analyses. Because breastfeeding is performed by the mother, I begin with the mother/child dyad. In the first two sets of analyses I focus on individual mother, child, and family characteristics, to determine the extent to which maternal characteristics are correlated with breastfeeding. In the third set of analyses I recognize that individuals are embedded within broader social contexts (defined geographically), and characteristics of these places may affect whether or not a woman breastfeeds. Finally, in the last set of analyses, I consider whether breastfeeding is related to one aspect of child well being—child cognitive development. In the following paragraphs I briefly describe each analysis.

Analyses 1 & 2

Breastfeeding is a unique process because it must be performed by the child's biological mother. Consequently, individual mothers make the final decisions regarding whether and how long to breastfeed their children. However, these decisions are shaped by the circumstances in which the choice is made. In the first two analytic sections I

examine the relationship between mother characteristics and breastfeeding. I focus on two maternal characteristics that are strongly related to breastfeeding in the US—education and place of nativity.

First, because advantaged mothers have higher breastfeeding rates, I focus on the relationship between maternal education and breastfeeding. Specifically, I consider the extent to which individual and family level factors that are linked to both education and breastfeeding, including marital status, race/ethnicity, household income, mother's work status, mother's use of parenting resources, and family background, seem to contribute to the relationship between maternal education and breastfeeding initiation and duration or whether the relationship between education and breastfeeding remains net of these other factors.

In the second analysis I consider the relationship between maternal place of birth and breastfeeding. More than 20% of children born in 2001 had a mother that was born outside the US; consequently, the behaviors of foreign born mothers have important implications for a large proportion of *US born* children. In this analysis I consider whether the relationship between maternal nativity status (foreign or US born) and breastfeeding is the same across four broad racial/ethnic groups—non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic Asian. I also consider whether the relationship between nativity and breastfeeding varies among foreign born mothers based on different aspects of their migration experience, including length of time in the US, age of arrival to the US and use of English at home.

Analysis 3

While individual and family characteristics are important determinants of health and health behaviors, individuals are embedded within larger social contexts. These social contexts, which are frequently defined geographically, have institutional and social resources that may make it easier or harder for women to initiate and sustain breastfeeding. In the third section I examine the relationship between state characteristics and breastfeeding in the US. In particular, I consider state breastfeeding legislation and the medical environment surrounding births in the state, based on the prevalence of c-section births, midwife assisted births, and home births.

Analysis 4

Breastfeeding matters to the extent that it has benefits for child development. Breastfeeding has been linked to a variety of positive outcomes for children, including cognitive development, although there is considerable debate over whether the relationship between breastfeeding and cognitive development is spurious. In the third section I examine the relationship between breastfeeding and child cognitive outcomes. In particular, I consider the relationship between the duration of breastfeeding and the likelihood of a child scoring more than 1 SD below the mean on the Bayley Mental Scales at age 2 or scoring more than 1 SD below the mean on standardized assessments of early math and literacy skills at preschool age, controlling for a wide range of individual characteristics and parenting behaviors that are related to both breastfeeding and cognitive functioning.

Organization of Dissertation

This dissertation is organized into seven chapters. The current chapter (Chapter One) introduces the topic, explains the motivation, and briefly describes each analytic section. Chapter Two describes the primary data source, the Early Childhood Longitudinal Study Birth cohort (ECLS-B). Chapter Three, the first analytic chapter, examines the relationship between maternal education and breastfeeding initiation and duration. Chapter Four analyzes the relationship between maternal nativity and breastfeeding. Chapter Five considers the relationship between breastfeeding and contextual factors at the state level. Chapter Six, the final analytic chapter, examines the relationship between breastfeeding and child cognitive outcomes at age 2 and preschool age. Chapter Seven, the conclusion, summarizes the results and contributions of this dissertation, and discusses directions for future research.

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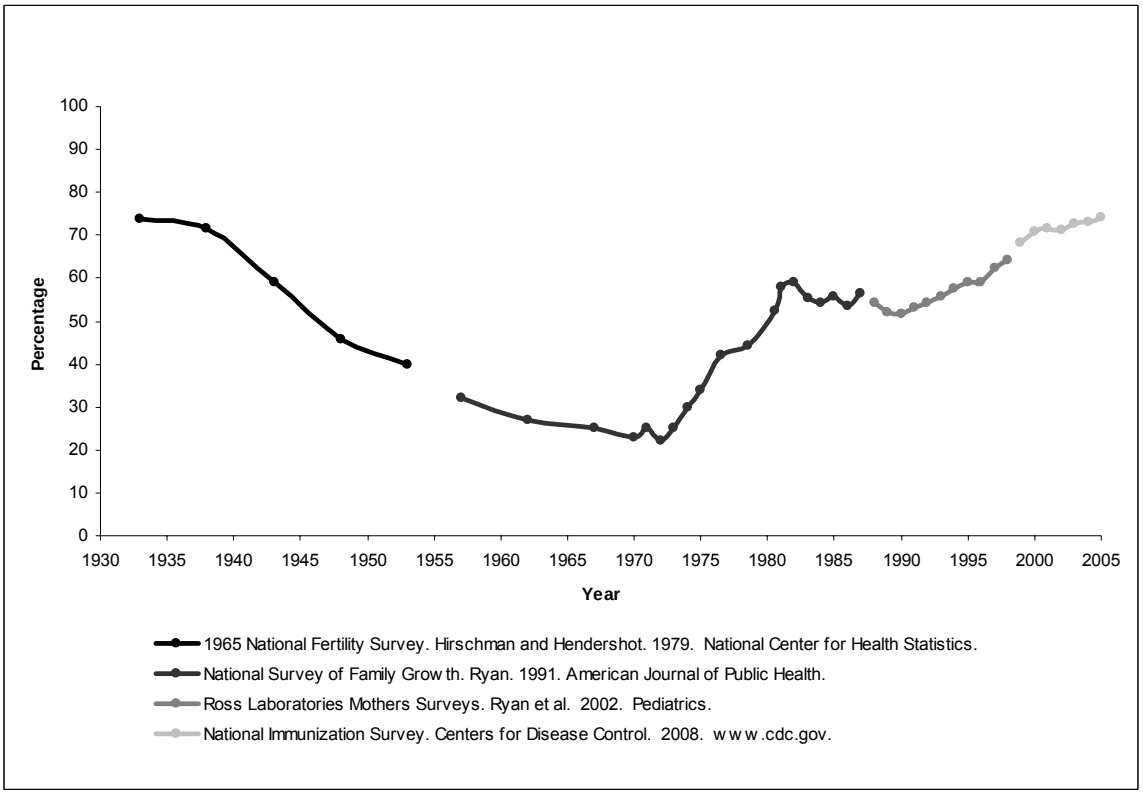
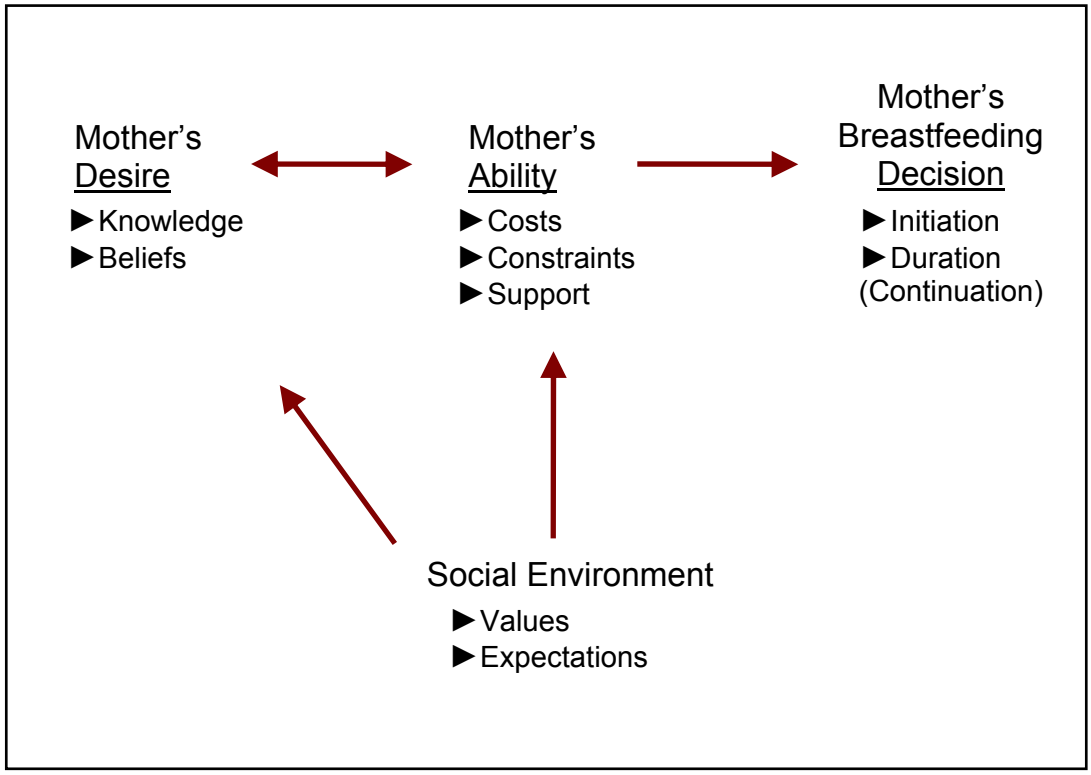
Tables and Figures

Figure 1.1. Historical Trends in Breastfeeding Initiation in the US



Note: Breastfeeding initiation refers to the percentage of children born in a given year who were breastfed, regardless of breastfeeding duration. Breastfeeding initiation rates from the 1965 National Fertility Survey are based on reports from married women living with spouses in 1965. Rates from first and second births are averaged to create an overall rate. First parity births have higher initiation rates than higher order births, so this may be an overestimate breastfeeding rates in the first half of the 20th century.

Figure 1.2. Conceptual Diagram of the Decision to Breastfeed



CHAPTER TWO: DATA

The Early Childhood Longitudinal Study, Birth Cohort (ECLS-B)

The primary data source for this project is The Early Childhood Longitudinal Study, Birth Cohort (ECLS-B). The ECLS-B is a birth cohort study that consists of a nationally representative sample of ~10,700 children born in the US in 2001.[1] The study was designed to examine children's health, development, care, and education from birth through school entry. Sample children were selected from birth certificate records. The sampling frame also included an over-sample of Asian and Pacific Islander children, Chinese children, American Indian and Alaska Native children, twins, and low and very low birth weight children to allow for analysis of these low prevalence but potentially unique groups. Children born to mothers under 15 and children adopted at birth were excluded from the sample design. Consequently results are not generalizable to very young mothers. However, in 2001, only .2% of births were to mothers under age 15 (CDC 2008).

The ECLS-B incorporated 5 waves of data collection in addition to birth certificate data. The first two waves of data were collected when the children were ~9 months and ~2 years old. After the 2 year wave, data collection switched from an age-based to a school-year based data collection schedule, with follow ups in fall 2005 ("preschool age" — ~4 years old), and fall 2006 ("school age" — ~5 years old). A final

[1] Per instructions from the National Center for Educational Statistics (NCES), all sample sizes are rounded to the nearest 50 cases.

data collection wave occurred in fall 2007, which included the sub-sample of children who entered Kindergarten in that year rather than fall 2006. Data are currently available from the first three data waves (9 months, 2 years, preschool age), each of these data waves are used in the analyses.

Data collection instruments included birth certificates, direct child assessments, interviews with a primary respondent (usually the child's mother), resident father questionnaires, non-resident father questionnaires, child care provider questionnaires, child care direct observation, and teacher questionnaires. In the first three analytic chapters, which consider breastfeeding initiation and duration (Chapters 3 to 5), I make use of the birth certificate information and primary respondent interviews at 9 months and 2 years. For the final analytic chapter on child cognitive development (Chapter 6), I use the data from the birth certificate, parent interviews at 9 months, 2 years, and preschool age, and direct assessments of the mother-child interaction and child cognitive performance at 2 years and preschool age.

ECLS-B Strengths

A major strength of this analysis is the data source, the Early Childhood Longitudinal Study, Birth Cohort, which is the first nationally representative longitudinal study in the US to follow children from birth to Kindergarten entry. The nationally representative nature of the data means that results are generalizable to all children born in the US in 2001. The large sample size provides adequate numbers of children to consider interaction terms and the over-sampling of Chinese and Asian and Pacific Islander children allows for subgroup analyses in this population of interest. The comprehensive set of data collection instruments in the ECLS-B allows for the

incorporation of a wide variety of measures relevant to breastfeeding from multiple sources. Furthermore, the ECLS-B data can be easily merged to data indexed with social variables at the county or state geographic level as place of birth is reported on the birth certificate and included in the data file.

The combination of birth certificate and mother reports at the first interview collection wave allow in the ECLS-B allow for substantial information on the circumstances surrounding birth. These include the child's birth weight, gestational age, and twin status and the mother's c-section and midwife use, which are included in the birth certificate data. The birth certificate data is combined with a mother's report of use of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) during pregnancy, marital status at birth, length of maternity leave, and breastfeeding information (including initiation, duration, and age of introduction of other sources of nutrition). Moreover, interviewer observations and video-recorded assessments of mother/child interactions from each available interview round (9 months, 2 years, and preschool age) can be combined with mother reports to describe a child's home environment. Finally, the direct child assessments at each interview wave allow for less subjective measure of child cognitive skills than could be provided by maternal reports; although it is important to note that such assessments are not entirely objective and may have cultural biases.

Analysis Sample

Because information about breastfeeding is most readily collected from the mother, analyses are limited to children whose biological mothers were the primary respondent at the 9 month interview. Approximately 99% of children in the ECLS-B

sample meet this criterion (n=10,550). A small number of children whose mothers did not report breastfeeding information (n<50) were also dropped from the analyses. Further sample restrictions for particular analyses are described within the particular analytic chapters.

Supplementary Data

In addition to the primary ECLS-B data, supplementary data at the state level are used in the Chapter 5, which examines the relationship between state level contextual factors and breastfeeding. The ECLS-B birth certificate data includes Federal Information Processing Standards (FIPS) codes for the state of residence for each birth. These FIPS codes were used to link the ECLS-B data to contextual factors from a number of data sources. The supplementary data sources used in the analysis are described briefly in the following section. Particular measures from each data source will be described in detail in Chapter 5.

State Level Supplementary Data

This analysis uses two primary sources of supplemental data at the state level. First, *state breastfeeding legislation* information—intended to protect and promote a mother's ability to breastfeed—are compiled from online sources, including the Centers for Disease Control (www.cdc.gov) and individual state websites. Analyses are based on the existence of state legislation in 2001. Second, *state level vital statistics* from the Centers for Disease Control (CDC) are used to determine the prevalence of birth methods (c-section rates, midwife use, and home births) within each state in 2000. These statistics

are meant to capture the medical environment into which the mothers of the 2001 ECLS-B cohort gave birth, measured in the year before the children were born.

Missing Data

There are two primary types of missing data in the ECLS-B—item non-response and system or instrument non-response. My process for dealing with each is described below:

Item Non-Response

Item non-response includes items that the respondent refused to answer, reported not knowing the answer, or the response was recorded as "not ascertained" (for example if it is not known whether the respondent should have answered a question because the lead question had no response). The prevalence of each of these responses for any given question is very low in the ECLS-B instruments that were assessed in-person (such as the Parent CAPI interview, as opposed to those that were self-administered, such as the non-resident father questionnaire, which is not used in this analysis). Because missingness rates are low, in the analyses I generally group each of these types of item non-response together as "unknown or missing".[2]

Some concepts are captured through multiple instruments or at multiple time points, and to the extent possible this information is used to supplement survey responses and reduce item missingness. For example, the foreign born status on the birth certificate is used to supplement a mother's own report of place of birth. The National Center for Education Statistics (NCES) also provides a number of composite variables, which

[2] There are some exceptions. For example, a response of "don't know" on a question used in the parent knowledge questions is coded as "incorrect" rather than missing.

incorporate information from multiple sources (some of which are not available to the end user); use of these composite variables also contributes to low rates of missingness on individual variables in the analysis. Most of the composite variables from NCES include some item non-response; however, the NCES uses "hot deck" multiple imputation to fill in missing values on a few variables—including occupation and income—and these imputed values are included in the analyses.

In the analysis, I drop the small number of observations with item non-response on the breastfeeding initiation and duration questions in the first interview—the question used to create the primary dependent variable in Chapters 3 through 5. In Chapter 6 I also drop the children who do not have a valid cognitive score for a given data wave. For other variables in the analyses, a dummy indicator is used to indicate that an individual did not respond to a particular question or if a measure could not be calculated due to missingness in one of its components. For continuous variables, missing values are mean coded in addition to incorporating this dummy indicator. Item missingness is generally less than .5% for any given measure used in my analyses. When missingness exceeds this threshold, the indicator is presented in the descriptive statistics and results table.

System or Instrument Non-Response

The second type of missingness is system or instrument non-response. The ECLS-B contains multiple instruments at multiple waves, and each can be a source of non-response if the relevant respondent does not complete a particular wave or instrument. In my analysis, this type of non-response is addressed using the ECLS-B weights. The NCES provides a variety weights that correspond to particular combinations of waves and instruments. Weights were designed by the sampling agency

to adjust for disproportionate sampling, survey non-response, and non-coverage of the target population. This analysis primarily uses the parent interviews, which are necessary for a child to get a non-zero weight at any given survey wave. Because information on breastfeeding is primarily collected at the first interview wave, I use the weight associated with the parent interview at the first wave for the first three analytic chapters.[3] All children in the ECLS-B have this instrument and thus a non-zero weight. In the final analytic chapter, I use the results of direct child assessments at the second and third interviews (age 2 and preschool age). For these analyses I use the weights associated with the direct child assessment at each wave, which exclude children who drop out between waves, but the remaining children are weighted to make up for non-random attrition.

[3] For children who were still being breastfed at the first interview wave (9 months) breastfeeding duration information is supplemented with maternal reports at the second interview wave (age 2). In the event history analyses, the breastfeeding duration is censored for children who were still being breastfed at the time of the first interview, but dropped out of the sample between the first and second interviews.

CHAPTER THREE. MATERNAL EDUCATION AND BREASTFEEDING

Introduction

In this first analytic chapter, I examine the relationship between maternal education and breastfeeding, with a goal of better understanding why more educated mothers are consistently more likely to breastfeed than less educated mothers. Recognizing that maternal education may reflect various aspects of a mother's social environment, I consider the extent to which maternal education remains a strong predictor of breastfeeding after controlling for individual and family level factors that are linked to both education and breastfeeding, including marital status, race/ethnicity, household income, family background, use of parenting resources, and work status.

Why Education Might be Related to Breastfeeding

From the rational/utilitarian perspective presented in Chapter One, differences in breastfeeding among mothers with different education levels would be explained by differences in their desire (based on knowledge and beliefs) and ability (based on costs and constraints) to breastfeed. For example, if highly educated mothers are more likely to seek out information regarding parenting, they may have more knowledge regarding the perceived benefits of breastfeeding. At the same time, highly educated mothers as a group may have certain beliefs and expectations about how children should be raised,

which may also contribute to differences in whether or not a mother feels she should—or has to—breastfeed to meet those social expectations. More educated mothers, who also tend to be older, married, and have higher household income (i.e., relatively more support and fewer constraints) may also have a greater ability to put their breastfeeding desires into practice. Although notably, because mothers with high education are able to get higher paying jobs, they may also face large opportunity costs if they want to breastfeed long term. Education is a social institution, and the knowledge and beliefs of mothers with different education levels—for example, what it means to be a "good mother"—are likely reflective of the individual and social background that contributes to a mother's education level as well as the social implications of the education itself.

Background and Literature Review

Education is widely seen as a resource that increases individuals' options and reduces their constraints. In less developed countries, increasing women's schooling is considered a critical step toward improving women's social status and helping women to increase control over their lives, and in such contexts maternal education has been linked to reduced child morbidity and mortality and increased immunizations (Cleland 1990; Caldwell and Caldwell 1993; Parashar 2005). In the US, mother's education is predictive of investment in children's health, including routine doctor visits and having a regular place for medical care (Case and Paxson 2001). Mother's education is also negatively related to low birth weight, which is considered an indicator of poor prenatal care (Currie and Moretti 2003). Maternal education is also positively associated with breastfeeding rates in the US and other highly developed countries (Peterson and Davanzo 1992; Hendricks et al. 2006). However, education is correlated with other factors that are

linked with increased breastfeeding, such as marital status and income, and it is difficult to determine why maternal education matters for mother's health behaviors or what maternal education really measures (Desai and Alva 1998).

The link between education and breastfeeding has been documented in other research. Education is almost universally included as a control in studies of breastfeeding, and researchers have found a positive link between education and breastfeeding in bivariate (Ryan et al. 1991) and multivariate associations as well as in nationally representative (Peterson and Davanzo 1992; Hendricks et al. 2006) and more localized samples (Hla et al. 2003; Heck et al. 2006) in the US. Education has also been linked to increased breastfeeding in other highly developed countries (Dubois and Girard 2003; Nolan and Goel 1995; Riva et al. 1999; Scott et al. 1999; Ludvigsson and Ludvigsson 2005; Alvik et al. 2006).[4] Moreover, not only is education regularly positively correlated with breastfeeding, the correlation between education and breastfeeding is strong, and often remains after adding controls for other correlated factors such as income and occupation (Dubois and Girard 2003; Heck et al. 2006; Hendricks et al. 2006; Taylor et al. 2006). Nonetheless, education is normally only considered as a control rather than a focus of the analysis, often measured dichotomously, and other than a study from Heck et al. (2006), which examines a population of mothers from California, most research does not explicitly and systematically consider the links between maternal education and breastfeeding.

[4] In contrast, maternal education is often negatively related to breastfeeding in less developed countries (Stewart et al. 1991; Adair et al. 1993). Moreover, education has not always been positively related to breastfeeding in the U.S., for example, in the early 1950's breastfeeding initiation rates were among the lowest for those with college degrees (Hirschman and Hendershot 1979).

There are a number of pathways through which education might affect breastfeeding. One is knowledge. The educational level of a woman may be representative of her specific knowledge in a particular area, as well as her overall level of general knowledge. If women with higher levels of education are more likely to seek out and use resources regarding childrearing, we might expect that more educated women would be more likely to breastfeed.

However even if a mother knows that breastfeeding is the medically recommended form of infant feeding, and believes that breastfeeding has health benefits for her child, this does not mean that the mother will breastfeed (Guttman and Zimmerman 2000). Other factors may prevent mothers from putting their knowledge into practice. Low education is often linked to other types of disadvantages, such as poverty, single motherhood, and youth—and lack of breastfeeding tends to parallel these disadvantages. Younger, single, and poor women are less likely to breastfeed than their older, married, and richer counterparts (Ryan et al. 1991; Li et al. 2005; Callen and Pinelli 2004; Kiernan and Pickett 2006).

Work is often directly related to education, and may affect a mother's ability and decision to breastfeed. It is difficult to combine work and breastfeeding, and the timing of return to work is linked to the cessation of breastfeeding (Lindberg 1996; Roe et al. 1999; Dennis 2002; Clifford et al. 2006; Kimbro 2006; Scott et al. 2006; Hawkins et al. 2007). However, work situations vary substantially among women. If higher educated women are in positions that offer longer leave and maternity benefits, we would expect this to help explain the link between higher education and increased breastfeeding. Moreover, women with more education may hold jobs that offer more autonomy and

flexible working conditions—and women in such positions may be more able to combine work and breastfeeding (Kimbro 2006; Hawkins et al. 2007). Nonetheless, part time and stay at home moms likely have an easier time fitting breastfeeding into their schedule (Lindberg 1996; Ryan et al. 2006)—this may reduce the positive correlation between maternal education and breastfeeding duration, as highly educated women are less likely to stay home long term after a birth (Roe et al. 1999).

The link between maternal education and breastfeeding may also be a reflection of social class differences in parenting behavior (Desai and Alva 1998). The desire to be good parents is universal (Hays 1996; McCormack 2005); however, what it means to be a good parent varies substantially among groups. The extent to which mothers and parents find breastfeeding an important component of "good parenting" likely varies. Parents in different social classes employ different parenting behaviors (Hays 1996; Blum 1999; Lareau 2003)—and differences in breastfeeding may be one example of such differences. Higher educated parents may be more likely to practice “intensive mothering” techniques (Hays 1996),[5] which include involving older children in a multitude of extracurricular activities (Lareau 2003) and may also include the breastfeeding of infants (Blum 1999). Mothers and parents who put less weight into the belief that good mothering requires intensive and exclusive mothering may be less likely to conform to medical recommendations regarding breastfeeding if these recommendations do not fit in with their conceptions of what it takes to be a good parent. Mothers also modify their conceptions of "good mothering" in order to reconcile such understandings with their particular situation and work circumstances (Murphy 2000; McCormack 2005; Johnston

[5] Hays describes "intensive mothering" as "child-centered, expert-guided, emotionally absorbing, labor-intensive, and financially expensive child rearing"(1996, p.64).

& Swanson 2006). Consequently, the material and structural constraints facing lower educated mothers may reinforce norms that sustain the practice of formula feeding over breastfeeding.

Current Analysis on Education and Breastfeeding

In this analysis I systematically examine the relationship between maternal education and breastfeeding initiation and duration among a nationally representative cohort of children in the US. To do this I sequentially control for a series of factors that are linked to both education and breastfeeding, including marital status, race/ethnicity, age, household income, and mother's work status, to see whether the relationship between maternal education and breastfeeding remains after controlling for these demographic factors. I also consider whether the relationship between education and breastfeeding is related to unequal use of parenting resources or unequal exposure to breastfeeding knowledge. Finally, because a mother's education may be as much a reflection of her social environment as it is an individual characteristic, I consider whether controlling for other familial factors that may influence a mother's prior and current social environment help to explain the relationship between maternal education and breastfeeding, or whether a mother's own education seems to matter above and beyond others' contributions to her social environment.

ECLS-B Data Analysis Sample

As outlined in the data chapter, the primary data for this dissertation come from the Early Childhood Longitudinal Study, Birth Cohort. For this chapter I make use of the birth certificate information and primary respondent interviews at 9 months and 2 years.

I only include children whose biological mothers were the primary respondent at the 9 month interview, because they are the best able to comment on their own breastfeeding experiences (n=10,550). Most models incorporate all children; however, models that consider father characteristics are limited to mothers who were cohabiting or married to the child's father at the time of birth (n=8,700)

Variables

Dependent Variables (Breastfeeding Outcomes)

The guidelines established by the American Academy of Pediatrics indicate that initiation and duration are both important components of breastfeeding. Researchers have taken many approaches to deal with the fact that breastfeeding can be measured in terms of both instantaneous "events" and durational "spells".[6] Some focus on the dichotomous initiation event (Gibson-Davis and Brooks-Gunn 2006; Merewood et al. 2006)—did a mother initiate breastfeeding? Others incorporate a duration component into the analysis of the event (Gibson-Davis and Brooks-Gunn 2006; Kelly et al. 2006; Taylor 2006)—for example, did a mother breastfeed for at least 6 months? Others consider multiple outcomes simultaneously (Kiernan and Pickett 2006; Singh et al. 2007)—for example, did a mother breastfeed at all, vs. breastfed but for less than 6 months, vs. breastfed for at least 6 months. Still others take an event history approach and analyze breastfeeding spells rather than events (Harley 2007; Kimbro 2006) — what factors contribute to shorter or longer breastfeeding spells? There is no consensus on

[6] Exclusivity is also important (the APA recommends exclusive breastfeeding for 6 months), and some researchers consider *exclusive* breastfeeding rather than *any* breastfeeding. Exclusivity is not addressed in this chapter. In general, the relationship between maternal education and initiation and duration of "any breastfeeding" is similar to the relationship between maternal education and initiation and duration of "exclusive breastfeeding" (Li et al. 2002).

which approach is best, and many use a combination of approaches to capture various aspects of the breastfeeding decision. The combination chosen largely depends on the specific research questions of interest.

In this analysis I take an approach similar to Kimbro (2006) and analyze both the breastfeeding initiation event and the breastfeeding spell. I structure the analysis sequentially—to first consider whether certain mothers are more likely to initiate breastfeeding, and then to consider whether mother characteristics are linked to longer breastfeeding intervals among those mothers that do initiate breastfeeding. I choose a two step approach because initiation and duration are two separate (but related) components of the breastfeeding process, and both may be related to maternal education. I analyze the components separately because factors that are correlated with breastfeeding initiation may not be related in the same way to breastfeeding continuation (Hirschman and Butler 1981). By considering breastfeeding initiation as well as duration, I can determine what factors are correlated with each component.

Breastfeeding Initiation

Mother's breastfeeding initiation is a dichotomous indicator based on the following question at the 9 month interview: "Did you ever breast-feed {child's name}?"

Breastfeeding Duration

Breastfeeding duration is valid for mothers that initiated breastfeeding. Breastfeeding duration is based on the following questions at the 9 month interview: "Did you ever breast-feed {child's name}?"; "Are you still breast-feeding {child's name}?"; "For how many months did you breast-feed him/her?" For mothers still breastfeeding at

the 9 month interview this variable was supplemented with information from the 2 year interview: "How old was {child's name} in months when you completely stopped breast-feeding him/her?"

Independent Variable of Interest

Mother's Education

In this chapter the main independent variable of interest is mother's education. Mother's education is based on self-report at the 9 month interview. Because the benefits of education in the US depend on meeting certain milestones, mother's education is divided into categories—eight years or less, 9-12 years (but no diploma), high school diploma, some college (but no degree), vocational/technical program or associate's degree, bachelor's degree (but no graduate degree), graduate degree (master's, doctorate, or professional degree).

Other Independent Variables (Control Variables)

Control variables used in the analysis are described in Table 3.1.

Methods and Models

A separate model is used to predict breastfeeding initiation and duration/cessation. Logistic regression is used to predict the dichotomous outcome of whether or not a woman initiates breastfeeding. A woman is said to have initiated breastfeeding if she reports any breastfeeding, regardless of whether that breastfeeding is supplemented with formula or other milk sources.

The basic logistic regression model is as follows:

$$\ln(p_i/1\text{-}p_i) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_j X_{ji} + e_i$$

Where p is the probability of initiating breastfeeding for mother (*i*) with a covariate vector X.

Because factors that inhibit the continuation of breastfeeding (such as work status) vary over time, it is useful to take an event history approach to model breastfeeding duration, as this method allows for time-varying covariates. Breastfeeding duration is measured in months rather than continuously in the ECLS-B, so a discrete time hazard model is used to model breastfeeding duration. This model requires that the data be formatted into person-time files. Each mother has a record for each month in which she is still breastfeeding up to the month in which she stops breastfeeding (or is censored if she is still breastfeeding at the time of interview). A dichotomous variable is set to 1 in the month that the mother reports that she stopped breastfeeding and 0 in all preceding months. Logistic regression is then used to determine the likelihood of quitting for the covariates in question. The person-month structure allows the inclusion of a set of dummy variables used to indicate the number of months since birth—thereby permitting the underlying odds of quitting breastfeeding to vary over time, as women are more likely to quit in certain months. In the models estimating breastfeeding duration, only births in which a mother initiated breastfeeding are included. Breastfeeding duration is censored at 12 months. The 7050 breastfeeding mothers contribute 38200 person months of breastfeeding to the breastfeeding duration analyses.

The basic discrete time hazard regression model is as follows:

$$\ln\{p_{it} / (1- p_{it})\} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \ldots + \beta_j X_{jit} + e_i$$

Where, p is the conditional probability of stopping breastfeeding for mother (*i*) in month (*t*), given that the event did not occur prior to month (*t*). A mother (*i*) has a covariate vector (X) that may vary as a function of month (*t*).

Analytic Plan

In this chapter I examine the relationship between maternal education and breastfeeding initiation and duration (cessation). It is unlikely that maternal education directly affects a woman's likelihood of breastfeeding, as most women do not learn about infant care in the course of their schooling. Therefore, it is useful to investigate the factors that might help explain the link between maternal education and breastfeeding. Breastfeeding initiation is examined first, followed by breastfeeding cessation. For both outcomes I consider a series of nested models to see whether various factors—mother characteristics, household resources, mother's work status, mother's use of parenting resources and exposure to breastfeeding information from health care professionals, and mother's social background (mother's parents' education and mother's partner's occupational prestige)—seem to help explain the relationship between maternal education and breastfeeding.

Results

Descriptive Statistics

The distribution of variables used in the analysis is presented in Table 3.2. The first set of columns includes proportions from the ECLS-B sample, while the second set of columns includes estimates that are weighted to be nationally representative and to account for the complex survey design of the ECLS-B.

Figure 3.1 shows the basic relationship between maternal education and breastfeeding initiation and duration. Overall, the results suggest that education is positively related to breastfeeding initiation and duration for mothers that have at least an 8th grade education. About 87% of mothers with at least a bachelor's degree initiate breastfeeding, compared to only 60% with a high school degree. However, the positive relationship between education and breastfeeding does not hold for the small percentage of mothers with less than an eighth grade education, who despite low education levels have a relatively high likelihood of breastfeeding, with 77% initiating breastfeeding and 36% of initiators continuing beyond 6 months.

Maternal Education and Breastfeeding Initiation

In Table 3.3, I use logistic regression to examine the relationship between mother's education and breastfeeding initiation in a multivariate context.[7] The results are presented as coefficients and can be interpreted as the increase or decrease in the log odds of initiating breastfeeding for a mother in the category in question as compared to the reference category. The coefficients can be exponentiated to get odds ratios; which reflect the relative odds of initiating breastfeeding as compared to the reference category, controlling for the other covariates in the model. Model 1 shows the relationship between education and breastfeeding initiation controlling for child characteristics, location of the household, and circumstances surrounding the birth. Mother of various education levels are compared to mothers with a high school degree but no post-secondary education. Overall, maternal education is positively related to breastfeeding. The more education women have, the more likely they are to breastfeed. Women with

[7] Due to the complex sampling structure of the ECLS-B, all regression models use Taylor series linearization methods to compute standard errors.

graduate education have more than six times the odds of breastfeeding than individuals with a high school degree (OR=exp(1.8)=6.3). Again, the one exception to this relationship is the small group of women with very low education, who are also very likely to breastfeed. Mothers with a junior high education or less have about 1.7 times the odds of breastfeeding than mothers with a high school degree.

While a mother's education is strongly and positively related to breastfeeding, there are many maternal characteristics, such as family structure and race/ethnicity, which are associated with both education and breastfeeding initiation. In the second model of Table 3.3, I add controls for mother's race/ethnicity, nativity, age, and marital status and child parity to see whether accounting for these maternal characteristics and measures of household structure seems to reduce the relationship between maternal education and breastfeeding initiation rates. The inclusion of controls for mother and other characteristics does seem to somewhat reduce the link between education and breastfeeding for most education categories. Controlling for these additional mother characteristics in Model 2, women with a college degree have 3.5-5.4 times the odds of initiating breastfeeding than women with a high school degree. Women with less than 8 years of education are not significantly more likely to initiate breastfeeding than women with a high school degree in models controlling for mother characteristics. The significance of this relationship in the prior model seems to be driven by the high breastfeeding rates of foreign born and Hispanic women who tend to have low education (see Celi et al. 2005; Gibson-Davis and Brooks-Gunn 2006; Harley et al. 2007).[8]

[8] I explore the relationship between nativity and breastfeeding more extensively in the next analytic chapter (Chapter 4).

In Model 3 I add indicators of income and work status to the model. Two income indicators are included. The first, WIC, is a program that helps provide food to low income pregnant women and new mothers and is an indicator of low income. While one stated goal of WIC is to promote breastfeeding, WIC also provides free infant formula to non-breastfeeding mothers, and WIC has been shown to be negatively correlated with breastfeeding (Ryan and Zhou 2006; Jacknowitz et al. 2007). The second income indicator is a series of dummy variables signifying the income of the child's household.

In addition to the two income indicators, two work variables are also added to Model 3—mother's work status at birth and mother's occupation. The expected relationship between education, work, and breastfeeding is complicated. The time demands of both work and breastfeeding means that work may inhibit a mother's ability to breastfeed. Consequently, controlling for work status may increase the positive relationship between education and breastfeeding because highly educated women are more likely to work. However, women with high levels of education are more likely to have jobs that offer maternity leave and job autonomy—factors that might increase a woman's ability to breastfeed, given that she is employed. In this analysis, mother's work status at birth is divided into three categories—on paid maternity leave, working before birth without paid leave, and not working before birth (or quit work without intending to return). Mother's occupation is divided into categories based on her occupation at the time of the first interview—professional or science, arts or education, sales or administrative, manual, care, working in unknown occupation, or no occupation (not

working).[9] Overall, the net effect of income and work seems to slightly reduce the positive relationship between education and breastfeeding.

To this point I have considered the extent to which demographic factors that are correlated with maternal education appear to help explain the relationship between high maternal education and increased breastfeeding initiation. While controlling for these factors seems to somewhat reduce the relationship between maternal education and breastfeeding initiation, a mother's education remains a large and strong predictor of breastfeeding initiation. Another potential pathway that might link education to breastfeeding is parenting knowledge. It may be that women with higher education are more knowledgeable about the best infant care practices, and it is this increased knowledge that explains the link between education and breastfeeding. If this is true, we would expect that controlling for use of to parenting materials and exposure to information regarding breastfeeding would reduce the relationship between education and breastfeeding. In the fourth specification of Table 3.3, I add indicators for whether the mother reported using books on parenting and whether she reported being told about breastfeeding during prenatal care visits. Mothers who report being told about breastfeeding during prenatal care visits are not significantly more likely to initiate breastfeeding than other mothers; however, women who report using parenting books have about a 60% higher odds (OR= exp(.456)=1.58) of initiating breastfeeding than women who did not report using such materials.[10] Nonetheless, despite the fact that

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[9] Because interviews take place when the child is ~ 9 months, use of this variable in the analysis of breastfeeding initiation requires the assumption that the type of work a mother has at 9 months after birth was known to her at birth, and could therefore affect her decision to breastfeed.

[10] This could be because those who read parenting books learn about breastfeeding in those books. However, it could also be a selection effect in which those who read parenting books are more likely to follow guidelines than those who don't. If that is the case, then encouraging people to read parenting

higher educated women are more likely to report using parenting books, inclusion of this variable in the model seems to do little to explain the different breastfeeding rates between more and less educated women. It is reasonable to expect that the relationship between the use of parenting books and breastfeeding initiation could vary by education level; however, inclusion of an interaction term between use of parenting books and education does not significantly improve model fit (model not shown), suggesting that the influence of using parenting books does not vary by mother's education level.

Maternal education is strongly related to breastfeeding initiation even controlling for differences in maternal characteristics, household income, mother's work status and occupation, and use of parenting materials. Another potential explanation is that education is reflective of a mother's social class or social environment, and women in different social classes have different parenting practices (due to a combination of ideological and material/structural differences). It may be that women with higher education put more weight on the benefits of particular mothering practices, such as breastfeeding.

Since parents have a large influence on the social environment of their children, a mother's own parents may play a large role in determining her education level, her social environment and sources of social support, and her parenting practices as an adult. In the final specification of Table 3.3, I consider whether the relationship between mother's education and breastfeeding initiation remains significant after controlling for the education of the mother's parents (Model 5). Controlling for the education of the child's maternal grandparents does seem to reduce the relationship between the mother's

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materials or providing easy to read parenting materials to less educated women would not necessarily increase their compliance with recommended breastfeeding practices.

education and her likelihood of breastfeeding initiation. Moreover, the maternal grandparents' education is associated with a mother's likelihood of breastfeeding above and beyond a mother's own education.[11] However, a mother's own education remains a strong predictor of breastfeeding initiation; with college educated mothers having about 2.4 to 3.4 times the odds of initiating breastfeeding as high school educated mothers.

Maternal Education and Breastfeeding Duration (Cessation)

In addition to recommending that women expose their babies to breast-milk, the medical community also sets specific guidelines for length of breastfeeding. Medical guidelines advocate that mother's breastfeed their children for one year, including six months of exclusive breastfeeding. In this section I examine the relationship between a mother's education and her likelihood of quitting breastfeeding in a given month since birth (breastfeeding cessation). This set of analyses includes only women who initiate breastfeeding and once again includes all breastfeeding regardless of whether it is supplemented with other food sources. Since breastfeeding is a selective process, women who initiate breastfeeding are likely those that believe that breastfeeding is good for their children. However, breastfeeding is a demanding and time consuming task that requires continual commitment on a daily (and even hourly) basis. Consequently some women are more likely than others to continue their breastfeeding for extended durations.

Breastfeeding duration is modeled using a discrete time hazard model, in which a woman has a record for every month in which she continues breastfeeding up to the

[11] It is unknown whether the mothers were breastfed by their own parents when they were infants. However, the higher educated grandparents that are positively related to the breastfeeding of their grandchildren did not necessarily breastfeed their own children, as medical promotion of breastfeeding began in the late 1970s, and many of the mothers would have been infants before such recommendations were in place.

recommended 12 months. The results are estimated using logistic regression and presented as coefficients, which can be interpreted as the log odds of *quitting* breastfeeding in any given time interval for the particular covariate in question. Once again the coefficients can be exponentiated to determine the odds of quitting breastfeeding in a given month. Each model includes a series of dummy variables indicating the month since birth, thereby allowing the risk of cessation to vary by month.

