

# UC Berkeley

## UC Berkeley Electronic Theses and Dissertations

### Title

Three Essays on the Role of Public Policy in Shaping Parental Behavior in a Child's Early Life

### Permalink

<https://escholarship.org/uc/item/84n4h14c>

### Author

Martin-Anderson, Sarah Marie

### Publication Date

2013

Peer reviewed|Thesis/dissertation

Three Essays on the Role of Public Policy in Shaping Parental Behavior in a Child's Early Life

By

Sarah Martin-Anderson

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Public Policy

in the

Graduate Division

of the

University of California, Berkeley

Committee in Charge:

Professor Rucker Johnson  
Professor Jesse Rothstein  
Professor Ralph Catalano

Spring 2013

## Acknowledgments Page

The author would like to acknowledge the amazing support of her main doctoral advisers, Rucker Johnson and Jesse Rothstein. Both often went above and beyond the call of duty—there was usually tears involved. She would also like to acknowledge the rest of her qualifying exam committee for their feedback: Robert MacCoun and Ralph Catalano. She would also like to acknowledge her qualifying paper reviewers for their hard work: Michael O’Hare and Jane Mauldon. Their tough love made this dissertation better.

The author would like to acknowledge Dr. Henry Lee (UCSF and Stanford) for his co-authorship of Essay 3 as well as the opportunity for research collaboration. The doctoral seminar at the Goldman School of Public Policy deserves immense acknowledgment for their support and insight into this work—especially the feedback of Sarah Tahamont, Aaron Chalfin and Eugene Smolensky.

## Dedication Page

This dissertation would not have been possible without the love and support of my family and friends... they are too numerous to mention. A special thank you goes to the staff of Sweet and Flour Patisserie in Minot, North Dakota who let me use their beautiful café as an office for many hours.

Thanks also to Kendrick Lamar for the dissertation soundtrack.

This dissertation is dedicated with all my love to Jude, Emaline, and August and Nate. Thank you for standing by me the last five years. Thank you for understanding when I had to work on weekends.

# Sarah Martin-Anderson, MPP MPH

605 Ohlone Avenue #606 · Albany, CA 94706 · (661) 205-9924 · sarahm\_a@berkeley.edu ·  
www.smartinanderson.weebly.com

---

## EDUCATION

**University of California, Berkeley**, Goldman School of Public Policy

*PhD Candidate in Public Policy, Expected Graduation May 2013*

- Dissertation Title: Three Essays on the Role of Public Policy in Shaping Early-Life Parental Behavior
- Committee Members: Dr. Rucker Johnson, Public Policy; Dr. Jesse Rothstein, Public Policy and Economics; Dr. Ralph Catalano, Public Health and Demography
- Field Exams: Economic Demography, Statistical Methods for Program Evaluation

**University of California, Berkeley**, School of Public Health

*Master of Public Health in Epidemiology, May 2010*

Fields of Focus: Social Epidemiology; Epidemiologic Methods

**University of California, Berkeley**, Goldman School of Public Policy

*Master of Public Policy, May 2008*

Thesis: The Health Effects of Economic Development in Alameda County

**California State University, Bakersfield**

*Bachelor of Arts in Political Science and Art History, June 2003*

## ACADEMIC PUBLICATIONS AND SUBMISSIONS

Lee, H.C., **Martin-Anderson, S.**, and Dudley, A. “Clinician Perspectives on Skin to Skin Care in the Neonatal Intensive Care Unit”. *Breastfeeding Medicine*. *Breastfeeding Medicine*. April 2012, 7(2): 79-84.  
doi:10.1089/bfm.2011.0004.

**Martin-Anderson, S.** “Exploring the Direction of Selection Bias in a Widespread United States Nutrition Program” *Social Science and Medicine*. *Forthcoming*. doi: 10.1016/j.socscimed.2013.03.013

Lee, H.C., **Martin-Anderson, S.**, Lydon, A., and Dudley, A. “Clinician Perspectives on Opportunity for Breast Milk Feeding in the Neonatal Intensive Care Unit.” *Breastfeeding Medicine*. E-pub ahead of print.  
doi:10.1089/bfm.2012.0056

## GOVERNMENTAL REPORTS AND PUBLICATIONS

**Martin-Anderson, S.** “Foreclosure and Community Health—What Gets Left Behind” for Alameda County Public Health Department and Just Cause Oakland, Summer 2009

**Martin-Anderson, S.** *Chapter 7--Transportation* and *Chapter 8--Land Use* in “Life and Death from Unnatural Causes: Health Inequity in Alameda County” for Alameda County Public Health Department, Spring 2008

**Martin-Anderson, S.** “Why Place Matters: A Needs Assessment Addressing the Social Determinants of Health in Oakland” for the Alameda County Public Health Department, Spring 2008

## CONFERENCE PRESENTATIONS

“Prenatal Feeding Intentions and Parity Predict Take-Up of the Supplemental Food and Nutrition Program for Women, Infants and Children.” Accepted for presentation at the All-CA Labor Economic Conference, September 2012

“Factors Determining Take-Up of the Supplemental Nutrition Program for Women, Infants and Children: A Complex Selection Bias Story.” Accepted for oral presentation at the American Public Health Association, October 2012

“The Effect of Time of Birth on Infant Morbidities in a Large Neonatal Intensive Care Unit” Accepted for oral presentation at the Association of Public Policy and Management, November 2012

“WIC, Prenatal Intentions and Breastfeeding Duration: A Propensity Score Matching Approach” Presented for the Robert Wood Johnson Foundation Child Health Disparities Conference, May 2011; Presented for the Association of Public Policy and Management, November 2011; Presented for the Population Association of America Conference, May 2012

"Why WIC May Not Work: Understanding Disincentives to Breastfeeding among WIC Recipients" Oral presentation for Association of Public Policy and Management, November 2009

“Effects of Happiness and Wantedness on Breastfeeding Duration over the First Year: A Survival Analysis”. Oral presentation for American Public Health Association Conference, November 2009

## AWARDS

University Dissertation Year Full Fellowship 2012-2013

Departmental Fellowship, Goldman School of Public Policy 2011-2012

National Science Foundation, Interdisciplinary Training Grant (IGERT Fellowship) 2009-2011

Robert Wood Johnson Foundation, Travel Grant, University of Michigan Child Health Disparities Symposium 2011

University of Minnesota, Travel Grant, Minnesota Population Center Symposium 2010

## TEACHING EXPERIENCE

Research Methods and Statistical Analysis for Policy Analysis: Probability theory, Hypothesis Testing, Multivariate Analysis, Econometrics. (Undergraduate and Graduate Level) 2007-2009

Leadership and Strategy: Effective management of groups, inspiring social change (Graduate Level) 2009-2012

Wealth and Poverty: The roots of income and resource inequality in America and the consequences for wealth, health and prosperity (Undergraduate Level) 2009-2012

Microeconomics (Undergraduate Level) 2007

Political Science Research Methods (Undergraduate Level) 2006-2007

## WORK EXPERIENCE

*Research Analyst, Co-Investigator*

**University of California, San Francisco Department of Pediatrics and Neonatology**

Project coordinator and study designer for large-scale qualitative data collection projects

San Francisco, CA

November 2009-Present

*Policy Analyst* Oakland, CA  
**Alameda County Department of Public Health** December 2007-October 2009  
Developed a local policy agenda to address health and social inequity in Alameda County, and specifically the city of Oakland.

*Consultant* Oakland, CA  
**Human Impact Partners** January 2008-May 2008  
Wrote and presented research on the intersection of Campaign Finance, Health Care and Environmental Justice.

*Research Analyst* Mounds View, MN  
**Minnesota Institute of Public Health** June 2007-August 2000  
Designed trainings for state prevention health workers on applying epidemiologic methods and data-driven decision making to regional substance abuse prevention efforts.

*Policy Analyst* Oakland, CA  
**Pacific Institute for Studies in Development, Environment & Security** January 2007-May 2007  
Researched the intersection of the built environment and community health concerns.

*Research Analyst* Berkeley, CA  
**Labor Project for Working Families** January 2007-May 2007  
Assisted in analyzing the effects of legislation regarding mandatory paid sick days in California.

### COMMUNITY ACTIVITIES

Appointee, Advisory Council, Bay Area Air Quality Management District  
Appointee, Editorial Board, *The Nation's Health*, a publication of the American Journal of Public Health  
Chair of UC Berkeley Child Care Parent's Advisory Council 2006-2008

## **Abstract**

*Three Essays on the Role of Public Policy in Shaping Parental Behavior in a Child's Early Life*

by

Sarah Martin-Anderson  
Doctor of Philosophy in Public Policy  
University of California, Berkeley  
Professor Rucker Johnson, Chair

This dissertation is comprised of three article-length essays, all of which concern important issues in early-life health and well-being. All three essays focus on the decision to formula feed or breastfeed—one of the first decisions a mother makes in her child's life. Two of the papers—one quantitative and one qualitative—study the environment of the Neonatal Intensive Care Unit and the potential effect of hospital policy and procedures on breast milk feeding. The remaining paper investigates a large federal policy and the consequences of altering the costs of infant formula relative to breast milk. All papers are tied together by an eye towards the plasticity of these early life experiences, as well as the troubling persistence of health disparities by race, class and maternal education.

*Essay One:* Breast milk feeding in the Neonatal Intensive Care Unit (NICU) is associated with a host of improved health outcomes. However, breast milk feeding rates differ by socioeconomic status, race, ethnicity and maternal education indicating that these results are vulnerable to selection bias. Qualitative work by this author and others suggests that women giving birth in the late-night hours are less likely to begin a successful milk expression regimen due to the lack of experienced clinicians working during these shifts. Using the hour of birth as an instrument for breast milk feeding, this study attempts to isolate the effects of breast milk feeding on incidence of deadly conditions in the NICU, as well as the infant's growth patterns and length of stay. This study also uses innovative measures of the indications for delivery type in order to construct a sub-sample whose distribution of delivery times is the most random, thereby increasing the validity of the analysis. The first-stage of the analysis revealed no significant relationship between late-night births and breast milk feeding at discharge, contrary to the claims of clinicians and mothers interviewed in a separate study. C-Section delivery and shorter maternal lengths of stay significantly predictive of decreased breast milk feeding at discharge, even after controlling for potential confounders. The reduced-form analysis suggests that infants born in the evening (5pm-Midnight) are roughly 2-4% more likely to contract Necrotizing Enterocolitis at some point during their stay in the NICU. The majority of associations between hour of birth and other health outcomes were insignificant. Evidence of heterogeneity in hour of birth effect size by birth weight, gestational age, race/ethnicity and maternal age were also explored.



*Essay Two:* It is impossible in most countries to randomize assignment into child health programs that may offer benefits. In the absence of this gold standard of program evaluation, researchers face the threat of selection bias—the possibility that there are unmeasured differences, relevant to outcomes, between those who are treated and those to whom they are compared. A common concern is that people who are eligible for a program but choose not to enroll may differ from those who do enroll. Because policies geared towards a country's most vulnerable people are determinants of health inequities, it is imperative that sources of selection bias be identified and that evaluation methods minimize the impact of selection bias on our estimations of treatment effects. Using a case study of a large Federal nutrition program in the United States, this study reviews how researchers have attempted to minimize selection bias and presents an analysis illustrating how the decision to take up the program can highlight sources of this bias. Relying on data from a longitudinal study of mothers and infants, I show that *prenatal* attitudes and beliefs may determine *postnatal* program enrollment, and that the direction of the bias differs by demographic variables. Further, I show that magnitude of supposed program effects vary significantly as a function of these prenatal beliefs. In sum, this paper makes the case for more careful study of the factors that determine take-up of a program, and inclusion of those factors in an evaluation of the program

*Essay Three:* The third paper in this series diverges from the methodology of the first two essays. This paper is the culmination of a year-long survey data collection effort; the work is a collaboration between UC Berkeley, UC San Francisco and Alta Bates Summit Medical Center (Berkeley, CA). The objective of this study was to investigate determinants of breast milk feeding in the NICU, and to try and account for the pervasive racial, ethnic, socioeconomic and language disparities in breast milk outcomes. The survey was developed by the authors of this essay based on established theories of decision making about infant feeding. Over the course of the study period, mothers giving birth at less than 32 weeks gestational age were invited to participate in the study, either through filling out a survey in the hospital, participating in a one-on-one interview, or both. This essay focuses on the results from the survey which were later linked to medical outcome data of the infant upon discharge home. An innovation of this study is the collection of breast milk exclusivity—that is, if a dose-response relationship between breast milk and outcomes did exist, our data collection method would be able to capture it. Results indicate that mothers who participated in the study were less likely to breast milk feed if they were: of black race, non-Hispanic (any race), low-income, or living a long distance from the NICU. Measures of social support, peer effects, and attitudes towards breast milk feeding also predicted the proportion of an infant's feeding that was breast milk.. Implications of these findings are discussed, as are the lessons learned from pursuing this type of study.

## **Introduction to the Three Essays**

This dissertation is comprised of three article-length essays, all of which concern important issues in early-life health and well-being. All three essays focus on the decision to formula feed or breastfeed—one of the first decisions a mother makes in her child’s life. Two of the papers—one quantitative and one qualitative—study the environment of the Neonatal Intensive Care Unit and the potential effect of hospital policy and procedures on breast milk feeding. The remaining paper investigates a large federal policy and the consequences of altering the costs of infant formula relative to breast milk. All papers are tied together by an eye towards the plasticity of these early life experiences, as well as the troubling persistence of health disparities by race, class and maternal education.

A growing movement in the life and social sciences seeks to understand the effect of early-life environments on health disparities over the life course. A child’s early-life environment is shaped by the family’s environment—itsself shaped by cultural, social and political forces. Specifically, my research is driven by whether and how public programs in the United States “get under the skin”. The pathways for these relationships are both biochemical and behavioral. Nutrition, health care and environmental exposures interact with such concepts as income effects and maternal stress.