The first model of Table 3.4 shows the relationship between education and breastfeeding, controlling for child characteristics, location of the household, circumstances surrounding the birth, and month since birth. While educated women are more likely to begin breastfeeding, the results also suggest that more educated women breastfeed longer. Controlling for basic child characteristics, household location, and circumstances surrounding the birth, mothers with at least a college degree have about a 40-50% lower odds of quitting breastfeeding in any given month than mothers with a high school education, while women with at least some college have about a 14-18% lower odds of quitting. As with breastfeeding initiation, very low education is also linked to extended breastfeeding durations—mothers with less than 8 years of education are less likely to quit breastfeeding in any given time period than women with a high school degree (OR=.68).

In the second model of Table 3.4, I add controls for mother's race/ethnicity, nativity, age, marital status and child parity.[12] Adding basic demographic controls in does seem to reduce the relationship between mother's education and breastfeeding duration. In Model 3 there is no significant difference in continuing breastfeeding

[12] Controls added to the duration (cessation) models parallel those in the initiation models; however, work status variables are time-varying rather than measured at the time of birth.

between either mothers with some high school and mothers with a high school degree or between mothers with an associate's degree and mothers with a high school degree net of model controls. Mothers with some college remain somewhat less likely to quit than mothers with a high school degree (OR=exp(-.13)=.88); while mothers with at least a bachelor's degree are substantially less likely to quit breastfeeding in a given month than mothers with a high school degree (OR=.67 to .72). Notably, while controlling for race/ethnicity and nativity seems to entirely account for the increased breastfeeding *initiation* rates of women with less than a junior high education, mothers in the lowest education group remain significantly less likely to quit breastfeeding than mothers with high school degrees, even controlling for nativity and race/ethnicity (OR=.79).

In the third specification in Table 3.4, I consider whether income and work factors help to explain the higher breastfeeding duration rates of women with high education. In addition to indicators for WIC use and categorical household income, I also add time-varying variables to account for a mother's work status and occupation (working next month and currently working in a particular occupation type). While a woman's type of work might affect her decision to initiate breastfeeding, it is even more likely to affect her breastfeeding duration, as continuing breastfeeding may involve combining work and breastfeeding.

The net effect of adding income and work variables seems to slightly increase the positive association between education and breastfeeding. Notably, women who are currently working in any type of job are more likely to quit breastfeeding in a given month than women who are not working, and the magnitude of the coefficients is relatively similar for all occupational categories, suggesting that mothers working in

ANY occupational field have difficultly combining breastfeeding and work as compared to mothers who are not working.[13] Consistent with other research, mothers are also more likely to quit breastfeeding in the month before they return to work (Kimbro 2006).

In Table 3.4, Model 4 I add controls for exposure to parenting resources and breastfeeding knowledge. Mothers who report reading books on parenting are less likely to quit breastfeeding than those who do not report reading such books (OR=exp(-.156)=.85). Interestingly, women who report learning about breastfeeding during their prenatal care are *more* likely to quit (OR=exp(.242)=1.28). This is a somewhat curious result; however, reporting that a health care provider spoke with them about breastfeeding during prenatal care is inversely related to maternal education (descriptive statistics not shown), and it may be that medical personnel are more likely to talk about breastfeeding with women who seem less likely to breastfeed. Alternatively, it is possible that women who learn about breastfeeding but decide not to breastfeed for long intervals are more likely to recall such conversations. Notably, maternal education remains a strong predictor even controlling for parenting resources and knowledge.

In the final model in Table 3.4, I add controls for a mother's parents' education. Inclusion of variables for education of the mother's parents does seem to reduce the relationship between a mother's own education and her likelihood of quitting breastfeeding. In this model mothers with a college degree have only a 20-27% lower odds of quitting breastfeeding in a given month than women with a high school degree, net of other factors. Notably, the education of the child's maternal grandparents is related

[13] It is possible that this is reverse causation, and the timing of quitting influences the return to work rather than the return to work affecting the cessation of breastfeeding. However, work from Roe et al. (1999), suggests that the direction of causation is from work to breastfeeding rather than vice versa. There could also be a selection issue if women who work are less inclined to breastfeed for long durations—for example, they may be more work oriented and less child oriented.

to the likelihood of the mother quitting breastfeeding above and beyond the effects of the mother's own education. Women whose parents had any college have a 16-35% lower odds of quitting breastfeeding in a given month than women whose parents had at most a high school degree.

Father's Occupational Prestige and Breastfeeding Initiation and Duration

In previous models we saw that mother's education is related to both breastfeeding initiation and duration, and the relationship between maternal education and breastfeeding is significant even in models with extensive controls for child, mother, and family characteristics. In the next set of models I consider only mothers cohabiting or married to a partner at the time of the baby's birth and add controls for a father's occupational prestige—another indicator of social environment—to the models. In the models examining breastfeeding initiation (Table 3.5, Models 1-2), we see that net of other factors, including their own education and their parents' education, mothers with co-resident partners with occupational prestige scores above 60 have about a 57% higher odds of initiating breastfeeding than mothers with partners with occupational prestige scores below 40. However, a group significance test suggests that the addition of father's occupational prestige scores does not improve model fit above controls already included in the model (p=.22).

On the other hand, father's occupational prestige is significantly associated with breastfeeding duration (Table 3.5, Models 3-4). Mothers with co-resident partners with occupational prestige above 50 have a 14-29% lower odds of quitting breastfeeding in any given month than those with partners with occupational prestige below 40.

Moreover, in models controlling for the father's occupational prestige, the relationship between maternal education and breastfeeding duration is no longer significant.[14]

Breastfeeding Duration Differences by Educational Groups

Extending breastfeeding duration is a goal of healthcare professionals, and it is informative to consider whether there are differences in the timing of breastfeeding cessation between less educated and more educated mothers. In Table 3.6, I consider whether the patterns of quitting breastfeeding vary by educational group. To simplify the model I divide mother's education in three categories, grouping mothers based on whether or not the mother had a college degree and whether or not she had any high school. The results of the cessation models in Table 3.4 suggest that this grouping is appropriate. The first model in Table 3.6 includes the monthly duration dummies for time since birth, along with an indicators for whether the mother had a either a college degree or less than a high school degree. Examining the monthly time dummies in model 1, we see that mothers are most likely to report that they quit breastfeeding in the early months (1-3) or at the prescribed breastfeeding intervals (months 6 and 12). In all other months women are less likely to report quitting than in the sixth month.[15]

In Model 2 I interact the indicator for mother with a bachelor degree with time since birth, to test whether the likelihood of quitting in a given month is different for

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[14] With the exception of mothers with less than a junior high education, who have about a 25% lower odds of quitting net of controls.

[15] It is possible that the higher quitting rates in months 6 and 12 are due to heaping rather than true differences in stopping practices. Incorrect reporting is likely if mothers try to report acceptable levels of breastfeeding (the socially desirable response), or if mothers do not remember how long they actually breastfed. It is not possible to determine whether social desirability played a part in the distribution of responses; however, because interviews took place with mothers when the children were still young (9 months and 2 years), memory is likely to be less of a problem than in other surveys in which mothers are forced to recall breastfeeding behaviors for multiple children and over longer periods of time.

mothers with a high education level.[16] In the interactive model (Table 3.6, Model 2), the monthly dummy coefficients can be interpreted as the log likelihood of quitting for a mother without a college degree in that month, while the interaction terms can be interpreted as the difference in log likelihood of quitting in that month for a mother with a college degree as compared to one without. The results indicate that there are timing differences in quitting according to the mother's education level. While mothers without a college degree are highly likely to quit breastfeeding in the second through fourth months (that is, they are not significantly less likely to quit than in the sixth month), mothers with a college degree are significantly less likely to quit in these months. Moreover, while mothers without a college degree have about 1.7 times the odds of quitting in the first month than the sixth month (OR=exp(.531)=1.7); mothers with a college degree are actually less slightly likely to quit in the first month than in the sixth month (OR=exp(.531-.637)=.9). These results suggest that education does matter for timing of breastfeeding cessation, and having a college education seems to be especially protective against quitting in the first few months. Beyond month four, the likelihood of quitting by month does not vary by mother's education—women who breastfed for at least four months are equally likely to quit in a subsequent month regardless of education level.[17] Notably these models control for whether or not a mother is currently working or returning to work in the next month (although not part time or full time status), so this difference is not simply due to differences in work status.

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[16] I restrict the interaction to the indicator for bachelor's degree because too few mothers are in the lowest education category (less than 8 years) for an interaction to be meaningful. This effectively constrains the effect of time since birth to be the same for mothers with any high school and mothers with less than high school (while allowing the underlying likelihood of quitting to be lower among those with less than 8 years of school). The substantive results are the same if the interactions between the monthly time dummies and the indicator for less than 8 years of education are included.

[17] Nonetheless, (all) women remain more likely to quit in some months than other months.

These results suggest that highly educated mothers are more likely to attempt (or at least to report) to stick to the recommended guidelines for breastfeeding and are less likely to quit at months that do not align with medically prescribed intervals.[18] It is not possible to tell whether higher rates of cessation among lower educated women are due to physical breastfeeding difficulties, difficulties in combining breastfeeding with other activities that are not explicitly controlled for in the analyses, or less conviction in the importance of breastfeeding. If we believe that mothers who initiate breastfeeding are at least open to the idea of breastfeeding, it would be useful to figure out why women with less education who decide to initiate breastfeeding quit after shorter intervals and how to support longer breastfeeding intervals for these women.

Predicted Probabilities

To get a better sense of the importance of the relationship between education and breastfeeding, Figures 3.2 and 3.3 show the predicted probabilities of breastfeeding initiation and cessation for a mother with a given set of individual characteristics, but varying levels of education (Long 1997; Long and Freese 2006). Figure 3.2 shows the probability of breastfeeding *initiation*, and is based on Model 5 of Table 3.3. The strength and linearity of the relationship between education and breastfeeding initiation is striking. Mothers with the baseline characteristics with some high school but less than a high school degree have only about a .49 probability of initiating breastfeeding, compared to a .83 probability for a mother with the same characteristics plus a bachelor's degree.

[18] Note that I am not explicitly testing the APA guidelines since I do not consider whether the breastfeeding is full or partial in the first sixth months.

Figure 3.3 shows the predicted probabilities of *quitting* breastfeeding for a mother with various education levels based on Model 5 of Table 3.4. The cessation model is based on a mother with the same baseline characteristics as presented in the initiation model, and the predicted probabilities are calculated for month 6 (recall that the underlying hazard of quitting varies by month). The results suggest that the overall relationship between education and breastfeeding duration is positive, with mothers with higher education more likely to quit breastfeeding in a given month. However, the relationship between education and breastfeeding cessation is not as linear or smooth as that for initiation.

Conclusion

Breastfeeding is a unique process because it must be performed by the child's biological mother. Nonetheless, while individual mothers make the final decisions regarding whether and how long to breastfeed their children, these decisions are shaped by the social circumstances in which the choice is made. Maternal education is one factor that has implications for both the material and social environment in which a mother decides whether or not to breastfeed. Thus education likely affects a mother's desire as well as ability to breastfeed.

Results indicate that while mothers with more education tend to be advantaged in many aspects in their lives, including income and household structure, these factors do relatively little to explain the relationship between maternal education and breastfeeding initiation rates. Even after controlling for mother characteristics, household income and a mother's work status, mothers with a college degree have 3 to 4 times the odds of initiating breastfeeding and a 30 to 40% lower odds of quitting breastfeeding in a given

time interval than mothers with only a high school degree. Moreover, while highly educated mothers are most likely to report using parenting books, and mothers who report using parenting books are more likely to initiate and continue breastfeeding, differences in breastfeeding rates do not appear to be related to more educated women's higher likelihood of using such materials.

If resource use does not seem to explain the higher breastfeeding rates of highly educated women, then conceivably disparities in beliefs and ideas about parenting practices could contribute to differing breastfeeding rates. Both parenting ideas and maternal education are connected to a mother's social environment as an adult and child, and controlling for other indicators of a mother's social environment, such as her parents' education and her partner's occupational prestige, does seem to reduce the relationship between education and breastfeeding initiation. Nonetheless, maternal education remains a strong predictor of breastfeeding initiation, regardless of model controls.

Educational differences in breastfeeding rates may reflect differences in autonomy, structural constraints, or parenting knowledge facing lower educated mothers that are not captured in the models. Descriptive statistics indicate that exposure to breastfeeding knowledge among mothers is high. Some 87% of mothers report being told about breastfeeding during prenatal care, and less educated mothers are *more* likely than more educated mothers to report learning about breastfeeding during prenatal care. While the content of this breastfeeding information is not known, the high level of maternal exposure to medical knowledge regarding breastfeeding suggests that there other factors that are encouraging or preventing mothers from initiating and continuing to breastfeed their infants. Moreover, the difficulty in combining work with breastfeeding

evidenced by the higher stopping rates of working mothers attests to the importance of promoting family and work contexts that are supportive of the time demands of breastfeeding. Such support would allow both higher and lower educated mothers to breastfeed if they so desire.

Alternatively it may be that differences in breastfeeding rates among mothers with different education levels reflect normative parenting preferences related to social class, and a mother's own contributions to her social environment (through her educational attainment) contribute heavily to those preferences. A social behaviorist perspective suggests that people act in ways that are met with social approval, thereby reinforcing those behaviors (Collins 1994; Ritzer 2001). It may be that breastfeeding is a socially desired behavior among those with more education (perhaps because of its reported health benefits); therefore mothers in this social group may feel that they are expected to breastfeed (and may find it difficult *not* to breastfeed)—regardless of the material and social differences between less and more educated mothers.[19]

[19] Nonetheless, it is important to note that group beliefs are likely modified by the constraints they face, so groups that are less able to act in a certain way may also be less likely to believe that is the way they should act.

Tables and Figures

Table 3.1. Description of Variables Used in the Analysis of Breastfeeding Initiation and Cessation in the US

	Description	Source*
DEPENDENT VARIABLES		
Breastfeeding Initiation	dichotomous indicator: "Did you ever breast-feed {child's name}?"	9 mo
Breastfeeding Duration	dichotomous indicator set to 1 in the month in which a formerly breastfeeding mother reported that she stopped breastfeeding. Breastfeeding is censored at 12 months. Based on the following questions at the 9 month interview: "Did you ever breast-feed {child's name}?"; "Are you still breast-feeding {child's name}?"; "For how many months did you breast-feed him/her?" For mothers still breastfeeding at the 9 month interview this variable was supplemented with information from the 2 year interview: "How old was {child's name} in months when you completely stopped breast feeding him/her?" Valid for mothers that initiated breastfeeding	9 mo/2 yr
INDEPENDENT VARIABLES		
Child Characteristics		
Twin	dichotomous indicator for twin status	BC/9 mo
Male	dichotomous indicator for male child	BC/9 mo
First Child	dichotomous indicator for first child of mother	BC/9 mo
Circumstances Surrounding Birth		
Delivery Type	dichotomous indicator for c-section section	BC
Delivery Attendant	dichotomous indicator for use of a midwife	BC
Birthweight	very low birthweight (<1500g), low birthweight (1500-2500g), normal weight(>2500g)	BC
Use of Neonatal Intensive Care Unit (NICU)	dichotomous indicator for any stay in NICU at birth	9 mo
Household Location		
Region	four category variable based on mother's region--north, south, midwest, west	9 mo
Rural household	dichotomous indicator for living in a rural area	9 mo
Mother Characteristics		
Mother's Education	8 years or less, 9-12 years (no diploma), high school diploma (or equivalent), some college (no degree), associate's degree, bachelor's degree, graduate degree	9 mo
Mother's Marital Status at Birth	married, cohabiting, never married, previously married	9 mo
Mother's Race/Ethnicity	white, black, Hispanic, Asian, other	9 mo/BC
Mother's Place of Birth	US born, foreign born	BC/2 yr
Mother's Age at Birth	15-19, 20-24, 25-29, 30-34, 35 plus	BC/9 mo

(continued)

Table 3.1 (continued)

Mother's Work		
Mother's Work Status at Birth	in models of breastfeeding initiation, mother's work status at birth is divided into three categories—on paid maternity leave, working before birth without paid leave, and not working before birth (or quit work without intending to return)	9 mo
Mother's Occupation	in models of breastfeeding initiation, mother's occupation is divided into categories based on her type of work at the time of the interview—professional or science, arts or education, sales or administrative, manual, care, working in unknown occupation, or no occupation (not working). Mothers who were not working at the time of interview are considered to not have an occupation (not working)	9 mo
Mother's Current Work Status (time-varying)	in models of breastfeeding cessation a dichotomous variable is used to indicate the month before a mother returns to work	9 mo
Mother's Current Occupation (time-varying)	in models of breastfeeding cessation a time varying variable is used to indicate whether a mother is currently working in the following occupations: professional/science, arts/education, sales/administration, manual, care, unknown occupation, unemployed	9 mo
Household Resources		
Household Income	less than $5,000, $5,000 to less than $10,000, $10,000 to less than $30,000, $30,000 to less than $50,000, $50,000 to less than $75,000, $75,000 or more	9 mo
WIC use during pregnancy	dichotomous indicator for mother's report of WIC use during pregnancy	9 mo
Mother's Knowledge of Breastfeeding		
Learned about Breastfeeding during Prenatal Care	Dichotomous indicator: "During any of your prenatal care visits, did a doctor, nurse, or other health care worker talk with you about breast-feeding your {babies/baby}?"	9 mo
Used Parenting Books	Dichotomous indicator: "Have you used any books or magazines about babies or parenting to help you with {child's name}?"	9 mo
Social Background		
Highest Education of Mother's Parents	less than high school, high school, some college, bachelors, bachelors plus, unknown education	9 mo
Father's Occupational Prestige	six category variable based on mother's description of father's occupation: prestige less than 40, prestige 40-50, prestige 50-60, prestige 60 plus, unknown occupation, father unemployed [Prestige scores coded by the National Center for Education Statistics using the 1989 General Social Survey prestige scores]	9 mo

*BC=birth certificate; 9 mo=9 month interview; 2 yr=2 year interview

Table 3.2. Distribution of Variables Used in the Analysis of Individual and Family Characteristics and Breastfeeding in the US

	Sample Distribution*		Population Distribution**	
	Proportion	SE	Proportion	SE
Breastfeeding				
Ever breastfed	0.67	0.005	0.69	0.008
Mother Education				
less than 8 years	0.03	0.002	0.04	0.003
8-12 years (no diploma)	0.16	0.004	0.16	0.007
high school (or equivalent)	0.28	0.004	0.28	0.007
some college (no degree)	0.18	0.004	0.18	0.006
associate's degree	0.09	0.003	0.09	0.004
bachelor's degree	0.18	0.004	0.17	0.008
graduate degree	0.09	0.003	0.07	0.005
Mother Race/Ethnicity				
Non-Hispanic white	0.46	0.005	0.57	0.017
Non-Hispanic black	0.16	0.004	0.14	0.009
Hispanic	0.18	0.004	0.23	0.013
Non-Hispanic Asian	0.13	0.003	0.03	0.002
Other	0.07	0.002	0.03	0.002
Mother Nativity				
US born	0.74	0.004	0.79	0.008
Born outside US	0.26	0.004	0.21	0.008
Mother Age at Birth				
15-19	0.11	0.003	0.11	0.004
20-24	0.25	0.004	0.25	0.008
25-29	0.25	0.004	0.27	0.006
30-34	0.24	0.004	0.24	0.007
35 plus	0.15	0.003	0.14	0.007
Mother Marital Status at Birth				
married	0.64	0.005	0.65	0.010
cohabiting	0.19	0.004	0.19	0.007
never married	0.14	0.003	0.13	0.006
previously married	0.03	0.002	0.03	0.003
Child Characteristics				
twin	0.15	0.004	0.03	0.001
male	0.51	0.005	0.51	0.007
parity 1 (first child)	0.39	0.005	0.40	0.006
Circumstances Surrounding Birth				
any NICU stay	0.19	0.004	0.07	0.003
normal birth weight (>=2500g)			0.93	0.002
low birth weight (1500-2500g)	0.15	0.004	0.06	0.002
very low birth weight (<1500g)	0.11	0.003	0.01	0.000
c-section	0.33	0.005	0.26	0.007
midwife as birth attendant	0.07	0.003	0.09	0.009
Household Location				
south	0.35	0.005	0.37	0.009
northeast	0.15	0.004	0.17	0.009
midwest	0.23	0.004	0.22	0.008
west	0.27	0.004	0.24	0.009
rural	0.15	0.003	0.14	0.010

(continued)

(Table 3.2 continued)

WIC Use				
mother used WIC during pregnancy	0.42	0.005	0.41	0.013
Household Income				
less than $5,000	0.06	0.002	0.05	0.004
$5,000 to less than 10,000	0.06	0.002	0.06	0.003
$10,000 to less than 30,000	0.32	0.005	0.33	0.009
$30,000 to less than 50,000	0.21	0.004	0.21	0.006
$50,000 to less than 75,000	0.15	0.003	0.15	0.006
$75,000 plus	0.20	0.004	0.20	0.011
Mother's Work Status at Birth				
not working at birth	0.50	0.005	0.49	0.007
paid maternity leave	0.45	0.005	0.46	0.007
working before birth no paid maternity leave	0.05	0.002	0.05	0.003
Mother's Occupation				
professional/science	0.12	0.003	0.11	0.004
arts/education	0.17	0.004	0.19	0.006
sales/administration	0.05	0.002	0.06	0.003
manual	0.08	0.003	0.08	0.005
care	0.08	0.003	0.08	0.004
uknown occupation	0.09	0.003	0.09	0.004
unemployed	0.41	0.005	0.39	0.007
Mother's Knowledge of Breastfeeding				
learned about breastfeeding during prenatal care	0.86	0.003	0.87	0.006
used parenting books	0.69	0.005	0.69	0.008
Highest Education of Mother's Parents				
mom/dad less than high school	0.26	0.004	0.26	0.010
mom/dad high school	0.28	0.004	0.27	0.008
mom/dad some college	0.19	0.004	0.20	0.006
mom/dad bachelors	0.15	0.004	0.15	0.007
mom/dad bachelors plus	0.09	0.003	0.09	0.004
mom/dad unknown education	0.03	0.002	0.03	0.002
Father's Occupational Prestige* **				
prestige less than 40	0.43	0.005	0.46	0.009
prestige 40-50	0.10	0.003	0.11	0.004
prestige 50-60	0.23	0.005	0.22	0.010
prestige 60 plus	0.07	0.003	0.06	0.004
unknown occupation	0.06	0.003	0.06	0.004
father unemployed	0.10	0.003	0.10	0.005

n=10,550 observations

*estimates unweighted to reflect sample distribution

**estimates weighted to reflect population distribution

***sample limited to mothers living with partners at the child's birth

Table 3.3. Logistic Regression of Maternal Education and Breastfeeding Initiation among Mothers in the US, 2001

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Mother Education										
less than 8 years	0.538 **	0.180	-0.303	0.197	-0.313	0.201	-0.231	0.203	-0.147	0.204
8-12 years (no diploma)	-0.496 ***	0.086	-0.464 ***	0.093	-0.473 ***	0.096	-0.429 ***	0.097	-0.384 ***	0.095
high school (or equivalent)	---	---	---	---	---	---	---	---	---	---
some college (no degree)	0.414 ***	0.074	0.417 ***	0.075	0.392 ***	0.075	0.377 ***	0.076	0.281 ***	0.077
associate's degree	0.727 ***	0.129	0.675 ***	0.123	0.628 ***	0.121	0.594 ***	0.121	0.518 ***	0.120
bachelor's degree	1.400 ***	0.124	1.258 ***	0.122	1.099 ***	0.136	1.066 ***	0.137	0.895 ***	0.140
graduate degree	1.848 ***	0.185	1.687 ***	0.188	1.469 ***	0.192	1.427 ***	0.195	1.215 ***	0.198
Household Location										
south	-0.897 ***	0.107	-0.731 ***	0.109	-0.713 ***	0.108	-0.702 ***	0.109	-0.681 ***	0.110
northeast	-0.952 ***	0.094	-0.882 ***	0.097	-0.901 ***	0.104	-0.875 ***	0.106	-0.868 ***	0.108
midwest	-0.758 ***	0.100	-0.549 ***	0.102	-0.529 ***	0.101	-0.517 ***	0.101	-0.513 ***	0.101
west	---	---	---	---	---	---	---	---	---	---
rural	-0.384 ***	0.086	-0.333 ***	0.083	-0.269 ***	0.080	-0.273 ***	0.082	-0.247 **	0.082
Child Characteristics										
twin	-0.160	0.099	-0.093	0.101	-0.108	0.101	-0.136	0.100	-0.151	0.101
male	-0.025	0.067	-0.023	0.068	-0.035	0.068	-0.031	0.068	-0.040	0.068
any NICU stay	-0.067	0.144	-0.070	0.156	-0.076	0.157	-0.062	0.156	-0.082	0.158
Circumstances Surrounding Birth										
normal birth weight (>=2500g)	---	---	---	---	---	---	---	---	---	---
low birth weight (1500-2500g)	-0.348 ***	0.089	-0.295 **	0.098	-0.296 **	0.100	-0.305 **	0.100	-0.289 **	0.099
very low birth weight (<1500g)	-0.193	0.155	-0.101	0.162	-0.123	0.163	-0.133	0.162	-0.104	0.163
c-section	-0.167 *	0.073	-0.201 **	0.073	-0.210 **	0.072	-0.213 **	0.072	-0.212 **	0.071
midwife as birth attendant	0.161	0.133	0.190	0.140	0.214	0.140	0.218	0.140	0.228	0.140
Mother Race/Ethnicity										
Non-Hispanic white			---	---	---	---	---	---	---	---
Non-Hispanic black			-0.403 ***	0.107	-0.312 **	0.104	-0.296 **	0.104	-0.255 *	0.103
Hispanic			-0.684 ***	0.150	-0.699 ***	0.143	-0.679 ***	0.144	-0.662 ***	0.142
Non-Hispanic Asian			0.114	0.101	0.184	0.102	0.175	0.101	0.285 **	0.100
Other			-0.167	0.163	-0.117	0.164	-0.103	0.165	-0.101	0.164
Mother Nativity										
US born			-0.996 ***	0.128	-1.003 ***	0.127	-0.988 ***	0.126	-1.044 ***	0.130
Mother Age at Birth										
15-19			-0.101	0.139	-0.130	0.145	-0.131	0.146	-0.151	0.145
20-24			0.026	0.092	0.052	0.097	0.059	0.098	0.040	0.097
25-29			---	---	---	---	---	---	---	---
30-34			-0.072	0.092	-0.120	0.093	-0.132	0.095	-0.118	0.094
35 plus			0.129	0.119	0.065	0.117	0.041	0.118	0.061	0.118
Mother Marital Status at Birth										
married			---	---	---	---	---	---	---	---
cohabiting			-0.298 **	0.096	-0.200 *	0.091	-0.199 *	0.092	-0.202 *	0.092
never married			-0.575 ***	0.097	-0.474 ***	0.106	-0.471 ***	0.106	-0.498 ***	0.106
previously married			-0.270	0.173	-0.125	0.187	-0.118	0.193	-0.101	0.195
Child parity										
first child			0.328 ***	0.086	0.339 ***	0.088	0.229 **	0.086	0.227 **	0.086

(continued)

(Table 3.3 continued)

WIC Use during Pregnancy								
mother used WIC				-0.211 **	0.069	-0.227 **	0.074	-0.198 **	0.075
Household Income								
less than $5,000				-0.326 *	0.151	-0.293	0.152	-0.240	0.151
$5,000 to less than 10,000				0.015	0.163	0.040	0.168	0.063	0.169
$10,000 to less than 30,000				-0.099	0.077	-0.075	0.079	-0.053	0.078
$30,000 to less than 50,000				---	---	---	---	---	---
$50,000 to less than 75,000				-0.050	0.122	-0.068	0.122	-0.085	0.124
$75,000 plus				0.189	0.121	0.174	0.120	0.151	0.119
Mother's Work Status at Birth								
not working at birth				---	---	---	---	---	---
paid maternity leave				-0.118	0.077	-0.116	0.077	-0.115	0.078
working before birth no paid maternity leave				-0.041	0.171	-0.034	0.175	-0.022	0.173
Mother's Occupation								
professional/science				0.064	0.145	0.068	0.144	0.087	0.146
arts/education				-0.355 ***	0.096	-0.358 ***	0.096	-0.355 ***	0.098
sales/administration				-0.201	0.148	-0.201	0.146	-0.183	0.144
manual				-0.375 ***	0.114	-0.368 **	0.117	-0.345 **	0.116
care				-0.072	0.116	-0.068	0.115	-0.062	0.116
uknown occupation				-0.051	0.108	-0.051	0.108	-0.043	0.107
unemployed				---	---	---	---	---	---
Mother's Knowledge of Breastfeeding								
learned about breastfeeding during prenatal care						0.098	0.094	0.101	0.093
used parenting books						0.456 ***	0.075	0.438 ***	0.075
Highest Education of Mother's Parents								
mom/dad less than high school								-0.235 **	0.086
mom/dad high school								---	---
mom/dad some college								0.076	0.076
mom/dad bachelors								0.363 **	0.116
mom/dad bachelors plus								0.408 **	0.144
mom/dad unknown education								-0.477 **	0.159
Intercept	1.273 ***	0.098	2.103 ***	0.161	2.383 ***	0.177	2.017 ***	0.196	2.048 ***	0.210

n=10,550 observations

Table 3.4. Discrete Time Hazard Models of Maternal Education and Breastfeeding Cessation among Mothers in the US, 2001

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Mother Education										
less than 8 years	-0.383 ***	0.096	-0.236 *	0.101	-0.271 *	0.108	-0.304 **	0.104	-0.300 **	0.107
8-12 years (no diploma)	0.194 *	0.080	0.087	0.085	0.086	0.082	0.069	0.081	0.072	0.080
high school (or equivalent)	---	---	---	---	---	---	---	---	---	---
some college (no degree)	-0.202 **	0.064	-0.133 *	0.065	-0.157 *	0.067	-0.142 *	0.067	-0.072	0.068
associate's degree	-0.148 *	0.074	-0.023	0.076	-0.060	0.074	-0.056	0.073	0.017	0.076
bachelor's degree	-0.510 ***	0.059	-0.323 ***	0.070	-0.355 ***	0.073	-0.334 ***	0.073	-0.217 **	0.079
graduate degree	-0.655 ***	0.081	-0.408 ***	0.089	-0.494 ***	0.089	-0.478 ***	0.090	-0.312 **	0.098
Household Location										
south	0.312 ***	0.063	0.307 ***	0.065	0.288 ***	0.065	0.288 ***	0.066	0.273 ***	0.067
northeast	0.288 ***	0.087	0.323 ***	0.083	0.321 ***	0.081	0.314 ***	0.081	0.307 ***	0.080
midwest	0.250 ***	0.063	0.247 ***	0.068	0.221 **	0.070	0.218 **	0.070	0.215 **	0.070
west	---	---	---	---	---	---	---	---	---	---
rural	0.009	0.075	-0.013	0.080	-0.050	0.084	-0.052	0.085	-0.085	0.085
Child Characteristics										
twin	0.333 ***	0.051	0.393 ***	0.054	0.425 ***	0.053	0.435 ***	0.054	0.442 ***	0.054
male	0.040	0.040	0.027	0.039	0.027	0.039	0.024	0.038	0.031	0.038
any NICU stay	0.167	0.095	0.152	0.095	0.128	0.095	0.134	0.093	0.147	0.093
Circumstances Surrounding Birth										
normal birth weight (>=2500g)	---	---	---	---	---	---	---	---	---	---
low birth weight (1500-2500g)	0.155 *	0.060	0.129 *	0.062	0.166 **	0.060	0.155 *	0.059	0.140 *	0.059
very low birth weight (<1500g)	0.286 **	0.106	0.240 *	0.105	0.341 **	0.106	0.344 **	0.106	0.316 **	0.104
c-section	0.072	0.046	0.112 **	0.041	0.100 *	0.040	0.099 *	0.041	0.096 *	0.041
midwife as birth attendant	-0.192 **	0.073	-0.216 **	0.078	-0.210 **	0.078	-0.225 **	0.077	-0.211 **	0.077
Mother Race/Ethnicity										
Non-Hispanic white			---	---	---	---	---	---	---	---
Non-Hispanic black			0.109 *	0.054	0.060	0.056	0.033	0.056	0.000	0.058
Hispanic			0.305 **	0.099	0.322 ***	0.096	0.316 ***	0.096	0.317 ***	0.095
Non-Hispanic Asian			0.154 *	0.071	0.123	0.073	0.121	0.075	0.078	0.078
Other			-0.264 *	0.111	-0.325 **	0.120	-0.329 **	0.117	-0.343 **	0.116
Mother Nativity										
US born			0.337 ***	0.064	0.309 ***	0.065	0.312 ***	0.065	0.325 ***	0.062
Mother Age at Birth										
15-19			0.271 **	0.100	0.282 **	0.099	0.286 **	0.100	0.291 **	0.101
20-24			0.075	0.063	0.066	0.061	0.065	0.059	0.080	0.059
25-29			---	---	---	---	---	---	---	---
30-34			-0.177 ***	0.052	-0.183 ***	0.053	-0.167 **	0.051	-0.180 ***	0.051
35 plus			-0.261 ***	0.046	-0.282 ***	0.049	-0.275 ***	0.050	-0.282 ***	0.050
Mother Marital Status at Birth										
married										
cohabiting			0.275 ***	0.062	0.184 **	0.065	0.183 **	0.065	0.179 **	0.065
never married			0.418 ***	0.080	0.300 ***	0.087	0.305 ***	0.088	0.303 ***	0.087
previously married			0.309 **	0.106	0.152	0.110	0.159	0.111	0.164	0.108
Child parity										
first child			0.028	0.047	0.006	0.047	0.028	0.048	0.027	0.048

(continued)

(Table 3.4 continued)

WIC Use during Pregnancy										
mother used WIC					0.222 ***	0.063	0.207 ***	0.062	0.194 **	0.062
Household Income										
less than $5,000					0.250	0.143	0.242	0.143	0.222	0.141
$5,000 to less than 10,000					0.207	0.115	0.190	0.112	0.191	0.112
$10,000 to less than 30,000					0.036	0.061	0.021	0.061	0.013	0.060
$30,000 to less than 50,000					---	---	---	---	---	---
$50,000 to less than 75,000					0.027	0.068	0.013	0.068	0.014	0.068
$75,000 plus					0.166 *	0.070	0.168 *	0.069	0.172 *	0.071
Mother's Current Work Status										
returning to work next month					0.268 ***	0.064	0.262 ***	0.066	0.248 ***	0.065
Mother's Current Occupation										
working in professional/science					0.559 ***	0.071	0.550 ***	0.070	0.543 ***	0.068
working in arts/education					0.461 ***	0.090	0.454 ***	0.089	0.439 ***	0.090
working in sales/admin					0.584 ***	0.085	0.586 ***	0.085	0.564 ***	0.085
working in manual					0.439 ***	0.123	0.437 ***	0.121	0.422 ***	0.121
working in care					0.460 ***	0.097	0.438 ***	0.095	0.408 ***	0.102
working in unknown job					0.280 *	0.121	0.288 *	0.123	0.286 *	0.117
unemployed										
Mother's Knowledge of Breastfeeding										
learned about breastfeeding during prenatal care							0.248 ***	0.056	0.242 ***	0.055
used parenting books							-0.161 **	0.051	-0.156 **	0.051
Highest Education of Mother's Parents										
mom/dad less than high school									-0.035	0.057
mom/dad high school									---	---
mom/dad some college									-0.175 ***	0.052
mom/dad bachelors									-0.277 ***	0.057
mom/dad bachelors plus									-0.428 ***	0.065
mom/dad unknown education									-0.166	0.149
Intercept	-1.636 ***	0.107	-2.042 ***	0.134	-2.311 ***	0.138	-2.405 ***	0.140	-2.285 ***	0.143

n = 7,050 mothers, 38,200 person months

All models control for monthly time dummies

Table 3.5. Father's Occupational Prestige and Mother's Breastfeeding Initiation and Cessation among Married and Cohabiting Mothers in the US, 2001

	INITIATION				CESSATION			
	Model 1		Model 2		Model 3		Model 4	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Mother Education								
less than 8 years	-0.119	0.222	-0.111	0.223	-0.290 *	0.119	-0.294 *	0.118
8-12 years (no diploma)	-0.413 ***	0.106	-0.412 ***	0.108	0.136	0.101	0.134	0.100
high school (or equivalent)	---	---	---	---	---	---	---	---
some college (no degree)	0.312 ***	0.085	0.307 ***	0.086	-0.034	0.073	-0.026	0.073
associate's degree	0.493 ***	0.134	0.472 ***	0.135	0.028	0.081	0.045	0.079
bachelor's degree	0.900 ***	0.146	0.855 ***	0.150	-0.200 *	0.083	-0.152	0.085
graduate degree	1.274 ***	0.206	1.176 ***	0.211	-0.273 **	0.103	-0.194	0.106
Highest Education of Mother's Parents								
mom/dad less than high school	-0.297 **	0.103	-0.288 **	0.103	-0.001	0.053	-0.005	0.065
mom/dad high school	---	---	---	---	---	---	---	---
mom/dad some college	0.043	0.094	0.046	0.094	-0.167 **	0.067	-0.169 **	0.060
mom/dad bachelors	0.375 **	0.133	0.367 **	0.132	-0.284 ***	0.058	-0.278 ***	0.062
mom/dad bachelors plus	0.370 *	0.154	0.352 *	0.152	-0.448 ***	0.062	-0.432 ***	0.068
mom/dad unknown education	-0.711 ***	0.170	-0.697 ***	0.168	-0.172	0.069	-0.172	0.177
Father's Occupational Prestige								
prestige less than 40			---	---			---	---
prestige 40-50			0.069	0.139			-0.019	0.099
prestige 50-60			0.145	0.088			-0.148 **	0.049
prestige 60 plus			0.453 *	0.208			-0.338 ***	0.085
unknown occupation			0.153	0.134			0.006	0.108
father unemployed			-0.037	0.133			0.174 *	0.077

Initiation models: n = 8,700 mothers with co-resident partners

Duration models: n = 6,150 mothers with co-resident partners who breastfed (34,750 person months)

Note: Models 1 and 2 include controls from Table 3.3, Model 5. Models 3 and 4 include controls from Table 3.4, Model 5.

Table 3.6. Discrete Time Hazard Models of Differences in Breastfeeding Cessation by Maternal Education, 2001

	Model 1		Model 2	
Time since birth	Est.	SE	Est.	SE
month 1	0.344 ***	0.086	0.531 ***	0.099
month 2	-0.105	0.088	0.035	0.101
month 3	-0.149	0.092	0.040	0.099
month 4	-0.323 **	0.101	-0.154	0.121
month 5	-0.834 ***	0.114	-0.757 ***	0.123
month 6	---	---	---	---
month 7	-0.647 ***	0.113	-0.586 ***	0.141
month 8	-0.651 ***	0.126	-0.634 ***	0.158
month 9	-0.260 *	0.109	-0.239	0.129
month 10	-0.445 ***	0.119	-0.526 **	0.187
month 11	-0.499 **	0.156	-0.424 *	0.185
month 12	0.854 ***	0.110	0.797 ***	0.128
Mother Education				
less than 8 years	-0.322 **	0.103	-0.317 **	0.100
any high school	---	---	---	---
bachelor's degree	-0.214 ***	0.055	0.105	0.104
Interactions				
bach. degree x month 1			-0.637 ***	0.175
bach. degree x month 2			-0.415 *	0.158
bach. degree x month 3			-0.576 ***	0.157
bach. degree x month 4			-0.481 **	0.170
bach. degree x month 5			-0.196	0.235
bach. degree x month 7			-0.156	0.226
bach. degree x month 8			-0.044	0.250
bach. degree x month 9			-0.059	0.234
bach. degree x month 10			0.178	0.267
bach. degree x month 11			-0.201	0.215
bach. degree x month 12			0.103	0.163

n = 7,050 mothers (38,200 person months)

Note: Models include controls from Table 3.4, Model 5.

Figure 3.1. Maternal Education and Breastfeeding Initiation and Duration in the US, 2001

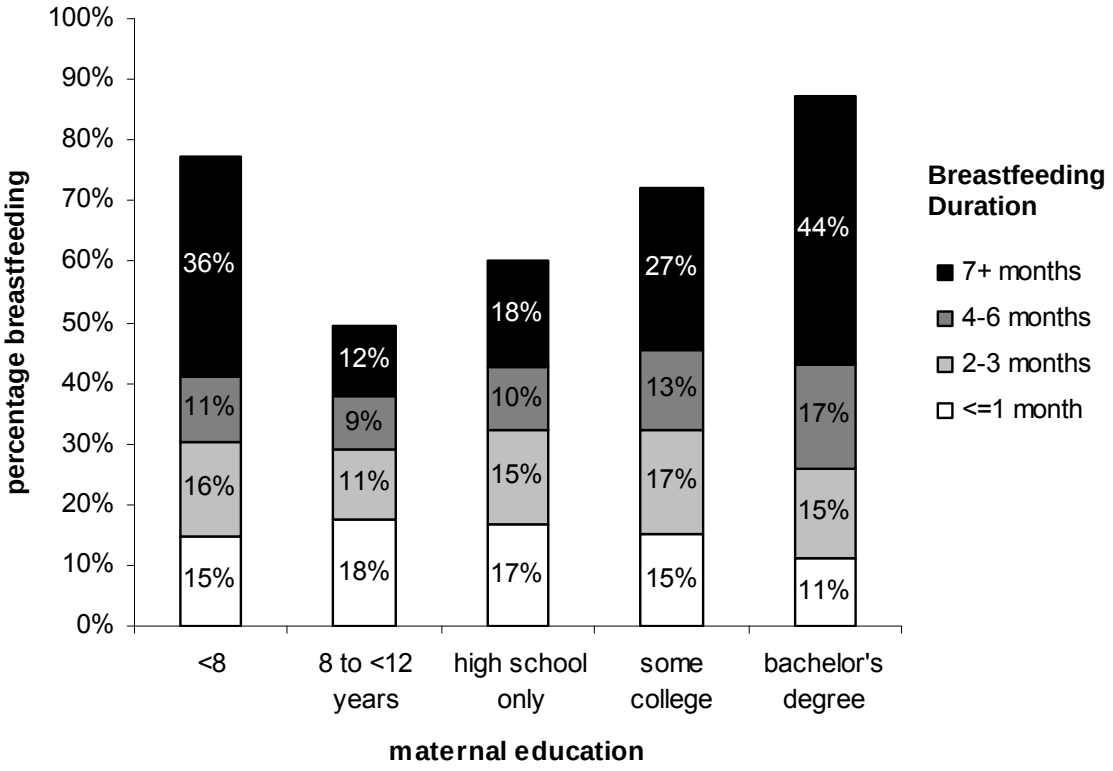
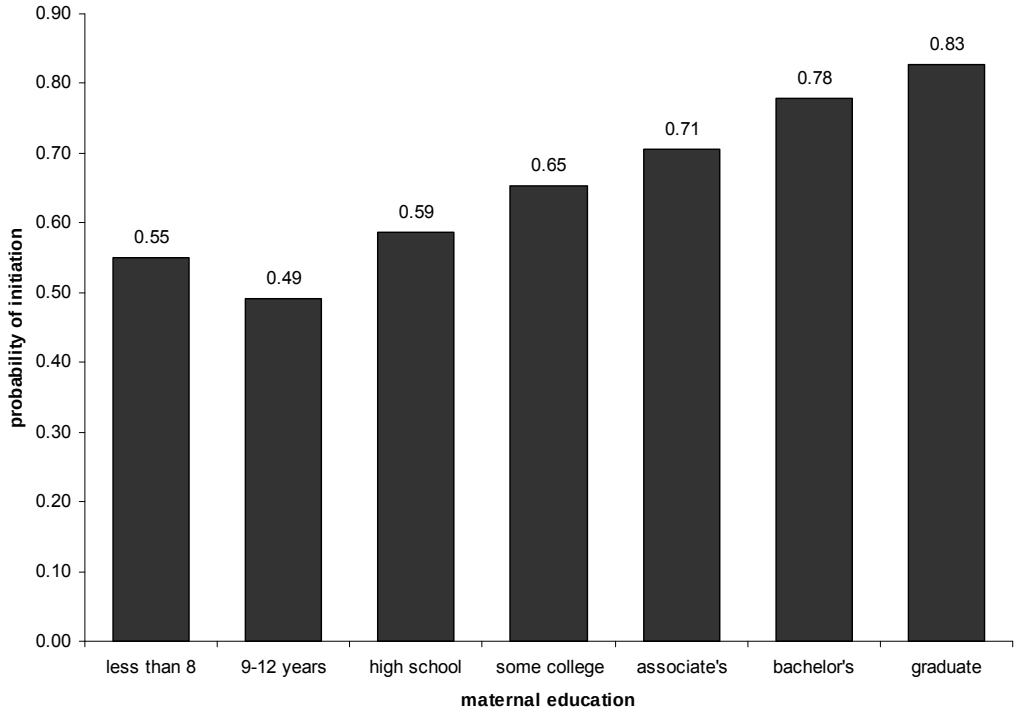


Figure 3.2. Predicted Probability of Breastfeeding Initiation for Mothers of Children Born in 2001 by Maternal Education

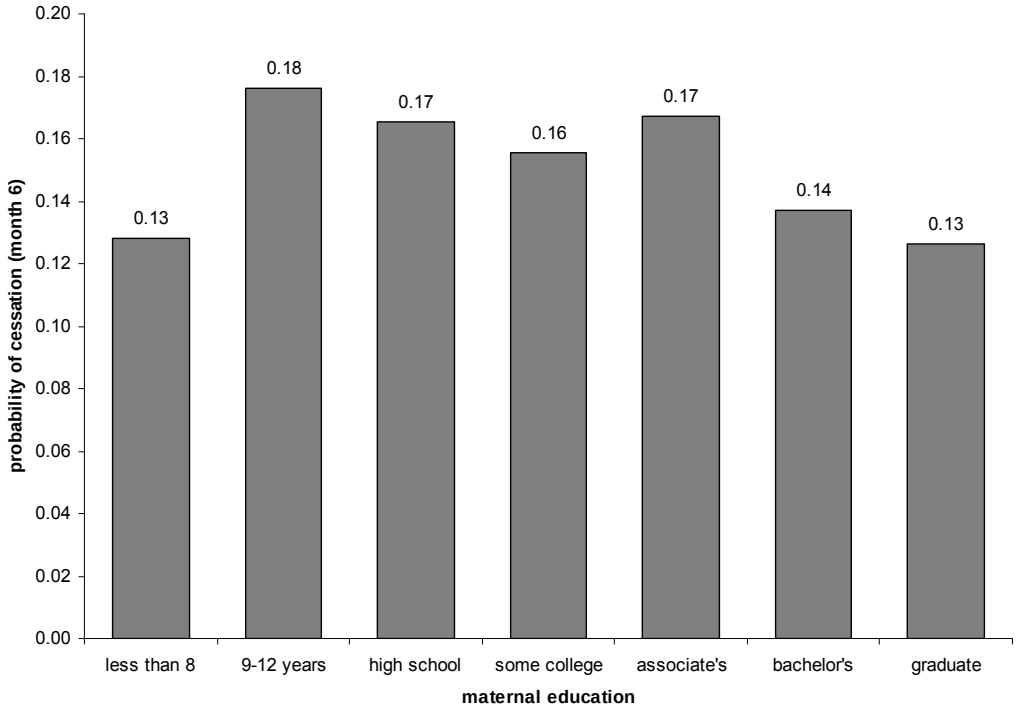


Notes:

Predicted Probabilities based on Table 3.3, Model 5.

Baseline characteristics: non-twin, first born, female child of normal birth-weight, that was not delivered via c-section or midwife, with a 25-29 year old, married, US born, non-Hispanic white mother, with income between $30-50,000, who did not use WIC during pregnancy, was not working or on maternity leave at birth, was not told about breastfeeding during prenatal care, did not use parenting books, and had at least one parent with a high school education (but not more than a high school education), living in the non-rural northeast.

Figure 3.3. Predicted Probability of Breastfeeding Cessation for Mothers of Children Born in 2001 by Maternal Education



Notes:

Predicted probability of quitting breastfeeding in month 6 for mothers who initiated breastfeeding and were still breastfeeding at month 6.

Predicted Probabilities based on Table 3.4, Model 5.

Baseline characteristics: non-twin, first born, female child of normal birth-weight, that was not delivered via c-section or midwife, with a 25-29 year old, married, US born, non-Hispanic white mother, with income between $30-50,000, who did not use WIC during pregnancy, was not working or on maternity leave at birth, was not told about breastfeeding during prenatal care, did not use parenting books, and had at least one parent with a high school education (but not more than a high school education), living in the non-rural northeast.

CHAPTER FOUR. NATIVITY AND BREASTFEEDING

Introduction

This chapter continues the examination of individual and familial characteristics and breastfeeding, focusing on the relationship between maternal place of birth (US or elsewhere) and breastfeeding in the US. In 2001 approximately 1 in 5 children born in the US had a mother that was born outside the United States. Because such a high proportion of children in the US have foreign born mothers, maternal immigration status is highly relevant for understanding maternal related health behaviors, such as breastfeeding.

The relationship between place of origin and health outcomes is an important topic of inquiry among social scientists. Immigrant status has been linked to positive health outcomes, predominantly among Hispanic populations, and particularly in terms of adult mortality, infant mortality, and low birth weight (Markides and Coreil 1986; Singh and Yu 1996; Singh and Siahpush 2001). Given the relatively low socio-economic status of Hispanic immigrants, such positive outcomes are somewhat surprising, and the phenomenon has been called the "epidemiologic (also Hispanic or immigrant) health paradox" (Markides and Coreil 1986). One potential source of health disparities between immigrant and US born individuals is differing health behaviors. However, some theories suggests that if, and when, immigrants become integrated (acculturated) into

their new places their health behaviors may change for the worse and their health advantages may disappear.[20]

Breastfeeding is one health behavior that can be considered a part of the immigrant health paradox (Kimbro et al. 2008). Research has suggested that foreign born mothers have higher breastfeeding rates, and this difference is generally attributed to differences in norms and practices in their countries of origin. At the same time, there is some evidence that indicators of acculturation are negatively related to breastfeeding rates. To this point research on the relationship between nativity and breastfeeding has for the most part been limited to non-representative samples of Hispanic mothers. In the current chapter I revisit the relationship between maternal birth place (foreign vs. US) and breastfeeding in a nationally representative sample of children. First, I examine the relationship between race/ethnicity and nativity and breastfeeding in the US to determine whether the positive relationship between foreign born status and breastfeeding exist across four broadly defined racial/ethnic groups—non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic Asian. I then examine the relationship between foreign born status and breastfeeding in sub-samples from the two ethnic populations of mothers that have the highest proportions of foreign born members and also comprise the highest proportion of foreign born mothers in the US—Hispanic mothers and non-Hispanic Asian mothers. I consider differences between foreign born and US born mothers, to determine whether the relationship between foreign born status and breastfeeding depends on how long the mother has lived in the US, the age the mother came to the US, or the use of English at home—three indicators that could reflect

[20] A review of research on the relationship between acculturation and health behaviors among Latinos in the U.S. suggests that acculturation seems to have negative effects on health behaviors, such as nutrition, smoking, and drug use, but positive effects on health care use and access (Lara et al. 2005).

differences in acculturation, but notably may also reflect differences in the selection processes that contributed to the mother's decision to migrate to the US and remain in the US.

Why Foreign Born Status Might be Related to Breastfeeding

Following the rational/utilitarian perspective presented in Chapter One, differences in breastfeeding between foreign born and US born mothers and among foreign born mothers would be expected to be related to differences in the desire and ability to breastfeed between these groups. Differences in the desire to breastfeed may be related to variation in the beliefs and knowledge regarding breastfeeding. If foreign born mothers are more likely to believe that breastfeeding is something that a mother should do (a mother's role) or to believe in the benefits of breastfeeding, then foreign born mothers may be more likely to breastfeed than US born mothers.[21] We may also expect differences in the desire to breastfeed among foreign born mothers based on their pre- and post-migration experiences. A socialization perspective suggests that a person's beliefs and behaviors are shaped by his or her social environment. Consequently, we might expect that a mother's beliefs regarding breastfeeding may be shaped by whether she spent different periods in her life in the US or elsewhere, as well as the content of her social group and peers in each location (for example, whether she is surrounded by US born children and adults or other foreign born children and adults after arriving in the US).

Foreign born mothers may also differ in their ability to implement their breastfeeding intentions. If a foreign born mother does not work (due to difficulties

[21] We would also expect the beliefs of foreign born mothers to vary based on place of origin.

finding work or lack of intention to work), then we might expect that such a mother would have fewer constraints to breastfeeding than US born mothers (who are likely to work). Moreover, for such mothers breastfeeding could provide a relatively inexpensive source of food (particularly if a mother is not aware of or does not qualify for federal assistance). On the other hand, if a foreign born mothers is working, or if she came to the US to work, then she is likely to be to faced with the constraint of combining work and breastfeeding.[22]

Background and Literature Review

In the US, advantage is generally related to breastfeeding; however, this correlation tends to break down when we consider that Hispanic mothers, a markedly disadvantaged group in the US, nonetheless have one of the highest breastfeeding rates. This is in stark contrast to black mothers, another highly disadvantaged group, that have very low breastfeeding rates (www.cdc.gov). Recent research suggests that this disparity is largely attributed to differences in place of birth (Gibson-Davis and Brooks-Gunn 2006), and a much higher proportion of Hispanic mothers than black mothers are born outside the US.

While race/ethnicity has long been considered a strong predictor of breastfeeding in the US (Forste et al. 2001); researchers have only recently begun to recognize and explore the importance of immigration status. Analysis of data from the National Survey of Children's Health found that immigrant status was positively related to breastfeeding across multiple racial/ethnic groups, including Hispanics, whites, blacks, and "others"

[22] Notably, the working status of the mother may be related to differences in the beliefs regarding appropriate mothering roles or the importance of work, etc.

(Singh et al. 2007). Moreover, breastfeeding rates appear to be more similar across immigrant groups with different racial/ethnic backgrounds than between immigrant and non-immigrant groups with the same racial/ethnic background (Celi et al. 2005; Gibson-Davis and Brooks-Gunn 2006; Singh et al. 2007).

The recognition that immigrant status is an important predictor of breastfeeding has been accompanied by a more recent focus on factors that differentiate immigrants from each other—particularly, acculturation. Researchers hypothesize that differences in breastfeeding between immigrant and non-immigrant parents may be related to normative differences in support for breastfeeding. Foreign born mothers may be more likely than their US born counterparts to have come from places that were supportive of breastfeeding. As/if/when those born outside the US become less like the people they used to live with and more like the people they currently live among, they may be increasingly likely to follow what they consider the normative behaviors in their new environment. This could include giving up what they may consider more "traditional practices" such as breastfeeding (Kimbro et al. 2008). This process of integration, involving "the acquisition of the cultural elements of the dominant society" is known as acculturation (Lara et al. 2005, p. 369). Notably, the form, directionality, and inevitability of acculturation processes are highly debated (Lara et al. 2005).

While processes of acculturation are debated, the identification of significant associations between different categories of foreign born mothers and health outcomes or behaviors is undoubtedly useful. If certain proxies for acculturation are negatively related to breastfeeding, then those interested in increasing breastfeeding rates may want to target specific groups of foreign born mothers rather than assuming that all foreign

born mothers will have high breastfeeding rates. Indeed from a public health perspective, knowing who is less likely to breastfeed may be more important than knowing that acculturation is negatively related to breastfeeding, because it helps to identify particular segments of the population that may benefit from breastfeeding support.

In examining the relationship between foreign born status and breastfeeding, researchers have used a number of variables as proxies for acculturation, including generation status (Singh et al. 2007), years spent in the US (Gibson-Davis and Brooks-Gunn 2006; Harley et al. 2007; Sussner et al. 2008), and language use (Gibson et al. 2005; Sussner et al. 2008). The working hypothesis is that acculturation will lead a reduction in breastfeeding, and most research on acculturation and breastfeeding in the US with significant results has indeed concluded that acculturation is negatively related to breastfeeding initiation and duration (Gibson et al. 2005; Gibson-Davis and Brooks-Gunn 2006; Singh et al. 2007; Kimbro et al. 2008).

However, the results of previous research are often mixed or inconclusive. For example, some research only finds differences between US born mothers and foreign born mothers but no significant differences within foreign born mothers in multivariate analyses (Harley et al. 2007). Other research has found that some measures of acculturation are significantly related to breastfeeding but not others (Sussner et al. 2008; Kimbro et al. 2008). For example, Sussner et al. (2008) tested multiple measures of acculturation in a sample of Latinas from two northeastern cities and found that exclusive use of a native language was positively related to breastfeeding initiation and duration and maternal grandparents' nativity was significantly associated with greater breastfeeding durations. However, years of residence in the US (less than or greater than

8) and mother's own nativity were not significantly related to either initiation or duration in multivariate models.

Furthermore, most research on acculturation and breastfeeding has been focused on non-representative samples and mothers with Hispanic ancestry (Gibson-Davis and Brooks-Gunn 2006; Kimbro et al. 2008; Sussner et al. 2008). Only two studies focusing on immigration status, acculturation and breastfeeding in the US have used nationally representative samples. The first, using mothers from the National Health and Nutrition Examination Survey, found that Hispanic mothers with high acculturation based on a Spanish Language Use Scale (the Short Acculturation Scale) were less likely to have breastfed all their children for at least one month than their less acculturated Hispanic peers (Harley et al. 2007). However, this study divided all Hispanic mothers into acculturated or non-acculturated and did not explicitly consider mother's place of birth; for example, there was no comparison of acculturated foreign born Hispanics to US born Hispanics (who were presumably likely to be in the high acculturation group). Moreover, the analysis did not distinguish between births that occurred in the US and births that occurred elsewhere, and some of the mothers may have given birth to all their children outside the US. Finally, acculturation was measured at the time of the survey—based on the sample of mothers who were age 20 to 40—and may or may not have reflected the mother's acculturation at the time of the child's birth.

The second study to use a nationally representative sample to examine the relationship between immigrant status, acculturation, and breastfeeding was based on analysis of data from the National Survey of Children's Health and used generation status as an indicator of acculturation. The authors compared foreign born children, children

with one or two immigrant parents, and children with US born parents (Singh et al. 2007). The results showed some support for the importance of acculturation, at least among children with Hispanic parents. Among those of Hispanic ancestry, a foreign born child was significantly more likely to be breastfed than a US born child with US born parents or only 1 immigrant parent, and a foreign born child was more likely to be breastfed for six months than any US born child. However, breastfeeding rates among Hispanic mothers of US born children did not appear to be significantly different from each other. Moreover, the data were limited in that they did not contain information on the length of immigration of the parents and were also missing key controls such as the infant's health at birth, maternal age, and maternal employment status.

Current Analysis on Immigration and Breastfeeding

The high proportion of US born children with foreign born mothers highlights the importance of understanding differences in maternal health behaviors between US and foreign born mothers as well as differences within foreign born mothers. In the current analysis I revisit the relationship between nativity and breastfeeding in a nationally representative cohort of children born in the US. I complement and extend previous research in three ways. First, I use a nationally representative sample of children. Second, I separately consider three specifications of foreign born status—years in the US, age of arrival to the US, and use of English as a home language. Finally, while most previous research focuses on mothers of white, black and Hispanic categories (grouping all those with other race/ethnicities into the "other" category), this analysis includes a separate "Asian" category. This is possible because the ECLS-B included an over-sampling of Chinese and other Asian and Pacific Islander children. This is significant as

Asian mothers comprise the second largest contingent of foreign born mothers in 2001 and may have different behaviors than foreign born Hispanic mothers. While there is certainly heterogeneity within the Asian category (as well as within the Hispanic category), inclusion of Asian mothers is a step forward from previous research on maternal place of nativity and breastfeeding, which generally focuses exclusively on mothers of Hispanic origin.

ECLS-B Data Analysis Sample

As outlined in the data chapter, the primary data for this analysis come from the Early Childhood Longitudinal Study, Birth Cohort. As with chapter 3, for this chapter I make use of the birth certificate information and primary respondent interviews at 9 months and 2 years. The initial sample includes the n=10,550 children with a biological mother respondent at the 9 month interview (99% of ECLS-B children). The analyses of differences in breastfeeding among foreign born mothers is restricted to two sub-samples—Hispanic (n=1,900) and non-Hispanic Asian (n=1,400) mothers. This is because other racial/ethnic categories do not have a large enough number or proportion of foreign born mothers to consider differences within foreign born mothers.

Variables

Dependent Variables (Breastfeeding Outcomes)

The dependent variables, *breastfeeding initiation* and *breastfeeding duration*, parallel those used in Chapter 3 (see Chapter 3, Table 3.1 for description).

Nativity

Maternal nativity is based on self reports. Mothers indicated whether they were born in the US (50 states or DC), US Territories, or some other country. Mothers who were born in the 50 states are considered *native born*; mothers born in the US Territories or some other country are considered *foreign born*. Information on the nativity status of the mother was not collected from the respondent until the second interview. Because some mothers were lost to follow up at the second round, nativity information from self reports is supplemented with nativity information from birth certificates in order to retain all children in the analyses.

In some analyses, foreign born mothers are further divided into categories intended to capture differences in their experiences in the US as well as differences in their experiences prior to coming to the US. Three specifications are considered—years in the US (categorical), age to the US (categorical), and home language (dichotomous).

The first specification of nativity status considers a mother's time in the US. The idea is that the longer a mother has lived in the US, the more time she will have been exposed to "American" mothering and feeding practices. It may also reflect selection pressures as not all foreign born mothers are equally likely to remain in the US long term. At the first follow-up interview, when the child was approximately 2 years old, mothers who were not born in the 50 US states or DC were asked the age when they first moved to the US. For foreign born mothers, years in the US at the time of birth was determined by subtracting the age when the mother first moved to the US from the mother's age at

the birth of the ECLS-B child.[23] This variable is divided into four categories of roughly equal size (0-3; 4-8; 9-15; and 16 plus years). These categories are combined with a dummy indicator for the small number of those who *do not report the age* at which they moved to the US, a dummy indicator for those who did not receive the question because they were *foreign born but lost to follow up* after the first round, and a dummy indicator for *US born*.

The second specification of nativity status considers the age at which the foreign born mother arrived in the US rather than how long she has been in the US. The idea is that mothers' behaviors may depend on the stage of their own life course that they arrived in the US, as age of arrival will affect their exposure to US school systems and peers, which may influence the extent to which a mother's parenting practices are shaped by her country of origin or her country of destination (Glick 2009). Age of arrival in the US may also reflect differences in selection pressures that contributed to their migration. In this specification, mother's are divided into categories based on age of arrival to the US—early childhood (age 8 or younger), middle childhood/early adolescence (age 9 to 15), late adolescence (age 16-19), early adulthood (20-25), and late adulthood (26 plus). These categories are again combined with a dummy indicator for those who *do not report the age* at which they moved to the US, a dummy indicator for those who did not receive the question because they were *foreign born but lost to follow up* after the first round, and a dummy indicator for *US born*.

The final specification of nativity status is based on what the foreign born mother reports to be the "home language" of the child at the first interview. The home language

[23] There is no information on whether a mother made multiple moves or had been in the U.S. continuously since the first move. This analysis assumes the mother had been in the U.S. continuously since the first move.

is intended to indicate a mother's comfort as well as preference for communicating in English, the predominant language spoken in the US. It may also indicate a mother's ability to access information from US sources. *English home language* indicates foreign born mothers who report English as their child's home language. *Non-English home language* indicates foreign born mothers who report using some other language as their child's home language. These categories are combined with a dummy indicator for *US born*.

Other Independent Variables (Control Variables)

Control variables include mother's race/ethnicity (Hispanic, non-Hispanic white, non-Hispanic black, non-Hispanic Asian, and non-Hispanic other),[24] maternal education, mother's marital status at birth, mother's age at birth, child parity, child twin status, child sex, child birth weight, c-section birth, midwife assisted birth, household region, urban/rural location, household income, and maternal work status. Control variables used in the analysis are a sub-sample of those used in Chapter 3 and are described in Table 3.1 of Chapter 3.[25] Descriptive statistics of control variables are included in Table 3.2 of Chapter 3.

Methods and Models

Following analyses presented in Chapter 3, a separate model is used to predict breastfeeding initiation and duration (cessation). Logistic regression is used to predict

[24] Non-Hispanic other includes non-Hispanic mothers who reported multiple race/ethnicities.

[25] Three explanatory variables included in Chapter 3 Table 1 are not included as controls in this chapter—mother's knowledge of breastfeeding, mother's occupation, and education of mother's parents.

the dichotomous outcome of whether or not a woman initiates breastfeeding. A discrete time hazard model is used to model breastfeeding duration.

Analytic Plan

In this chapter I examine the relationship between maternal nativity and breastfeeding initiation and duration (cessation). I first examine the additive relationship between a mother's place of birth (US or foreign born) and breastfeeding with and without control variables. I then estimate an interactive model to see whether foreign born status depends on race/ethnicity. Next, because the relationship between foreign born status and breastfeeding may be different among foreign born mothers with different migration experiences and levels of exposure to the US, I examine alternate specifications of foreign born status to see whether the relationship between foreign born status and breastfeeding is the same among all foreign born mothers. Because the relationships between immigration status and breastfeeding may work differently within different racial/ethnic groups, I estimate the models separately for the two racial/ethnic groups with adequate proportions of foreign born mothers—Hispanic mothers and Non-Hispanic Asian mothers.[26] Notably, these are also the two racial/ethnic groups that comprised the largest proportion of foreign born mothers who gave birth in the US in 2001.

[26] While these sub-groups consist of individuals with very different places of origin, the assumption is that there may be relevant between group differences that lend value to modeling these processes separately. This is supported by the interactive models presented in Table 2.

Results

Nativity, Race/Ethnicity, and Breastfeeding

Table 4.1 shows the distribution of foreign born mothers who gave birth in 2001 by race/ethnicity and nativity status, along with their breastfeeding initiation rates. Proportions are weighted to be representative of the entire population of children born in 2001. The top panel includes the racial/ethnic and nativity distribution of the entire sample of mothers, as well as the proportion foreign born within each racial/ethnic group. Overall, 21% of mothers of children born in the US in 2001 and still living in the US at 9 months of age were foreign born. Of the foreign born mothers about 2/3 were of Hispanic origin, while 14% were of Asian origin, 12% were non-Hispanic white, and 7% were non Hispanic black. A high proportion of Hispanic mothers in the US were foreign born (~61%); however, non-Hispanic Asian mothers were most likely to be foreign born, with 87% of mothers in 2001 of Asian origin born outside the US. Non-Hispanic white and black mothers were much less likely to be foreign born, at 5% and 11% respectively. The middle panel of Table 4.1 includes the breastfeeding rates among all US born mothers and within each racial/ethnic grouping of US born mothers, while the bottom panel of Table 4.1 includes the breastfeeding rates among all foreign born mothers and within each racial/ethnic grouping of foreign born mothers. The bottom panel also includes the distribution of foreign born mothers within each racial/ethnic grouping based on the three categorizations used in the analyses. These descriptive statistics are presented for all racial/ethnic categories of foreign born mothers; however, due to the small proportion and number of foreign born non-Hispanic white and non-Hispanic black

mothers, differences in breastfeeding within foreign born mothers are not examined for these groups.

Table 4.2 shows the relationship between a mother's place of nativity and breastfeeding. The top panel shows the results for breastfeeding initiation; while the bottom panel shows the results for breastfeeding cessation. The first model shows includes only the nativity indicator and controls for race/ethnicity, the second model includes controls for other mother, family, and child characteristics, and the final model includes an interaction term between nativity and race/ethnicity. Results of the first two models in the top panel indicate that foreign born mothers are more likely than US born mothers to initiate breastfeeding, regardless of whether controls for other factors are included in the models. Does the relationship between nativity and breastfeeding initiation depend on maternal race/ethnicity? The third model in Table 4.2 adds an interaction between race/ethnicity and nativity. Addition of the interaction terms significantly improves model fit ($p<.001$). The positive coefficient on the main foreign born term indicates that foreign born white mothers are more likely to initiate breastfeeding than US born white mothers. Moreover, the significant interactions indicate that the relationship between nativity and breastfeeding initiation does depend on race/ethnicity. The positive interaction term between foreign born status and non-Hispanic black suggests that being foreign born is particularly beneficial for black mothers in terms of breastfeeding initiation. This term is only marginally significant ($p=.051$); however, foreign born black mothers make up a very small proportion of the sample and population. Controlling for other factors, the relationship between nativity and breastfeeding is eliminated and even partially reversed for Asian mothers—the

negative coefficient on the interaction term between foreign born and Asian status more than counteracts the positive coefficient on the main foreign born term.

The bottom panel of Table 4.2 includes models of breastfeeding cessation. These models parallel those for breastfeeding initiation. Recall from Chapter 3 that a positive coefficient in the cessation models means that someone with that particular characteristic is *more likely to quit* breastfeeding in a given month, so a positive coefficient implies less breastfeeding.[27] Results of the additive models indicate that foreign born status is negatively related to breastfeeding cessation—that is foreign born mothers are *less likely* to quit breastfeeding in a given month than US born mothers, with and without controls for individual and family factors (Table 4.2, Panel 2, Models 1 and 2). The final model in the bottom panel of Table 4.2 includes an interaction between race/ethnicity and nativity. Results indicate that the relationship between a mother's place of nativity and breastfeeding duration also depends on race/ethnicity. Once again, addition of the interaction terms significantly improves model fit ($p<.001$). The lack of significance on the main foreign born term indicates that foreign born white mothers are not significantly less likely to quit breastfeeding than US born white mothers. However, the positive coefficients on the interaction between foreign born and non-Hispanic black term and foreign born and Hispanic term indicate that foreign born status increases breastfeeding duration within these two racial/ethnic groups.

To help clarify the somewhat complex relationship between nativity and breastfeeding as it varies by race/ethnicity, Figure 4.1 shows the breastfeeding cessation

[27] A characteristic that is positively related to breastfeeding would have a *positive* coefficient in models of breastfeeding *initiation*; while a characteristic that is positively related to breastfeeding would have a *negative coefficient* in models of breastfeeding *cessation* (since cessation means no longer breastfeeding). Consequently, a variable that had the *same* relationship with breastfeeding initiation and duration would be expected to have *opposite* signs in the two models.

rates for women who initiate breastfeeding, according nativity and race/ethnicity status. These results are based on Kaplan-Meier estimates of the survival function. Survival curves show the proportion of mothers that are still breastfeeding at a given time subsequent to birth. Only mothers who initiated breastfeeding are included in the model, so at time = 0 (birth) all survivor curves meet at 1. Foreign born mothers are represented by solid lines and US born mothers represented by dashed lines, while racial/ethnic groups are designated by different colored lines. These estimates do not control for any factors other than race/ethnicity and nativity.

The results suggest that there is far more variation in breastfeeding cessation among groups of individuals that are US born than among groups of individuals that are foreign born. US born Hispanics and non-Hispanic blacks have the steepest survival curves, suggesting that mothers in both groups quit breastfeeding at a relatively rapid pace. Notably, the survival curves among the foreign born groups are quite similar and well above that of US born Hispanics and US born non-Hispanic blacks. The survival curve of US born non-Hispanic whites is similar to those of the foreign born categories. US born Asians have the highest survival curve, particularly after the first and second months, indicating that US born Asian mothers are the least likely to quit breastfeeding once they begin. This is significant because it goes against the usual pattern of US born individuals breastfeeding less than foreign born individuals in the same racial/ethnic group. However, it is important to note that Asian mothers born outside the US also have high breastfeeding continuation rates, which are in line with those of foreign born mothers from other racial/ethnic groups.

Thus far we have seen that the relationship between foreign born status and breastfeeding depends both on the race/ethnicity of the mother as well as whether the breastfeeding outcome is initiation or duration. Among non-Hispanic black and Hispanic mothers, foreign born status is beneficial both for breastfeeding initiation and duration. Among non-Hispanic white mothers foreign born status is beneficial for breastfeeding initiation, but not for duration. The relationship between foreign born status and breastfeeding seems to work differently for Asian mothers. When evident, US born status appears to be positively related to breastfeeding initiation and duration among Asian mothers. In the next section I further explore the relationship between nativity and breastfeeding in the two groups that comprise the largest proportion of foreign born mothers in the US—Hispanic mothers and non-Hispanic Asian mothers.

Nativity and Breastfeeding among Hispanic and non-Hispanic Asian Mothers

In this section I consider whether the relationship between foreign born status and breastfeeding is the same for all foreign born mothers in a racial/ethnic group, or if the relationship varies systematically within foreign born mothers. Results thus far indicate that the relationship between foreign born status and breastfeeding operates differently among racial/ethnic groups in the US; consequently, I examine the relationship between foreign born status and breastfeeding in separate sub-samples divided by racial/ethnic status. I consider only non-Hispanic Asian and Hispanic mothers, both because they comprise the largest proportion of foreign born mothers who gave birth in 2001, and

because as subgroups they contain a large enough proportion of foreign born individuals to adequately explore variation within the foreign born.[28]

Tables 4.3 and 4.4 show the relationship between foreign born status and breastfeeding among *Hispanic* mothers, while Tables 4.5 and 4.6 show the same relationships among *Non-Hispanic Asian* mothers. Within each set of tables, the first table focuses on breastfeeding *initiation* (Tables 4.3 and 4.5), while the second table focuses on breastfeeding *cessation* (Tables 4.4 and 4.6). Within each racial/ethnic group and outcome I am interested in understanding the relationship between nativity status and breastfeeding. To do this I run separate models in which I divide foreign born mothers into three sets of categories based on the following criteria—how long the mother has lived in the US (Model 2), the age the mother came to the US (Model 3) and the use of English as the home language (Model 4). Within each categorization, foreign born mothers are compared to US born mothers. I also include confidence intervals around the estimates for foreign born mothers in order to determine whether any differences between foreign and US born mothers varies across foreign born categories.

Nativity and Breastfeeding among Hispanic Mothers

I begin with an examination of Hispanic mothers. Table 4.3 Model 1 shows the basic relationship between nativity and breastfeeding initiation among Hispanic mothers. The results confirm what we saw earlier, foreign born Hispanic mothers are more likely to breastfeed than US born Hispanic mothers (OR=exp(.801)=2.23). In the second model,

[28] Hispanic and Asian mothers make up the largest proportion of foreign born mothers at 66 and 14% respectively. Moreover, within the Hispanic and Asian populations, the majority of mothers in 2001 were foreign born (at 61 and 87% respectively). In contrast only 5% of white mothers than 11% of black mothers are foreign born, making it difficult to divide the foreign born mothers into categories large enough to detect significant differences.

foreign born mothers are divided into categories based on number of years that they had lived in the US before the birth of the focal child in 2001. Results indicate that foreign born Hispanic mothers who have lived in the US for the longest durations (at least 16 years) are not significantly more likely to initiate breastfeeding than those who were born in the US. All other categories of foreign born mothers are significantly more likely to initiate breastfeeding.

A socialization perspective suggests that a person's beliefs and behaviors are shaped by his or her social environment. Mothers that were born elsewhere but arrived in the US when they were young would be exposed to different social environments during critical periods in their lives than immigrants that arrived to the US in their late teens or in their 20s. For example, migrants who arrived at younger ages may be more likely to have early contact with non-immigrant peers in school or elsewhere (Glick 2009). This perspective indicates that the place of socialization (in the US or elsewhere) should be as or more important as number of years in a particular place in determining behaviors. Moreover, a life course perspective suggests that the timing of events, such as migration, will have implications for the consequences of such event. Indeed, the timing, or age of migration, may reflect differences in selection processes that contributed to the decision to migrate in the first place. From each of these perspectives, we would expect that a mother's *age of migration* would have consequences for her breastfeeding behavior. Model 3 incorporates this socialization/life course perspective.

Rather than consider the number of years a mother has been in the US (such as Model 2), this specification includes the age category that the mother arrived in the US.[29] Results indicate that foreign born Hispanic mothers who arrived in the US in any of the age categories except age 9-15 are more likely to initiate breastfeeding than US born Hispanic mothers, although this relationship seems to be largest for those who arrived at the oldest ages—age 26 or older.

The final specification of Table 4.3 considers home language use. Exclusive use of Spanish language has been considered an important measure of lack of acculturation that is associated with health benefits for Hispanic immigrants (Sussner et al. 2008), and foreign born mothers that consider English their home language may be more removed from the practices of their place of origin than foreign born mothers who are most comfortable speaking in other languages (or have had less exposure to English prior to coming to the US). In 2001, only about 13% of foreign born Hispanic mothers reported that English was used as their home language (see Table 4.1). There is not significant difference in breastfeeding initiation among foreign born Hispanics that use English as their home language and US born Hispanics; however, foreign born Hispanics that use some other language as their home language are more likely to initiate breastfeeding than US born Hispanic mothers.

The next set of regressions (Table 4.4) considers the same categorizations of foreign born status and the same racial/ethnic population (Hispanic mothers); however, the model type changes to discrete time hazard and the model outcome changes to breastfeeding cessation. In these models, negative coefficients indicate earlier cessation

[29] The correlation between years in the U.S. and age of arrival is high (~-.77 across foreign born mothers). However, these measures capture concepts that are in theory substantively different, thus considering both perspectives can be informative.

and therefore less breastfeeding. As with initiation, foreign born status is related to more breastfeeding, and foreign born Hispanics are less likely to quit breastfeeding in a given month than US born Hispanics (Model 1; OR=exp(-.455)=.64). Similar to what was seen in the initiation models, all foreign born mothers except those that have lived in the US for 16 plus years are less likely to quit breastfeeding in a given month than US born Hispanic mothers (Model 2). Moreover, the size of the coefficients is similar in magnitude across most of the foreign born categories. When we consider age of arrival to the US (Model 3), foreign born Hispanic mothers that arrived at any age group after age 8 are significantly less likely to quit in a given month than US born mothers. The final models (Model 4) suggest that there is no significant difference between Hispanic foreign born mothers with and without English as their home language; both are less likely to quit breastfeeding in a given month than US born Hispanic mothers.

Nativity and Breastfeeding among Asian Mothers

Tables 4.5 and 4.6 consider the same set of regressions as Table 4.3 and 4.4 for the sub-sample of non-Hispanic Asian mothers. As we saw in Model 4 of Table 4.2, the relationship between nativity and breastfeeding is somewhat different in Asian mothers. Among Asian mothers, US born mothers are no more or less likely to initiate breastfeeding than foreign born mothers (Table 4.5, Model 1). Nor are there significant differences between US and any category of foreign born mothers when we divide foreign born mothers based on years in the US (Model 2), age of arrival to the US (Model 3), or use of English as a home language (Model 4). However, supplementary analysis suggests that there is some evidence that there are differences among foreign born Asian mothers when considering use of English as a home language. In terms of language use,

speaking English at home is *positively* related to breastfeeding initiation among foreign born Asian mothers—those that do not use English as their home language are significantly *less likely* to initiate breastfeeding than foreign born mothers that use English as their home language (comparison not presented in table).

Table 4.6 shows the results for breastfeeding cessation among Asians. Foreign born Asian mothers are *more* likely to quit breastfeeding in a given month than foreign born Asian mothers (Model 1). That is, Asian mothers born in the US breastfeed for longer than their foreign born counterparts. When we consider time in the US, foreign born mothers are more likely to quit breastfeeding in a given month than native born mothers regardless of how long they have lived in the US, with the exception of foreign born Asian mothers who have been in the US for 9-15 years, who are not significantly more likely to quit than US born Asian mothers. The results of the age of arrival models (Model 3) indicate that Asian mothers that moved to the US at the youngest ages (before age 9) are not significantly more likely to quit breastfeeding than US born Asian mothers; however, mothers that moved to the US in all other age categories are more likely than US born Asian mothers to quit. Finally, if we consider English language use, foreign born Asian mothers who do not primarily use English at home are significantly more likely to quit than US born Asian mothers (Model 4). They are also more likely to quit than foreign born Asian mothers who use English as their home language (comparison not shown in table). There is no difference in cessation between foreign born Asian mothers who use English as a home language and US born Asian mothers.

Predicted Probabilities

To get a better sense of how breastfeeding initiation and duration rates vary between and among US born and foreign born mothers, Figures 4.2-4.3 translate the results of Table 4.3-4.6 into predicted probabilities. Figure 4.2 shows the predicted probabilities of breastfeeding initiation and cessation for Hispanic mothers with a given set of baseline characteristics but varying nativity statuses. Results are based on the models presented in Tables 4.3 and 4.4. For simplification, predicted probabilities are presented only for US born vs. foreign born status, number of years in the US, and use of English as a home language (Models 1, 2, and 4). Figure 4.3 shows predicted probabilities of breastfeeding initiation and cessation for non-Hispanic Asian mothers. Results are based on the models from Tables 4.5 and 4.6.

For Hispanic mothers, the predicted probabilities confirm that foreign born Hispanic mothers have higher breastfeeding initiation rates and breastfeed for longer durations than US born Hispanic mothers. Among foreign born Hispanic mothers, the predicted probabilities seem to show a slight trend toward higher initiation rates for mothers who have been in the US for the longest time. In terms of cessation, the trend is much less linear and foreign born Hispanic mothers in all categories seem to have a lower probability of cessation than their US born Hispanic counterparts.