The prevalence of racial, ethnic and socioeconomic health disparities at all stages of life is a concern for policymakers. The Healthy People 2010 and 2020 initiatives underscore this (United States Department of Health and Human Services, 2010). Data from 2010 shows significant differences among races and education levels in terms of mortality and disease burden. Table 1 lists the top ten causes of death in the United States for 2010 (National Center for Health Statistics 2011), as well as the rates by race or ethnicity and education level for each.

**Table 1: Ten most prevalent causes of all-age death in the United States, 2010 with Racial, Ethnic and Education-Level. Rates per 100,000**

Cause of Death	American Indian, Alaska Native	Asian or Pacific Islander	Black, Not Hispanic	White, Not Hispanic	Hispanic or Latino, Any Race	Less than HS <sup>1</sup>	HS Grad <sup>1</sup>	Some College <sup>1</sup>
Heart Disease	108	83	188	144	114	101	71	28
Cancer	119.4	106.5	221.7	184.6	118	158.3	129.3	64.9
Stroke	29	37	63	42	34	23	15	6
Chronic Lower Respiratory Diseases <sup>2</sup>	627.2	415	958	749.4	546.1	n/a	n/a	n/a
Unintentional Injury	56.7	16.9	39.2	42.1	31.5	87.8	60.3	20.1
Alzheimers Disease	n/a	n/a	16.9	44.8	7.0	n/a	n/a	n/a
Diabetes	98	55	130	68	86	61	41	16
Influenza/Pneumonia	33.1	12.8	19.9	17.8	15	n/a	n/a	n/a
Nephritis, nephrotic syndrome, and nephrosis	n/a	n/a	29.3	16.2	n/a	n/a	n/a	n/a
Septicemia	n/a	n/a	21.6	10.1	n/a	n/a	n/a	n/a

1: Data only available for respondents aged 25-64; 2: Includes Asthma, Bronchitis, Emphysema, and COPD.

Source: National Center for Health Statistics

According to this data, the overburden of disease in the Black population is staggering. Furthermore, in the seven measures with data available for all groups, Hispanics and Asians fare better than the White, Non-Hispanic subgroup. Native Americans fare worse on two of the five measures available for that group. Only Alzheimer’s disease tends to overburden the white population—which research attributes to their longer life expectancy and access to life-extending health care (Burchard et al., 2003). These results raise interesting questions. What is particular to the Black experience in America that leads to the health inequities in Table 1? Why do Latino and Asian Americans face more favorable life-odds than Blacks and Whites, even with their increased likelihood of living in poverty?

Research indicates a persistent residue of infant ill-health into adulthood that could partly explain the variation in later health by race and class. In 2003, Lu and Halfon used a “life-course approach” to analyze two major models of health disparities by race and class. The first model posits that “that exposures and experiences during particular sensitive developmental periods in early life may encode the functions of organs or systems that become manifest in health and disease later in life” (Barker, 2001). This is called the “Early Programming” theory, and was pioneered by David Barker; while Barker’s main hypothesis, that fetal malnutrition led to a “thrifty phenotype” that predisposed exposed individuals to diabetes, overweight/obesity, and associated

conditions (Barker, 2001), is focused on prenatal environments, newer research is uncovering that these periods of developmental plasticity extend well into childhood and beyond. Infants whose mothers have depressive prenatal symptoms score lower on multiple reactivity tests and are more likely to have higher-than-normal resting heart rates and cortisol levels (Gunnar & Nelson, 1994). This over-exposure to stress hormones in infancy may lead to inflammatory diseases later in life (Surtees et al., 2003). Furthermore, girls may be more vulnerable to premature birth and Low Birth Weight because of hyperactivity in the stress-hormone regulating axis of the brain (Sanderson & Emanuel, 2009). Because the subjects in these studies are infants, this type of work is less susceptible to reverse causality—it's easier to believe that the directionality of causality flows from mother to child, or from a third cause to both mother and child, and not the other way around.

The second model Lu and Halfon highlight is the “Cumulative Pathway Model” which suggests that “chronic accommodation to stress results in wear and tear” on the body. Bruce McEwen, in his seminal 1998 work refers to this accumulation as “allostatic load” (Flier, Underhill, & McEwen, 1998). Salivary cortisol levels give insight into how the body is reacting to stress; elevated activity of the HPA axis (the part of the brain that controls stress reactions and body process regulation) is associated with increased risk of mortality, cardiovascular disease and decreased physical and cognitive performance (Seeman, McEwen, Roe and Singer 2001). During the perinatal period, breastfeeding has been shown to increase the coregulation of maternal-infant salivary cortisol (Neu, Laudenslager and Robinson 2009). This indicates that postnatal bonding with babies synchronizes the stress response hormones of the mother-child pair. Further, the act of holding babies may itself improve infant health outcomes, especially among low birthweight babies. Breastfed babies, according to a 2003 Australian study, are held on average 37 minutes more per day than non-breastfed babies. They are also “cuddled” and “read to” more often, even after controlling for potential confounders (Baxter, Cooklin, & Smith, 2009). In South Africa, the research of Bergman, Linley and Fawcus (2006) showed that of the eligible low-birthweight (1200-2199 grams) babies randomized to skin-to-skin contact (STSC) or an incubator directly after a premature birth, those in the STSC group were much more likely to be classified as stable, less likely to experience hypothermia, and more likely to experience consistent heart and breathing rates. The authors contend this is in part due to decreased “separation” crying—or mammalian “protest-despair” biology—yet another mechanism through which breastfeeding may influence infant well-being. In the context of McEwen’s work, an increased allostatic load in the perinatal period sets the stage for a higher accumulation of wear-and-tear throughout life and alters the future probability of healthy stress responses<sup>1</sup>.

---

<sup>1</sup> Both the Early Programming and Cumulative Pathway models focus on somatic outcomes. There may also be a biological basis for later *behavior* that is modified by maternal decisions in early life. If one assumes that early life environments can alter the expression of genes, then we might accept that these variations in gene expression explain behavioral differences in later life—behaviors such as anxiety, quick temper, altruism, greed, or even violence are finding roots in genetics. In 2010, an international team of researchers showed an association between altruistic behavior and certain specific differences in the same biological markers that explain “social bonding in lower animals” (Ebstein, Israel, Chew, Zhong, & Knafo, 2010). This finding “suggests a common evolutionary mechanism” at work that is modified by maternal

How and what a child is fed in the first months of its life is an important component of the early life experience. If one believes the research indicating persistent effects of early life environments on later life health outcomes, then it is in the best interest of the government to create the optimal infant environment. This may include, if research supports it, promotion of breast feeding over formula feeding and the integration of this principle into social policies.