For non-Hispanic Asian mothers, the predicted probabilities indicate there is little difference in terms of initiation between US born mothers and foreign born mothers in any category. In terms of cessation, overall, foreign born Asian mothers are more likely to quit breastfeeding in a given month than US born Asian mothers. The pattern of cessation within foreign born Asian mothers is less easily interpretable, except foreign

born mothers who report that English is not their home language quit at higher rates than those that are primarily English speakers—whether US or foreign born.

Conclusion

The goal of this chapter is to examine the relationship between nativity and breastfeeding initiation and duration in the US to determine 1) whether the relationship between nativity and breastfeeding is the same for all racial/ethnic groups, and 2) whether the relationship between foreign born status and breastfeeding depends on factors that might be related to aspects of the migration experience or the experiences since migration.

The results of the first part of the analysis indicate that immigrant status is positively related to breastfeeding for most groups, including non-Hispanic white, non-Hispanic black, and Hispanics mothers. Among non-Hispanic white mothers, having been born in the US is negatively related to breastfeeding initiation, but not significantly related to breastfeeding cessation among mothers who breastfed. Among non-Hispanic black and Hispanic mothers, having been born in the US is negatively related to both breastfeeding initiation and duration (that is, positively related to breastfeeding cessation). In contrast, the relationship between nativity and breastfeeding among Asian mothers is quite different than among other groups. When nativity status matters, *US born status* is associated with *more breastfeeding* among Asian mothers. Controlling for other factors, nativity is not significantly related to breastfeeding initiation among Asian mothers, suggesting that foreign and native born mothers are equally likely to breastfeed in this group. However, Asian mothers who were born in the US are less likely to quit breastfeeding in a given month than foreign born Asian mothers. Due to the low overall

proportion of Asian mothers in the US, previous research has not been able to examine the relationship between non-Hispanic Asian ethnicity and breastfeeding. While Asian mothers were a small portion of all mothers who gave birth in 2001 (~3%), Asian mothers are a population of relevance as they make up a relatively large proportion of foreign born mothers (14% foreign born mothers in the US who gave birth in 2001).

The second part of the analysis considered differences in breastfeeding among categories of foreign born mothers in two racial/ethnic groups—Hispanic mothers and non-Hispanic Asian mothers. This analysis considered three categorizations of foreign born mothers—years in the US, age of arrival to the US, and use of a home language. Previous research on behavioral differences among immigrants has framed the analysis in terms of acculturation. Each of the groupings in this analysis could be considered proxies for acculturation. In terms of breastfeeding, the expectation is that foreign born mothers who are more acculturated (lived in the US for the longest duration, arrived at the earliest ages, speak English at home) will be less likely to breastfeed.

However, while most research focuses on acculturation as a potential mechanism for differences in breastfeeding among foreign born mothers, differences among foreign born mothers may also reflect selection processes. For example, young children who move with their parents are likely to undergo different selection pressures than young adults who migrated on their own or with a partner, and this selection effect could contribute to differences in breastfeeding rates.[30] For this reason, considering alternate

[30] Note: While different selection pressures may contribute to differences in breastfeeding between and among foreign born mothers, there may also be selection in the sample via differential attrition, as children with foreign born mothers may be particularly likely to move abroad or hard to follow up. In the ECLS-B, breastfeeding is primarily measured in the first data collection round, so between wave attrition is not a substantial issue. However, information on maternal nativity was not collected until the second wave, so information on time in the US and age of arrival to the US is not available for foreign born mothers of children who left the sample (though notably if these children left the US, their exposure to breastfeeding is

specifications of foreign born mothers can be particularly useful in helping to understand differences among foreign born mothers.

If we consider the measures of foreign born status as proxies for acculturation, there is evidence some evidence that acculturation among foreign born Hispanic mothers is negatively related to breastfeeding; although these differences are only evident at the most extreme categories of foreign born. Mothers that had been in the US for the longest durations (16 plus years) are not significantly different from US born mothers in terms of initiation or duration. However, foreign born Hispanic mothers in each of the other duration categories in the US were more likely to initiate and less likely to quit breastfeeding than US born Hispanic mothers. The relationship between age of arrival to the US and breastfeeding is slightly more complicated that might be expected by a strict acculturation story. In terms of the timing of migration, mothers that had arrived in the US in any age category after age 8 are less likely to quit breastfeeding than Hispanic mothers born in the US. This supports an acculturation story. However, mothers that arrived in the US at any age except 9-15 were more likely to initiate breastfeeding than Hispanic mothers that were born in the US; although notably foreign born mothers that arrived at the oldest ages were the most likely to initiate breastfeeding.

For the most part, there are not significant differences in breastfeeding among foreign born Asian born mothers. However, to the extent categorizations within foreign born Asians mattered, measures that indicate more exposure to the US or US behaviors are often *positively* related to breastfeeding among Asian mothers. Neither years in the

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not relevant for understanding outcomes for children in the US). Moreover, since the first data round was not collected until the children were 9 months old, it is possible that there was differential attrition before the data were collected. Thus the data from the ECLS-B are reflective of children born in the US in 2001 who were still living in the US at age 9 months.

US or age of arrival to the US are significantly related to breastfeeding initiation among Asian mothers. However, there are some differences in terms of cessation. When we consider age of arrival to the US, all foreign born Asian mothers except those that moved to the US when they were 8 or younger are more likely to quit breastfeeding than US born Asian mothers, indicating that acculturation may contribute to increased breastfeeding rates among foreign born Asians (or perhaps age based selection contributes to lower breastfeeding rates among foreign born Asian migrants that arrive at older ages). The relationship between years in the US and breastfeeding cessation is somewhat less straightforward—all mothers who were born outside the US except those who have been in the US for 9-15 years are more likely to quit breastfeeding than US born Asian mothers. Finally, foreign born mothers who do not use English as a home language are more likely to quit breastfeeding in a given month, suggesting that among foreign born Asians, those with more "American behaviors" are more likely to breastfeed. If higher English use is a sign of acculturation, this also suggest that acculturation may contribute to increased breastfeeding rates among foreign born Asians; although, again, use of English at home may be picking up selection differences if different types of migrant mothers are more likely to speak English before leaving their country of origin or more likely to transition to English after arriving in the US.

Differences in the relationship between foreign born status and breastfeeding between Hispanic and non-Hispanic Asian mothers may also be related to differences in selection pressures affecting those two groups. Alba (1997) noted the bimodal pattern of immigration to the US including "human capital migrants" mostly from Asia and "labor migrants" from Mexico and Central America. Differences in type of migration may have

implications for the relationship between foreign born status and breastfeeding. For example, if foreign born Asian mothers come to the US to develop or take advantage of their high levels of human capital, they may prioritize this part of their life, and given the difficultly of combining work and breastfeeding, may have lower breastfeeding rates relative to Asian mothers who were born in the US.

This analysis examined the relationship between place of nativity (US or elsewhere) within two broadly defined racial/ethnic groups—Hispanic and non-Hispanic Asian. However, it is important to recognize that there is significant variation in place of origin among mothers within each of these groups. Data on a mother's country of birth is not available in the ECLS-B data files, but to get a sense of where these foreign born mothers are from, Table 4.7 shows the self-reported race/ethnicity of mothers in the Hispanic and non-Hispanic Asian groups. Proportions add up to slightly more than one because a very small number of mothers reported more than one race/ethnicity. A large majority of foreign and US born Hispanic mothers describe themselves of Mexican race/ethnicity (~70%). In contrast, there is substantial variation in reported race/ethnicity of non-Hispanic Asian mothers, with significant proportions reporting Asian Indian (26%), Chinese (24%), Filipino (15%), Vietnamese (12%), Korean (10%) and Japanese (5%) backgrounds. Moreover, there are large differences in self-reported race/ethnicity between foreign born and US born non-Hispanic Asian mothers. However, while such compositional differences could contribute to observed differences in breastfeeding between US and foreign born non-Hispanic Asian mothers, controlling for self-reported race/ethnicity does not change substantive results, suggesting that race/ethnicity based

composition differences do not explain differences in breastfeeding rates among foreign born and US born non-Hispanic Asian mothers (models not shown).

Tables and Figures

Table 4.1. Descriptive Statistics: Breastfeeding Initiation and Nativity Status among Mothers who Gave Birth in 2001 by Race/Ethnicity

All Mothers	ALL		FOREIGN BORN		WHITE		BLACK		HISPANIC		ASIAN		OTHER	
	Prop.	SE	Prop.	SE	Prop.	SE	Prop.	SE	Prop.	SE	Prop.	SE	Prop.	SE
Ever breastfed	0.69	0.008	0.82	0.012	0.71	0.012	0.49	0.021	0.76	0.011	0.81	0.013	0.63	0.032
Born in US	0.79	0.008	0		0.95	0.004	0.89	0.016	0.39	0.024	0.13	0.011	0.93	0.014
Born outside of US	0.21	0.008	1		0.05	0.004	0.11	0.016	0.61	0.024	0.87	0.011	0.07	0.014
Non-Hispanic white	0.57	0.017	0.12	0.014	1									
Non-Hispanic black	0.14	0.009	0.07	0.011			1							
Hispanic	0.23	0.013	0.66	0.020					1					
Non-Hispanic Asian	0.03	0.002	0.14	0.010							1			
Other	0.03	0.002	0.01	0.002									1	
sample size	10550		2700		4850		1700		1900		1400		750	

US Born Mothers	ALL US BORN		WHITE		BLACK		HISPANIC		ASIAN		OTHER	
	Prop.	SE	Prop.	SE	Prop.	SE	Prop.	SE	Prop.	SE	Prop.	SE
Ever breastfed	0.66	0.009	0.70	0.012	0.44	0.018	0.68	0.024	0.85	0.032	0.63	0.035

Foreign Born Mothers	ALL FOREIGN BORN		WHITE		BLACK		HISPANIC		ASIAN		OTHER	
	Prop.	SE	Prop.	SE	Prop.	SE	Prop.	SE	Prop.	SE	Prop.	SE
Ever breastfed	0.82	0.012	0.87	0.034	0.86	0.030	0.82	0.015	0.81	0.015	0.74	0.068
Years in US at birth of child (mean)[1]	9.31	0.268	10.73	0.873	9.52	0.886	8.78	0.350	10.14	0.273	13.14	1.667
Years in US												
0-3 years	0.27	0.013	0.28	0.047	0.24	0.032	0.28	0.016	0.24	0.013	#	
4-8 years	0.21	0.013	0.19	0.037	0.19	0.044	0.23	0.016	0.21	0.015	#	
9-15 years	0.20	0.012	0.16	0.043	0.16	0.044	0.22	0.014	0.20	0.014	#	
16 plus years	0.19	0.013	0.26	0.042	0.22	0.051	0.16	0.016	0.22	0.014	#	
years unknown[2]	0.13	0.009	0.11	0.029	0.19	0.039	0.12	0.013	0.14	0.010	#	
Age of Arrival to US												
0-8	0.14	0.010	0.22	0.039	0.13	0.036	0.13	0.013	0.13	0.014	#	
9-15	0.12	0.009	0.06	0.025	0.14	0.025	0.13	0.012	0.11	0.011	#	
16-19	0.17	0.010	0.07	0.024	0.13	0.030	0.21	0.013	0.09	0.009	#	
20-25	0.25	0.013	0.22	0.039	0.14	0.028	0.27	0.015	0.27	0.017	#	
26 plus	0.19	0.011	0.31	0.051	0.28	0.037	0.14	0.012	0.25	0.017	#	
years unknown[2]	0.13	0.009	0.11	0.029	0.19	0.039	0.12	0.013	0.14	0.010	#	
Home Language												
English as home language	0.24	0.015	0.54	0.047	0.59	0.043	0.13	0.013	0.28	0.017	#	
English not home language	0.76	0.015	0.46	0.047	0.41	0.043	0.87	0.013	0.72	0.017	#	
sample size	2700		200		150		1050		1250		50	

[1]Valid for foreign born mothers who report the age at which they came to the US (~87%)

[2]Includes no response and lost to follow up

Prop.s omitted due to insufficient sample size.

Note: Prop.s are weighted to reflect population distribution.

Table 4.2. Logistic Regression Models of Breastfeeding Initiation and Cessation in the US by Mother's Nativity and Race/Ethnicity

	Model 1		Model 2[1]		Model 3[1]	
INITIATION	Est.	SE	Est.	SE	Est.	SE
Non-Hispanic white	---	---	---	---	---	---
Non-Hispanic black	-1.003 ***	0.094	-0.331 **	0.104	-0.404 **	0.417
Hispanic	-0.191	0.097	0.165	0.102	0.209 †	0.358
Non-Hispanic Asian	-0.162	0.141	-0.688 ***	0.146	0.418	0.366
Other	-0.372 *	0.155	-0.114	0.161	-0.092	0.478
Foreign born	0.928 ***	0.123	0.998 ***	0.127	0.982 **	0.359
US born	---	---	---	---	---	---
Interactions						
Foreign born x black					0.856 †	0.433
Foreign born x Hispanic					-0.081	0.401
Foreign born x Asian					-1.275 **	0.480
Foreign born x other					-0.481	0.538

	Model 1		Model 2[1]		Model 3[1]	
CESSATION	Est.	SE	Est.	SE	Est.	SE
Non-Hispanic white	---	---	---	---	---	---
Non-Hispanic black	0.444 ***	0.048	0.067	0.056	0.098	0.062
Hispanic	0.357 ***	0.065	0.128	0.074	0.302 ***	0.078
Non-Hispanic Asian	0.198 *	0.081	0.322 **	0.096	-0.237	0.146
Other	-0.126	0.105	-0.326 **	0.120	-0.321 *	0.125
Foreign born	-0.331 ***	0.062	-0.309 ***	0.064	-0.083	0.113
US born	---	---	---	---	---	---
Interactions						
Foreign born x black					-0.464 **	0.153
Foreign born x Hispanic					-0.654 ***	0.140
Foreign born x Asian					0.295	0.185
Foreign born x other					-0.250	0.397

[1]Models 2 and 3 include the following controls: mother's education, mother's marital status at birth, mother's age at birth, child parity, child twin status, child sex, child birthweight, delivery type (c-section), delivery attendant (midwife), region, urban/rural location, household income, maternal work status at birth (initiation: working, stay at home, on paid maternity leave; cessation: working next month or working this month). Cessation models also include inidicator for month since birth.

Initiation models are logistic regression models. Cessation models are discrete time hazard models.

Initiation models n=10,550 mothers; Cessation models n=7,050 mothers (38,200 person months)

Table 4.3. Logistic Regression Models of Nativity Status and Breastfeeding *Initiation* among **Hispanic** Mothers who Gave Birth in the US in 2001

	Model 1			Model 2			Model 3			Model 4		
	Est.	95% CI	SE	Est.	95% CI	SE	Est.	95% CI	SE	Est.	95% CI	SE
Nativity												
Foreign born	0.801	(0.44 , 1.17) ***	0.184									
US born	---	---	---									
Years in US[1]												
0-3 years				1.248	(0.67 , 1.83) ***	0.292						
4-8 years				1.401	(0.84 , 1.97) ***	0.285						
9-15 years				0.558	(0.04 , 1.08) *	0.262						
16 plus years				0.395	(-0.19 , 0.98)	0.293						
US born				---	---	---						
Age of Arrival to US[1]												
US born							---	---	---			
0-8							0.660	(0.07 , 1.25) *	0.296			
9-15							0.457	(-0.06 , 0.97)	0.259			
16-19							1.040	(0.53 , 1.55) ***	0.256			
20-25							0.873	(0.31 , 1.44) **	0.285			
26 plus							2.102	(1.23 , 2.98) ***	0.441			
Home Language												
English not home language										0.864	(0.45 , 1.27) ***	0.206
English as home language										0.512	(0.00 , 1.03)	0.259
US born										---	---	---

n= 1900

All models include the following controls: mother's education, mother's marital status at birth, mother's age at birth, child parity, child twin status, child sex, child birthweight, delivery type (c-section), delivery attendant (midwife), region, urban/rural location, household income, maternal work status at birth (working, stay at home, on paid maternity leave).

[1]This specification includes a dummy indicator for the small number of those who *do not report the age* at which they moved to the US, and a dummy indicator for those who did not receive the question because they were *foreign born but lost to follow up* after the first round.

Table 4.4. Discrete Time Hazard Models of Nativity Status and Breastfeeding *Cessation* among **Hispanic** Mothers who Gave Birth in the US in 2001

	Model 1			Model 2			Model 3			Model 4		
	Est.	95% CI	SE	Est.	95% CI	SE	Est.	95% CI	SE	Est.	95% CI	SE
Nativity												
Foreign born	-0.455	(-0.62 , -0.28) ***	0.086									
US born	---	---	---									
Years in US[1]												
0-3 years				-0.580	(-0.81 , -0.35) ***	0.116						
4-8 years				-0.399	(-0.64 , -0.15) **	0.124						
9-15 years				-0.527	(-0.81 , -0.25) ***	0.141						
16 plus years				-0.250	(-0.52 , 0.02)	0.136						
US born				---	---	---						
Age of Arrival to US[1]												
US born							---	---	---			
0-8							-0.253	(-0.57 , 0.06)	0.158			
9-15							-0.595	(-0.94 , -0.25) ***	0.172			
16-19							-0.423	(-0.68 , -0.17) ***	0.128			
20-25							-0.553	(-0.76 , -0.34) ***	0.105			
26 plus							-0.337	(-0.67 , 0.00) *	0.169			
Home Language												
English not home language										-0.464	(-0.65 , -0.27) ***	0.096
English as home language										-0.415	(-0.70 , -0.13) **	0.145
US born										---	---	---

n= 1400 mothers; 7200 person months

All models include the following controls: month since birth, mother's education, mother's marital status at birth, mother's age at birth, child parity, child twin status, child sex, child birthweight, delivery type (c-section), delivery attendant (midwife), region, urban/rural location, household income, maternal work status at birth (working next month or working this month).

[1]This specification includes a dummy indicator for the small number of those who *do not report the age* at which they moved to the US, and a dummy indicator for those who did not receive the question because they were *foreign born but lost to follow up* after the first round.

Table 4.5. Logistic Regression Models of Nativity Status and Breastfeeding *Initiation* among **Non-Hispanic Asian** Mothers who Gave Birth in the US in 2001

	Model 1			Model 2			Model 3			Model 4		
	Est.	95% CI	SE	Est.	95% CI	SE	Est.	95% CI	SE	Est.	95% CI	SE
Nativity												
Foreign born	-0.163	(-0.76 , 0.43)	0.298									
US born	---	---	---									
Years in US [1]												
0-3 years				-0.216	(-0.84 , 0.41)	0.313						
4-8 years				-0.170	(-0.84 , 0.50)	0.338						
9-15 years				-0.038	(-0.75 , 0.67)	0.357						
16 plus years				-0.017	(-0.77 , 0.73)	0.378						
US born				---	---	---						
Age of Arrival to US [1]												
US born							---	---	---			
0-8							0.234	(-0.77 , 1.24)	0.504			
9-15							0.041	(-0.73 , 0.81)	0.388			
16-19							-0.127	(-0.98 , 0.72)	0.428			
20-25							-0.321	(-0.94 , 0.30)	0.311			
26 plus							-0.302	(-0.92 , 0.31)	0.309			
Home Language												
English not home language										-0.351	(-0.95 , 0.25)	0.301
English as home language										0.202	(-0.51 , 0.91)	0.357
US born										---	---	---

n= 1400

All models include the following controls: mother's education, mother's marital status at birth, mother's age at birth, child parity, child twin status, child sex, child birthweight, delivery type (c-section), delivery attendant (midwife), region, urban/rural location, household income, maternal work status at birth (working, stay at home, on paid maternity leave).

[1]This specification includes a dummy indicator for the small number of those who *do not report the age* at which they moved to the US, and a dummy indicator for those who did not receive the question because they were *foreign born but lost to follow up* after the first round.

Table 4.6. Discrete Time Hazard Models of Nativity Status and Breastfeeding *Cessation* among **Non-Hispanic Asian** Mothers who Gave Birth in the US in 2001

	Model 1			Model 2			Model 3			Model 4		
	Est.	95% CI	SE	Est.	95% CI	SE	Est.	95% CI	SE	Est.	95% CI	SE
Nativity												
Foreign born	0.437	(0.11 , 0.76) **	0.163									
US born	---	---	---									
Years in US[1]												
0-3 years				0.427	(0.05 , 0.80) *	0.190						
4-8 years				0.605	(0.24 , 0.97) **	0.185						
9-15 years				0.277	(-0.12 , 0.68)	0.202						
16 plus years				0.375	(0.02 , 0.73) *	0.177						
US born				---	---	---						
Age of Arrival to US[1]												
US born							---	---	---			
0-8							0.098	(-0.32 , 0.51)	0.208			
9-15							0.471	(0.02 , 0.92) *	0.225			
16-19							0.751	(0.33 , 1.17) ***	0.210			
20-25							0.494	(0.12 , 0.87) **	0.189			
26 plus							0.373	(0.03 , 0.71) *	0.171			
Home Language												
English not home language										0.612	(0.26 , 0.97) ***	0.179
English as home language										0.153	(-0.21 , 0.51)	0.181
US born										---	---	---

n= 1100 mothers; 6550 person months

All models include the following controls: month since birth, mother's education, mother's marital status at birth, mother's age at birth, child parity, child twin status, child sex, child birthweight, delivery type (c-section), delivery attendant (midwife), region, urban/rural location, household income, maternal work status at birth (working next month or working this month).

[1]This specification includes a dummy indicator for the small number of those who *do not report the age* at which they moved to the US, and a dummy indicator for those who did not receive the question because they were *foreign born but lost to follow up* after the first round.

Table 4.7. Self Reported Race/Ethnicity for Hispanic and Non-Hispanic Asian Mothers

Hispanic Mothers	ALL		US BORN[1]		FOREIGN BORN	
	Proportion	SE	Proportion	SE	Proportion	SE
Mexican	0.70	0.023	0.68	0.035	0.71	0.027
Puerto Rican	0.07	0.011	0.13	0.019	0.03	0.009
Cuban	0.02	0.005	0.02	0.007	0.02	0.006
Other Hispanic	0.21	0.020	0.16	0.031	0.24	0.025

Non-Hispanic Asian Mothers	ALL		US BORN[1]		FOREIGN BORN	
	Proportion	SE	Proportion	SE	Proportion	SE
Asian Indian	0.26	0.016	0.05	0.018	0.29	0.018
Filipino	0.15	0.013	0.31	0.052	0.13	0.012
Chinese	0.24	0.011	0.14	0.027	0.26	0.012
Japanese	0.05	0.009	0.20	0.044	0.03	0.007
Korean	0.10	0.011	0.15	0.045	0.09	0.011
Vietnamese	0.12	0.012	0.03	0.014	0.13	0.013
Other Asian	0.09	0.013	0.14	0.044	0.08	0.011

Note: proportions are weighted to reflect US population distribution of mothers giving birth in 2001.

Note: proportions sum to more than 1 because a very small number of mothers reported more than one race/ethnicity.

Hispanic mothers: n = 1900

Non-Hispanic Asian mothers: n = 1400

[1]Includes mothers born in the 50 states or Washington, DC

Figure 4.1. Kaplan-Meier Survival Curve of Breastfeeding Duration in the US by Mother's Nativity and Race/Ethnicity, 2001

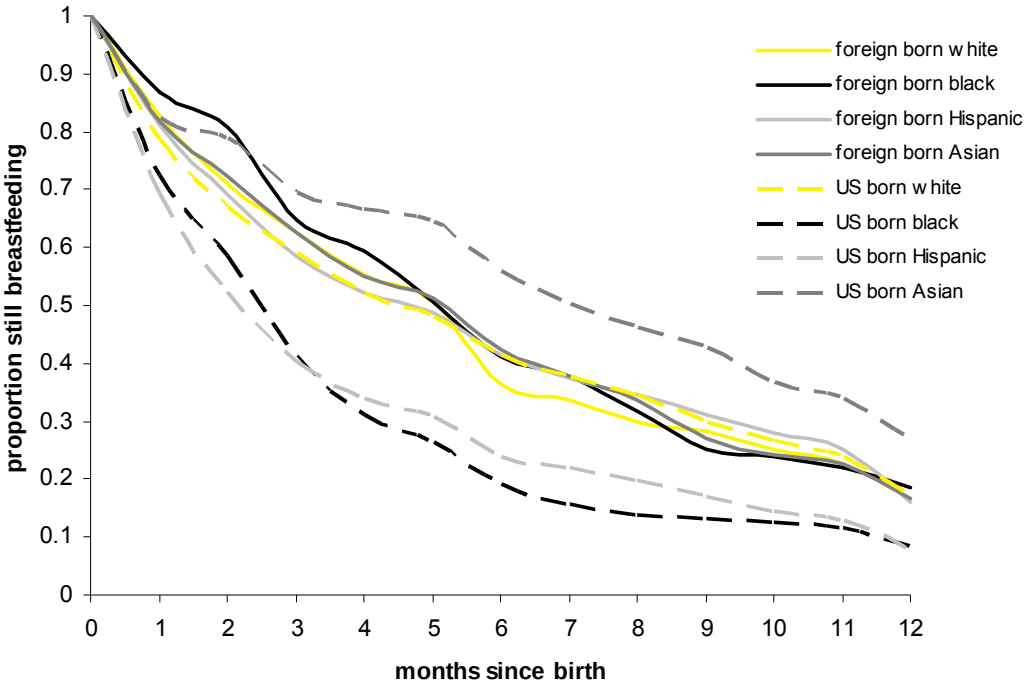
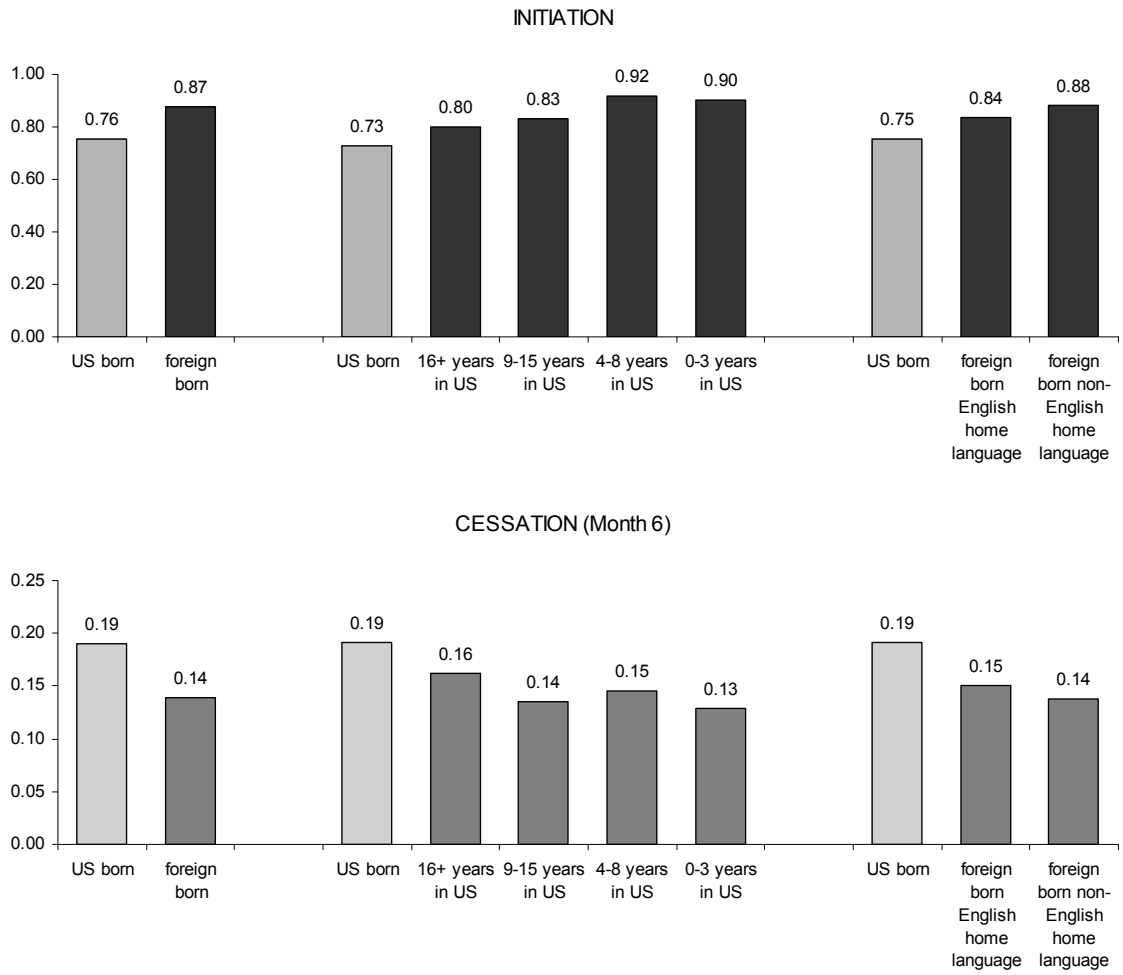


Figure 4.2. Predicted Probability of Breastfeeding Initiation and Cessation for **Hispanic Mothers** of Children Born in 2001 by Nativity



Notes:

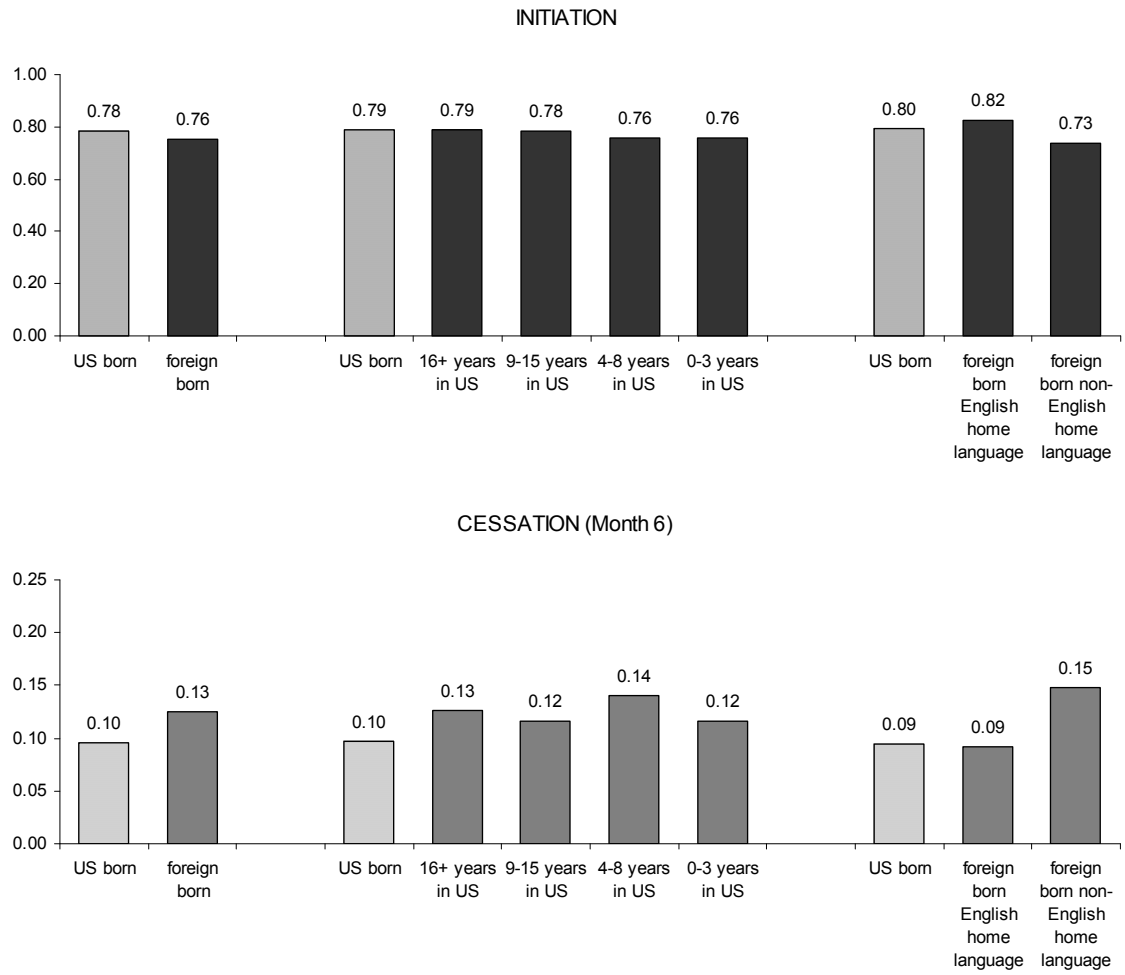
Predicted Probabilities based on models presented in Table 4.3 (top panel) and Table 4.4 (bottom panel).

Top panel: Predicted probability of initiating breastfeeding for a mother with the baseline characteristics.

Bottom panel: Predicted probability of quitting breastfeeding in month 6 for mothers who initiated breastfeeding and were still breastfeeding at month 6 for a mother with the baseline characteristics.

Baseline characteristics: non-twin, first born, female child of normal birth-weight, that was not delivered via c-section or midwife, with a 25-29 year old, married, high school educated mother, with income between $30-50,000, who did not use WIC during pregnancy, was not working or on maternity leave at birth, living in the non-rural northeast.

Figure 4.3. Predicted Probability of Breastfeeding Initiation and Cessation for **Non-Hispanic Asian Mothers** of Children Born in 2001 by Nativity



Notes:

Predicted Probabilities based on models presented in Table 4.5 (top panel) and Table 4.6 (bottom panel).

Top panel: Predicted probability of initiating breastfeeding for a mother with the baseline characteristics.

Bottom panel: Predicted probability of quitting breastfeeding in month 6 for mothers who initiated breastfeeding and were still breastfeeding at month 6 for a mother with the baseline characteristics.

Baseline characteristics: non-twin, first born, female child of normal birth-weight, that was not delivered via c-section or midwife, with a 25-29 year old, married, high school educated mother, with income between $30-50,000, who did not use WIC during pregnancy, was not working or on maternity leave at birth, living in the non-rural northeast.

CHAPTER FIVE. BREASTFEEDING AND STATE CONTEXT

Introduction

While individual characteristics are important determinants of health and health behaviors, individuals are embedded within social contexts. Characteristics of these contexts can constrain choices and affect individual behaviors and outcomes above and beyond individual characteristics (Diez-Roux 1998). As a result, there is widespread interest in the importance of context and health as well as the mechanisms—physical environment, institutions (e.g., schools and hospitals), social resources (e.g., community organizations, social efficacy), stress—that explain why context might matter. The importance of context has been studied primarily for child-related health *status* outcomes, such as infant mortality and low birth weight; but context is also expected to affect child-related health *behaviors* such as breastfeeding. Health behaviors are particularly important because they are potential mediators between context and child health status.

We know little about how the characteristics of places, such as states, are correlated with breastfeeding practices. There is reason to believe that place matters for breastfeeding. Breastfeeding rates in the US vary across regions and states, and place remains a significant predictor of breastfeeding even after controlling for individual characteristics (Visness and Kennedy 1997; Ryan et al. 2004; Kogan et al. 2008).

Identifying contextual factors that are related to breastfeeding is useful for better understanding between place differences in breastfeeding. In this analytic chapter I

examine the relationship between *state level* characteristics and breastfeeding in the US. I focus on between state differences because previous research has suggested substantial between state variation in breastfeeding (Kogan et al. 2008). The primary research questions are as follows: First, are state level contextual factors, particularly state breastfeeding legislation and the use of medical related birth practices, related to between-state variation in breastfeeding? Second, do these state level factors remain significant when controls for individual characteristics related to breastfeeding are added to the model? Finally, does the relationship between state factors and breastfeeding depend on individual mother characteristics?

Why State Context Might Matter for Breastfeeding

Why might state differences matter for an individual mother's decision to breastfeed? One possibility is that social attitudes, norms, and support toward breastfeeding vary between states. Research has shown that family level social support is important for increasing individuals' intention and likelihood of breastfeeding (Matich and Sims 1992; Baranowski et al. 1993; Giugliani et al. 1994; Humphreys et al. 1998; Guttman and Zimmerman 2000). Because infants require frequent feedings, mothers who want to breastfeed have to fit breastfeeding into the structure of their lives. Moreover, at some point they inevitably have to feed their child outside the privacy of their home. Therefore, it is reasonable to believe that social attitudes and support at a broader level could also make it easier or harder for mothers to breastfeed their children. State level differences in norms and attitudes regarding breastfeeding may affect a mother's *desire* to breastfeed by contributing to between state differences in mothers' knowledge and beliefs regarding breastfeeding.

In addition to potential differences in breastfeeding attitudes, states may also vary in their structural levels of breastfeeding support. Between state differences in structural support may affect a mother's *ability* to breastfeed by contributing to differences in the constraints and costs faced by mothers of newborns. Structural support can come from multiple sources, including hospital practices supportive of breastfeeding, the existence of professional breastfeeding support advocates, or legislation that allows employers to provide mothers with a place to breastfeed at work. Between state differences in the administration of government support to mothers (e.g., WIC, food stamps) may also create differences in structural support for breastfeeding.

While both state differences in attitudes and structures supporting breastfeeding are likely to contribute to a mother's desire and ability to breastfeed, the importance and source of each is nearly impossible to disentangle. In reality, attitudes and structural support are likely to be interrelated and mutually reinforcing concepts. The current analysis uses two variables intended to capture differences in the normative and structural breastfeeding environment—state breastfeeding legislation and the medical environment surrounding births. Both, in part, are thought to capture differences in attitudes regarding breastfeeding as well as differences in structural support for breastfeeding.

Background and Literature Review

Breastfeeding Attitudes in the US

Data on breastfeeding attitudes in the US are sparse. The only source of national data on breastfeeding attitudes is the HealthStyles survey—a private proprietary national marketing survey sent via mail to a sample of adults aged 18 years and older, which is

designed to be nationally representative of seven US Census Bureau demographic characteristics—age, sex, marital status, race/ethnicity, income, region, and household size. The CDC has contributed breastfeeding questions to the HealthStyles survey since 1999 (http://www.cdc.gov/breastfeeding/data/index.htm). Based on the results published by Hannan et al. (2005) using the HealthStyles data, overall public attitudes regarding breastfeeding are not overwhelmingly positive, with less than half of the US population agreeing that women should have the right to breastfeed in public, and less than a third agreeing that it is appropriate to show a woman breastfeeding on TV.[31] These attitudes toward breastfeeding exist despite the widespread belief that breastfeeding is healthier than formula feeding. Nonetheless, while approximately two-thirds of the population considers breastfeeding healthy, the general public does not necessarily feel that *not breastfeeding* is *unhealthy*—and less than one-quarter of the population agrees that feeding a baby formula instead of breastmilk will increase the chance that the baby will get sick (Hannan et al. 2005). Interviews with low income mothers suggest that mothers feel these contradictory messages regarding public attitudes toward breastfeeding—both believing that the public thinks that breastfeeding is what mothers should do, but also feeling that others have negative reactions to seeing mothers breastfeed in public (Guttman and Zimmerman 2000). Public health agencies believe that changing public attitudes toward breastfeeding—convincing both mothers and the general public that breastfeeding is the normative method of infant feeding—would make it easier for mothers to breastfeed and contribute to increased breastfeeding levels (Merewood and Heinig 2004).

[31] Hannan et al. (2005) include the top two categories of a 5 point Likert Scale (strongly agree, moderately agree) to define the percentage of the population that "agrees" with a given statement regarding breastfeeding.

Breastfeeding and Place

Breastfeeding rates vary substantially by place. A cross-national comparison found that breastfeeding rates are higher in Europe and Australia than in the United States and Canada (Callen and Pinelli 2004). Researchers have noted large regional differences in breastfeeding rates in the US. Within the US, women in the West have significantly higher rates of breastfeeding than women in other regions (Visness and Kennedy 1997; Ryan et al. 2004). In 2002, 43% of mothers in the West were still breastfeeding at 6 months compared to 37% in New England, 32% in the North, and only 29% in the South (Ryan et al. 2004). Moreover, while race has frequently been considered an important contributor to breastfeeding differentials (Forste et al. 2001), Ryan et al. (2004) found that black mothers in the West had higher breastfeeding rates than white mothers in the North or South, and concluded that, in terms of breastfeeding, region mattered more than race. Other evidence also suggests that regional identity may trump individual characteristics. Cubbin et al. (2008) found that the importance of individual characteristics varied by place—with race/ethnicity, marital status, paternal education, and income significant predictors of breastfeeding initiation in the (southern) state of Florida but not in the (western) state of Washington. One possible explanation for regional differences in breastfeeding rates is differences in attitudes toward breastfeeding. Indeed public attitudes regarding breastfeeding also vary significantly by region, with those in the West displaying more positive attitudes regarding breastfeeding than those in other regions (Hannan et al. 2005).

While attitudes regarding breastfeeding vary between places, places also vary in their structural levels of breastfeeding protection, promotion and support (CDC 2008;

DiGirolamo et al. 2008). A 2008 report from the CDC lists five types of community level support which may affect breastfeeding rates: birth facility support, professional support, mother-to-mother support, state legislation, and public infrastructure (CDC 2008; DiGirolamo et al. 2008). In an examination of state level process indicators of this community level support,[32] western and New England states showed the highest levels of overall breastfeeding support, while southern states showed the lowest levels. A survey of all hospitals and birth centers in the US found that maternity practices supportive of breastfeeding[33] followed similar regional patterns (CDC 2008; DiGirolamo et al. 2008).

Research on Breastfeeding and Contextual Factors

Socio-demographic Factors and Breastfeeding

Despite the apparent importance of place for breastfeeding, very few studies have incorporated contextual factors into analyses of breastfeeding in more developed countries. Two studies have examined the relationship between socio-demographic contextual factors and breastfeeding (Griffiths et al. 2005; Cubbin et al. 2008). Neither explicitly used hierarchical models to model the variation between places.

In the first study, Griffiths et al. (2005) examined the association between breastfeeding and community level disadvantage and ethnicity using a large nationally

[32] Process indicators of breastfeeding support include: percent of live births occurring in facilities designated as Baby Friendly; number of International Board Certified Lactation consultants per 1000 live births; number of La Leche League groups per 1000 live births, state legislation about breastfeeding in public places; state legislation about breastfeeding and employment; number of state health department FTEs (full time equivalents) dedicated to breastfeeding; presence of an active statewide breastfeeding coalition; and presence of a coalition website.

[33] Maternity practices supportive of breastfeeding were considered in seven categories—labor and delivery; breastfeeding assistance; mother-newborn contact; newborn feeding practices; breastfeeding support after discharge; nurse/birth attendant breastfeeding training and education; and structural and organizational factors related to breastfeeding. Examples of specific practices in these categories include the following: mother-newborn skin to skin contact, early breastfeeding initiation, instruction provided on infant feeding, not giving pacifiers to newborns, and avoidance of separation during postpartum facility stay.

representative cohort of children in England. They categorized election wards as "ethnic" (>30% ethnic), "disadvantaged" (non-ethnic but in the poorest 25% of wards), or "advantaged" (all other wards). The authors found that controlling for individual characteristics, women living in ethnic and advantaged wards were more likely to initiate breastfeeding than women living in disadvantaged wards, but not significantly more likely to breastfeed for at least one month. Although they don't show the results, the authors also reported that the benefit of living in an ethnic neighborhood on breastfeeding initiation was particularly advantageous for single white mothers, young mothers, and mothers with low education.

In a second study of breastfeeding and socio-demographic context, Cubbin et al. (2008) used separate state-wide samples of recent mothers in Florida and Washington to examine the relationship between neighborhood deprivation at the tract level and four indicators of maternal behavior and child health. After controlling for individual characteristics, they found no relationship between the extent of neighborhood deprivation at the tract level (low, moderate, or high) and never breastfeeding in either Florida or Washington. However, they did find that the magnitude and significance of individual characteristics (such as marital status) varied by state—with individual characteristics of mothers much more likely to be significant predictors of breastfeeding initiation in Florida than in Washington.

Overall, the Griffiths et al. (2005) and Cubbin et al. (2008) studies found mixed results for the importance of socio-demographic contextual characteristics for breastfeeding. The results from the UK study suggest that the ethnicity and advantage status of places mattered for breastfeeding initiation across England, particularly for

individuals in groups that were at risk of not breastfeeding (Griffiths et al. 2005). In contrast, the US study found that differences in neighborhood disadvantage status did not affect breastfeeding initiation within two states in the US (Cubbin et al. 2008); however, there are a number aspects of their analysis that suggest more research is needed before concluding that contextual factors don't matter for breastfeeding in the US. First, the analysis only included two states, which were analyzed separately; consequently, the results indicate that relative neighborhood disadvantage at the tract level did not matter within the states of Florida or Washington. However, these states may have very different levels of disadvantage, and comparing tracts within a state ignores between state variation in breastfeeding. It is possible that neighborhood disadvantage would have been significantly related to breastfeeding had they compared both within and between states. Second, the authors only considered disadvantage at the tract level. Relationships between socio-demographic factors and health often depend on the level of aggregation (Soobader and LeClere 1999). While tracts are considered the best census geography in terms of representing neighborhoods and consequently often considered a preferred unit of analysis, it is possible social factors related to breastfeeding operate on a larger scale, such as between states. Third, Cubbin et al. (2008) only considered neighborhood disadvantage. There may be other contextual factors that are related significantly related to breastfeeding. Finally, the authors did not control for the foreign born status of the mother in their analyses. This is an important confounder as foreign born status is positively related to breastfeeding (Gibson-Davis and Brooks-Gunn 2006; Singh et al. 2007) but could be negatively related to neighborhood deprivation (if immigrants tend to live in poorer neighborhoods); consequently, omission of this individual characteristic

may have contributed to the lack of a relationship between neighborhood deprivation and breastfeeding duration.

State Structural Factors and Breastfeeding

In addition to the two studies that examined *socio-demographic* contextual factors and breastfeeding, a third study examined the relationship between *structural* contextual factors and breastfeeding rates in the US. Kogan et al. (2008) used the 2003 National Survey of Children's Health to consider the relationship between breastfeeding promotion legislation and breastfeeding rates among mothers of children 6 to 71 months at the time of the survey. The authors found that mothers living in states with *multiple laws before 1999* were significantly more likely to initiate breastfeeding and breastfeed for six months than mothers living in states with no breastfeeding promotion laws in 2003, states with a first law between 1999 and 2003, and states with only one law before 1999. In general, there was no significant difference in likelihood of breastfeeding among mothers in states with *no laws* regarding breastfeeding in 2003 and states with only *one law before 1999* or states with a *first law between 1999 and 2003.* Overall the results suggest that mothers in states with the earliest and most extensive breastfeeding promotion laws have the highest likelihood of breastfeeding. The authors suggest that breastfeeding legislation may influence breastfeeding by increasing the profile of breastfeeding, reinforcing public norms, or increasing resources devoted to breastfeeding; however the authors also note that the relationship between breastfeeding legislation and breastfeeding rates may not be causal and legislation may be a "proxy for a culture more favorable toward breastfeeding" (Kogan et al. 2008; p.1877). In either case, interpretation of the results from this analysis is somewhat difficult because in the

analysis the categorization of laws was related to the date of the survey rather than date of the birth of the child, indicating that more research on the relationship between breastfeeding legislation and breastfeeding rates would be fruitful.[34] I revisit this relationship in the current analysis.

Between State Differences in Breastfeeding

In the current chapter I explore between state variation in breastfeeding and use multi-level models to determine the extent to which state level and individual level factors help to explain between state variation. One other paper also considered between state variation in breastfeeding using the National Survey of Children's Health (Kogan et al. 2008). The primary focus was to determine the extent to which social and behavior factors at the *individual level* could account for state level differences in breastfeeding. The authors found that controlling for individual characteristics explained ~34% of state variation in ever breastfeeding and ~19% of state variation in breastfeeding for six months (Kogan et al. 2008); however, state of residence remained a strong predictor of breastfeeding even after controlling for individual characteristics. Kogan et al. controlled for between state variation by including dummy variables for each state. They then added controls for individual characteristics to determine the extent to which individual characteristics reduce the coefficients of the state variables and the predicted proportions of breastfeeding mothers. This is the equivalent of a fixed effects model, which cannot be used to test contextual factors because differences between contexts are already explained away by the state dummy variables (Snijders and Bosker 1999). In the current

[34] Children used in the analysis ranged from 6 to 71 months at the time of the survey in 2003, so laws between 1999 and 2003 would have come into effect before the birth of some of the children but after the birth of others.

analyses I ask a similar question but use a random-coefficient model rather than a fixed effect models—the random coefficient specification *models* rather than *controls* for between state variation. Use of a random coefficient models allow me to test the effects of group level characteristics (simultaneously with individual characteristics), and to determine the extent to which contextual factors are related to between state variation in breastfeeding.

Contribution of Current Analysis

The limited research on contextual factors and breastfeeding, combined with significant variation in breastfeeding by state, suggests that there is value in conducting research on the relationship between state level factors and breastfeeding rates in the US. In the current research I add to previous research by using hierarchical models to examine whether state level factors help to explain between state variation in breastfeeding. States are a particularly relevant level of analysis because family and health policies are often implemented at the state level. I focus on two state level characteristics—breastfeeding legislation and statewide use of medical related birthing practices (proportion of births by c-section, proportion of births with a midwife attendant, and proportion of births at home). Both are intended to capture between state variation in attitudes and structures supportive or unsupportive of breastfeeding.

Supplementary Data and Analysis Sample

Supplementary Data

In addition to the primary ECLS-B data, this analysis uses supplementary data which is linked to the ECLS-B child records based on the FIPS (Federal Information

Processing Standards) codes for the state of residence for each birth, which is reported on the child's birth certificate. These are two primary sources of contextual data. First, *state breastfeeding legislation* information is compiled from online sources, including the Centers for Disease Control (CDC; www.cdc.gov) and individual state websites. Second, *state level vital statistics* from the CDC are used to determine the prevalence of c-section assisted births, midwife assisted births, and home births within each state in 2000. These vital statistics are meant to capture the medical environment into which the mothers of the 2001 ECLS-B cohort gave birth.

ECLS-B Analysis Sample

As described in the data chapter, only children whose biological mothers were the primary respondent at the 9 month interview are included in the analysis. Analysis of contextual factors requires that the ECLS-B data be merged with supplemental data sources based on a location code (state FIPS). Location codes are available from the ECLS-B children's birth certificates, and a small number of children (~.7%) were dropped because they were missing birth certificate information. Some n=10,450 mothers remain in the final analytic sample (~98%). These mothers represent 47 states of residence.[35] As with chapters 3 and 4, breastfeeding duration/continuation models are restricted to mothers that initiated breastfeeding—n=7000 mothers who ever breastfed residing in 46 states at the time of birth.

[35] Some states have as few as one mother. This is not a problem for hierarchical modeling as long as some states have more than one mother; however, groups with fewer numbers of individuals will have a smaller influence on the results (Snijders and Bosker 1999, p.52). This is because they have less precise estimates of within group variation (groups of n=1 can't contribute to estimates of within group variation), and consequently provide less information regarding between group variation.

Variables

Dependent Variables (Outcome Variables)

Characteristics of the places in which a mother gives birth is likely to influence both her decision to breastfeed as well as how long she breastfeeds. The outcomes of interest in this analytic section are breastfeeding *initiation* and breastfeeding *continuation.* In this analysis both breastfeeding initiation and breastfeeding continuation are both measured dichotomously.

Breastfeeding Initiation

As with the first two analytic chapter, mother's breastfeeding initiation is a dichotomous indicator based on the following question at the 9 month interview: "Did you ever breast-feed {child's name}?"

Breastfeeding Continuation (Duration)

Following previous research on breastfeeding and context (Griffiths et al. 2005; Kogan et al. 2008), breastfeeding duration is also measured dichotomously in this chapter. The breastfeeding duration variable, *breastfeeding continuation,* is based on the following questions at the 9 month interview: "Did you ever breast-feed {child's name}?"; "Are you still breast-feeding {child's name}?"; "For how many months did you breast-feed him/her?" A mother is said to have "continued breastfeeding" if she breastfed for at least 6 months. Analysis of breastfeeding continuation is restricted to mothers who ever breastfeed (following Gibson-Davis and Brooks-Gunn 2006). This restriction allows me to more accurately capture the potentially different processes involved in initiating and continuing to breastfeed.

Independent Variables of Interest (State Level Variables)

The state level variables used in this analysis were selected with the intent of capturing aspects of the social environment that could plausibly influence and/or help to explain differences in breastfeeding across states. The analysis focuses on two state level factors—state breastfeeding legislation and the medical environment surrounding births. Other state level contextual variables were considered but not included in the final analyses, such as state level immunization coverage and prenatal care use by disadvantaged groups. These variables were omitted because they were not significantly related to breastfeeding in bivariate models and they had weaker theoretical links to breastfeeding behaviors than the variables included in the final analyses.

Breastfeeding Legislation.

The first state level characteristic considered in this analysis is based on differences in breastfeeding laws in 2001. Breastfeeding laws may have both structural and cultural implications for mothers' behaviors. That is, while breastfeeding laws are examples of structures that are supportive of breastfeeding, they may also be an indicator of public support for breastfeeding. I hypothesize that breastfeeding legislation is reflective of state support for breastfeeding or places that have more structural support for breastfeeding mothers. Therefore, I expect a positive relationship between breastfeeding legislation and a woman's likelihood of breastfeeding. However states implement laws for different reasons and in some cases breastfeeding legislation may be passed in states with low breastfeeding rates in order to encourage breastfeeding. This complicates my hypothesis regarding the expected direction of breastfeeding legislation variables—particularly because in a cross-sectional sample of births it is not possible to compare

breastfeeding rates before and after the passage of legislation. If breastfeeding legislation is in fact a consequence of low breastfeeding rates rather than a reflection of positive breastfeeding attitudes or structural support, this could contribute to a lack of significance or even a negative relationship between state legislation and breastfeeding.

In the US, breastfeeding legislation is generally implemented at the state level. There are two primary types of state breastfeeding laws 1) Laws regarding breastfeeding in public places—whether or not a state has an explicit law that protects a woman's right to breastfeed in public, and 2) Laws regarding breastfeeding and employment—such as whether or not an employer is required to provide break time and a place for breastfeeding. In the primary analyses in this chapter, I use a single dichotomous indicator for whether the state in which a mother resides had either a law regarding breastfeeding in public OR a law regarding breastfeeding and employment in the year that the child was born.[36] I also consider other specifications of breastfeeding law based on the timing of breastfeeding legislation and the number of laws.

Medical Environment Surrounding Births.

The second state level contextual variable used in this analysis is based on CDC vital statistics from birth certificates in 2000, and intended to capture the medical environment into which the ECLS-B children were born. The idea is that mothers of children born in states with a high prevalence of "natural" birthing practices may be more likely to breastfeed either because there is greater availability of organizations that

[36] I considered including measuring public place and employment laws separately. However, in 2001 seven states had breastfeeding and employment laws, but only one state (Tennessee) had a breastfeeding and employment law but not a breastfeeding in public places law. This suggests that having an "employment law" is highly dependent on having a "public places" law.

support such practices or because mothers are simply exposed to these practices in their communities and therefore feel more normative support—or pressure—to conform to "natural" practices themselves.[37] Three indicators of the medical context are combined to capture state differences on the continuum from a more "natural" to a more "medicalized" birth environment. State prevalence of midwife assisted births and state prevalence of home births are used to indicate the use of "natural" birth methods; while state prevalence of c-section assisted births is used to indicate a "medicalized" birth environment. To determine the overall medical environment surrounding births in a state, the proportion of births using a midwife, the proportion of births at home, and the proportion of births by c-section are standardized and averaged to create an overall birth environment scale. C-section use represents a more "medicalized" birth practice, so I multiply this term by -1 before adding it to the other terms in the scale.[38] A higher score on the birth environment scale indicates a more "natural" birth environment and a lower score indicates a more "medicalized" birth environment. The final scale is divided into quartiles. Models also include controls for an individual mothers' use of a particular birth method, to reduce potential confounding between individual and group factors.

Table 5.1 includes the proportions and standard deviations of the state level contextual variables used in the analyses, as well as each of the components included in the categorical variable capturing the medical environment surrounding births. Means

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[37] However, it is not possible to infer a causal process, and it may be that mothers chose to live where they do because others in the area have similar values and orientations—a reverse causation problem.

[38] Proportions for three components are standardized because the range of values varies significantly between the three components. Means and ranges of the scale components are included in Table 1. There is a strong positive correlation between the proportion of midwife assisted births and proportion of births at home ($\rho = .37$). There is a strong negative correlation between the proportion of births by c-section and proportion of births at home ($\rho = -.59$). There is also a strong negative correlation between the proportion of births by c-section and proportion of midwife assisted births ($\rho = -.39$).

and standard deviations are calculated at the state level based on the 47 states represented in the analysis.

Methods and Models

A multi-level logistic random intercept model is used to analyze the relationship between state context and a mother's likelihood of breastfeeding. Estimation of a two-level model, with individuals nested within states and a random intercept ($\mathbf{U_{0j}}$) at the state level, allows each state to have an average rate of breastfeeding that is above or below the overall average breastfeeding rate. The idea behind random intercept models is that there may be some underlying latent factor that contributes to different rates of breastfeeding between states. These between state differences in the propensity to breastfeed are modeled with a random intercept term. Contextual variables, measured at the state level, can be added to the model to reduce or "explain away" the between state variation in breastfeeding. Because the composition of individuals varies between states, controlling for individual characteristics may also reduce the unexplained between state variation in breastfeeding.

The basic model is as follows:

$$\ln(p_{ij}/1-p_{ij}) = \gamma_0 + \gamma_x X_{ij} + \gamma_z Z_{0j} + U_{0j}$$

where,

j = index for the groups (states)

i = index for the individuals (mothers) within the groups

p_{ij} = probability of breastfeeding for mother i in state j

X = vector of explanatory variables at the individual level

Z = vector of explanatory variables at the state level

U_{0j} = random state dependent deviation

γ_0 = intercept

γ_x = vector of estimated coefficients for individual level covariates

γ_z = vector of estimated coefficients for the state level covariates

(modified from Snijders and Bosker 1999, p. 216)

Analytic Plan

The goal of the analysis is to determine the extent to which state and individual variables contribute to between state differences in breastfeeding. I consider both breastfeeding initiation and breastfeeding continuation. For each outcome, I first estimate a random intercept model with no covariates to determine the extent to which breastfeeding varies by state (proportion of the variation that is attributed to state vs. individual factors). I then use nested multivariate models in which the state variables and individual variables are sequentially added to the models. After examining the additive models for each outcome, I consider cross level interactions to determine whether the effect of state level factors seems to depend on the individual characteristics of a mothers,

focusing on four individual mother attributes associated with breastfeeding—age, education, race/ethnicity, and marital status.

Results

Breastfeeding and Context

Before examining the relationship between state level factors and breastfeeding, it is useful to determine how much variation in breastfeeding can be attributed to between state differences in the tendency to breastfeed. In a random intercept model, the intra class correlation represents the unexplained variation in breastfeeding that is attributed to the state level. The intra class correlation can be calculated by dividing the residual variation at the state level by the sum of the residual variation at the state and individual levels. In a two-level logistic model with a random intercept at the state level, a state level intercept variance of τ^2_0 and an individual level variance of $\pi^2/3$ the intra class correlation is defined as follows: [40]

$$\rho_1 = \tau^2_0 / (\tau^2_0 + \pi^2/3)$$

(Snijders and Bosker 1999, p. 224)

In an empty regression models (without covariates), with only a random intercept at the state level, the intra class correlation can be interpreted as amount of variance that is attributed to state level differences in the tendency to breastfeed. The result of the empty model for breastfeeding initiation is presented in Model 1 of Table 5.2. The

[40] Note: In logistic regression the variance is a function of the mean, and is defined by the logistic distribution as $\pi^2/3$. Consequently, in multi-level logistic models the variation attributed to the individual is fixed at $\pi^2/3$.

results of the estimation indicate that about 7.8% of variation in breastfeeding initiation is attributed to between state differences in breastfeeding. While these results suggest that most variation in breastfeeding initiation is attributed to differences within individuals in a state, the between state variation in breastfeeding initiation is large enough to warrant further exploration.

Model 2 adds an indicator for whether a state had legislation regarding breastfeeding in public places or legislation regarding breastfeeding and employment in 2001. This variable is not significant, indicating that state legislation regarding breastfeeding is not significantly related to between state differences in breastfeeding initiation in this cross-sectional sample of births in the US.

Model 3 adds the categorical indicators for type of birth environment into which the ELCS-B child was born, based on the relative prevalence of c-sections, midwife assisted births, and births at home in the state in the year prior to the birth of the ECLS-B children. States are divided into quartiles, and those with more natural/less medicalized birth practices are compared to those with the least natural/most medicalized birth practices (highest rates of c-sections; lowest rates of midwife use and home births). Results of Model 3 indicate that giving birth in a state with a higher prevalence of midwife births and home births and a lower prevalence of c-sections is positively related to breastfeeding. Mothers that live in a state categorized as "highest natural" have more than 3 times the odds of initiating breastfeeding as mothers living in a state with a birth environment categorized as "highest medical" (OR=exp(1.205)=3.34). Mothers that live in states categorized in the middle quartiles have about 1.5-1.6 times the odds of initiating breastfeeding than those live in states with the most medicalized birth environments.

After controlling for between state differences in the birth environment the proportion of unexplained variation in breastfeeding initiation attributed to between state differences is only about 3%.

The final model in Table 5.2 incorporates the individual level covariates, including mother, family and child characteristics. In this model, the state medical environment remains a significant predictor of breastfeeding, even controlling for individual characteristics. States are comprised of mothers with different individual characteristics, so we would expect that controlling for individual characteristics would also contribute to between state variation in breastfeeding. Indeed after adding controls for the individual characteristics of the newborn children, mothers, and households, only about 1.3% of variation in the model is attributed to "unexplained" between state differences.

Table 5.3 presents a parallel series of models for the breastfeeding continuation outcome—the likelihood that a mother will continue breastfeeding for sixth months, given that she initiates breastfeeding. Once again it is useful to first examine the intra class correlation in the empty regression model, with only a random intercept at the state level. The results of the empty model indicate that about 4% of the variation in continuing breastfeeding for at least six months can be attributed to between state variation (Table 5.3, Model 1, icc=.041). This means that between state variation seems to be smaller for breastfeeding continuation than for breastfeeding initiation. Nonetheless, it is useful to consider the extent to which state legislation and the birth environment are related to between state variation in breastfeeding continuation.

Model 2 incorporates the indicator for state breastfeeding legislation. Unlike in models of breastfeeding initiation, in which breastfeeding legislation was not a significant predictor, living in a state with breastfeeding legislation is significantly and positively associated with breastfeeding continuation (Table 5.3, Model 2). Mothers who initiate breastfeeding and live in a state with breastfeeding legislation have about a 33% higher odds of continuing breastfeeding for six months than those that do not live in a state with breastfeeding legislation (OR=exp(.282)=1.33).

Model 3 incorporates the indicators for the birth environment. Once again, living in a state categorized as having a high proportion of natural birthing activities—a high proportion of midwife and home births and a low proportion of c-sections—is positively related to breastfeeding continuation. Mothers living in a state in which the birth environment is categorized as "highest natural/lowest medicalization" have nearly twice the odds of continuing breastfeeding for six months as mothers living in a state that is categorized as "lowest natural/highest medicalization". In models that control for the presence of a breastfeeding law and the medical environment surrounding births only about 2.1% of the variation in the model attributed to unexplained between state differences. Notably, once the indicators for the medical environment surrounding birth are added to the model, the indicator for breastfeeding legislation is no longer statistically significant. Individual characteristics also contribute to between state variation in breastfeeding continuation, and after individual mother, child, and family characteristics are added in Model 4 only 1.4% of the variation in the model is attributed to unexplained between state variation. Controlling for individual covariates also appears to slightly

reduce the strength of the relationship between the medical environment surrounding births and breastfeeding continuation.

Supplementary Analysis: Breastfeeding Legislation

Results of this analysis suggest the living in a state with legislation regarding breastfeeding in public and/or legislation regarding breastfeeding and employment is not significantly associated with breastfeeding initiation in bivariate models, and is not related to breastfeeding continuation once either the medical environment surrounding births or individual characteristics are added to the models. In this section I consider three additional specifications of the legislation variable to see whether the timing or number of breastfeeding laws is significantly related to a mother's likelihood of breastfeeding initiation or continuation.

Table 5.4 shows the results of this analysis. The first two models show the results for breast feeding initiation (Models 1 and 2), while second two models show the results for breastfeeding continuation (Models 3 and 4). Each horizontal panel shows a different specification of the legislation variable. Within each specification and outcome (initiation or continuation), the first model (Models 1 and 3) shows the estimates of the state level random intercept models with only the legislation indicator and no controls, while the second model (Models 2 and 4) adds controls for individual characteristics. None of the models control for the state medical environment surrounding births.

The models presented in Table 5.4 include the four specifications of the breastfeeding legislation variable. The first panel shows the results for the basic law variable already presented in Tables 5.2 and 5.3—states with either a law regarding breastfeeding in public places OR a law regarding breastfeeding and employment OR

both are compared to states with no breastfeeding law as of 2001. Having legislation is not significantly associated with initiation, but is significantly associated with breastfeeding continuation. However, this variable is no longer significant in the breastfeeding continuation model once individual controls are added to the model (Table 5.4, panel 1, Model 4).

The second specification considers the strength of the legislation based on whether the state has both a law regarding breastfeeding in public places AND a law regarding breastfeeding and employment (multiple laws); a law regarding breastfeeding in public places OR a law regarding breastfeeding and employment (single law); or neither type of law. The idea is that places with more than one law regarding breastfeeding may exhibit stronger normative support for breastfeeding. However, the evidence does not support this hypothesis. Neither having multiple laws or a single law is significantly related to breastfeeding initiation. While both having one law or having both laws is positively related to breastfeeding continuation, only the coefficient on *single law* is significantly related to continuation in bivariate models; however, the difference between having multiple laws and having a single law is not significant (model not shown). Furthermore, neither indicator is a significant predictor of breastfeeding continuation once controls for individual characteristics are added to the model (Table 5.4, panel 2, Model 4).

The third specification focuses on timing of the breastfeeding legislation, and pertains only to the timing of legislation regarding breastfeeding in public places (recall that in 2001 only one state had legislation regarding breastfeeding and employment but not breastfeeding in public places). There are at least two competing hypotheses for why

the timing of the law might matter. The first is that the relationship between breastfeeding policy and an individual's likelihood of breastfeeding will be largest in states with the earliest breastfeeding laws. This is because early adopting states may have the most positive public climate toward breastfeeding. However, another hypothesis is that the relationship between breastfeeding legislation and breastfeeding will be largest in states with the most recent legislation, because mothers and others in such states may be more aware of the legislation and the health benefits of breastfeeding in general due to recent media coverage. In the third specification (Table 5.4, panel 3), the timing of legislation regarding breastfeeding is broken into three categories and compared to having no legislation as of 2001. None of the breastfeeding legislation coefficients are statistically significant in either models with or without individual covariates (Table 5.4, panel 3, Models 1 and 2). In terms of breastfeeding continuation, living in a place with relatively old legislation regarding breastfeeding in public places (6+ years old) is positive and significant in models without controls, but not significant once individual controls are added to the model (Table 5.4, panel 3, Model 4). However, living in a state with a recent law (0-2 years from the birth) is significant in terms of breastfeeding continuation both in models with and without controls for individual characteristics (Table 5.4, panel 3, Models 3 and 4); however, as a group the set of legislation variables are not significant ($p=.06$).

The final specification (panel 4) also examines the timing of legislation regarding breastfeeding in public places. However, this model incorporates the passage of legislation after the ECLS-B children were born. This specification retains the categories of panel 3, but divides states that had no law in 2001 (previous reference category) into

those that added a law from 2002-2008, and those that had no law as of 2008 (reference category in panel 4). Inclusion of such information is questionable, because the order of events is reversed (legislation after 2001 cannot contribute to breastfeeding in 2001 and before). However, there is some indication that mothers living in states that implemented legislation between 2002 and 2008 had lower breastfeeding continuation rates than either mothers living in states that had earlier legislation or mothers living in states that had no legislation as of 2008. While this difference was not significant once controls for individual level covariates were added to the model (Table 5.4, panel 4, Model 4), a group significance test indicates that as a group these variables are significantly different than 0 ($p=0.043$).

Cross Level Interactions

In the next set of regression analyses I consider whether the relationship between state level contexts and breastfeeding depend on individual characteristics. That is, do state level contextual factors matter the same for everyone? To do this I consider cross level interactions, in which each of the state level contextual factors are interacted with a series of individual mother characteristics—age, education, race/ethnicity, marital status. In these interactions (and in this entire chapter) mother's age and education are measured with continuous variables in order to take advantage of their ordinal nature. The state level contextual measure capturing the medical environment surrounding births is also measured continuously in the interactive models.

Cross Level Interactions—Breastfeeding Legislation

Previous models have indicated that state breastfeeding is not significantly related to breastfeeding initiation. Furthermore, while breastfeeding legislation is positively and significantly related to breastfeeding continuation, the significance of this relationship tends to disappear once controls for other contextual factors or individual characteristics are added to the model. However, while breastfeeding legislation is generally not significantly related to breastfeeding initiation or continuation in models that incorporate individual controls, it may be breastfeeding legislation matters for some mothers but not others. To see whether the relationship between breastfeeding legislation and breastfeeding initiation or continuation depends on individual characteristics, in a series of eight models, I interact breastfeeding legislation indicator with mother's age, education, race/ethnicity, and marital status.

Model results (not shown) indicate that, in general, breastfeeding legislation is not significantly related to breastfeeding initiation or continuation regardless of mother characteristics. However, to the extent that breastfeeding legislation is correlated with breastfeeding, it seems to matter for advantaged rather than disadvantaged mothers. Of the eight models with interactive terms, only one set of interactions significantly improves model fit—in the model of breastfeeding initiation, there is a positive and significant coefficient on the interaction term between breastfeeding legislation and a mother's years of education ($p<.05$). This suggests that living in a place with legislation is more beneficial for mothers with higher education. The relationship between state breastfeeding legislation and breastfeeding *initiation* does not depend a mother's age (years), marital status (married, cohabiting, never married, previously married), or

race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian, other). Nor does the relationship between state breastfeeding legislation and breastfeeding *continuation* depend on mother age, education, race/ethnicity, or marital status.

Cross Level Interactions—State Medical Environment Surrounding Births

Does the relationship between the medical environment surrounding births and breastfeeding depend on individual characteristics? Or is living in a state with a high proportion of "natural" birth practices related to higher breastfeeding rates for all mothers? In a series of models I interact the continuous indicator for the medical environment surrounding birth with mother's age, education, race/ethnicity, and marital status.[41] In the breastfeeding *initiation* models, the relationship between the state medical environment and breastfeeding does not depend on a mother's age, education, or marital status. That is, regardless of age, education or marital status, mothers who live in a state with a high prevalence of midwife and home births, and a low prevalence of c-sections have higher breastfeeding rates. However adding the interactive terms between the medical environment surrounding birth and race/ethnicity significantly improves model fit ($p<.001$), suggesting that the relationship between the medical environment surrounding births does differ by race/ethnicity. In particular, there is a large and significant negative coefficient on the interaction between Hispanic race/ethnicity and the medical environment surrounding births indicating that while living in a state with more "natural" birth practices is highly positive for mothers of other race/ethnicities, such environments are less beneficial for Hispanic mothers in terms of breastfeeding

[41] Higher values on the scale indicate more "natural" and less "medicalized" birth environments.

initiation.[42] In breastfeeding continuation models, there is a similar negative relationship between Hispanic race/ethnicity and the medical environment surrounding births ($p<.05$); however, the interaction terms do not reach significance as a group, providing less support for racial/ethnic differences in the relationship between the birth environment and breastfeeding continuation.

In other interactive models of breastfeeding continuation, the interaction term between the birth environment and a mother's years of education is significant and positive, indicating that living in a state with high rates of natural birthing practices is particularly beneficial in terms of breastfeeding continuation for mothers with higher levels of education. The relationship between the birth environment and breastfeeding continuation does not depend on mother's age or marital status.

Supplementary Analysis: The Medical Environment Surrounding Births

The medical environment surrounding births is a strong correlate of breastfeeding initiation and continuation. Living in a state with a high proportion of midwife assisted births, a high proportion of home births, and a low proportion of births by c-section is positively and significantly related to both breastfeeding initiation and continuation in all models, even when controlling for a mother's own use of a particular birthing practice. The measure was intended to capture differences in attitudes surrounding birth practices,

[42] The results of chapter 4 indicated that the relationship between race/ethnicity and breastfeeding depends on nativity. However, in this chapter race/ethnicity and nativity are included in models as additive variables. Supplementary analyses indicate that exclusion of the interaction between race/ethnicity and nativity does not change the substantive results regarding state level contextual factors. Additional analyses indicate that it is foreign born Hispanics (who already have high breastfeeding rates) that incur less of a benefit from living in a state with a higher score on the birth environment scale ("more natural/less medicalized" birth practices). The coefficient on the interaction between birth environment and US born Hispanic mother is also negative, but smaller and insignificant.

with the idea that states with relatively fewer c-sections and more midwife assisted and home births would have more positive inclinations toward natural birth practices, and thus would be more supportive of breastfeeding. However, it is possible that the variable captures some other aspect of the place of birth that helps to explain this relationship. Consequently, it is useful to more carefully consider what this variable represents.

To get a better sense of what this variable might be capturing, I examine the bivariate correlations between the individual components of the birth environment scale (proportion of births with a midwife, proportions of home births, and proportions of births by c-section), the overall birth environment scale, and other state level variables from the CDC. The results of the correlations are presented in Table 5.5. The first set of variables is taken from the 2000 CDC vital statistics—the same source as the components of the birth environment scale.

Overall, these results suggest that c-section assisted births are more likely to occur in places where mothers are disadvantaged; while midwife assisted births are more likely to occur in places where mothers are advantaged. C-section rates are positively correlated with births to unmarried mothers, low birth weights, births to young mothers, and births to mothers with less than a high school degree. The proportion of midwife assisted births is positively correlated with the proportion of births to older mothers, and negatively correlated with low birth weight children, births to young mothers, and births without prenatal care. The relationship between advantage and home births is more complex. Home births are negatively correlated to births to unmarried mothers and births to low weight children (aspects of disadvantage), but they are also negatively correlated with early prenatal care and mothers with a bachelor's degree (aspects of advantage).

The second set of variables in Table 5.5 are taken from the *2008 CDC Breastfeeding Report Card* and are intended to capture *structural* between state differences that could help to explain variation in breastfeeding between states with different types of birth environments. The CDC has identified five different types of community support related to breastfeeding—birth facility support, professional support, mother-to-mother support, state legislation, and public infrastructure—and has recently started collecting and publishing data on process indicators of these types of support (CDC 2008; DiGirolamo et al. 2008). Unfortunately, these data were not collected or published until 2008. Consequently, most structural indicators of breastfeeding support are only available for 2008, and thus are not appropriate for predicting breastfeeding rates of mothers who gave birth in 2001.[43] Nonetheless, while levels of breastfeeding support may change over time, it is still informative to consider the correlations between some of these indicators and the medical environment surrounding births in 2000. Notably, the correlation between three of the four indicators of breastfeeding support—the extent to which a state's birth facilities provide maternity care that is supportive of breastfeeding (the "mPINC" score), the number of International Board Certified Lactation Consultants per 1000 live births, and the number of La Leche League groups (an organization of trained and accredited volunteer mothers that provide mother-to-mother breastfeeding support) per 1000 live births—are strongly and negatively associated with to the proportion of births by c-section in 2000, and strongly but positively related to the proportion of births using a midwife and the proportion of home births in 2000 and the overall environment scale. This provides some evidence that the indicator for the birth

[43] I was able to extrapolate the data on breastfeeding legislation using information from the CDC and state websites, and that information was included in the regression analyses.

environment is effectively capturing something about the statewide normative medical environment surrounding births as it relates to breastfeeding—places that have a high proportion of midwife births and home births also seem to have higher levels of structural breastfeeding support, while places that have a high proportion of c-section births, tend to have lower levels of breastfeeding support. Notably, interactions between a mother's own birth practices and the state level medical environment surrounding births were not significant (models not shown), suggesting that the contextual variable measuring the state medical environment surrounding births does not simply capture a mother's own birth-related behaviors.

Predicted Probabilities

How much does the state level medical environment surrounding births matter? To get a better sense of how strongly the prevalence of birth practices in a state are related to breastfeeding initiation and duration rates, I calculated predicted probabilities to determine how the likelihood that a mother with a given set of characteristics would initiate breastfeeding and continue breastfeeding for at least 6 months varied according to the medical environment surrounding births in the state in which she lived. Results, presented in Figure 5.1, confirm the relevance of the state birth environment (and its unobserved correlates) for a mother's decision to breastfeed. A mother with a given set of characteristics who lives in a state with a low rate of medicalized birth practices has a .86 probability of initiating breastfeeding, compared to only .67 for a similar mother in a state with a high rate of medicalized birth practices. This probably ranges from .64 to .49 for breastfeeding continuation.

Conclusion

This chapter addresses three primary questions. First, are state level contextual factors related to between-state variation in breastfeeding? Second, do these state level factors remain significant when controls for individual characteristics related to breastfeeding are added to the model? Finally, does the relationship between state factors and breastfeeding depend on individual mother characteristics? I focus on two contextual factors at the state level—breastfeeding legislation and the use of birth related medical practices.

The results of the analysis suggest that breastfeeding rates vary substantially between states. Approximately 8% of the variation in breastfeeding initiation and 4% of the variation in breastfeeding continuation can be attributed to between state differences in breastfeeding.

In terms of contextual factors, breastfeeding legislation was not a strong predictor of between state differences in breastfeeding. This dissertation takes the perspective that to the extent that it matters, breastfeeding legislation is likely to be positively related to breastfeeding. This is because breastfeeding is thought to be reflective of both normative and structural support for breastfeeding. However, it is not entirely surprising that the breastfeeding legislation variables are generally not significant in this analysis. States pass or do not pass laws for many reasons, and it may be that some states have breastfeeding legislation because they have low breastfeeding rates. Similarly, some states may not pass legislation regarding breastfeeding because they already have high breastfeeding rates. This potential heterogeneity in the breastfeeding legislation categories could contribute to the insignificance of the breastfeeding legislation terms.

The "timing of breastfeeding legislation" variables were included in the analysis in part with the idea that they may capture some of these different motivations for implementing legislation. However, there may simply be too much variation in the motivations behind breastfeeding legislation to capture any relationship between breastfeeding legislation and breastfeeding rates in a cross sectional sample of births.

In contrast to breastfeeding legislation, the medical environment surrounding births in a state was a strong predictor of both breastfeeding initiation and breastfeeding continuation. Controlling for the medical environment surrounding births seemed to account for a substantial portion of between state differences in breastfeeding, considerably reducing the unexplained between state variation in breastfeeding initiation and continuation. Mothers living in places with a high proportion of midwife assisted births, a high proportion of home births, and a low proportion of births by c-section were more likely to initiate and continue breastfeeding, even when controlling for a mother's own use of a particular birthing method. This categorical variable was included in the analysis with the idea that more use of midwives and home births and less use of c-sections might be related to norms or structural factors that are supportive of more natural and less medicalized birthing practices. Correlations of state indicators of c-section, home birth, and midwife use with more recent direct indicators of structural breastfeeding support provide evidence that these measures tap into a useful concept regarding the state level birth environment in which a mother gives birth and decides whether or not to breastfeed. More research is needed to better understand why these circumstances surrounding births are correlated with direct measures of structural support for

breastfeeding and why such factors are correlated with breastfeeding above and beyond a mother's own birthing experience.

For whom does context matter? There was no evidence in cross level models that context matters more for individuals at high risk of not breastfeeding. To the extent that contextual factors varied by individual characteristics, they tended to exacerbate differences between more advantaged and less advantaged groups. In particular, living in a state with contextual factors that were supportive of breastfeeding was particularly advantageous for mothers with more education. In models of breastfeeding initiation, there was a positive interaction between state legislation and maternal education level. This indicates that states with breastfeeding legislation may have an even larger gap in breastfeeding between more educated and less educated mothers. A similar pattern was found for the relationship between the medical environment surrounding births and breastfeeding continuation—the gap in breastfeeding continuation between mothers with more education and mothers with less education increased in states with a higher prevalence of natural birthing practices. There was also evidence that living in a state with a higher prevalence of natural birth practices was less beneficial for Hispanic mothers in terms of breastfeeding initiation.