Breastfeeding is generally considered beneficial to both mother and baby. The American Academy of Pediatrics (AAP) estimates that postneonatal infant mortality rates in the US are 21 percent lower in breastfed infants than in formula-fed infants (American Academy of Pediatrics, 2005). Extensive reviews of the literature indicate that breastfed infants are less likely to contract diseases such as Necrotizing enterocolitis (Weimar, 2001), Alpha-1 Antitrypsin Deficiency (Udall, 1985), and Crohn's (Koletzko, 1989). Although these diseases are relatively rare, the prevalence of more common diseases is also lower in those who were breastfed as infants. Incidence of upper respiratory infections (L. Wright, 1989), Celiac disease (Greco, 1988) and urinary tract infections (Pisacane, 1992) are all lower among breastfed infants, as is the incidence of gastrointestinal infections that induce vomiting and diarrhea. Breastfed infants are 50% less likely to experience a GI episode, but if they do experience an episode, theirs is on average shorter and less intense (Beaudry, Durfour, & Marcoux, 1995).

Formula feeding has been associated with hyper-increased growth in the first few weeks after birth—a phenomenon that researchers now contend may alter the epigenetic processes and make formula fed babies more susceptible to Type II Diabetes, central adiposity, obesity and metabolic syndrome in their later years (Stocker, Arch, & Cawthorne, 2005). This latter study is part of a new wave of research that investigates the associations between infant feeding and gene expression—these studies move beyond the nutritive and into the other realms of breastfeeding that are harder to dissect. The mechanisms through which breastfeeding may influence outcomes is twofold (Sacker, Quigly, & Kelly, 2003). The first mechanism is biochemical, and based solely on the composition and digestion/absorption of milk (M., B., C., & R., 1999). The second mechanism is physical, and is based on the attachment of baby to mother's breast and the suckling involved. The effects of skin contact, eye contact and suckling concern the neurobiology (Bergman, 2007), physical (Palmer, 1998) and cognitive development of the child (Anderson, Johnstone and Remley 1999). Policies that encourage breastfeeding may address both of these mechanisms, but often solely address the biochemical and immunologic aspect of breast milk feedings. There is little research on how much each of the two mechanisms contributes to the overall effect of breastfeeding. It is impossible to randomize models of high-intensity, high-touch postnatal environments for humans, so little research has been done on the value of each breastfeeding component to child health. Breastfeeding is not just about milk but also the multi-sensory benefits of holding, touching, hearing and eye contact. Policies to improve breast feeding rates should address both milk and suckling, though in practice it often neglects the latter.

---

attachment behaviors in the early years. This is yet another piece of evidence that suggests the early perinatal period is a critical intervention point for improvements in adult health.

Epidemiologic literature, while controlling for potential confounders, often fails to fully address issues of selection bias. Because the impact of fetal environments can have potentially powerful physiologic effects in infancy, by the time a woman chooses to breastfeed, one cannot dismiss the correlation between stressful prenatal environments and likelihood to breastfeed. In other words, women who are more likely to have harmful fetal environments (malnutrition and maternal stress, specifically) may also be less likely to breastfeed. Researchers found that women who experienced high-stress pregnancies, or who described themselves as “high stress” or “anxious” individuals were less likely to breastfeed (J. Li et al., 2008). Furthermore, women who give birth prematurely, or who suffer medical conditions such as preeclampsia are also less likely to breastfeed (Oddy et al., 2006). For some health outcomes, there is conflicting evidence regarding an advantage in breastfed infants. Despite the 1999 meta-analysis suggesting a positive return to cognitive development from breastfeeding, especially in premature infants, there exists a controversy in the literature as to the strength of studies purporting this connection (Anderson, Johnstone and Remley 1999). In the closest thing to a randomized trial available for breastfeeding, Michael Kramer’s Promotion of Breastfeeding Intervention Trial (PROBIT) project in Belarus randomized women to Baby-Friendly Hospital Initiative (BFHI) birth centers and then tracked both uptake of breastfeeding and health outcomes over the child’s early years (Kramer et al., 2001). While the PROBIT study confirmed the protective effects of breastfeeding against the aforementioned infections, it did not support associations with cognitive or behavioral benchmarks or obesity (Kramer et al., 2002; Kramer et al., 2009).

In the social science literature, a recent study by Evenhouse and Reilly used sibling comparisons to control for unobserved between-family heterogeneity. The authors examine 15 indicators of physical health, emotional health and cognitive ability, and exploit within-family variation to investigate whether differences in siblings’ outcomes are associated with differences in the siblings’ breastfeeding histories. They find significant positive returns to cognitive development, but insignificant effects on physical and emotional health. Their results led them to conclude that epidemiologic studies supporting this relationship were overstated the long-term somatic effects of breastfeeding (Evenhouse & Reilly, 2005). Two other studies, using sibling fixed-effects models, confirmed the PROBIT findings that breastfeeding had an insignificant effect on obesity. Nelson et al (2004), using the Add Health data, found that the negative relationship between breastfeeding and child obesity became insignificant after the inclusion of mother fixed effects (Gordon-Larsen, Adair, Nelson, & Popkin, 2004). These findings were further supported by the work of Anderson, Butcher and Levine (2003), who also found insignificant negative relationships between breastfeeding and childhood obesity using sibling variation in breastfeeding. These sibling analyses indicate that this relationship may be attributable to unmeasured confounding related to mothers’ choice to breastfeed or other childhood risk factors for overweight. However, while the use of sibling comparisons helps to control for unobserved family-level factors that are *equal* between siblings, they do not control for unobserved factors that *differ* by sibling. The literature on breastfeeding establishes that the act of breastfeeding is more than nutritive—it is also an issue of maternal attachment, skin-to-skin contact and nurturing behaviors in the early days of life. Maternal behavior towards the infant cannot be measured fully by breastfeeding data, because in none of the datasets used is the amount

of breastfeeding, and mode (bottle-fed expressed milk or at the breast) controlled for. Further, if it is more likely that second children are breastfed as opposed to first children, as the Evenhouse and Reilly study suggests, *duration* of breastfeeding could be a more powerful predictor of health than initiation. A limitation of the use of sibling designs to study impacts of breastfeeding concerns the difficulties of identifying interactions between genes and environment and issues of assortative mating. In a recent report on the future of genetic research in economic studies, the author cautions against relying on uniformity of unobservable family characteristics, since panel studies include members of the same family with varying genetic compositions (Spinath 2008). Even if the blueprint of DNA is the same, interactions with the environment can alter the gene expression such that the econometric use of sibling studies is vulnerable to violations of the Stable Unit Treatment Value Assumption (SUTVA). If heterogenous treatment effects exist, then they will be masked by studies reporting average effects in sibling models.

Another empirical approach outside the normal confines of medical research is the use of natural experiments—in essence, using policy changes that might affect breastfeeding to understand the contribution of infant nutrition on health. For instance, policies could be implemented to change maternity leave laws that affect initiation and duration of breastfeeding. In Canada, while maternity leave mandates significantly increased both partial and exclusive breastfeeding duration and time home with the child, they had little to no statistical effect on initiation of breastfeeding (Baker & Milligan, 2008). There was, however, significantly lower prevalence of both asthma and allergies in the first year of birth among the cohorts of babies exposed to longer duration of breastfeeding as well as significantly lower rates of bronchitis at 13-24 months post-birth.