Tables and Figures

Table 5.1. Descriptive Statistics of State Level Contextual Variables

	Prop.	SD	Min	Max
STATE VARIABLES				
Medical Environment Surrounding Birth				
Birth Environment Scale Components				
Proportion of births by c-section	0.22	0.031	0.15	0.28
Proportion of births assisted by midwives	0.08	0.055	0.02	0.28
Proportion of births at home	0.01	0.008	0.002	0.045
Four Category Variable [1]				
Highest natural/lowest medicalization	0.23	0.428		
Medium natural/low medicalization	0.26	0.441		
Low natural/medium medicalization	0.23	0.428		
Lowest natural/highest medicalization (reference)	0.28	0.452		
Breastfeeding legislation				
Dichotomous Variable				
Right to breastfeed in public law and/or breastfeeding and employment law in 2001	0.55	0.503		
Strength of Legislation (# Laws)				
Right to breastfeed in public law AND breastfeeding and employment law in 2001	0.13	0.337		
Right to breastfeed in public law OR breastfeeding and employment law in 2001(not both)	0.43	0.500		
Neither right to breastfeed in public law NOR breastfeeding and employment law in	0.55	0.503		
Timing of Breastfeeding in Public Legislation				
Law as of 2001				
Law 6+ years old (<=1995)	0.21	0.414		
Law 3-5 years old (1996-1998)	0.13	0.337		
Law 0-2 years old (1999-2001)	0.19	0.398		
No Law as of 2001 (reference)	0.47	0.504		
Law from 2002-2008	0.38	0.491		
No law as of 2008 (reference)	0.09	0.282		

n=47 states of residence in ECLS-B sample

[1] Based on scale combining standardized proportion of c-sections (reverse coded), midwife assisted births, and births at home in a state

Table 5.2. State Level Random Intercept Models of Breastfeeding Initiation

	Model 1		Model 2		Model 3		Model 4	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
STATE VARIABLES								
Breastfeeding Legislation								
right to breastfeed in public law and/or breastfeeding and employment law			0.244	0.173	0.132	0.124	0.072	0.094
Medical Environment Surrounding Births[1]								
Highest Natural/Lowest Medicalization					1.205 ***	0.179	1.082 ***	0.142
Medium Natural/Low Medicalization					0.470 **	0.148	0.284 *	0.112
Low Natural/Medium Medicalization					0.386 *	0.160	0.199	0.118
Lowest Natural/Highest Medicalization (reference)					---	---	---	---
INDIVIDUAL LEVEL VARIABLES								
Child Characteristics								
twin							-0.105	0.070
first child							0.358 ***	0.052
male child							-0.052	0.046
any stay in NICU							0.045	0.080
normal birth weight (reference)							---	---
low birth weight (1500-2500g)							-0.304 ***	0.072
very low birth weight (<1500g)							-0.229 *	0.101
Circumstances Surrounding Birth								
c-section delivery							-0.212 ***	0.052
midwife as birth attendant							0.157	0.094
home birth							0.435	0.425
Mother Characteristics								
education (years)							0.154 ***	0.011
Non-Hispanic white (reference)							---	---
non-Hispanic black							-0.351 ***	0.071
Asian							-0.533 ***	0.108
Hispanic							0.266 **	0.084
Other race/ethnicity							-0.071	0.097
foreign born (Y/N)							0.813 ***	0.082
married (reference)							---	---
cohabiting							-0.285 ***	0.065
never married							-0.549 ***	0.078
previously married							-0.267 *	0.125
age (years)							0.011 *	0.005
household income (in $10,000's)							0.028 ***	0.008
WIC use during pregnancy							-0.217 ***	0.056
not working or on maternity leave (reference)							---	---
maternity leave							-0.109 *	0.050
working							-0.152	0.109
Intercept	-0.358 ***	0.067	0.604 ***	0.135	0.235 *	0.113	0.722 ***	0.101
model intra class correlation	0.078		0.074		0.030		0.013	

# of mothers = 10,450

# of states = 47

[1] Based on scale combining standardized proportion of c-sections (reverse coded), midwife assisted births, and births at home in a state

Table 5.3. State Level Random Intercept Models of Breastfeeding Continuation (Breastfeeding for at Least 6 Months among Mothers that Initiated Breastfeeding)

	Model 1		Model 2		Model 3		Model 4	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
STATE VARIABLES								
Breastfeeding legislation								
right to breastfeed in public law and/or breastfeeding and employment law			0.282 *	0.129	0.212	0.114	0.180	0.103
Medical Environment Surrounding Births[1]								
Highest Natural/Lowest Medicalization					0.658 ***	0.157	0.631 ***	0.142
Medium Natural/Low Medicalization					0.274 *	0.137	0.216	0.123
Low Natural/Medium Medicalization					0.270	0.147	0.168	0.129
Lowest Natural/Highest Medicalization					---	---	---	---
INDIVIDUAL LEVEL VARIABLES								
Child Characteristics								
twin							-0.487 ***	0.087
first child							0.012	0.058
male child							-0.121 *	0.052
any stay in NICU							-0.120	0.100
normal birth weight (reference)							---	---
low birth weight (1500-2500g)							-0.319 ***	0.092
very low birth weight (<1500g)							-0.561 ***	0.133
Circumstances Surrounding Birth								
c-section delivery							-0.243 ***	0.061
midwife as birth attendant							0.252 *	0.099
home birth							1.432 **	0.509
Mother Characteristics								
education (years)							0.082 ***	0.012
Non-Hispanic white (reference)							---	---
non-Hispanic black							-0.185	0.102
Asian							-0.554 ***	0.106
Hispanic							0.026	0.092
Other race/ethnicity							0.214	0.115
foreign born (Y/N)							0.404 ***	0.083
married (reference)							---	---
cohabiting							-0.411 ***	0.082
never married							-0.629 ***	0.116
previously married							-0.392 *	0.168
age (years)							0.046 ***	0.005
household income (in $10,000's)							0.001	0.007
WIC use during pregnancy							-0.277 ***	0.070
not working or on maternity leave (reference)							---	---
maternity leave							-0.461 ***	0.058
working							-0.087	0.130
Intercept	-0.358 ***	0.067	-0.537 ***	0.104	-0.748 ***	0.108	-0.047	0.115
model intra class correlation	0.041		0.035		0.021		0.014	

# of mothers = 7,000

# of states = 46

[1] Based on scale combining standardized proportion of c-sections (reverse coded), midwife assisted births, and births at home in a state

Table 5.4. State Level Random Intercept Models of Breastfeeding Initiation and Continuation by Existence, Number, and Timing of State Breastfeeding Laws

Breastfeeding Legislation	INITIATION				CONTINUATION			
	Model 1		Model 2[1]		Model 3		Model 4[1]	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Dichotomous Variable								
Neither right to breastfeed in public law NOR breastfeeding and employment law in 2001(reference)	---	---	---	---	---	---	---	---
Right to breastfeed in public law and/or breastfeeding and employment law in 2001	0.244	0.173	0.141	0.148	0.282 *	0.129	0.230	0.122
	Model 1		Model 2[1]		Model 3		Model 4[1]	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Strength of Legislation (# Laws)								
Neither right to breastfeed in public law NOR breastfeeding and employment law in 2001(reference)	---	---	---	---	---	---	---	---
Right to breastfeed in public law OR breastfeeding and employment law in 2001 (not both)	0.204	0.182	0.114	0.156	0.274 *	0.137	0.224	0.130
Right to breastfeed in public law AND breastfeeding and employment law in 2001	0.368	0.254	0.223	0.217	0.308	0.185	0.247	0.173
	Model 1		Model 2[1]		Model 3		Model 4[1]	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Timing of Breastfeeding in Public Legislation								
No Law as of 2001 (reference)	---	---	---	---	---	---	---	---
Law 0-2 years old (1999-2001)	0.299	0.228	0.294	0.196	0.405 *	0.168	0.425 **	0.158
Law 3-5 years old (1996-1998)	0.438	0.251	0.187	0.216	0.270	0.183	0.129	0.171
Law 6+ years old (<=1995)	0.225	0.208	0.093	0.178	0.314 *	0.152	0.214	0.142
	Model 1		Model 2[1]		Model 3		Model 4[1]	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Timing of Breastfeeding in Public Legislation (including laws after 2001)								
No Law as of 2008 (reference)	---	---	---	---	---	---	---	---
Law after 2001 (2002-2008)	-0.674	0.345	-0.313	0.308	-0.541 *	0.249	-0.356	0.242
Law 0-2 years old (1999-2001)	-0.270	0.366	0.029	0.326	-0.045	0.262	0.130	0.253
Law 3-5 years old (1996-1998)	-0.129	0.381	-0.078	0.337	-0.174	0.271	-0.162	0.261
Law 6+ years old (<=1995)	-0.341	0.356	-0.171	0.316	-0.134	0.253	-0.080	0.243

Initiation models (models 1 and 2): # mothers =10,450; # states=47

Continuation models (models 3 and 4) # mothers =7,000; # states=46

[1]Models 2 and 4 include the following individual controls: mother's education, mother's marital status at birth, mother's age at birth, child parity, child twin status, child sex, child birthweight, delivery type (c-section), delivery attendant (midwife), home birth, region, urban/rural location, household income, maternal work status at birth (working, stay at home, on paid maternity leave).

Table 5.5. Correlations between State Proportions of Births with a Midwife Attendant, Proportions of Births Delivered via C-Section, and Proportions of Births at Home and Other State Level Variables

		Birth Environment Scale Components		
	Birth Environment Scale[1]	Proportion c section	Proportion midwife	Proportion home births
	correlation	correlation	correlation	correlation
CDC State Vital Statistics 2000				
Scale Components				
Proportion c section	**-0.83**	1.00	**-0.39**	**-0.59**
Proportion midwife	**0.74**	**-0.39**	1.00	**0.37**
Proportion home births	**0.82**	**-0.59**	**0.37**	1.00
Marital Status of Mothers				
Proportion births to unmarried mothers	**-0.25**	**0.34**	-0.06	**-0.21**
Prenatal Care of Mothers				
Proportion prenatal care in first trimester	-0.15	0.08	-0.04	**-0.24**
Proportion no prenatal care	-0.16	0.13	**-0.24**	-0.01
Age of Mothers				
Proportion mothers less than 20	**-0.30**	**0.33**	**-0.26**	-0.13
Proportion mothers more than 35	0.20	-0.15	**0.33**	-0.02
Education of Mothers				
Proportion mothers less than high school degree	**-0.24**	**0.30**	-0.13	-0.15
Proportion mothers w/ bachelor's degree	-0.01	-0.05	0.15	**-0.24**
Nativity Status of Mothers				
Proportion mothers US born	-0.05	0.05	-0.16	0.11
Characteristics of Children				
Proportion low birth weight	**-0.58**	**0.54**	**-0.38**	**-0.49**
CDC Breastfeeding Report Card 2008				
Birth Facility Charcteristics				
Birth facility practices supportive of breastfeeding (mPINC[2] score)	**0.59**	**-0.48**	**0.57**	**0.37**
Proportion of live births at "baby friendly"[3] facilities	0.17	**-0.24**	0.16	0.00
Professional Support				
International Board Certified Lactation Consultants (IBCLC's) per 1000 live births	**0.57**	**-0.33**	**0.60**	**0.43**
Mother to Mother Support				
La Leche League groups per 1000 live births	**0.43**	**-0.33**	**0.37**	**0.33**

correlations >.2 are in bold

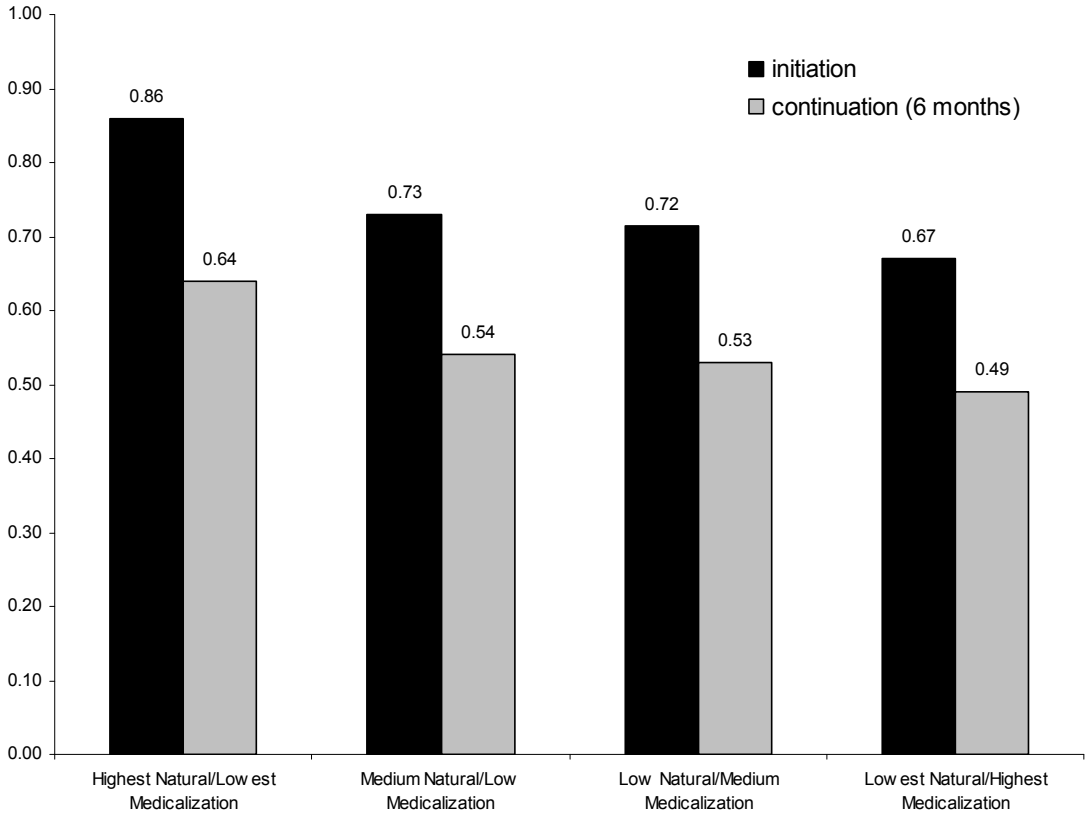
n=47 (47 states in sample)

[1] Based on scale combining standardized proportion of c-sections (reverse coded), midwife assisted births, and births at home in a state

[2] mPINC score based on results of Maternity Practices in Infant Nutrition and Care Survey, designed to measure breastfeeding related maternity care practices at birth facilities across the US

[3] The Baby Friendly Hospital Initiative is sponsored by the World Health Organization and designed to recognize hospitals that provide environments that are friendly toward breastfeeding

Figure 5.1. Predicted Probability of Breastfeeding Initiation and Continuation for Mothers of Children Born in 2001 by State Differences in the Medical Environment Surrounding Births



Notes:

Predicted Probabilities based on Model 4 in Table 5.2 (initiation) and Model 4 in Table 5.3 (continuation)

Initiation: Predicted probability of initiating breastfeeding months for a mother with a given set of baseline characteristics.

Continuation: Predicted probability of continuing breastfeeding for at least 6 months for a mother that initiated breastfeeding with a given set of baseline characteristics.

Baseline characteristics: non-twin, non-first born, female child of normal birth-weight, that was not delivered via c-section, midwife, or home birth, with a 27 year old, married, high school educated, non-Hispanic white mother, with average household income, who did not use WIC during pregnancy, was not working or on maternity leave at birth, and was living in a state with no breastfeeding law.

CHAPTER SIX. BREASTFEEDING AND COGNITIVE DEVELOPMENT IN EARLY CHILDHOOD

Introduction

From a life course perspective, development that occurs in infancy and early childhood forms the foundation for children's lives. Early childhood is widely believed to be a critical stage of life, due to the rapid development during this time period and the cumulative nature of developmental skills. However, children do not experience equal childhoods, and large differences exist both in children's exposure to parenting practices (Lareau 2003) and children's skill development (West et al. 2000). Children's paths begin to diverge very early in life, and by the time children begin Kindergarten they already exhibit wide variations in their abilities and knowledge (West et al. 2000). Children who begin schools with cognitive skills behind their peers are at danger of facing life long disadvantage. Schools begin to classify children early, and such classifications (grade retention, ability grouping, and special education) have implications for later achievement (Entwisle and Alexander 1993). Therefore, it is important to identify factors that contribute to early disparities in cognitive skills.

Exposure to breastmilk is one environmental factor that might contribute to early differences in cognitive development. Research has shown that breastfeeding is positively correlated with cognitive development. If breastfeeding *promotes* cognitive development, then not receiving breastmilk may be another source disadvantage that

some children face. On the other hand, children that are more advantaged are more likely to receive breastmilk, so breastfeeding may be a reflection of an advantaged environment, rather than a cause. Given the recommendation by the American Academy of Pediatrics that women breastfeed, this is an important distinction.

While breastfeeding is the recommended form of infant feeding, not all mothers are able to provide their children with breastmilk. Individual, social, physical, emotional or work constraints may prevent mothers from breastfeeding. Consequently, whether the parenting attitudes and behaviors can explain the relationship between breastfeeding and cognitive outcomes is a critical question. If the cognitive benefits of breastfeeding exist above and beyond the benefits of other positive parenting behaviors, then policy makers interested in improving cognitive outcomes in children may want to target structural constraints, such as work and social norms, that provide barriers to breastfeeding. On the other hand, if the relationship between breastfeeding and cognitive development is largely explained by differences in parenting behaviors, then policy goals may be better served by targeting parenting behaviors directly.

This final analytic chapter examines the relationship between breastfeeding and child cognitive development, controlling for a wide range of contextual factors that are related to both breastfeeding and cognitive functioning. Because children that experience normal cognitive development exhibit a range of cognitive scores, and it is children who are substantially behind their peers that are most at risk of poor developmental trajectories, the focus of this chapter is on children with cognitive scores that are substantially below average. Outcomes of interest include low scores on an overall cognitive assessment age 2 and low scores on an assessment math and literacy skills at

preschool age, each of which are directly assed via standardized tests in the ECLS-B. For each outcome, children are considered to have "low" cognitive scores if their cognitive development is more than one standard deviation below the mean score.

Background and Literature Review

Why Breastfeeding Might Matter

There are three primary *causal* channels through which breastfeeding might matter for child cognitive development—nutrition, disease prevention, and maternal-infant interaction (Currie 2005). The first channel, nutrition, is primarily a biological explanation. There may be some ingredient or combination of ingredients in breast-milk, such as long chain fatty acids, that are not available in formula, and provide a nutritional advantage for breastfed children. This nutritional advantage may contribute to cognitive development. The second mechanism, disease prevention, has both biological and social components. Breastfeeding has been linked to reduced ear infections, asthma, and other health outcomes in early childhood. Health problems can directly impair a child's cognitive ability or indirectly affect a child's cognitive ability by crowding out beneficial activities or changing the way a family treats a child (Currie 2005). To the extent that breastfeeding can reduce childhood diseases and infection, it could contribute to cognitive development. The final mechanism, mother-infant interaction, is primarily social. Breastfeeding requires extensive mother-child contact, and this contact may be beneficial for future mother-child relationships and child learning.

However, the relationship between breastfeeding and cognitive development may be spurious rather than causal. In the US and other highly developed countries, mothers

who breastfeed have more education and higher cognitive functioning. Breastfeeding mothers may also be more child-centered mothers. If these or other unobserved factors are related to breastfeeding *and* cognitive functioning, the relationship between breastfeeding and cognitive outcomes may be spurious. Breastfeeding may simply be a proxy for a broad set of behaviors and characteristics that promote cognitive development (Wolf 2007).

Breastfeeding and Cognitive Development

Researchers have long been interested in the relationship between breastfeeding and cognitive development. Results from as early as the 1920s noted cognitive benefits of breastfeeding, with children exclusively breastfed for the 4-9 months exhibiting better physical and mental development at ages 7 to 13 than children who had been formula fed (Hoefer and Hardy 1929). Research since that time has tended to confirm those results. Overall, children who are breastfed have higher cognitive scores than children who are not breastfed, and breastfeeding seems to be particularly beneficial for preterm and low birth weight children. The advantage for breastfed infants is small, but durable, stable, and evident from early childhood through adulthood (Anderson et al. 1999; Drane and Logemann 2000). A recent meta-analysis estimated that after controlling for confounders breastfed term infants exhibit 3.16 point IQ advantage and breastfed low birth weight children show a 5.18 point advantage (Anderson et al. 1999). Moreover, there appears to be a dose-response relationship—with children that are breastfed longer and children that are breastfed exclusively exhibiting higher cognitive scores than children who are partially breastfed, breastfed for short durations, or not breastfed at all. Nonetheless, given the links between maternal advantage (such as maternal IQ, education, income,

cognitively stimulating behaviors) and breastfeeding AND maternal advantage and child cognitive scores, the causal nature of this result is questionable and selection bias is a considerable issue.

Recent reviews question the methodological rigor and subsequent conclusions of studies that report breastfeeding improves children's cognitive outcomes. Failure to control adequately for confounding variables is frequently cited as a methodological issue (Drane and Logemann 2000; Jain et al. 2002; Rey 2003; Ip et al. 2007). Most studies conclude that breastfeeding promotes intelligence; however, higher quality studies, such as those that include controls for both socioeconomic status and a measure of child stimulation in the home, are less likely to find a significant link (Jain et al. 2002). The most recent reviews conclude that the effect of breastfeeding on cognitive development in full term infants is small or insignificant (Rey 2003; Ip et al. 2007). However, the ECLS-B offers a unique opportunity to re-examine this relationship over time in a large, nationally representative sample of children in the US.

Selection Bias in Breastfeeding Research

Methodological criticisms of past breastfeeding research means that more recent research has paid closer attention to addressing selection issues. Researchers examining breastfeeding and child cognitive outcomes deal with the problem of selection through a number of techniques—controlling for confounders, (modified) randomization, sibling comparison, and studying populations where SES and breastfeeding are not related.

Controlling for Confounders

The nature of breastfeeding makes it difficult, and many suggest unethical, to randomize children to "breastfed" and "not breastfed" groups; consequently, most researchers interested in associations with breastfeeding are forced to rely on observational studies. Selection is a problem for observational analyses because individuals in the comparison groups may be fundamentally different. One way to deal with selection effects is to control for variables—such as child and parent characteristics—that differ between breastfed and not breastfed children and that are associated with the outcome in question. For example, in the US maternal education is positively related to both breastfeeding and child cognitive outcomes, so failing to control for maternal education could inflate the positive relationship between breastfeeding and cognitive development.[44] Researchers find that controlling for confounding variables significantly reduces (Fergusson et al. 1982; Morrow-Tlucak et al. 1988; Gibson-Davis and Brooks-Gunn 2006) and in some cases eliminates (Wigg et al. 1998; Jacobson et al. 1999; Silva et al. 2006; Der et al. 2006) the relationship between breastfeeding and child cognitive outcomes. Maternal IQ and provision of a stimulating home environment (often measured with the HOME scale) seem to be the largest confounders in this relationship (Jacobson and Jacobson 2002; Rey 2003; Der et al. 2006; Gibson-Davis and Brooks-Gunn 2006). Other researchers control for confounding variables by limiting their sample to specific populations (for example, full term OR preterm children) or eliminating groups from their analyses (e.g., non-native born mothers). While controlling for confounding variables helps to reduce the possibility of selection bias, selection bias

[44] An alternate possibility is that breastfeeding is a mechanism that helps to explain the relationship between maternal education and child cognitive outcomes.

will still exist if the control variables do not adequately capture the contributing factor, or if there is some other unobserved factor that is related to both breastfeeding and child cognitive development.

(Modified) Randomization

While it is difficult to randomize mothers and infants to breastfeeding groups, one large study (PROBIT—Promotion of Breastfeeding Intervention Trial) in Belarus took a unique approach to examining the effects of breastfeeding. Mothers who initiated breastfeeding were randomly assigned to one of two groups, with one group receiving a breastfeeding promotion intervention. Baseline characteristics of the mothers were similar between the two groups, but those receiving the intervention had longer durations of breastfeeding and were seven times more likely to be breastfeeding exclusively at three months (Kramer et al. 2008). Children in the experimental group (whose mothers had similar baseline characteristics but higher breastfeeding durations and rates of exclusive breastfeeding) had significantly higher scores on both verbal subtests of the Wechsler Abbreviated Scales of Intelligence at age 6.5 although this result did not hold for the non-verbal subtests (Kramer et al. 2008). These results lend support to a causal relationship between breastfeeding and child verbal development. Nonetheless it is not possible to determine that the intervention did not have any effects other than increasing breastfeeding rates.

Sibling Comparison

A third way to control for selection effects is to use sibling fixed effects models. In sibling fixed effects models, siblings with different breastfeeding histories are

compared to see if they have different cognitive development outcomes. The fixed effects models effectively control for any characteristics that are family specific and do not vary between children. This eliminates the need to measure variables that may be important but are the same for both siblings, such as maternal intelligence. Nonetheless, it is still important to control for factors that are different between siblings, such as factors that contribute to different breastfeeding intervals.

Two researchers have used sibling fixed effects to examine the relationship between breastfeeding and cognitive outcomes US. Evenhouse and Reilly (2005) used sibling fixed effects to compare 15 adolescent outcomes in the domains of physical health, emotional health, and cognitive ability between 2734 sibling pairs in the National Longitudinal Study of Adolescent Health. While the relationship between breastfeeding and most outcomes were significant using standard regression models (12/15 were significant when breastfeeding was measured in months), only the relationship between breastfeeding and cognitive development (measured using the Peabody Picture Vocabulary Test) remained significant in the sibling fixed effects models. The authors concluded that the relationship between breastfeeding and many long term health and emotional outcomes may be overstated; but that the relationship between breastfeeding and cognitive ability may indeed be causal. However, as noted by Der et al. (2006) the authors use a liberal level of significance ($p<.10$) rather than the more conservative $p<.05$. Moreover, the relationships between breastfeeding and other academic outcomes (GPA, grade retention, likely to go to college) were not significant in the fixed effects models, suggesting that any differences in cognitive functioning did not have meaningful consequences in terms of academic performance. Furthermore, while the authors

considered that it was possible that breastfeeding differences between children may represent higher overall investment in one child over another, it is not clear how much of these potential parenting differences in investment they controlled for in their regressions. Omitted child-specific characteristics (such as child gestational age and health status at birth) that are related to both breastfeeding and child cognitive tests could also help to explain significant cognitive differences. The same could be true of parent characteristics that change over time (divorce, work status) that might contribute to different breastfeeding intervals between children.[45]

A study by Der et al. (2006) used sibling fixed effects to examine the relationship between breastfeeding and cognitive outcomes of children of the NLSY and found no significant relationship between breastfeeding and cognitive development. Der and colleagues also re-analyzed the sibling data from the Evenhouse and Reilly (2005) study and found "no support for an advantage of breastfeeding".

Results from sibling analyses suggest that breastfeeding is not causally related to cognitive outcomes. Nonetheless, while sibling fixed effects reduce selection bias by controlling for some of the unmeasured omitted factors, such models cannot solve the selection problem. Sibling models can only compare siblings and for that matter only compare siblings with different breastfeeding histories and cognitive outcomes. To the extent that these siblings are different than other children, the conclusions may not be generalizable to the population at large. Furthermore, these restrictions may contribute to small sample sizes—making it more difficult to detect significant differences.

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[45] Nonetheless, other factors may have underestimated the causal effect of breastfeeding. Breastfeeding information was collected retrospectively, and no measure of exclusive breastfeeding was available—both of which might underestimate the true effects of breastfeeding.

Examining Populations in which SES and Breastfeeding are Not Related

The primary problem with considering the relationship between breastfeeding and cognitive development in the US is that breastfeeding is highly correlated with other aspects of advantage that are also correlated with cognitive development. One way to avoid this problem is to study populations in which this association does not exist. That is, study populations in which breastfeeding is not associated with advantage. In the Philippines, where breastfeeding is inversely correlated with SES and other healthy maternal behaviors, Daniels and Adair (2005) found that breastfeeding was positively associated with cognitive scores at ages 8 and 11. Similarly, Eickman et al. (2007) found cognitive benefits of breastfeeding among 12 month old infants in Brazil—where mothers with the highest education were least likely to breastfeed. These results suggest that the cognitive development benefits of breastfeeding do not simply capture an unmeasured component of SES. Nonetheless, the relationship between breastfeeding and cognitive development may not be comparable between the United States and Brazil or the Philippines, where incomes are lower, food insecurity is potentially higher, and breastfeeding may play a different (and perhaps more beneficial) role as the alternatives to breastfeeding are likely not be the same as in the US.

Selection Bias in the Current Analysis

Selection bias is clearly a problem in research on the relationship between breastfeeding and child outcomes, and observational research in general. The current analysis takes the most common approach to dealing with selection in observational data and controls for potential confounders. Birth cohort breastfeeding studies tend to be of high quality because they collect information on breastfeeding early in life and provide

more opportunity to control for confounding factors (Jain et al. 2002). The advantage of the ECLS-B data is that there is a very large range of potential confounders from across the child's early life course that can be incorporated in the analysis—including information on the birth certificate, information from parent interviews at three ages (9 months, 2 years, 4 years), and information from direct assessments of mother/child interactions at each wave.

In addition to controlling for child and maternal confounders, this analysis also includes sensitivity analyses in which the relationship between breastfeeding and cognitive outcomes is considered among a select group of children who are clinically advantaged (full term, normal birth weight, non-twin).

Breastfeeding *Duration* and Cognitive Development

If breastfeeding is beneficial for cognitive development, then one might expect a dose-response relationship in which children who are breastfed longer have better cognitive functioning. However, it is difficult to assess the relationship between breastfeeding duration and cognitive outcomes because breastfeeding duration (and exclusivity) are often measured differently in different studies—with some studies considering a dichotomous breastfeeding indicator, others considering categories (of varying number and size), and still others considering a continuous measure of breastfeeding duration. In general, when any relationship is evident, there is a positive relationship between breastfeeding duration and cognitive development (Rogan and Gladen 1993; Horwood and Fergusson 2001; Mortensen et al. 2002; Oddy et al. 2003). Some suggest that there could be a threshold effect (e.g. Dee et al. 2007) or a ceiling effect (Mortensen et al. 2002; Dee et al. 2007). The relationship between breastfeeding

and cognitive outcomes also tends to be stronger when considering differences in exclusive rather than partial breastfeeding (Drane and Logemann 2000).

This analysis begins with a consideration the relationship between breastfeeding duration and cognitive development. This is followed by analyses using alternative specifications of breastfeeding that incorporate both duration and exclusivity. This is possible because of the ECLS-B's large sample size and long-term collection of breastfeeding data (up to age 2). This is an advantage as most other studies do not consider combine all three components—initiation, duration, and exclusivity.

Breastfeeding and Categorical Cognitive Outcomes

Most research on the relationship between breastfeeding and cognitive development considers differences in standardized test scores rather than measures of cognitive skills or academic achievement (Petryk et al. 2007). Indeed, use of a standardized test score is considered a marker of quality methodology (Jain 2002). Nonetheless, after controlling for confounding factors, differences in individual IQ scores between breastfed and not breastfed children tend to be small. While small differences may matter at the population level, for example, by increasing the number of students requiring special education (Drane and Logemann 2000), such differences may have minimal effects on an individual's chances of life success. Consequently, it is also important to consider cognitive outcomes that are categorical in nature as such outcomes may represent obstacles to later achievement and opportunities.

A small number of studies have considered the link between breastfeeding and cognitive outcomes other than the overall cognitive test scores. All found a positive relationship between breastfeeding and at least one cognitive outcome of interest.

Horwood and Fergusson (1998) found that breastfed children in New Zealand were less likely to leave school without qualifications. Rogan and Gladen (1993) found that breastfed children had higher English grades but not Math grades in 3rd grade. Comparing British children breastfed exclusively for more than 3 months to children exclusively bottle-fed, Pollack (1994) found that breastfed children were more likely to have above average scores on four out of eight measures of cognitive functioning at age 10. Richards et al. (2002) found that members of a 1946 British cohort of children were more likely to have "educational qualifications" at age 26. Dee (2007) used data on more than 22,000 US children from the 2003 National Survey of Children's Health to examine the relationship between breastfeeding and parent "concern" over children's language and motor skill development. Compared to those who did not initiate breastfeeding, mothers who initiated breastfeeding were 22% less likely to be concerned about their child's expressive language and 30% less likely to be concerned about their child's receptive language (Dee et al. 2007). However, this measure of child development is difficult to interpret because "concern" may capture a parent's attitude regarding the importance of school as well as a child's individual developmental progress.

Because of the importance of categorical classifications in children's academic lives, the current research uses standardized assessments of cognitive development, but rather than focus on the overall scores, the analysis identifies children whose scores are substantially below their peers, thereby complementing previous research that considers continuous measures of cognitive development.

Contribution of Research

This research contributes to knowledge about the relationship between breastfeeding and cognitive development. This study adds to previous research by using standardized direct assessments to identify children who have the lowest scores on cognitive assessments at age 2 and math and literacy skill skills at preschool age. The nationally representative nature of the data means that the results are generalizable to all children in the US. While much research considers short breastfeeding intervals and dichotomous or trichotomous breastfeeding categories (Drane and Logemann 2000; Petryk et al. 2007), the collection of breastfeeding data through age 2 combined with large sample size allow for analysis of continuous breastfeeding durations as well as consideration of any breastfeeding and full (exclusive) breastfeeding.

A recent review of the literature cited the importance of better measures of parent attitudes and behavior in analyses of breastfeeding and cognitive development (Petryk et al. 2007). The ECLS-B allows for controls for a wide variety of factors that reflect the child environment provided by the parent, which are widely regarded as potential confounders but much less frequently assessed than basic demographic characteristics. This analysis includes measures of parent behaviors from three sources—maternal reports, interviewer observations in the home, and video-taped mother and children interactions. Of particular interest is the assessment of mother/child interactions, which were evaluated at each data wave in the ECLS-B. While a number of researchers have considered the confounding influence of a positive and stimulating environment based on observations in the home, direct assessments of the quality of mother/child interactions

have not been considered. The inclusion of such assessments is a contribution of this study.

Despite extensive control variables available in the ECLS-B, there are some limitations to the data. Recent research has also suggested the importance of controlling for maternal IQ as a potential confounding variable between breastfeeding and child cognitive outcomes (Der et al. 2006; Gibson-Davis and Brooks-Gunn 2006). Unfortunately, the ECLS-B did not include an assessment of the mother's cognitive ability. Maternal IQ is positively correlated with child cognitive outcomes. The relationship between maternal IQ and cognitive outcomes likely captures both genetic (inherited ability) and environmental (parenting behavior) components. However, the relationship between maternal IQ and breastfeeding less clear. Controlling for maternal IQ is only important if maternal IQ is correlated with breastfeeding duration above and beyond other controls in the analysis, such as maternal education and parenting practices (for example, if among mothers with graduate degrees, those who have higher IQs breastfed longer). It is unclear that this would be the case, particularly given the ability to control for such a wide range of maternal characteristics and parenting behaviors in the ECLS-B. However, if maternal IQ is in fact positively related to breastfeeding above controls included in the analysis, the results may overstate the positive effects of breastfeeding.

The data also have limitations in terms of measurement of parenting behaviors. The first parent interview and assessments were conducted when the child was 9 months old, which means that a mother's breastfeeding behavior came before her other observed parenting behaviors. This is problematic if breastfeeding contributes directly to

differences in parenting behavior. To the extent that breastfeeding improves mothering behavior, controlling for such behaviors would actually understate the benefits of breastfeeding.

Analysis Sample

As in previous chapters, only children whose biological mothers were the primary respondent at the 9 month interview are included in the analysis (~99%). The analysis samples are further restricted to children who completed direct assessments at a given data collection wave. In order to include the most possible children in each analysis, separate samples are used to assess cognitive delay at 2 years and math and literacy delay at 4 years.

2 Year Old Analysis Sample

At age 2, 92% of children with mother respondents at the first wave were retained at the second wave (not lost to follow up). Of these, 91% of children had valid cognitive assessment scores. The analysis sample is further restricted to children who were assessed between ages 22 and 26 months—the age range for which the fielded version of the Bayley Scales of Infant Development test is considered valid—this includes 92% of the total sample of children who received cognitive assessments at age 2. The final 2 year old analysis sample includes 8100 children—76% of the wave 1 sample, 82% of the wave 2 follow up sample, and 92% of the wave 2 follow up sample with cognitive assessments.

Preschool Age Analysis Sample

At preschool age, 83% of children with biological mother respondents at the first wave remained in the sample at the third wave (91% from the second wave). Of these,

90% of children received direct assessments and 95% of these had valid math and literacy assessment scores.[46] The final preschool analysis sample includes 7500 children—70% of the wave 1 sample, 84% of the wave 3 follow up sample, and 94% of the wave 3 follow up children who received any direct assessment.

Variables

Dependent Variables

The outcome of interest in this analysis is whether or not a child exhibits a low score on assessments of child cognitive development. Cognitive development is measured via standardized assessments at the age 2 and preschool age waves. A description of the cognitive assessments used at each wave follows:

Overall Cognitive Development at Age 2

At 2 years the children's overall mental development was assessed in the ECLS-B using the Bayley Short Form-Research Edition. The Bayley Short Form-Research Edition (BSF-R) was designed specifically for the ECLS-B and contained selected items from the Bayley Scales of Infant Development, Second Edition (BSID-II)—a standardized assessment of developmental status for children from birth to 42 months of age. Content of the Bayley Assessment varies by child age to capture children's rapidly developing skills. The assessment battery used at the 2 year survey wave of the ECLS-B was valid for children age 22-26 months. The BSID-II provides a standardized score for

[46] At the preschool wave, children were first given a screener to determine their English proficiency, those deemed not proficient were excluded from the overall literacy and math assessments.

overall cognitive development and overall motor development but not within cognitive or motor domains.

This research uses the mental (cognitive) component of the Bayley scale. The Bayley mental scale was designed to capture children's cognitive development such as memory, means-end behavior, exploratory competence, object permanence, expressive communication and receptive communication. All children received a "core" set of items, and children performing sufficiently well or poorly were given a ceiling or basal set of items in order to get a more accurate measure of the child's ability. The data collection agency used Item Response Theory (IRT) to calibrate and develop scores for each child that corresponded to the overall BSID-II measurement scale (Nord et al. 2006).[47] Because young children gain cognitive skills rapidly with age, and not all children were tested at exactly the same age, age-normed T-scores (mean 50, SD 10) are used to determine cognitive delay. This allows for comparison of a child's level of development to other children of the same age. For this analysis, children with T-scores more than 1 SD below the mean (<40) are considered to have low scores as compared to their peers (Black and Matula 2000).

Cognitive Skill Development at Preschool Age (~age 4)

Cognitive development in the preschool age children is assessed within two domains—*math* and *literacy*. The Bayley Scales of Infant Development, used to measure

[47] Item Response Theory is based on the idea that the probability of a correct response for a given question is a function of a child's underlying (latent) ability. For each test item, a mathematical function, called an item response curve, models the probability of a correct response to a given item, given a particular ability. The functions are based on two properties of the test items—the difficulty of the item (location on the ability index) and the item's ability to discriminate between levels of ability (slope) (Andreassen, Fletcher, and Park 2007).

overall cognitive performance at age 2, are only appropriate for measuring child development up to age 42 months. Consequently, a different set of cognitive tests was administered at the preschool wave of the ECLS-B. The ECLS-B Direct Cognitive Assessment at the preschool wave was developed specifically for the ECLS-B study. Components of the ECLS-B Direct Cognitive Assessment were based on items from a variety of standardized instruments developed for other large scale studies of preschool age children, including: the Peabody Picture Vocabulary Test, the Preschool Comprehensive Test of Phonological and Print Processing, the PreLas® 2000, the Test of Early Mathematics Ability-2, as well as assessment items used in the Family and Child Experiences Study, the Head Start Impact Study, and the Early Childhood Longitudinal Study Kindergarten Cohort (Snow et al. 2007, ECLS-B 9 month to preschool user's manual). As is age appropriate, the preschool assessments examined cognitive development within specific domains—language, literacy, and math—rather than overall cognitive development.

For this analysis, population-normed, standardized T-scores from the math and literacy assessments are used to assess whether preschool age children have skill delays as compared to their peers. Because preschool T-scores are population normed (based on population of children born in 2001 and tested between August 2005 and June 2006) rather than *age* normed, it is particularly important to include controls for the child's age at assessment. The preschool math and literacy assessments are described more fully below:

Math Skills at Preschool Age

The ECLS-B preschool math assessment was used to evaluate children's early math skills across the following constructs: number sense, geometry, counting, operations, and pattern understanding. Administration of the math assessment was similar to administration of the Bayley cognitive tests at age 2. All children received a "core" set of 28 items, and children performing sufficiently well or poorly were given an additional ceiling or basal set of items in order to get a more accurate measure of the child's early math skills. Because all children did not receive all items, Item Response Theory methods were used by the data collection agency to create scale scores, which were then converted to population standardized T scores (mean 50, SD 10). Children with preschool math T-scores more than one standard deviation below the mean (<40) are considered to have low math scores.

Literacy Skills at Preschool Age

The ECLS-B preschool literacy assessment was designed to assess aspects of preschool age children's early literacy skills. The literacy test included 35 items spanning the following constructs: phonological awareness, letter-sound knowledge, letter recognition, print conventions, and word recognition. Skip rules were implemented to preclude children from receiving test items that were too difficult. Item Response Theory methods were used by the data collection agency to create overall early literacy scale scores, which were then converted to population standardized T scores (mean 50, SD 10). Children with preschool literacy T-scores more than one standard deviation below the mean (<40) are considered to have low literacy scores.

Independent Variables

Breastfeeding

In previous chapters the dependent variable of interest was breastfeeding. In this chapter, the primary *independent* variable of interest is breastfeeding. In order to incorporate information about both duration and exclusivity, breastfeeding is measured in three ways—any breastfeeding (breastfeeding initiation), breastfeeding duration, and full breastfeeding duration.

Breastfeeding Initiation (Any Breastfeeding)

A mother is said to have initiated breastfeeding if she reported that she ever breastfed the child.

Breastfeeding Duration

The primary measure of breastfeeding duration is continuous, and is top-coded at 12. This measure does not include information on the portion of the diet that consists of breastmilk.

Full breastfeeding

Children who receive breastmilk along with other foods may vary substantially in the amount of breastmilk they receive; consequently, it is useful to consider the relationship between breastfeeding and cognitive outcomes for children based on the duration of exclusive or full breastfeeding. At the 9 month interview wave of the ECLS-B, mothers who were currently feeding their child breast milk substitutes (formula or cows milk) were asked the age (in months) at which they introduced formula, cow's milk, solid foods, and finger foods. A breastfed child is considered to be exclusively breastfed

up to the month in which the mother reports that the first non-breastmilk food item was introduced and partially breastfed for any subsequent months of breastfeeding.[48] For example, if a mother reported breastfeeding for six months and introducing formula at month five, the child is considered to be breastfed for six months and full breastfed for five months. In this analysis, full breastfeeding is considered up to 6 months.

Initial child control variables

Since child characteristics are expected to contribute both to breastfeeding duration and child cognitive outcomes, all models control for the following basic set of child characteristics twin status, child parity, child birth weight, child sex, and child age at assessment.

Subsequent mother, household, and family control variables

After initial models displaying the basic relationship between breastfeeding and cognitive outcomes controlling only for child characteristics, subsequent models also control for the following mother and household characteristics: mother's age at birth, mother's marital status at the time of assessment (2 years OR preschool), mother's combined race/ethnicity/nativity, mother's education at birth, cumulative household

[48] In this analysis I use the terms "exclusive breastfeeding" and "full breastfeeding" interchangeably. According to the World Health Organization, an infant is considered to have been *exclusively* breastfed if the child receives only breastmilk and no other liquids (including water) or solids with the exception of vitamins, mineral supplements, or medicines (WHO 1991). In *predominant* breastfeeding, an infant's predominant source of nutrition is breastmilk, but the infant may also receive water or water based drinks (including sugar-water, fruit juice, oral rehydration salts, or ritual fluids) (WHO 1991). *Full breastfeeding* encompasses both exclusive and predominant breastfeeding. Technically, this analysis considers "full breastfeeding" not "exclusive breastfeeding," because ECLS-B mothers are not whether their child receives water-based drinks.

income at the time of assessment,[49] mother's work status in the first year of the child's life, and child's current participation in center based child care.

Parenting knowledge and behaviors

A primary focus of this chapter is to determine the extent to which differences in parenting knowledge and behaviors can help to explain the relationship between breastfeeding and poor child cognitive outcomes. This analysis considers five sets of indicators of parenting knowledge and behaviors—mother's health behaviors during pregnancy, mother's knowledge of child development, interviewer observed maternal behaviors, maternal reported behaviors, and video-recorded assessments of mother child interactions. Each set of variables are described below.

Mother's health behaviors during pregnancy

Breastfeeding is considered a positive health behavior—which may be directly related to children's positive cognitive outcomes. However, breastfeeding is also associated with other positive maternal health behaviors, so it may be that these other behaviors and not breastfeeding per se, can explain any link between breastfeeding and cognitive development. This analysis incorporates controls for two health behaviors during pregnancy:

Smoked during pregnancy—dichotomous indicator set to 1 if mother reported smoking during third trimester; based on maternal report at the 9 month interview. An

[49] At each wave, incomes were collected in ranges—increments of $5000 were used for incomes up to $50,000, followed by increments of $25,000 up to 100,000, and a single increment of 100,000 up to 200,000. Semi-continuous household incomes at each wave were computed by assigning each household the income value at the midpoint of the response category. Respondents in the highest income response category were down-coded to the lower limit ($200,001). Cumulative household income at age 2 was computed by averaging the household income at the 9 month and 2 year waves. Cumulative household income at the preschool wave was computed by averaging the household income at all three waves (9 months, 2 years, preschool).

indicator is included for children whose mother's smoking status during pregnancy cannot be determined.

No prenatal care during first trimester—dichotomous indicator set to 1 if mother did not report receiving prenatal care during the first trimester based on maternal reports at the 9 month interview. Missing data are supplemented with information from the birth certificate. An additional indicator is included for children whose mother's use of prenatal care cannot be determined.

Mother's child rearing knowledge

A mother's knowledge of child development milestones may contribute to her decision to breastfed. However, this knowledge may affect the content of child-rearing beyond its contribution to breastfeeding, and consequently may be an important confounder in the relationship between breastfeeding and cognitive outcomes. The ECLS-B included a series of questions related to child-rearing knowledge. These questions were combined to create a child rearing knowledge scale, which is described below:

Child rearing knowledge—12 point scale indicating a mother's knowledge of basic child development at the 9 month interview. Questions based on selected items from the Knowledge of Infant Development Index (KIDI, MacPhee 1981, cited in Nord et al. 2004)—a series of questions related to child development, such as whether a typical child could perform a certain task by a given age. Responses of "no" were followed up by whether a child could do the task at an older or younger age. Correct answers were coded as "1" and summed to create an index of child development knowledge. The final index ranges from 0 to 11, with higher values indicating greater knowledge.

Parenting Activities and Behaviors

Because the act of breastfeeding could be considered an example of a (intensive) parenting behavior, it is useful to consider and control for other parenting behaviors that directly contribute to cognitive development, but are also correlated with breastfeeding. This analysis includes three indicators that capture aspects of the parenting environment to which the child is exposed. Notably, the three indicators are collected from three sources—*maternal reports*, *interviewer observations*, and *video-recorded assessments* of mother/child interactions. Using three sources of information allow for better coverage of a child's environment than has been possible in previous research. The *maternal reported behaviors* and *interviewer observed behaviors* are based on components of the HOME (Home Observation for Measurement of the Environment) scale, which is designed to capture characteristics of the child's home environment and stimulation (Caldwell and Bradley 1979). The ECLS-B contains a shortened version of the HOME scale. This analysis includes two subscales derived from the HOME scale—the Literary Activities Scale which is based on maternal reports, and the Language Environment & Cognitive Stimulation Scale which is based on interviewer observations. Previous research has shown that the HOME scale is a strong predictor of child cognitive development (Bradley et al. 1989; Christian et al. 1998; Guo and Harris 2000; Bennet et al. 2002). It is also an important confounder between breastfeeding and cognitive outcomes (Gibson-Davis and Brooks-Gunn 2006). However, in general, the HOME scale is better at detecting poor quality households than variation in high quality households (Miller and Davis 1997). Consequently, it is useful to consider other measures of parenting behaviors and quality. In addition to interviewer observations, the ECLS-B

data includes *video-recorded direct assessments* of the content of mother/child interactions based on a 10 minute play activity at the 2 year and preschool waves. These direct assessments may provide a less skewed assessment of parenting behaviors, and consequently may be even more useful than the HOME scale components in explaining the relationship between breastfeeding and child cognitive outcomes. The three measures of parenting activities and behaviors are described below.

Maternal reported behaviors

Literary Activities Scale (cumulative)—10 point scale based on frequency that mother reports she or other family member reads books to the child, tells stories to the child, and sings songs with the child at each interview wave. For each question, values range from 0 (not at all) to 3 (every day) (Andreassen and Fletcher 2005). For each survey wave, responses to each question are combined into a scale. Scales used in the analysis are cumulative and based on the average of scales up to and including the assessment wave. The two year outcome models include the average of the scales at the 9 month and 2 year assessments. The preschool models include the average of the scales at the 9 month, 2 year, and preschool assessments. While this scale is based on a sub-scale of the HOME scale, this scale actually captures more variation in home environments than the traditional HOME scale, which considers literary activities dichotomously (< or >=3 times per week).

Interviewer observed behaviors

Language Environment and Cognitive Stimulation Scale (cumulative)—5 point scale based on interviewer observations during the 9 month and 2 year assessments

(Andreassen and Fletcher 2005). Interviewer observations of cognitive stimulation were not collected at the preschool wave. Respondents (mothers) receive one point for exhibiting each of the following 4 items: Caregiver spoke spontaneously to child. Caregiver responded verbally to child. Caregiver caressed/kissed/hugged child. Caregiver provided toys to child. A mother's final cumulative scale is based on her average score at first two assessments (age 9 months and 2 years). Those with missing scores at either of the first two assessment waves are given the score for either available assessment. An indicator is included for children with missing scores at both assessments.

Video-recorded assessments of mother/child interactions

At both the 2 year and preschool survey waves, mother/child interactions were assessed using a *Two Bags Task*—a semi-structured activity in which the mother and child were instructed to play with 2 different sets of toys. The interaction was video-recorded and later coded to assess aspects of the mother-child interaction.

2 Year Old Two Bags Task

At the 2 year interview the mother and child were asked to play with a children's picture book (*Good Night, Gorilla* by Rathmann, 1994) and a small set of dishes. Six Likert-type rating scales were created to describe aspects of the interaction from the parent's perspective—parent sensitivity, parent intrusiveness, parent stimulation of cognitive development and parent positive and negative regard. Scales range from 1 (very low) to 7 (very high). Due to high correlation between the items, the parent sensitivity, parent stimulation of cognitive development, and parent positive regard scales were averaged to create an overall parent supportiveness variable (Nord et al. 2006).

This composite variable is used in the analysis of cognitive delay at 2 years. A missing indicator is included in the analysis for children with missing scores.

Preschool Age Two Bags Task

During the preschool age Two Bags Task, the mother and child were asked to play with two different sets of toys—the picture book *Corduroy* by Freeman (1968) and Play-Doh with cookie cutters and a rolling pin. At the preschool age assessment, five Likert-type rating scales were created to assess the mother's interactions with the child. The scales were similar to those used at the 2 year interview, except parental emotional supportiveness replaced parental sensitivity, and parental positive regard was dropped from the scales. Scales range from 1 (very low) to 7 (very high). The parent emotional supportiveness and parent stimulation of cognitive development scales are averaged to create the overall parent supportiveness scale at the preschool age assessment. Parental positive regard was not coded at the preschool wave, so it is not included in the preschool age scale. The preschool parent supportiveness scale is then averaged with the overall parent supportiveness scales from the 2 year interview to create the overall parent supportiveness scale used in the analyses of preschool age literacy and math skills. In the preschool models, children with missing parent supportiveness scores at either assessment wave are given the score for either available assessment. An indicator is included in the model for children with missing scores at both assessments.

Methods and Models

Cognitive scores are measured dichotomously in this analysis, so logistic regression is used to predict the log odds of each outcome given the independent variable

of interest (breastfeeding). Rapid growth and development in early childhood means that the content and type of cognitive assessments vary by child age. There is no consensus as to how best to analyze data from multiple assessments, with some researchers combining data from multiple sources to create a single outcome, and others conducting separate analyses (Fitzmaurice et al. 2004). In the primary part of this analysis, separate models are used to predict low cognitive scores at age 2, low early literacy skills at preschool age, and low early math skills at preschool age.[50] These models take advantage of the longitudinal nature of the data by constructing and incorporating variables that capture a child's circumstances for all waves up to the current wave.

The basic model is as follows:

$$\ln(p_i / 1-p_i) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_j X_{ji} + e_i$$

Where p is the probability of having a cognitive score >1 SD below the mean for a given cognitive outcome for child (*i*) with a covariate vector X.

Analytic Plan

I begin by considering the relationship between breastfeeding and low cognitive scores on the Bayley Scales of Mental Development at age 2. Initially, breastfeeding duration is measured as a continuous variable and includes all breastfeeding regardless of exclusivity (full or partial). After examining the relationship between breastfeeding duration and child cognitive delay controlling only for child characteristics, I then add controls for other mother and household characteristics to see whether any relationship between breastfeeding duration and low cognitive scores exists above basic demographic

[50] At the end of the analysis I also consider a "multiple sources" model in which the outcomes from each assessment are modeled simultaneously.

differences between mothers. Next, in a series of five models controlling for child and mother characteristics, I separately add indicators for *each* of five sets of indicators of parenting knowledge and behaviors, to see whether the (negative) relationship between breastfeeding duration and low cognitive scores matters net of each of these parenting behaviors. The five sets of indicators include: mother's health behaviors during pregnancy, mother's knowledge of child development, interviewer observed maternal behaviors, maternal reported behaviors, and video-recorded assessments of mother child interactions. Finally, I examine the relationship between breastfeeding duration and having a low cognitive score controlling for child and mother characteristics as well as *all* of the indicators of parenting knowledge and behaviors. In two subsequent series of models, I take a similar approach to analyze breastfeeding duration and a low score on the assessment of early math skills and breastfeeding duration and a low score on the assessment of early literacy skills.

After examining the relationship between any breastfeeding duration and child cognitive delay, I then consider alternate specifications for breastfeeding duration. For each outcome, I consider a dichotomous indicator for whether the child was ever breastfed, a continuous indicator for the duration that a child was exclusively breastfed, and an interactive model in which includes breastfeeding duration and an interaction between breastfeeding duration and full breastfeeding duration.

I do two sets of supplementary analyses. First, to examine the possibility that differences cognitive outcomes for breastfed and not breastfed children are related to differences in which children are breastfed, I consider a child sample in which I restrict the data to children who are clinically advantaged—normal birth weight (>2500g),

singleton births, and born at term (37-39 weeks gestational age). Second, I consider a "multiple sources" model in which each of the three assessment outcomes are modeled simultaneously.

Finally, to determine the substantive impact of the findings, I consider predicted probabilities of having a low cognitive score for children exposed to different durations of breastfeeding.

Results

Descriptive Statistics

Table 6.1 shows the basic descriptive statistics for variables used in the analysis according to assessment sample. The first set of columns show the means and proportions for variables used in the analysis of 2 year cognitive delay, while the second set of columns show the means and proportions for the preschool models of math and literacy delay. The samples vary slightly between the 2 year and preschool models, due to attrition between waves, age restrictions placed on the validity of the cognitive assessments at the 2 year wave (restricted to children age 22-26 months), and children who did not complete cognitive assessments at one wave or the other. All descriptive statistics are weighted in order to correspond to the population of children born in the US in 2001. Notably, despite slightly different samples, the weighted population descriptive statistics are nearly identical between the 2 year and preschool samples used in the analyses (unweighted descriptives are similar as well). The final section of Table 6.1 shows the distribution of breastfeeding durations under a variety of breastfeeding definitions.

Breastfeeding and Bayley Cognitive Scores at Age 2

Table 6.2 shows the relationship between a mother's breastfeeding duration and a child's likelihood of having a score > 1 SD below the mean on the Bayley Scales of Mental Development among 2 year old children born in 2001. Breastfeeding durations are measured continuously, up to 12 months. The first model controls only for child characteristics, including twin status, birth weight, parity, child age, and child sex. Results suggest that breastfeeding is negatively associated with low cognitive scores, and longer breastfeeding durations are significantly associated with a lower likelihood of scoring more than 1 standard deviation below the mean on the Bayley Scales of Mental Development. For example, a child who was breastfed for 1 month has about a 5% lower odds of scoring more than 1 SD below the mean than a child who was not breastfed at all (OR=exp(-.057*1)=.95); while a child who was breastfed for six months has about a 30% lower odds of exhibiting low cognitive scores (OR=exp(-.057*6)=.71).

The second specification of Table 6.2 incorporates controls for mother characteristics (race/ethnicity/nativity, age, marital status, education, employment in the first six months after the child's birth), household income and a child's exposure to center based child care. Adding these measures seems to reduce the breastfeeding duration coefficient. Controlling for these characteristics, children who were breastfed for six months have about a 12% lower odds of having a low Bayley cognitive score at age 2 (OR=exp(-.045*6)=.88).

In the next set of models (Models 3 through 7) I individually incorporate five sets of variables intended to capture differences in parenting knowledge and behaviors, which may help to explain the relationship between breastfeeding and cognitive outcomes.

These variable sets include: mother's health behaviors during pregnancy, mother's knowledge of child development, interviewer observed maternal behaviors, maternal reported behaviors, and video-recorded assessments of mother child interactions. Results of these models indicate that while a mother's health behaviors during pregnancy are not significantly related to having a low score on the Bayley cognitive assessment at age 2 (Model 3), each of the other indicators of maternal knowledge and parenting behaviors are significantly and negatively related to having a low cognitive score.

In the final model (Model 8), all the measures of parenting knowledge and behavior are included simultaneously in the model. In this final model, controlling for child characteristics, mother and household characteristics, and parenting knowledge and behaviors, breastfeeding duration remains significantly related to low cognitive scores. However, the size of the coefficient is quite small. All else equal, a child that is breastfed for six months has about a 17% lower odds of exhibiting a Bayley cognitive score at age 2 that is 1 SD below the mean than a child that is not breastfed at all (OR=exp(-.032*6)=.83).

Breastfeeding and Early Math and Literacy Skills at Preschool Age

Results of the previous models suggest that breastfeeding is positively related to cognitive development, and this relationship exists above and beyond demographic and parenting behaviors that are included in the model. The next models consider whether breastfed children are also less likely to experience low scores in early math and literacy skills at preschool age.

Preschool Age Math Skills

Table 6.3 shows the relationship between a mother's breastfeeding duration and a child's likelihood of scoring more than 1 SD below the mean on a standardized assessment of early math skills at preschool age. Results in Model 1, controlling for child characteristics, suggest that breastfed children are significantly less likely to exhibit low math skills at preschool age than their non-breastfed peers. For example, a child that is breastfed for 6 months has about a 34% lower odds of exhibiting low math scores (Table 6.3, Model 1; OR=exp(-.069*6)=.66). However, this relationship is no longer significant once basic controls for mother characteristics, household income, and a child's use of center based care are added to the model (Table 6.3, Model 2).

Preschool Age Literacy Skills

Table 6.4 shows the relationship between breastfeeding and a child's likelihood of scoring more than 1 SD below the mean on a standardized test of basic literacy skills among preschool age children. Model 1, controlling for child characteristics, indicates that there is a negative relationship between breastfeeding and low scores on an assessment of early literacy skills. Controlling only for child characteristics, children who were breastfed for 6 months have about a 36% lower odds of exhibiting low literacy scores (OR=exp(-.074*6)=.64) than children who were not breastfed at all. The relationship between breastfeeding duration and having a low preschool literacy score remains significant after adding controls for maternal characteristics, household income, and a child's use of center care (Model 2). Breastfeeding duration also remains significantly and positively related to early literacy skills at preschool age in the final model (Model 8), which incorporates all child characteristics, mother and household

characteristics, and parenting knowledge and behaviors. Even controlling for a wide range of differences in parenting behaviors and environments, children who are breastfed for 6 months have about a 16% lower odds of exhibiting poor literacy skills at preschool age than children who are not breastfed (OR=(-.029*6)=.84),

Alternate Measures of Breastfeeding Duration

Table 6.5 examines the cognitive outcomes from Tables 6.2-6.4, using a series of alternate specifications for the breastfeeding measure. Each horizontal panel shows the results of a different cognitive outcome (low overall cognitive development at age 2, low literacy skills at preschool age, and low math skills at preschool age). Within each panel, four breastfeeding specifications are considered—breastfeeding initiation, breastfeeding duration, full breastfeeding duration, and breastfeeding duration with an interactive term between breastfeeding duration and full breastfeeding duration. Within each outcome (panel) and breastfeeding specification (row), there are three models (columns)—the first model includes only child controls, the second model includes child, mother, household income controls, and child's enrollment in center care, and the final model contains all controls (controls from Models 1, 2 and 8, respectively, in Tables 6.2-6.4). For ease of interpretation, only the coefficients for the breastfeeding variables are shown.

The first set of models in each panel of Table 6.5 (first row) include a dichotomous indicator for any breastfeeding (breastfeeding initiation), and compares children who received any breastfeeding to children who receive no breastfeeding. This dichotomous indicator of breastfeeding is not significant for any of the cognitive outcomes once basic mother and family controls are added to the models (first row in each panel, Model 2). This indicates that a simple dichotomous indicator is not sufficient

to capture any differences that might exist between children who are and are not breastfed. The second row of models in each panel includes the measure of continuous breastfeeding from the models presented in Tables 6.2 through 6.4, and is re-displayed for comparison purposes.

The final two models incorporate information on full breastfeeding. Previous models consider any breastfeeding, without distinguishing between full and partial breastfeeding. However, the problem with measuring overall breastfeeding duration is that if children are not receiving all their nutrition from breastmilk, it is not possible to tell how much of their diet is from other sources. Consequently, it is also useful to consider the duration of exclusive breastfeeding. Panel 4 (Table 6.6), includes a continuous indicator for the duration of full breastfeeding. An increased duration of exclusive breastfeeding is associated with a reduced likelihood of having a low score on the Bayley Cognitive Scales at age 2, even after controlling child, mother and household characteristics and parenting behaviors (Panel 1, Row 3, Model 3). However, duration of full breastfeeding is not significantly related to low math skill scores OR low literacy scores at preschool age, once controls are added to the models.

The duration of breastfeeding and duration of full breastfeeding are linked, and the relationship between breastfeeding and cognitive outcomes might be expected to depend on both. For example, models that only consider duration of full breastfeeding end up including children who were primarily breastfed for long durations but never exclusively breastfed in the reference category (full breastfeeding = 0). The final model in each panel examines the joint relationship between breastfeeding duration and low cognitive scores, but includes a term for the interaction between breastfeeding duration

and full breastfeeding duration. Because the full breastfeeding duration term is not valid if breastfeeding duration is 0, no main term for full breastfeeding is included in the model. A group significance test indicates that in the models with all controls, this specification is only valid for predicting low overall cognitive scores at age 2.

Sub-Sample Analysis

Thus far all models have included *all* children living with mothers at 9 months who completed cognitive assessments in the ECLS-B (and were age 22-26 months for the 2 year assessment), and are thus nationally representative of all children born in the US in 2001. However, some of these children are born with medical conditions that may have reduced their likelihood of receiving breastmilk and also contribute to their performance on cognitive tests. This would produce a spurious significant relationship in which breastfeeding would appear to be beneficial, but in reality would be a reflection of the advantageous characteristics of children who are breastfed. While previous models include controls for many such child factors, the incorporated controls may not adequately capture such effects. Consequently, I consider a set of models, using a sub-sample of clinically advantaged children—singleton, normal birth weight (>2500g), born at term (37-39 weeks gestational age). Results of the models of cognitive scores for clinically advantaged children (models not shown) parallel those in Tables 6.2 through 6.4, indicating that the positive relationship between breastfeeding and child cognitive outcomes are not simply a reflection of health differences at birth that select healthier children to be breastfed.

Multiple Source Model

Because children's developmental level changes rapidly over the course of early childhood, different tests were used to assess child cognitive development at the 2 year and preschool data collection waves of the ECLS-B. While each test evaluated aspects of cognitive development, it is not appropriate to use longitudinal or growth models to examine a child's development over time (Snow et al. 2007). This is because the different tests inevitably capture different facets of a child's cognitive ability and skills.

Are the same children in the "low" category on each of the measures? Yes and no—children who performed poorly on the cognitive skills test at age 2 were more likely to perform poorly on the math and literacy skills tests at preschool age, but a poor performance on the test at age 2 did not translate automatically into a poor performance on the tests at preschool age. Of the children who were more than 1 SD below the mean on the Bayley Mental Scale at age 2 (the low scorers) about 30% were "low scorers" on the Early Literacy Skills Assessment at and 28% were "low scorers" on the Early Math Skills Assessment at preschool age. In contrast, of those that were not "low scorers" on the Bayley Mental Scale at age 2 only 17% were "low scorers" on the Early Literacy Skills Assessment and 13% were "low scorers" on the Early Math Skills Assessment at preschool age. About 53% of children with "low" math scores at preschool age also have low literacy scores; while 43% of children with "low" literacy scores have low math scores.

While longitudinal models are not appropriate because different cognitive tests were used at different ages, it is possible to use a single model to jointly model each assessment outcome. These models are called a "multiple source" models because the

outcome data come from different (multiple) sources. When estimating models with multiple data points from a single individual it is important to account for the fact that data points from the same child will be correlated. If this correlation is not taken into account, the estimation will assume that each assessment comes from an independent source, when in reality a single child is providing three outcome data points (violating the independence of observations assumption). The advantage of multiple source models is that these models take advantage of the correlation between assessments from a given individual to more accurately estimate standard errors (without necessarily considering whether a child experienced "growth" over time).

When estimating models with repeated observations, the correlation between outcomes can be accounted for by modeling the covariance among the repeated measures (in addition to modeling the mean). There are two primary methods used to model the correlation among repeated observations—random effects models and covariance pattern models (Fitzmaurice et al. 2004). In random effects models, correlations between measurements from a single individual are typically modeled with a random intercept, with a separate intercept estimated for each individual in the data. Such models are meant to account for the unobserved factors that make some individuals "high responders" and other individuals "low responders" (Fitzmaurice et al. 2004). While random effects models estimate a separate intercept for each individual, covariance pattern models estimate a single covariance matrix, intended to capture the covariance between repeated measurements for the entire sample. In covariance pattern models, a model with n measurement occasions produces an n x n symmetric covariance matrix, consisting of the variance for each measurement (on the diagonal) and the covariance for

each pair of measurements (above and below the diagonals). Covariance pattern models are appealing for longitudinal data because they easily allow for observations taken closer in time to be more highly correlated with one another.[51] The main assumption[52] of covariance pattern models is homogeneity in covariance across individuals (Fitzmaurice et al. 2004)—that is, the relationship between measurements is expected to be the same across individuals. This is reasonable (and even appealing) if we believe that the measurements are correlated because they are tapping into similar constructs.

In this chapter I have chosen a covariance pattern model to account for the correlation between observations from an individual. Generalized Estimating Equations are used to model the coefficients (using a logit link function), and the covariance between repeated measures is assumed to be "unstructured"—that is, no assumptions are made about the variances and covariances between measurement observations. Because an unstructured covariance matrix requires the estimation of a separate parameter for each measurement and pair of measurements, this type of covariance structure is only possible when the number of subjects is large and the number of measurement occasions is small (in this case 3 measurements).

Multiple source models require that the data be formatted into person-assessment files (similar to person-time files), with each child having a record for each assessed

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[51] In contrast, models with a random intercept assume that the correlation among repeated measures from an individual is constant over time. This is not necessarily appealing for modeling data collected longitudinally because we might expect that observations taken closer in time will be more highly correlated (Fitzmaurice et al. 2004). Notably, it is possible (but computationally intensive) to incorporate random slopes that allow the random effect to vary by measurement occasion.

[52] Depending on the structure imposed on the covariance matrix, additional assumptions may be made regarding the relationship between measurements. Covariance matrices can be "unstructured" in which the covariance between observations is determined entirely from the data and allowed to arbitrarily over time or "structured" in which the covariance between observations is assumed to follow a predictable pattern, consequently, "structured" covariance matrices require the estimation of fewer parameters.

outcome (low Bayley Mental Score at age 2, low Literacy Skills score at preschool age, low Math Skills score at preschool age). An indicator for the particular assessment is included in the model, allowing the outcome to vary by assessment. An interaction term is included between the assessment indicator and the breastfeeding duration term, in order to allow the effect of breastfeeding duration to vary by assessment.

The basic model is as follows:

$$\ln(p_{ij} / 1\text{-}p_{ij}) = \beta_0 + \beta_1 A_{i2} + \beta_2 A_{i3} + \beta_3 BF_i + \beta_4 A_{i2} \times BF_i + \beta_5 A_{i3} \times BF_i + \beta_x X_{ij} \ldots + e_{ij}$$

Where,

i indexes individual children

j indexes the assessment:
1 = Age Two Bayley Scale of Mental Development
2 = Preschool Age Literacy Test
3 = Preschool Age Math Test

A_{ij} is a dummy indicator for a particular assessment (j=1, 2, 3; j=1 reference)

BF_i is the continuous measure of breastfeeding duration for a given child (*i*)

X_{ij} represents the matrix of other covariates for a given child (*i*) [which may vary with time/measurement(*j*)]

p_{ij} is the probability of having a cognitive score >1 SD below the mean for child (*i*) and outcome measurement (*j*)

$e_{ij} \sim N(0, \Sigma)$ ➔ the model errors are assumed to be normally distributed with a mean of 0 and an unstructured covariance matrix (Σ)

The coefficients of interest are β_3 - β_5, where:

β_3 is the relationship between breastfeeding duration and the log odds of having a low score on the Age Two Bayley Scales of Mental Development

β_4 is the difference in the relationship between breastfeeding duration and the log odds of having a low score on the Age Two Bayley Scales of Mental Development and breastfeeding duration and the log odds of having a low score on the Preschool Age Literacy Test

β_5 is the difference in the relationship between breastfeeding duration and the log odds of having a low score on the Age Two Bayley Scales of Mental Development and breastfeeding duration and the log odds of having a low score on the Preschool Age Math Test

Results of the "multiple source" model are presented in Table 6.6. Independent variables that vary between the models presented in Tables 6.2 through 6.5 are included as time-varying variables—child age at assessment, mother's marital status, household income (cumulative average), child's current center care enrollment, literary activities scale (cumulative average), and parent supportiveness scale (cumulative average). All other independent variables are included as time-invariant variables. The sample is restricted to children who are have valid results for each assessment (n=7900). Results are presented for each of the breastfeeding duration specifications (initiation, duration of any breastfeeding, duration of full breastfeeding, duration of any breastfeeding x duration of full breastfeeding). Within each breastfeeding specification (row), there are three models (columns)—the first model includes only child controls, the second model includes child, mother, household income controls, and child's enrollment in center care, and the final model contains all controls. Only the estimates for the breastfeeding coefficients are included in the table. The main breastfeeding coefficient can be interpreted as the relationship between breastfeeding duration and having a low score on the Bayley Mental Scale at age 2, while the interaction terms can be interpreted as the difference in the relationship between breastfeeding duration and having low score on the

Bayley Mental Scale at age 2 and the relationship between having a low score on each of the other two assessments.

In the models with all controls, the F-tests for joint significance indicate that the set of breastfeeding variables are not significantly different from 0 for only the dichotomous breastfeeding outcome. The relationship between breastfeeding and low cognitive test scores is significant in all other specifications (any breastfeeding duration, full breastfeeding duration, and breastfeeding duration interacted with full breastfeeding duration). Does the relationship between breastfeeding duration and low cognitive scores depend on the assessment? The interaction terms are generally not significant, indicating that there is little evidence that the relationship between breastfeeding and cognitive delay depends on the assessment. This suggests that breastfeeding is negatively related to low test scores for each outcome assessed—low scores on the Bayley Mental Scale at age 2, low literacy skills at preschool age, and low math skills at preschool age. Notably, the relationship between breastfeeding duration and a low score on the math assessment was not significant when the math assessment outcome was modeled separately.

Does Breastfeeding Really Matter for Preschool Skill Levels?

Results thus far indicate that breastfeeding is negatively related to having low cognitive scores at age 2 and preschool age. While this relationship seems to be smaller, it remains significant even when controlling for a wide range of child characteristics and demographic and behavioral characteristics of the mother. How can we understand this finding substantively? Does breastfeeding really matter in terms of whether or not a preschooler is likely to have the skills necessary to be ready for Kindergarten?

To answer this question, I calculate and graph a series of predicted probabilities. I focus on the relationship between breastfeeding and having a low literacy score at preschool age, because earlier disparities matter less if they do not persist as the child ages, and because the relationship between breastfeeding and low math scores at preschool age seems to be weaker than the relationship between breastfeeding and low early literacy scores. Figure 6.1 graphs the relationship between breastfeeding duration and the predicted probability of a low score on the examination of early literacy skills based on model 8 presented in Table 6.4. The solid line represents the baseline predicted probability of a low score for a child with various breastfeeding durations, with a given set of household, mother, and child characteristics[53] and a mother with average scores on the knowledge index, the literacy activities scale, the cognitive stimulation scale, and the parent supportiveness scale. The relationship between breastfeeding duration and low cognitive scores can be seen in the slope. For a child with the given set of household, mother, and child characteristics the probability of having a low score on the preschool literacy ranges from .13 for a child that is not breastfed to .09 for a child that is breastfed for 12 months—a relatively small difference between low literacy scores and breastfeeding duration controlling for other characteristics. Considering that the median breastfeeding interval is about 3-4 months, and a child that is breastfed for 3 months with the same covariates has about a .12 probability of having a low score, the effect of breastfeeding duration is quite small.

[53] A 52 month old, non-twin, first born, female child of normal birthweight that is not in center care, in a household with average income, with a 27 year old, married, non-Hispanic white, high school educated mother, who did not work in the first 6 months after the child's birth, did not smoke during pregnancy, and received prenatal care in the first trimester.

To put the relationship between breastfeeding and low literacy scores in perspective, I have also plotted predicted probabilities from Model 8 for a child with the same baseline household, mother, and child characteristics, but alternate scores on the parenting behavior measures. The two dashed lines show the predicted probability of having a low preschool literacy score for children exposed to various breastfeeding durations based on different levels of parenting. The large dashed line shows the probabilities of having a low preschool literacy score for a child whose mother receives parenting scores 1 SD *below* the mean on the knowledge scale, literary activities scale, cognitive stimulation scale and parent supportiveness scale, while the small dashed line shows the probabilities of a low score for a child whose mother demonstrates parenting scores 1 SD *above* the mean on the knowledge scale, literary activities scale, cognitive stimulation scale and parent supportiveness scale. Children whose mothers score above the mean are much less likely to display low literacy scores at preschool age than children whose mothers score below the mean. Moreover, the difference *between the lines* based on levels of parenting behavior are much larger than the differences *within a line* based on varying breastfeeding durations. For example, a child with the given characteristics who is breastfed for 6 months has a .07 probability of having a low literacy score if her mother scored 1 SD above average on the parenting behaviors scores, but a .16 probability of having a low score if her mother scored 1 SD below average on the parenting behavior scores. This result indicates that other parenting behaviors may be more important predictors of cognitive scores than breastfeeding duration.

Conclusion

Breastfeeding is important for children to the extent that it has consequences for child outcomes. This chapter examines the relationship between the length of breastfeeding a child is exposed to and the child's likelihood of performing significantly below his or her peers on cognitive assessments in early childhood, including the Bayley Mental Scale at age 2 and standardized tests of early literacy and math skills at preschool age.

Recent research has suggested that the relationship between breastfeeding and cognitive outcomes can be attributed almost entirely to factors that are related to both breastfeeding and cognitive development, including recent reviews (Rey 2003; Ip et al. 2007), and large scale studies in the US using the NSLY (Der et al. 2006) and the Fragile Families data (Gibson-Davis and Brooks-Gunn 2006). The current analysis, using the ECLS-B data, offers the advantage of being nationally representative (unlike Fragile Families), incorporating information on the introduction of supplementary formula and food (full breastfeeding), and using direct assessments of mother child interactions in the form of short a semi-structured, play activity (neither of which are included in the NLSY or Fragile Families analyses).

While breastfeeding is negatively related to cognitive scores more than 1 SD below the mean for all three outcomes, with longer breastfeeding intervals associated with greater reductions in low scores, results suggest that a large part of this relationship can be attributed to factors that are related both to breastfeeding and cognitive

development such as income, education, and parenting behaviors.[54] However, despite an apparent reduction in the relationship between breastfeeding and low cognitive scores in models controlling for extensive demographic and parenting differences, breastfeeding duration remained a negative predictor of low cognitive scores on the Bayley Mental Scale at age 2 and low scores on the literacy skills assessment at preschool age. Furthermore, when the assessments were modeled jointly, the results indicate that the relationship between the breastfeeding duration and having a low cognitive score are not significantly different for the preschool math assessment than for the 2 year Bayley Mental Scale score.

Nonetheless, despite significant differences, the substantive importance of breastfeeding in terms of Kindergarten readiness appears to be limited. Children who are exposed to long breastfeeding intervals are only slightly less likely to be categorized as having low literacy skill scores at preschool age than children who have not been

[54] In this analysis I chose to model cognitive outcomes dichotomously. This was a substantive choice because small differences in cognitive scores are unlikely to large implications on children's lives. Consequently, I was interested in identifying those children that are most at risk of negative consequences—those with scores substantially behind their peers. This follows recent discussion in the literature on the benefits of breastfeeding and cognitive outcomes that has become more focused on the magnitude and substantive importance of any apparent relationship (Rey 2003; Der et al. 2006; Gibson-Davis and Brooks-Gunn 2006; Ip et al. 2007). Nonetheless, from a statistical perspective, using a dichotomous rather than continuous indicator does reduce information that could be used to estimate the model. To determine the extent to which my results are driven by the measurement of the outcome, I re-ran the models in Tables 6.2-6.4 using the continuous scores (Age 2 Bayley Mental Score, Preschool Age Math Skills Score, and Preschool Age Literacy Score), which are standardized to a mean of 50 and standard deviation of 10. The substantive results are similar—while breastfeeding duration is positively related to continuous cognitive scores for each assessment, the relationship is substantially reduced when controls for demographic characteristics and parenting behaviors are added to the models. This is particularly true for the Preschool Age assessments. Controlling only for child characteristics, each month of breastfeeding is associated with .39 points on Bayley Mental Score at Age 2, .41 points on the Preschool Age Literacy Skills Score, and .43 points on the Preschool Age Math Skills Score. This translates into an ~2.5 point advantage on each of assessments for a child that is breastfed for 6 months compared to one that is not breastfed at all. Controlling for demographic characteristics and parenting behaviors reduces the relationship substantially. In the models with all controls each month of breastfeeding associated with only an additional .18 points on the Bayley Mental Score at Age 2 and .10 points on both the Preschool Age Literacy Skills Score and the Preschool Age Math Skills Score—more than a 50% reduction in the association between breastfeeding and 2 year old scores and more than a 75% reduction in the association at Preschool Age.

breastfed. Moreover, differences in parenting knowledge and behaviors are a larger predictor of having low cognitive scores than differences in breastfeeding behaviors, suggesting that those interested in improving school readiness would be better off targeting parenting behaviors other than breastfeeding—at least for this particular outcome.

Tables and Figures

Table 6.1. Descriptive Statistics: Low Cognitive Scores, Child Characteristics, Mother Characteristics, Parenting Activities and Behaviors, and Breastfeeding Initiation and Duration by Analysis Sample (2 years and Preschool)

	2 year old analysis sample proportion / mean (95% CI)	**preschool analysis sample** proportion / mean (95% CI)
Child's Cognitive Scores		
Bayley Mental T Score > 1 SD below mean (2 year assessment)	0.13 (0.12 , 0.15)	
Math Skills T Score > 1 SD below mean (preschool assessment)		0.15 (0.14 , 0.17)
Literacy Skills T Score > 1 SD below mean (preschool assessment)		0.18 (0.17 , 0.20)
Child Characteristics		
twin	0.03 (0.03 , 0.03)	0.03 (0.03 , 0.03)
first child	0.40 (0.38 , 0.41)	0.40 (0.39 , 0.42)
male	0.51 (0.50 , 0.53)	0.51 (0.49 , 0.52)
normal birth weight (>2500g)	0.93 (0.92 , 0.93)	0.93 (0.92 , 0.93)
low birth weight (1500-2500g)	0.06 (0.06 , 0.07)	0.06 (0.06 , 0.07)
very low birth weight (<1500g)	0.01 (0.01 , 0.01)	0.01 (0.01 , 0.01)
child age* (range 22-26) (2 year assessment)	24.15 (24.12 , 24.19)	
child age* (range 44-65.3) (preschool assessment)		52.57 (52.43 , 52.72)
Mother's Race/Ethnicity/Nativity		
white	0.58 (0.54 , 0.62)	0.60 (0.56 , 0.63)
black	0.14 (0.12 , 0.16)	0.14 (0.12 , 0.16)
foreign born Hispanic	0.14 (0.12 , 0.16)	0.11 (0.09 , 0.13)
US born Hispanic	0.09 (0.07 , 0.10)	0.09 (0.07 , 0.11)
Asian	0.03 (0.03 , 0.04)	0.03 (0.03 , 0.04)
other or unknown race	0.03 (0.02 , 0.03)	0.03 (0.02 , 0.03)

(continued)

(Table 6.1 continued)

Mother's Age at Child's Birth		
mother's age* (range 15-50)	27.44	27.36
	(27.14 , 27.73)	(27.08 , 27.64)
Mother's Marital Status at Age of Assessment		
married	0.69	
	(0.67 , 0.71)	
cohabiting	0.13	
	(0.12 , 0.14)	
single	0.17	
	(0.16 , 0.19)	
marital status unknown	0.01	
(2 year assessment)	(0.00 , 0.01)	
married		0.67
		(0.65 , 0.69)
cohabiting		0.10
		(0.09 , 0.11)
single		0.19
		(0.17 , 0.20)
marital status unknown		0.04
(preschool assessment)		(0.03 , 0.05)
Mother's Education at Birth		
less than high school	0.19	0.18
	(0.17 , 0.21)	(0.16 , 0.19)
high school	0.28	0.28
	(0.26 , 0.30)	(0.27 , 0.30)
some college less than bachelor's degree	0.28	0.28
	(0.26 , 0.30)	(0.27 , 0.30)
bachelor's degree plus	0.25	0.25
	(0.22 , 0.27)	(0.23 , 0.28)
Cumulative Household Income		
income* (range 2,500-200,000)	52000	
(average of 9 month and 2 year)	(49000 , 55000)	
income* (range 2,500-200,000)		55000
(average of 9 month, 2 year, and preschool)		(52000 , 58000)
Mother's Work in First 6 Months		
returned to work by 12 weeks	0.28	0.29
	(0.27 , 0.30)	(0.27 , 0.31)
returned to work 12-24 weeks	0.26	0.26
	(0.24 , 0.27)	(0.25 , 0.28)
Child Care at Assessment		
child in center care	0.17	
(2 year assessment)	(0.16 , 0.18)	
child in center care		0.47
(preschool assessment)		(0.45 , 0.49)
child in headstart		0.12
(preschool assessment)		(0.11 , 0.14)

(continued)

(Table 6.1 continued)

Pregnancy Related Health Behaviors		
smoke during third trimester	0.11	0.12
	(0.10 , 0.13)	(0.10 , 0.13)
no prenatal care in first trimester	0.08	0.08
	(0.08 , 0.09)	(0.07 , 0.09)
Knowledge of Child Development		
KIDI index* (range 0-11)	6.80	6.87
	(6.70 , 6.89)	(6.77 , 6.97)
Parenting Activities and Behaviors		
Literary Activities Scale* (range 0-9)	6.07	
(average of 9 month and 2 year)	(5.98 , 6.16)	
Literary Activities Scale* (range 0-9)		6.08
(average of 9 month, 2 year, and preschool)		(5.00 , 6.16)
Cognitive Stimulation Scale* (range 0-4)	3.64	3.65
(average of 9 month and 2 year)	(3.60 , 3.69)	(3.60 , 3.69)
Cognitive Stimulation Scale uknown	0.02	0.02
(both 9 month and 2 year unknown)	(0.02 , 0.03)	(0.02 , 0.03)
Parent Supportiveness Scale* (range 1-7)	4.38	
(2 year)	(4.34 , 4.41)	
Parent Supportiveness Scale unknown	0.15	
(2 year)	(0.13 , 0.17)	
Parent Supportiveness Scale* (range 1-7)		4.35
(average of 2 year and preschool)		(4.31 , 4.38)
Parent Supportiveness Scale unknown		0.03
(both 2 year and preschool unknown)		(0.02 , 0.03)
Breastfeeding Initiation and Duration		
Initiation		
any breastfeeding	0.69	0.70
	(0.67 , 0.71)	(0.68 , 0.71)
Continuous Months		
months (up to 12)*	4.06	4.03
	(3.87 , 4.26)	(3.82 , 4.23)
Full Breastfeeding Duration		
months (up to 6)*	1.78	1.79
	(1.68 , 1.88)	(1.68 , 1.88)
	n=8100	n=7500

Notes:

* mean

Weighted by 2 year child assessment and preschool child assessment weights (W2C0 and W3C0).