The impact of breastfeeding at a population level is greater than the aggregation of the individual benefits. There are fertility effects that have consequences for population growth rates, maternal mortality, family size and age structure. Breastfeeding delays return of menstruation, and therefore delays subsequent conceptions (Glasier, MacNeilly, Howell 2008). Most of the evidence for this impact has been evaluated in developing countries, though there are lessons to be learned for developed countries as well. In India, researchers found that the mechanisms through which breastfeeding delayed fertility were not limited to the delay of menses (Nath, Land, Singh 2008). This paper posited that sexual practices differed during a woman's lactation tenure, and that breastfeeding alone—with or without menses—had a marginal effect on longer birth intervals. In Ghana, the sexual taboo on breastfeeding women leads to a different outcome in the work of Benefo, Tsui and Johnson (1994). Their research showed that the sexual taboos had a negative effect on birth intervals (i.e., shorter birth intervals) through the mechanism of decreased breastfeeding duration. Results indicated that women felt pressured to stop breastfeeding so that sexual activity could resume (Benefo, Tsui, & Johnson, 1994). In the United Kingdom, similar research on breastfeeding and fertility found an interaction effect between decreased nutritional adequacy and lactation duration on return of menses and birth interval (Prema, et al., 1981). This finding is especially relevant to the topic of this paper, as public programs designed to increase both maternal nutritional adequacy and breastfeeding duration among low-income women are widespread in the United States.

Much of the infant health outcome literature focuses on SES and racial/ethnic disparities. Because the driving forces of these outcomes are highly complex, the gaps between rich, poor, white and non-white help to shape the story of maternal and child health in America. These patterns, for outcomes such as low birth weight and prematurity, show that instead of white vs. non-white dichotomies, what emerges is a story of black vs. non-black. As for education, some outcomes show virtually no difference between education levels, while others bear either a linear trend or an inverted u-shape. This is most likely a function of age and reproductive therapies among more educated women, as well as the disproportionate number of multiple-births among that population.



**Table 2: Selected Maternal and Infant Health Outcomes by Race and Education-Level, 2010**

<b>Health Outcome</b>	<b>American Indian, Alaska Native</b>	<b>Asian or Pacific Islander</b>	<b>Black, Not Hispanic</b>	<b>White, Not Hispanic</b>	<b>Hispanic or Latino, Any Race</b>	<b>Less than HS<sup>1</sup></b>	<b>HS Grad<sup>1</sup></b>	<b>Some College<sup>1</sup></b>
<b>Maternal Mortality, per 100K Births</b>	18.9	11.7 <sup>1</sup>	34.8	9.1	10.2	9.2	12.7	5.8
<b>Percent Low Birth Weight (&lt;2500 grams)</b>	7.5	8.1	14	7.3	8.7	8.2	8.2	7.0
<b>Percent Very Low Birth Weight (&lt;1500 grams)</b>	1.3	1.1	3.2	1.2	1.2	1.4	1.6	1.3
<b>Percent born Premature (before 37 weeks)</b>	14.2	10.9	18.5	11.7	12.2	13.1	12.6	11.0
<b>Perinatal Death (28 weeks or more gestation to 7 days post birth), per 1000 live births</b>	6.9	5.3	12.3	5.5	6.8	6.9	7.5	5.1
<b>Neonatal Death Rate (less than 28 days) per 1,000 live births</b>	4.0	3.4	9.1	3.7	3.9	4.6	5.0	3.6

Health Outcome	American Indian, Alaska Native	Asian or Pacific Islander	Black, Not Hispanic	White, Not Hispanic	Hispanic or Latino, Any Race	Less than HS <sup>1</sup>	HS Grad <sup>1</sup>	Some College <sup>1</sup>
Infant Death Rate, per 1,000 live births	8.1	4.9	13.6	5.8	5.6	7.9	7.6	5.6
Deaths due to SIDS, per 100,000 live births	1.11	.24	.99	.55	.28	.86	.62	.27

(1) Rate for this group only available for the year 2006. Source: National Center for Health Statistics

**Table 3: Breastfeeding Percentages by Race and Education-Level, 2006**

Breastfeeding Indicator	American Indian, Alaska Native	Asian or Pacific Islander	Black, Not Hispanic	White, Not Hispanic	Hispanic or Latino, Any Race	Less than HS	HS Grad	Some College
Percent Ever Breastfed	66	84	59	75	81	66	68	75
Percent Breastfeeding at 6 Months	42	52	26	43	45	37	34	40
Percent Breastfeeding at 1 year	24	29	12	21	24	20	16	19
Percent <i>exclusive</i> Breastfeeding at 3 Months	26	35	18	34	33	24	25	32

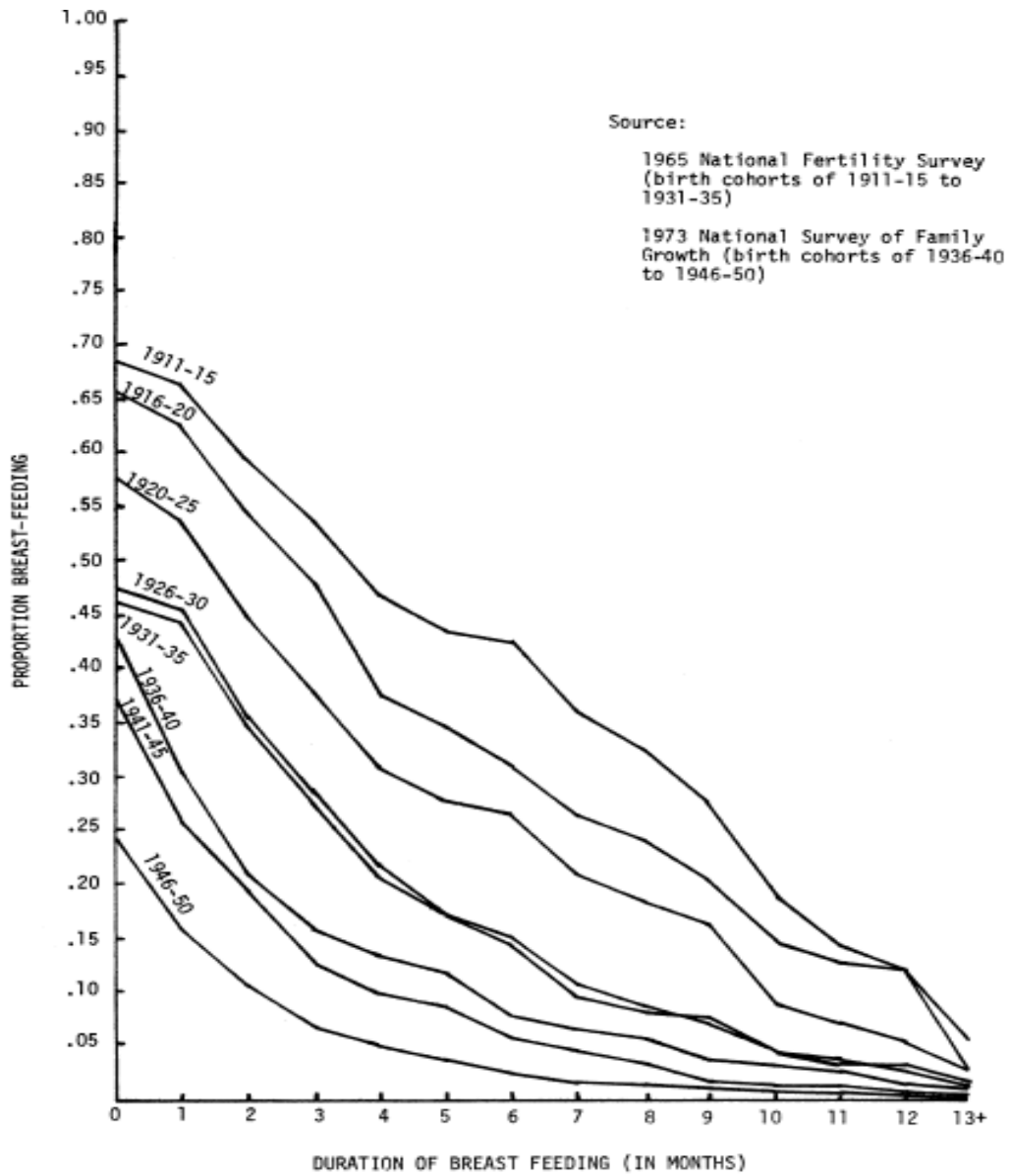
Source: National Center for Health Statistics

Racial, ethnic and educational patterns in perinatal, neonatal and infant deaths may signify different root causes. Perinatal deaths might sometimes be a rejection from the body of the baby; in other words, the uterus functions in such a way—either through genetic predisposition or health shock—to provide an inhospitable environment for the

growing baby. Even after birth, at 7 days post partum, the health of the baby is still largely a product of the uterine environment. As the baby ages, the influence of the fetal environment decreases. In this way, the neonatal and infant death rates might reflect more of the home and social environmental influences on health (Scott & Duncan, 1999). This theory can be formalized using the biometric analysis of the Bourgeois-Pichat model, which shows that fetal factors comprise less of the causes of death as a child ages. Using Bourgeois-Pichat plots, researchers have used historical demographic analysis to suggest not only a confirmation of this theory, but an increase in the susceptibility to external influences among infants who were not breastfed (Knodel & Kintner, 1977)

Descriptive breastfeeding statistics aid in understanding just how far below the American Academy of Pediatrics and Healthy People 2010 benchmarks some subgroups of mothers fall. The AAP recommends 6 months of exclusive breastfeeding. The benchmarks for the Healthy People Initiative are 75% initiation and 50% exclusive breastfeeding at 6 months. Black mothers have particularly low rates, especially compared with other historically marginalized groups such as American Indians and those of Hispanic origin. Only 18% of black mothers are breastfeeding at 3 months, and only 12% at 6 months. This finding suggests that Black stop breastfeeding much sooner than other racial or ethnic groups. For instance, while Native Americans experience similarly low initiation rates at birth, they are more likely to continue breastfeeding to the AAP recommended age. Research indicates that the current patterns are not aligned with historical trends. In the context of this paper, it is important to understand how the breastfeeding landscape has changed in the United States, specifically as the rise of infant formula as a socially acceptable and safe option for infants became more prevalent in the 20<sup>th</sup> century. Food safety laws, changes in women's employment status and changes in the culture of birth and mothers all contributed to infant formula as a normalized option (Quandt 1998). In 1981, Charles Hirschman and Marilyn Butler analyzed the National Study of Family Growth birth cohorts from 1911-1915 to 1951-1955 (Hirschman & Butler, 1981). Their findings indicate that before the "War on Poverty" in the 1960's and 1970's, the profile of the average breastfeeding mother was far different than the portrait one would paint today. Hirschman and Butler contend that Black women, particularly those giving birth in the earlier cohorts of the 20<sup>th</sup> century, were slightly more likely than other ethnic groups to breastfeed. Further, mothers of Hispanic origin were less likely than Blacks and White Protestants (the NSFG split mothers into mutually exclusive ethno-religious groupings) to breastfeed their first child, and much less likely to breastfeed their second child. As for education, the researchers found very similar U-shaped results compared to current trends—those with the lowest and highest levels of education were more likely to breastfeed. Over time, for all groups, later birth cohorts experienced significantly lower initiation and duration rates (Figure 1).

**Figure 1: Trends and Differentials in Breastfeeding Initiation by Birth Cohort**



Source: Hirschman and Butler (1981) using National Fertility Study and National Survey of Family Growth Data

Before the 1960's, initiation and duration of breastfeeding among women were declining. In the most recent cohort studied in the Hirschman and Butler paper, only 25% of babies born between 1946 and 1950 were ever breastfed, and less than 5% were still breastfed at 6 months of age. By the early 1970's, only one-fifth of women giving birth initiated breastfeeding—down from around 60% in the 1940's. Mothers in the 1940's, on average, were breastfeeding longer than women in the most current sample, though women today are more likely to initiate. Given the World Health Organization's recommendations of 1-2 years of breastfeeding for women in developed countries (WHO 2008), mean durations that range between 12 and 20 weeks since the 1940's are suboptimal. Interestingly, especially in light of present-day comparisons, the very factors that predict participation in the WIC program later in the 20<sup>th</sup> century (such as low-income, working class, Black race) are the same factors that predict higher rates of initiation and higher mean durations of breastfeeding in the 1940's and 1950's.

Anne L. Wright and Richard J. Schanler continue this analysis of historical trends in breastfeeding where Hirschman and Butler leave off (Wright & Schanler, 2001). Breastfeeding initiation rates sunk to the lowest point in the last 100 years in 1972, when 22% of women breastfed. Throughout the 1970's, breastfeeding rates increased—from 33.4% in 1975 to 54% in 1980. Over the next 15 years, however, rates remained stagnant—hovering between 55 and 60%. The main impetus for the increase in breastfeeding rates during the 1970's was the high rates of growth among affluent mothers—those living in high income households and with the highest levels of education. While there were modest increases among poor women during this time, the overall climb of breastfeeding initiation rates was driven by this well-educated group.

In contrast, according to Wright and Schanler, the early 1980's saw deep declines in breastfeeding initiation among the following groups of women: those who lived in low-income households; were not high school graduates; who were less than 25 years old; were unemployed; were African-American; and who participated in the WIC program. The reason for the stagnation during the 1980's and early 1990's in the national rates of breastfeeding, the authors contend, is due to the symmetry of the declines in breastfeeding among the poor and the increase among the more affluent. The more recent uptick in breastfeeding—between 1995 and present day—is due to the increases that occurred in the groups least likely to breastfeed, such as African-American mothers and those participating in the WIC program. According to the latest statistics from the Centers for Disease Control and Prevention (DATA2006), around 70% of women initiate breastfeeding in the hospital—a major achievement in Public Health. However, while most of the focus of the preceding research is on breastfeeding initiation, it is important to note that there has been no significant increase in breastfeeding duration over the last 30 years (R. Li, Zhao, Mokdad, Barker, & Grummer-Strawn, 2003).