Samples include all children who were living with a biological mom at wave 1 (~9 months) and have valid breastfeeding responses. 2 year sample includes only children who were assessed betweeen age 22-26 months.

Values in the same row mean that the same variable was used for both samples. When the variable used to capture a concept differs between waves, such as cumulative income, the values are presented in different rows.

Table 6.2. Bayley Mental T Score > 1 SD below Mean at Age 2 by Breastfeeding Duration

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Breastfeeding Duration																
months (continuous up to 12)	-0.057 ***	0.011	-0.044 ***	0.013	-0.045 ***	0.013	-0.043 ***	0.013	-0.039 **	0.013	-0.042 **	0.013	-0.034 *	0.013	-0.032 *	0.013
Mother and Household Characteristics																
non-Hispanic white																
non-Hispanic black			0.547 ***	0.147	0.505 ***	0.150	0.468 **	0.151	0.463 **	0.146	0.322 *	0.136	0.399 **	0.149	0.112	0.145
foreign born Hispanic			1.043 ***	0.177	1.002 ***	0.189	0.897 ***	0.185	0.890 ***	0.177	0.953 ***	0.166	0.842 ***	0.177	0.599 **	0.194
US born Hispanic			0.845 ***	0.178	0.810 ***	0.181	0.791 ***	0.179	0.770 ***	0.175	0.755 ***	0.169	0.829 ***	0.176	0.649 ***	0.170
non-Hispanic Asian			0.854 ***	0.158	0.814 ***	0.159	0.727 ***	0.155	0.727 ***	0.155	0.693 ***	0.157	0.616 ***	0.160	0.361 *	0.158
other or unknown race			0.575 **	0.208	0.562 **	0.211	0.559 **	0.210	0.582 **	0.212	0.559 **	0.213	0.530 *	0.219	0.516 *	0.228
age at birth of child (years)			0.012	0.010	0.012	0.010	0.011	0.010	0.014	0.010	0.012	0.011	0.015	0.010	0.018	0.011
married[2]			---	---	---	---	---	---	---	---	---	---	---	---	---	---
cohabiting			0.272	0.152	0.275	0.152	0.259	0.154	0.267	0.154	0.243	0.151	0.203	0.159	0.190	0.160
single (not married or cohabiting)			0.262	0.151	0.254	0.150	0.258	0.151	0.251	0.155	0.244	0.150	0.219	0.151	0.202	0.152
less than high school			0.127	0.128	0.122	0.128	0.104	0.129	0.083	0.131	0.073	0.132	0.036	0.123	-0.033	0.128
high school (reference)			---	---	---	---	---	---	---	---	---	---	---	---	---	---
some college			-0.001	0.134	-0.011	0.132	0.038	0.135	0.057	0.135	0.027	0.134	0.107	0.139	0.150	0.139
bachelor's plus			-0.201	0.174	-0.211	0.175	-0.139	0.175	-0.125	0.177	-0.182	0.173	-0.023	0.182	0.020	0.184
household income (in $10,000's) [3]			-0.056 ***	0.017	-0.057 ***	0.017	-0.052 **	0.016	-0.050 **	0.017	-0.056 ***	0.017	-0.046 **	0.016	-0.043 **	0.016
working before 12 weeks			-0.129	0.120	-0.124	0.121	-0.119	0.122	-0.179	0.119	-0.102	0.126	-0.113	0.118	-0.119	0.122
working between 12-24 weeks			-0.252 *	0.113	-0.245 *	0.113	-0.244 *	0.114	-0.243 *	0.113	-0.224	0.115	-0.219	0.114	-0.185	0.116
not working by 24 weeks (reference)			---	---	---	---	---	---	---	---	---	---	---	---	---	---
child in center care[2]			-0.217	0.145	-0.216	0.145	-0.220	0.145	-0.210	0.147	-0.248	0.155	-0.168	0.147	-0.199	0.159
Parenting Knowledge and Behaviors																
Health Behaviors During Pregnancy																
smoke during third trimester (Y/N)					-0.182	0.148									-0.211	0.149
no prenatal care in first trimester (Y/N)					0.239	0.153									0.150	0.157
Knowledge of Child Development[1]																
knowledge index (range 0-11)							-0.064 *	0.025							-0.014	0.023
Maternal Reports of Child's Literary Activities[3]																
literary activities scale (range 0-9)									-0.167 ***	0.030					-0.116 ***	0.030
Interviewer Observed Maternal Behaviors[3]																
cognitive stimulation scale (range 0-4)											-0.502 ***	0.079			-0.399 ***	0.081
cognitive stimulation scale missing											1.174 ***	0.225			1.112 ***	0.222
Assessment of Mother/Child Interactions[4]																
parent supportiveness scale (range 1-7)													-0.665 ***	0.070	-0.584 ***	0.071
parent supportiveness scale missing													0.407 **	0.134	0.361 **	0.135
Intercept	-2.065 ***	0.101	-2.873 ***	0.348	-2.866 ***	0.356	-2.833 ***	0.348	-2.962 ***	0.351	-2.918 ***	0.366	-3.148 ***	0.348	-3.189 ***	0.371

n=8100

* p< .05; **p<.01; *** p < .001

[1] measured at 9 month assessment; [2] measured at 2 year assessment; [3] average of 9 month and 2 year assessments; [4] measured at 2 year assessments

All models control for child age at assessment, twin status, first child status, child sex, and child birthweight (normal, low, very low)

Table 6.3. Early Math Skills T Score > 1 SD below Mean at Preschool Age by Breastfeeding Duration

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Breastfeeding Duration																
months (continuous up to 12)	-0.069 ***	0.012	-0.023	0.013	-0.023	0.014	-0.020	0.014	-0.020	0.013	-0.022	0.013	-0.016	0.014	-0.013	0.014
Mother and Household Characteristics																
non-Hispanic white			0.471 ***	0.129	0.454 ***	0.132	0.343 *	0.134	0.412 **	0.126	0.420 **	0.134	0.363 **	0.128	0.220	0.135
non-Hispanic black			0.782 ***	0.175	0.781 ***	0.183	0.543 **	0.183	0.677 ***	0.178	0.752 ***	0.174	0.581 **	0.183	0.343	0.199
foreign born Hispanic			0.429 **	0.160	0.414 *	0.159	0.343 *	0.160	0.376 *	0.155	0.409 *	0.163	0.423 **	0.160	0.310	0.157
US born Hispanic			-0.291	0.204	-0.316	0.208	-0.501 *	0.209	-0.366	0.203	-0.333	0.207	-0.491 *	0.201	-0.691 ***	0.204
non-Hispanic Asian			0.486 *	0.208	0.463 *	0.209	0.458 *	0.209	0.462 *	0.209	0.482 *	0.208	0.460 *	0.202	0.409 *	0.205
other or unknown race																
age at birth of child (years)			0.005	0.009	0.005	0.009	0.005	0.009	0.006	0.009	0.006	0.009	0.009	0.009	0.009	0.009
married[2]			---	---	---	---	---	---	---	---	---	---	---	---	---	---
cohabiting			0.161	0.134	0.142	0.139	0.145	0.134	0.154	0.133	0.154	0.135	0.107	0.135	0.077	0.138
single (not married or cohabiting)			0.016	0.138	0.000	0.140	0.004	0.138	0.011	0.137	0.011	0.138	-0.012	0.138	-0.037	0.138
less than high school			0.529 ***	0.110	0.518 ***	0.111	0.490 ***	0.110	0.488 ***	0.111	0.518 ***	0.111	0.440 ***	0.111	0.382 ***	0.112
high school (reference)			---	---	---	---	---	---	---	---	---	---	---	---	---	---
some college			-0.245	0.125	-0.247	0.126	-0.200	0.127	-0.214	0.123	-0.247 *	0.124	-0.164	0.126	-0.128	0.125
bachelor's plus			-0.717 ***	0.192	-0.716 ***	0.193	-0.626 **	0.195	-0.683 ***	0.192	-0.723 ***	0.191	-0.602 **	0.195	-0.534 **	0.197
household income (in $10,000's) [4]			-0.101 ***	0.027	-0.099 ***	0.027	-0.094 ***	0.027	-0.095 ***	0.027	-0.100 ***	0.027	-0.086 **	0.027	-0.078 **	0.026
working before 12 weeks			-0.167	0.122	-0.157	0.122	-0.162	0.123	-0.200	0.125	-0.163	0.123	-0.153	0.122	-0.162	0.124
working between 12-24 weeks			-0.106	0.122	-0.096	0.124	-0.089	0.121	-0.107	0.122	-0.099	0.123	-0.058	0.123	-0.040	0.122
not working by 24 weeks (reference)			---	---	---	---	---	---	---	---	---	---	---	---	---	---
child in center care[2]			-0.469 ***	0.109	-0.473 ***	0.108	-0.463 ***	0.110	-0.482 ***	0.110	-0.478 ***	0.110	-0.442 ***	0.112	-0.454 ***	0.111
child in head start[2]			-0.351 *	0.150	-0.347 *	0.152	-0.358 *	0.154	-0.355 *	0.150	-0.357 *	0.151	-0.359 *	0.154	-0.363 *	0.156
Parenting Knowledge and Behaviors																
Health Behaviors During Pregnancy																
smoke during third trimester (Y/N)					-0.035	0.150									-0.027	0.148
no prenatal care in first trimester (Y/N)					0.280	0.169									0.238	0.168
Knowledge of Child Development [1]																
knowledge index (range 0-11)							-0.109 ***	0.027							-0.083 **	0.028
Maternal Reports of Child's Literary Activities [4]																
literary activities scale (range 0-9)									-0.119 ***	0.028					-0.076 **	0.028
Interviewer Observed Maternal Behaviors [3]																
cognitive stimulation scale (range 0-4)											-0.113	0.073			-0.006	0.080
cognitive stimulation scale missing											0.491	0.256			0.390	0.268
Assessment of Mother/Child Interactions [5]																
parent supportiveness scale (range 1-7)													-0.498 ***	0.072	-0.434 ***	0.072
parent supportiveness scale missing													0.309	0.262	0.242	0.259
Intercept	-1.825 ***	0.088	-2.256 ***	0.287	-2.267 ***	0.287	-2.211 ***	0.284	-2.264 ***	0.284	-2.265 ***	0.287	-2.397 ***	0.282	-2.368 ***	0.280

n=7500

* p< .05; **p<.01; *** p < .001

[1] measured at 9 month assessment; [2] measured at preschool assessment; [3] average of 9 month and 2 year assessments; [4] average of 9 month and 2 year and preschool assessments; [5] average of 2 year and preschool assessr

All models control for child age at assessment, twin status, first child status, child sex, and child birthweight (normal, low, very low)

Table 6.4. Early Literacy Skills T Score > 1 SD below Mean at Preschool Age by Breastfeeding Duration

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Breastfeeding Duration																
months (continuous up to 12)	-0.074 ***	0.011	-0.036 **	0.014	-0.038 **	0.014	-0.035 *	0.014	-0.031 *	0.013	-0.036 **	0.014	-0.031 *	0.014	-0.029 *	0.013
Mother and Household Characteristics																
non-Hispanic white			0.225	0.135	0.179	0.139	0.181	0.139	0.138	0.132	0.170	0.139	0.152	0.139	0.005	0.148
non-Hispanic black			0.988 ***	0.149	0.938 ***	0.162	0.907 ***	0.152	0.832 ***	0.154	0.956 ***	0.146	0.851 ***	0.153	0.642 ***	0.168
foreign born Hispanic			0.627 ***	0.120	0.574 ***	0.126	0.597 ***	0.120	0.553 ***	0.118	0.603 ***	0.120	0.624 ***	0.120	0.485 ***	0.124
US born Hispanic			-0.320	0.180	-0.430 *	0.192	-0.391 *	0.180	-0.432 *	0.173	-0.360 *	0.177	-0.429 *	0.179	-0.648 ***	0.183
non-Hispanic Asian			0.153	0.218	0.141	0.218	0.143	0.218	0.119	0.219	0.145	0.216	0.120	0.213	0.078	0.215
other or unknown race																
age at birth of child (years)			0.002	0.009	0.002	0.009	0.002	0.009	0.003	0.008	0.003	0.009	0.005	0.009	0.005	0.009
married[2]			---	---	---	---	---	---	---	---	---	---	---	---	---	---
cohabiting			0.045	0.148	0.038	0.147	0.039	0.148	0.040	0.149	0.042	0.148	0.011	0.152	-0.001	0.154
single (not married or cohabiting)			0.185	0.140	0.177	0.139	0.179	0.141	0.174	0.141	0.181	0.139	0.170	0.139	0.155	0.139
less than high school			0.288 *	0.113	0.286 *	0.112	0.273 *	0.113	0.229 *	0.114	0.279 *	0.114	0.223	0.113	0.177	0.113
high school (reference)			---	---	---	---	---	---	---	---	---	---	---	---	---	---
some college			-0.267 *	0.122	-0.272 *	0.124	-0.252 *	0.122	-0.224	0.122	-0.265 *	0.121	-0.216	0.123	-0.197	0.126
bachelor's plus			-0.796 ***	0.197	-0.803 ***	0.200	-0.765 ***	0.203	-0.744 ***	0.195	-0.798 ***	0.196	-0.721 ***	0.204	-0.697 ***	0.207
household income (in $10,000's) [3]			-0.102 ***	0.020	-0.102 ***	0.020	-0.099 ***	0.020	-0.095 ***	0.020	-0.101 ***	0.020	-0.093 ***	0.020	-0.089 ***	0.020
working before 12 weeks			-0.046	0.113	-0.035	0.114	-0.044	0.113	-0.093	0.113	-0.042	0.113	-0.043	0.113	-0.074	0.115
working between 12-24 weeks			-0.219	0.112	-0.216	0.115	-0.214	0.112	-0.222 *	0.112	-0.213	0.113	-0.193	0.111	-0.196	0.115
not working by 24 weeks (reference)			---	---	---	---	---	---	---	---	---	---	---	---	---	---
child in center care[2]			-0.219 *	0.097	-0.232 *	0.096	-0.215 *	0.098	-0.235 *	0.098	-0.229 *	0.098	-0.197 *	0.098	-0.231 *	0.101
child in head start[2]			-0.433 ***	0.112	-0.428 ***	0.111	-0.434 ***	0.113	-0.435 ***	0.112	-0.438 ***	0.111	-0.439 ***	0.115	-0.438 ***	0.113
Health Behaviors During Pregnancy																
smoke during third trimester (Y/N)					-0.210	0.129									-0.229	0.134
no prenatal care in first trimester (Y/N)					0.220	0.142									0.211	0.142
Knowledge of Child Development[1]																
knowledge index (range 0-11)							-0.037	0.026							-0.014	0.027
Maternal Reports of Child's Literary Activities[4]																
literary activities scale (range 0-9)									-0.172 ***	0.026					-0.150 ***	0.027
Interviewer Observed Maternal Behaviors[3]																
cognitive stimulation scale (range 0-4)											-0.127	0.088			-0.042	0.091
cognitive stimulation scale missing											0.500 *	0.226			0.420	0.237
Assessment of Mother/Child Interactions[5]																
parent supportiveness scale (range 1-7)													-0.320 ***	0.073	-0.240 ***	0.071
parent supportiveness scale missing													-0.203	0.286	-0.257	0.267
Intercept	-1.569 ***	0.089	-1.877 ***	0.269	-1.839 ***	0.279	-1.854 ***	0.269	-1.885 ***	0.267	-1.885 ***	0.271	-1.949 ***	0.274	-1.899 ***	0.282

n=7450

* p< .05; **p<.01; *** p < .001

[1] measured at 9 month assessment; [2] measured at preschool assessment; [3] average of 9 month and 2 year assessments; [4] average of 9 month and 2 year and preschool assessments; [5] average of 2 year and preschool as

All models control for child age at assessment, twin status, first child status, child sex, and child birthweight (normal, low, very low)

Table 6.5. Low Bayley Mental Scores at 2 Years and Low Math and Literacy Skill Scores at Preschool Age with Alternate Measures of Breastfeeding Duration

	Bayley Mental T Score > 1 SD below Mean (age 2) (age 2)					
	Model 1		Model 2		Model 3	
Initiation						
any breastfeeding	-0.316 ***	0.087	-0.181	0.095	-0.056	0.091
Any Breastfeeding Duration						
months (up to 12)	-0.057 ***	0.011	-0.045 ***	0.013	-0.032 *	0.013
Full Breastfeeding Duration						
months (up to 6)	-0.171 ***	0.027	-0.126 ***	0.029	-0.101 ***	0.029
Breastfeeding Duration x Full Breastfeeding Duration						
months (up to 12)	-0.002	0.017	-0.011	0.017	0.006	0.016
months (up to 12) x full months (up to 6)	-0.015 **	0.004	-0.009 *	0.004	-0.010 *	0.004
p-value (F-test for joint significance)	*0.000*		*0.004*		*0.024*	
	Math T Score > 1 SD below Mean (preschool age)					
	Model 1		Model 2		Model 3	
Initiation						
any breastfeeding	-0.545 ***	0.102	-0.190	0.110	-0.100	0.112
Any Breastfeeding Duration						
months (up to 12)	-0.069 ***	0.012	-0.023	0.013	-0.013	0.014
Full Breastfeeding Duration						
months (up to 6)	-0.166 ***	0.026	-0.066 *	0.028	-0.043	0.029
Breastfeeding Duration x Full Breastfeeding Duration						
months (up to 12)	-0.041	0.023	-0.011	0.022	-0.002	0.022
months (up to 12) x full months (up to 6)	-0.007	0.005	-0.003	0.004	-0.003	0.004
p-value (F-test for joint significance)	*0.000*		*0.177*		*0.541*	
	Literacy Skills T Score > 1 SD below Mean (preschool age)					
	Model 1		Model 2		Model 3	
Initiation						
any breastfeeding	-0.490 ***	0.104	-0.192	0.106	-0.124	0.105
Any Breastfeeding Duration						
months (up to 12)	-0.074 ***	0.011	-0.036 **	0.014	-0.029 *	0.013
Full Breastfeeding Duration						
months (up to 6)	-0.148 ***	0.022	-0.058 *	0.026	-0.041	0.026
Breastfeeding Duration x Full Breastfeeding Duration						
months (up to 12)	-0.043	0.022	-0.021	0.021	-0.014	0.021
months (up to 12) x full months (up to 6)	-0.008	0.005	-0.004	0.004	-0.004	0.004
p-value (F-test for joint significance)	*0.000*		*0.030*		*0.082*	

* p< .05; **p<.01; *** p < .001

Model 1 includes child controls

Model 2 includes child controls, mother characteristics, household income, and child's enrollment in center care

Model 3 includes all controls (child controls, mother characteristics, household income, child's enrollment in center care, health behaviors during pregnancy, knowledge of child development, maternal reports of literary activities, interviewer observed maternal behaviors, assessment of mother/child interaction)

Table 6.6. Multiple Source Models of Low Cognitive Scores with Alternate Measures of Breastfeeding Duration

Breastfeeding Specification	Model 1		Model 2		Model 3	
Initiation						
any breastfeeding	-0.270 **	0.093	-0.056	0.100	0.046	0.101
any breastfeeding x low math score	-0.261 *	0.119	-0.170	0.127	-0.169	0.130
any breastfeeding x low literacy score	-0.225	0.121	-0.216	0.130	-0.217	0.133
p-value (F-test for joint significance)	*0.000*		*0.013*		*0.231*	
Any Breastfeeding Duration						
months (up to 12)	-0.052 ***	0.011	-0.029 *	0.012	-0.019	0.012
months (up to 12) x low math score	-0.014	0.014	-0.013	0.015	-0.013	0.015
months (up to 12) x low literacy score	-0.022	0.014	-0.005	0.015	-0.005	0.015
p-value (F-test for joint significance)	*0.000*		*0.000*		*0.020*	
Full Breastfeeding Duration						
months (up to 6)	-0.162 ***	0.026	-0.094 ***	0.027	-0.075 **	0.027
months (up to 6) x low math score	0.001	0.032	0.023	0.033	0.025	0.034
months (up to 6) x low literacy score	0.011	0.032	0.013	0.033	0.015	0.034
p-value (F-test for joint significance)	*0.000*		*0.000*		*0.005*	
Breastfeeding Duration x Full Breastfeeding Duration						
months (up to 12)	0.008	0.018	0.007	0.018	0.021	0.018
months (up to 12) x low math score	-0.047	0.026	-0.033	0.027	-0.036	0.027
months (up to 12) x low literacy score	-0.050	0.026	-0.035	0.027	-0.037	0.027
months (up to 12) x full months (up to 6)	-0.016 ***	0.004	-0.010 *	0.004	-0.011 *	0.004
months (up to 12) x full months (up to 6) x low math score	0.009	0.006	0.008	0.006	0.009	0.006
months (up to 12) x full months (up to 6) x low literacy score	0.008	0.006	0.006	0.006	0.007	0.006
p-value (F-test for joint significance)	*0.000*		*0.001*		*0.020*	

n=7900

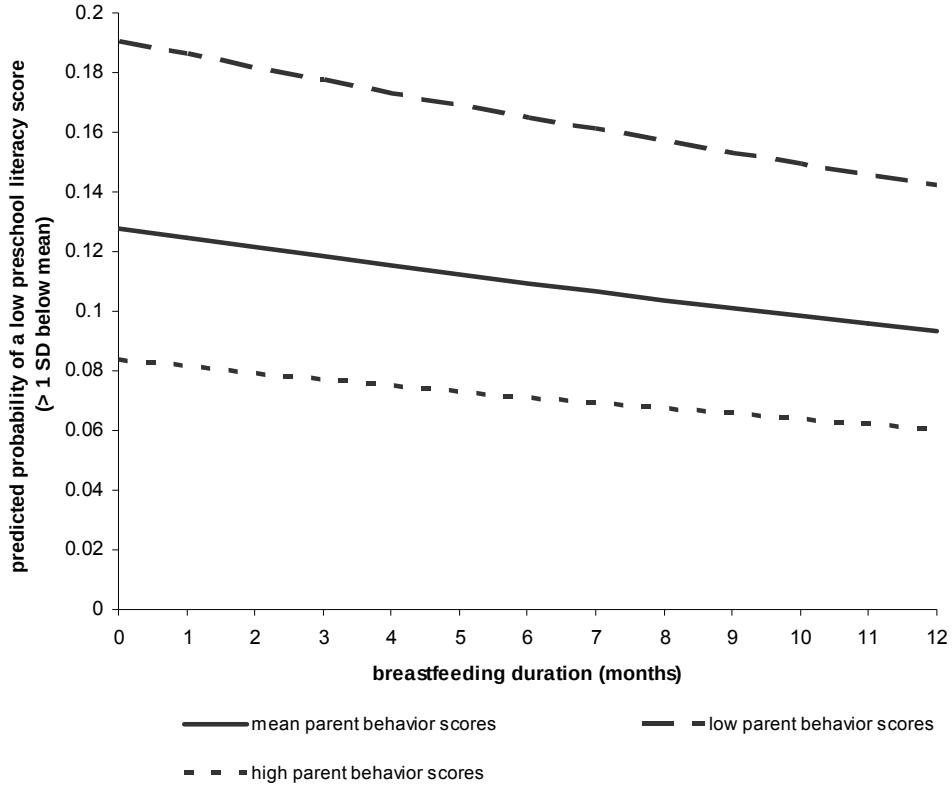
* p< .05; **p<.01; *** p < .001

Model 1 includes child controls

Model 2 includes child controls, mother characteristics, household income, and child's enrollment in center care

Model 3 includes all controls (child controls, mother characteristics, household income, child's enrollment in center care, health behaviors during pregnancy, knowledge of child development, maternal reports of literary activities, interviewer observed maternal behaviors, assessment of mother/child interaction

Figure 6.1. Predicted Probability of having a Literacy Skill Score > 1 SD below the Mean by Breastfeeding Duration for Preschool Age Children Born in 2001



Notes:

Predicted probabilities based on Table 6.4, Model 8.

Baseline characteristics: 52 month old, non-twin, first born, female child of normal birthweight that is not in center care, in a household with average income, with a 27 year old, married, non-Hispanic white, high school educated mother, who did not work in the first 6 months after the child's birth, did not smoke during pregnancy, received prenatal care in the first trimester, and had average scores on the knowledge index, the literary activities scale, the cognitive stimulation scale, and the parent supportiveness scale

Low parent behavior scores: same as baseline characteristics except scores 1 SD *below* the mean on the knowledge scale, literary activities scale, cognitive stimulation scale and parent supportiveness scale

High parent behavior scores: same as baseline characteristics except scores 1 SD *above* the mean on the knowledge scale, literary activities scale, cognitive stimulation scale and parent supportiveness scale

CHAPTER SEVEN: CONCLUSION

Introduction

Previous research findings suggest that breastfeeding is associated with superior general health and improved growth and development for children. As a result U.S. and International Health Organizations, such as the American Academy of Pediatrics and the Word Health Organization, regard breast milk as the best source of nutrition for infants. These health organizations recommend that mothers breastfeed their children for a full year—or more—beginning with six months of exclusive breastfeeding in which the child receives no other solids or liquids, including water (although notably, excluding vitamins and medicines; WHO 1991). These breastfeeding recommendations place a large demand on a child's individual mother, who—rare exceptions in the US—is the person that provides this source of nourishment to her child.

Breastfeeding is a medically recommended but highly socially determined practice. While it is *individual mothers* must provide their children with breastmilk, newborns need to be fed often, thus the ability of a mother to initiate and continue to breastfeed a child over time is highly dependent on resources and constraints in her *social environment*. Therefore, it is important to better understand the relationship between a mother's social environment—at the micro and macro level—and breastfeeding. If breastfeeding does promote child health, then we care who gets breast milk because disparities in breastfeeding may contribute to the intergenerational transmission of

inequality, and a better understanding of the relationship between social factors and breastfeeding is necessary to better encourage breastfeeding. However, it is also important to question biological explanations for developmental and health correlates of behaviors that are themselves highly socially linked. This is particularly important given the large burden that breastfeeding places on *mothers*, and the potential of tasks restricted to mothers to reinforce gendered divisions of labor both inside and outside the household.

Using data from Early Childhood Longitudinal Study Birth Cohort (ECLS-B), a large, nationally representative sample of children born in the US in 2001, this dissertation examines the social correlates of breastfeeding in the United States. The goal is to better understand both potential determinants and potential consequences of breastfeeding. In a series of analyses I address the following questions: 1) What social and demographic factors are associated with breastfeeding initiation and duration? 2) How relevant are state level characteristics in explaining between state differences in breastfeeding prevalence? 3) Is breastfeeding related to higher cognitive scores in early childhood?

Overview of Dissertation Framework

This dissertation takes a holistic approach to understanding the relationship between breastfeeding and social characteristics—first examining individual, family, and contextual correlates of breastfeeding initiation and duration, and then considering breastfeeding initiation and duration as a potential correlate of child cognitive development. In the first two sets of analyses I focus on maternal characteristics—mother's education and mother's place of birth—to determine the extent to which these characteristics, and their social implications, are correlated with breastfeeding. In the

third set of analyses, I recognize that families are embedded within broader social contexts (which I define geographically as states), and characteristics of these places may be related to whether or not a mother breastfeeds. Finally, in the last set of analyses, I consider whether breastfeeding is related to one aspect of child well being (child cognitive development), and whether this relationship holds after considering other parenting behaviors that are correlated with both breastfeeding and child cognitive development.

Summary of Findings and Future Directions

Maternal Education and Breastfeeding Initiation and Duration

While it is mothers that breastfeed their child, their ability and desire to do so is largely affected by their social circumstances. In chapter three I examined the relationship between maternal education and breastfeeding to determine the extent to which individual and family level factors that are linked to both education and breastfeeding, including marital status, race/ethnicity, household income, family background, use of parenting resources, and work status, can account for the relationship between maternal education and breastfeeding. Logistic regression was used to model whether a mother ever breastfed (breastfeeding initiation), while discrete time hazard models were used to model the likelihood of quitting breastfeeding in a given month for mothers who had initiated breastfeeding (breastfeeding duration/cessation).

Results suggest that with the exception of mothers with very low education, who have relatively high breastfeeding rates, education is strongly and positively related to both breastfeeding initiation and duration among mothers in the US. Moreover, while

controlling for differences in mother and family characteristics seems to reduce the positive relationship between education and breastfeeding, the relationship remains strong. Results also indicate that some of this relationship may be attributed to differences in a mother's own social background and current social environment. Finally, interactive models indicate that maternal education is particularly protective against quitting in the early months of breastfeeding, implying that mothers with less education who initiate breastfeeding may particularly benefit from support during this early time period.

In future research it would be useful to examine interactive effects to consider the extent to which the relationship between education and breastfeeding is the same across groups of mothers. Are individuals in some groups less likely to breastfeed even if they have high education levels? It would also be fruitful to take a closer look at the interrelationships between education, work and breastfeeding. For example, to examine how combinations of work/breastfeeding vary by education level, distinguishing between full and part time work, paid and unpaid maternity leave, and work status prior to birth. Finally, it would be useful to interview breastfeeding and non-breastfeeding mothers of various education levels to find out more about the factors that contributed to their decision to breastfeed or not, including potential normative pressure and support from their peers and social networks. Currently such research focuses on low-income mothers (Guttman, and Zimmerman 2000), but talking to groups of mothers with high breastfeeding rates may be particularly constructive in determining the factors that encourage or discourage breastfeeding.

Mother's Place of Birth and Breastfeeding Initiation and Duration

Maternal nativity is an important consideration for understanding maternal health behaviors, as more than 20% of children born in 2001 had a mother that was born outside of the US. In chapter four I investigated the relationship between maternal place of nativity (US born or not) and a mother's likelihood of initiating breastfeeding and continuing breastfeeding between and within racial/ethnic groups in the US. As with chapter three, logistic regression was used to model whether a mother ever breastfed (breastfeeding initiation), while discrete time hazard models were used to model the likelihood of quitting breastfeeding in a given month for mothers who had initiated breastfeeding (breastfeeding duration/cessation).

Overall, maternal place of birth is a strong predictor of breastfeeding, with foreign born mothers breastfeeding at higher rates than their US born counterparts. However, while foreign born status is positively related to breastfeeding *initiation* for most racial/ethnic groups (non-Hispanic white, Hispanic, non-Hispanic black), this relationship does not hold for non-Hispanic Asian mothers. Foreign born status is also positively related to breastfeeding *duration* for Hispanic and non-Hispanic black mothers, but the relationship is not significant for non-Hispanic white mothers, and US born non-Hispanic Asian mothers have longer breastfeeding durations than their foreign born counterparts.

I also considered the relationship between maternal nativity and breastfeeding initiation and duration within Hispanic and non-Hispanic Asian mothers—the two racial/ethnic groups that comprised the largest proportion of foreign born mothers in 2001. Within each racial/ethnic group, I examined differences between US born and foreign born mothers based on three categorizations of foreign born mothers—years in

the US, age of arrival to the US, and use of English as a home language. These categorizations likely capture both differences mothers' post migration experiences (acculturation processes) as well as differences in mothers' experiences prior to migration (selection processes).

Among foreign born Hispanic mothers, there is some evidence that supports a negative relationship between acculturation processes and breastfeeding, as foreign born Hispanic mothers have lived in the US for the longest durations (at least 16 years) are not significantly different in terms of breastfeeding initiation and duration than those that were US born. Similarly who arrived in the US at the earliest ages are not significantly different than US born mothers in terms of breastfeeding duration; although even those that arrive before age 9 are significantly more likely to initiate breastfeeding than US born mothers. Overall, however, differences between US and foreign born Hispanic mothers seem to be larger and more consistent than differences within foreign born Hispanic mothers.

Among Asian mothers, differences in breastfeeding *initiation* are not evident between foreign born and US born Asian mothers based on time in the US or age of arrival to the US. In terms of *duration*, US born non-Hispanic Asian mothers are significantly less likely to quit breastfeeding than nearly all foreign born Asian mothers, with the exception of foreign born Asian mothers that arrived very early in life (age 0-8) and foreign born Asian mothers that have lived in the US for 9-15 years. While there is no significant difference between foreign born Asian mothers who speak English at home and US born Asian mothers, foreign born Asian mothers that do not speak English as

their home language are more likely to quit breastfeeding than that are US born Asian mothers.

In future research it may be fruitful to explore combinations of these (and other) measures of foreign born status (duration, timing, English use), and thus simultaneously consider these aspects that are reflective of the pre-migration and post-migration experience. In addition, it would also be interesting to consider other factors that might contribute to differential breastfeeding rates among foreign born Hispanic mothers—such as whether a mother's first child was born inside or outside the US or how long a mother had been in the US when her first child was born. I would also be interested in whether differences in household composition among foreign born mothers contributes to differences in breastfeeding rates. For example, are foreign born mothers living with partners or their own parents in the household more likely to breastfeed? To the extent that it is possible, it would be productive to explore the relationship between maternal nativity, paternal nativity, and breastfeeding. Unfortunately, with the ECLS-B data it is not easy to tell whether the mother's own partner was foreign born, since that information was only collected from a limited number of fathers (those who completed the father questionnaire). Finally, while this research considered breastfeeding within two broad racial/ethnic groups—Hispanic and Non-Hispanic Asian mothers—in future research it would be productive to examine diversity in breastfeeding by place of origin within these broad racial/ethnic groupings.

State Factors and Breastfeeding

The results of the first two analytic chapters indicate the importance of a mother's social environment as measured through her individual characteristics—education and

place of birth. In the fifth chapter I examine the relationship between contextual factors at the state level and a mother's likelihood of breastfeeding. States are a particularly relevant level of analysis because there are significant between state differences in breastfeeding, and policies and programs affecting families are often implemented at the state level. This chapter used hierarchical logistic regression, with a random intercept at the state level, to model breastfeeding initiation and breastfeeding continuation—the likelihood of a mother breastfeeding for at six months given that she initiated breastfeeding. The analysis focused on two measures of the state environment— 1) state legislation regarding breastfeeding in public places or employment and 2) a scale capturing the medical environment surrounding births based on the standardized proportions of c-sections (additive inverse), midwife assisted births, and home births in the state.

The results indicate that approximately 8% of variation in breastfeeding initiation and 4% of variation in breastfeeding continuation can be attributed to between state differences in breastfeeding. Controlling for state level contextual variables seems to reduce the unexplained between state variation, indicating that differences in state environments may contribute substantially to breastfeeding differences. In particular, individuals living in states with fewer c-section births (fewer "medicalized" birth practices) and more midwife assisted and home births (more "natural" birthing practices), were significantly more likely to breastfeed than those living in states with higher c-section rates and lower proportions of midwife assisted and home births.

On the other hand, the presence of state legislation regarding breastfeeding was not strongly related to breastfeeding initiation or continuation. State legislation was not

significantly related to breastfeeding *initiation*. State legislation was positively and significantly related to breastfeeding *continuation*, but this relationship was no longer significant once controls for individual factors were added to the model.

While state legislation was not a significant predictor in this analysis, this does not necessarily indicate that legislation does not matter. From a policy perspective, breastfeeding legislation matters to the extent that it encourages breastfeeding. More research is needed to examine within state differences in breastfeeding before and after the passage of breastfeeding legislation. For example, with the appropriate data, a fixed effects approach could be used to compare breastfeeding rates before and after a state adopted a breastfeeding law—variation that cannot be captured with a cross sectional sample of births such as the ECLS-B.

Future research should also explore whether between state differences in the type and structure health organizations, such as hospitals, contribute to the observed relationship in a mother's likelihood of breastfeeding and between state differences in the use of birth practices (c-sections, midwife assisted births, and home births). Many social programs that are funded in part by the federal government are implemented at the state level, so it would be interesting to see whether differences in the content and implementation of these social services, such as Medicaid, the Special Supplemental Nutrition Program for Women Infants and Children (WIC), or the State Children's Health Insurance Program (SCHIP) contribute to between state differences in breastfeeding rates. Such information is particularly useful because these programs may be good places to originate parenting support programs.

Breastfeeding and Child Cognitive Development

The first three analytic chapters examined social correlates of breastfeeding at micro and macro levels in order to gain a better understanding of why some mothers breastfeed and others do not. However, whether or not mothers breastfeed matters to the extent that breastfeeding has benefits for children. The final analytic chapter examined one potential benefit of breastfeeding—child cognitive development. Using extensive measures of parenting behaviors from multiple sources (maternal reports, interviewer observations, and video-recorded assessments of mother/child interactions) and collected at multiple ages (9 months, 2 years, and preschool age), the focus of the analysis was to determine whether breastfeeding duration remained a significant predictor of cognitive development above and beyond extensive controls for child and mother characteristics and parenting behaviors.

Assessments of child cognitive development were based on direct assessments of the ECLS-B children at age 2 and preschool age, with children scoring 1 SD below the mean on a given assessment designated as having "low" scores. Using logistic regression, I modeled the relationship between a mother's breastfeeding duration and a child's likelihood of having a low score on each of three assessments.

In separate models that control only for child characteristics, breastfeeding is negatively related to low overall scores on the Bayley Scales of Mental Development at age 2, and low overall scores on assessments of math skills and assessments of literacy skills at preschool age. However, controlling basic mother and household characteristics and parenting behaviors eliminates the significance of the relationship between breastfeeding duration and low math scores at preschool age and seems to reduce the

relationship between breastfeeding duration and low overall cognitive scores on the Bayley Scales of Mental Development at age 2 and low literacy scores at preschool age. Moreover, while breastfeeding remains a significant covariate in models of overall cognitive performance at age 2 and literacy skills at preschool age, the size of the coefficient is small. Predicted probabilities indicate that children who are exposed to long breastfeeding intervals are only slightly less likely to be categorized as having low literacy skill scores at preschool age than children who were not breastfed at all. Moreover, differences in parenting knowledge and behaviors seem to be a much larger predictor of having low cognitive scores than differences in breastfeeding behaviors, suggesting that those interested in improving school readiness skills would be better off targeting parenting behaviors other than breastfeeding.

In this research breastfeeding and parenting behaviors were considered separately and additively, in future research it would be useful to consider groups of parenting behaviors (including breastfeeding) simultaneously. It will be interesting to see if there is any remaining relationship between breastfeeding duration and children's skill development in the next wave of data—when the ECLS-B children reach kindergarten age.

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