Over the last 100 years, socio-demographic correlates of breastfeeding have shifted dramatically. How much of that variation is due to changes in birthing and mothering culture, expanding employment opportunities for women, or the decreased price and increased safety of breast milk substitutes is a salient research question. Specifically, what role did policy changes over this same time period play in the trend differentials between today's mothers and the mothers of the early 70's? In the middle of

the last century, breastfeeding was a poor, non-white mothers' most likely option. Today, those social expectations have reversed: breastfeeding is associated with higher income and educational attainment.

No matter whether the “policy” focus is macro (such as the WIC program) or micro (hospital administrative decisions), the essays in this dissertation all explore the extent to which policy environments affect maternal decisions to breastfeed. Two of the essays are quantitative in nature, while the third is a small-sample qualitative study. I believe that the mixture of these methods creates a rich combination of papers. Though the decision focus in this dissertation is breastfeeding, the methods in these papers can be applied to many health decisions made in by parents in their children's early life.

## Essay 1

### *Time of Birth, Breast Milk Feeding and Health Outcomes in the Neonatal Intensive Care Unit*

#### **Introduction: Breast Milk Feeding in the Neonatal Intensive Care Unit**

Premature, low birth weight infants are believed to be at a health and social disadvantage over the life course compared to their full-term, normal weight counterparts (Örtenstrand et al., 2010) (Klassen et al., 2004) (Anderson, Doyle, & the Victorian Infant Collaborative Study Group, 2003) (Stein, Siegel, & Bauman, July 2006). A large volume of medical research supports the beneficial effects of breast milk feeding in the neonatal intensive care unit (NICU). Breast milk feeding is associated with lower risk of serious gastrointestinal illnesses, such as Necrotizing Enterocolitis (Moore, Hanson, & Anderson-Berry, 2011), (Lucas & Cole, 1990). Necrotizing Enterocolitis, while rare, is one of the most dangerous illnesses in the NICU population (Berseeth, Bisquera, & Paje, 2003). Breast milk feeding is also associated with superior developmental outcomes at 18 (Vohr et al., July 2006) and 30 (Vohr et al., October 2007) months of age. Breast milk feeding is associated with shorter lengths of stay in the NICU (Örtenstrand et al., 2010), as well as decreased incidence of sepsis and other infections (Hylander, Strobino, & Dhanireddy, 1998). Some research hypothesizes that breast milk feeding can have significant *programming* effects, implying that maternal feeding decisions in the early years can impact a child's health into adulthood (Lucas 2005)

The above studies are based on observational data. Systematic reviews of the evidence on breast milk feedings and premature infant health suggest that these observational studies suffer from poor study designs, small sample sizes and inconsistent definition of treatment (de Silva, Jones and Spencer 2004). Bauchner, Leventhal and Shapiro (1986) state that “The studies that met important methodological standards and controlled for confounding variables suggest that breast-feeding has at most a minimal protective effect in industrialized countries.” Observational studies of breast milk feeding and infant health outcomes in the NICU suffer from the threat of Omitted Variables Bias. The same factors that determine the likelihood of breast milk feeding may determine likelihood of adverse health outcomes. Because of this, past estimates of the effects of breast milk feeding are either over or understated—the direction depends on the correlation between our omitted variables and both breast milk feeding and health outcomes.

More certain evidence about causal effects in medical studies typically comes from randomized controlled trials. Because this is not entirely possible for this type of treatment, researchers have attempted to introduce exogenous variation in other ways. Many times, researchers randomize mothers of NICU infants into treatment and control groups based on an intervention (McInnes & Chambers, 2008). The majority of quasi-experimental studies focus on interventions to increase skin-to-skin care, itself associated with breast milk feeding. Rojas, et al (2003) found that those randomly assigned to interventions to increase skin-to-skin contact experience statistically significant increases in breast milk feeding rates and head circumference growth, as well as decreased

episodes of oxygen desaturation. There was no evidence of advantage in other measures. Blaymore-Bier, et al (1996) found that a similar intervention to increase rates of skin-to-skin care also increased rates of breast milk feeding and decreased incidence of oxygen desaturation. In 1989, Alfonso, et al randomly assigned mothers into groups based on the type of skin-to-skin care performed (true skin-to-skin vs. conventional swaddled holding). He found that in the true skin-to-skin group, there were statistically significant differences in breastfeeding rates (higher), length of stay in the NICU (lower), time in the incubator (lower) and weight gain (higher). Another form of intervention common to these types of studies is treatment to increase milk production. Gunn, et al (1996) found in a randomized trial of human growth hormone (hGH) that hGH increased breast milk volume by 31% ( $p < .001$ ) and that infant health outcomes in the treatment group were significantly better than the control group. Limitations of these quasi-experiments include: small sample sizes (usually between 20 and 50), differential definition of the treatment variable, non-random attrition and lack of clarity in the causal pathways. On the latter point, it is difficult to isolate whether the increase in breastfeeding *causes* the increased potential for improved health outcomes or whether the intervention causes the outcomes in a different way. Because of the impossibility of randomly assigning breast milk feeding in the NICU, we must approach the question of causality in a different way.

In this study, I apply an Instrumental Variables approach. This method is superior to standard techniques, as long as the instrument is valid. The IV approach requires finding a set of variables that is highly correlated with the treatment variable (in this case, breast milk feeding), but uncorrelated with omitted variables that determine our outcomes. A history of the Instrumental Variables approach can be found in (Stock & Trebbi, 2003).

### **A Conceptual Model of Breast Milk Feeding in the NICU**

Infant health outcomes in the neonatal intensive care unit are a function of prenatal and postnatal experience. As an infant ages in the NICU, less of the prenatal environment is responsible for the health outcomes (Scott and Duncan, 1999) Breast milk feeding is one part of the postnatal environment that is a function of maternal and institutional constraints. Maternal choice, supply issues and institutional capacity are all determinants of whether an infant will be fed breast milk, formula, or a combination of both.

A mother may optimize the amount of breast milk she expresses for her child by considering the following: time it takes to express milk (pump), travel time to deliver the milk, her perception of the benefits of breast milk, and her physical ability or comfort in the act of expression. Institutions may optimize the amount of breast milk fed to an infant in the NICU based on formal or informal operating procedures. Certain institutions may favor infant formula over breast milk for some clinical presentations, depending on the culture of the organization and the beliefs of the leadership (Lee & Gould, 2009). There is wide variation in hospital's dedication to increasing breast milk feeding in the NICU. Variations at the individual and institutional level are non-random. Studies have found that hospitals most likely to be designated "baby friendly" are more likely to have NICU populations that breast milk feed upon discharge (Merewood, Philipp, Chawla, & Cimo,



2003) (Merten, Dratva, & Ackermann-Liebrich, 2005). Studies also find that willingness to breast milk feed is positively correlated with socio-economic status, maternal age and maternal education (Lee & Gould, 2009). While some studies find significantly higher rates of breast milk feeding among non-US-born Hispanic women who give birth to premature infants (Merewood, Brooks, Bauchner, MacAuley, & Mehta, October 2006), others find no significant difference in breast milk feeding rates among different racial or ethnic groups (Espy & Senn, 2003).

I developed the following model to illustrate that breast milk feeding is a function of endogenous variables and its relationship to infant health outcomes.

$$BMF = b_0 + b_1X + b_2Z + \varepsilon$$

$$Health = a_0 + a_1BMF + a_2X + \mu$$

BMF indicates whether an infant received breast milk while in the NICU; X is a vector of characteristics that influence both health outcomes and likelihood of being fed breast milk; Z is a vector of variables that influence whether a baby is fed breast milk, but are uncorrelated with  $\mu$  and *Health* is an indicator for the health outcomes of the infant.

I hypothesize that the following variables have an impact on both infant health outcomes and likelihood of breast milk feeding. These variables must be adequately confronted in any empirical analysis of breast milk and health outcomes.

- Newborn Diagnoses and Clinical Stability. Infants who are very high risk may be ordered to gain weight more rapidly. Studies show that infant formula is associated with hyper-active growth in the first weeks of life—a detriment to full term babies, but a potential life-saver for premature infants. Depending on the institutional standard procedures, these highest risk babies might be more likely to receive infant formula and more likely to have poor health outcomes. Conversely, infants with severe gastrointestinal illnesses during their hospital stay may be more likely to receive breast milk, given the research evidence supporting the strongest link between GI morbidities and breast milk feeding.
- Maternal distance from hospital. Mothers who live far away from the hospital may be less likely to transport expressed milk, and also less likely to visit. Visitation is also an important determinant of likelihood to engage in skin-to-skin care (STSC). STSC is associated with improved health outcomes, specifically in improved weight gain and decreased incidence of respiratory distress (STSC).
- Maternal length of stay in the hospital. Mothers who stay longer in recovery may be exposed to more education and more time to express milk under the tutelage of experienced clinicians. However, the maternal length of stay may be connected to a third variable indicating poor health of the mother that could also affect the health of the child in-utero and beyond.

### *Choosing a Suitable Instrument*

The most important consideration in any IV approach is to select instruments that influence likelihood of the treatment but are uncorrelated with  $U$ . For this study, I propose that the hour of birth is a valid instrument for breast milk feeding. The inspiration for this approach comes from both reviews of the literature on full-term infants and maternal length of stay (Malkin, Broder, Keeler, 2000) and interviews with clinicians and mothers in the NICU as part of my work with the University of California, San Francisco Department of Pediatrics and Neonatology. Through my work on this project, I noticed trends in the qualitative data suggesting that staff buy-in and education was an important factor in whether a mother who gives birth prematurely would begin to express milk in a timely manner. Research indicates that women should begin to express milk as soon as possible after birth in order to induce an adequate supply (Groh-Wargo & Sapsford, June-July 2009). Milk expression should be initiated within 4-6 hours of birth. For this to occur, the mothers must be given a hospital-grade breast pump, be taught how to use it, and be taught to pump early and quite often (Nyqvist, 2004). Qualitative work (Lee, et al. 2012) suggests that breast milk feeding is itself a product of the hour of birth; more skilled and experienced staff in the daytime hours may be more likely to initiate and sustain milk expression. Certified Lactation Consultants are often short staffed and spread among many patients (Davanzo et al., 2009), and much of the primary initiation of milk expression is led by the nursing staff both in Labor and Delivery and Postpartum Recovery (Gooding, et al., 2011). More experienced staff tends to work the day shift, normally between the hours of 8:00-20:00, according to the interviews I collected and previous evidence by health services researchers (Coffey, Skipper, & Jung, 1988).

There is ample evidence that night-shift work is correlated with higher job stress and lower job performance among nurses. (Fitzpatrick, While, & Roberts, 1999). Because of this disparity in the experience between day and night shifts, it follows that women who give birth in the late-night and early-morning hours would be less likely to express breast milk than women in the daytime hours, and therefore less likely to establish an adequate supply and continue breast milk feeding for the duration of her infants' stay in the NICU.

Previous research finds a negative relationship between late-night deliveries and risk of mortality for both full-term and pre-term infants (Stephanson, et al. 2003) (S. K. Lee et al., 2003). Delivery room death attributable to human error, rather than intrapartum causes, is more common for infants born in the late-night hours (Heller, et al. 2000). The potential pathways between hour of birth and mortality are two-fold: 1) Higher-risk births may present themselves in the middle of the night, either for natural or non-natural reasons and 2) less-skilled clinicians, or clinicians on-call suffering fatigue, may be in the delivery room at the time of birth. The safety of late-night shift work is of interest to policymakers; however, this interest is not equally spread throughout the different clinicians responsible for NICU quality of care. To date, "No state or federal regulations restrict the number of hours a *nurse* may voluntarily work in twenty-four hours or in a seven-day period" (Rogers, 2004). Only California, Maine, New Jersey and Oregon have attempted to restrict working hours by passing bans on mandatory overtime

for nurses. However, there are no laws on the books mandating what sorts of hours nurses freely choose to work.

For doctors, and particularly for residents in teaching hospitals, there are policies protecting both staff and patients from the potential hazards of sleeplessness and impaired decision making. In 1989, the highly publicized Bell Regulations in New York regulated that medical residents could not work more than 80 hours per week or more than 24 hours consecutively (Whetsell, 2004). Since then, numerous states and the federal government have enacted similar laws.

There is no published literature to date studying the longer-term health effects of time of birth. For full term births, the influences of the family, the neighborhood and other outside forces may be too complicated to dissect. With premature infants, we are offered a unique situation—one in which every input and output are recorded. In this controlled environment, we are more easily able to isolate potential causes of health outcomes without introducing bias from “the outside”. Premature births are also less planned—the timing of the birth is more likely a function of necessity, and less a function of convenience, compared to full term births.

#### *Threats to the Validity of the Instrument*

There are two glaring problems with using the hour of birth as an instrument for breast milk feeding. The first potential problem lies in the pathways between hour of birth and health outcomes. In order for the instrument to be valid, the hour of birth cannot affect health outcomes in any way above and beyond its effect on breast milk feeding. If more risky pregnancies occur during nighttime hours, then this medical vulnerability can account for both the timing of birth and the eventual outcomes. Further, if birth trauma is a function of clinician fatigue or skill, and those traumas have longer-term effects on health outcomes, then our instrument is invalid. In order to address this issue, I will isolate my analysis to health outcomes not associated in any past literature with delivery room trauma. I will also show a balance of covariates between daytime and PM births in my analysis sample.

Another potential problem with using hour of birth as an instrument for breast milk feeding is the relationship between hour of birth and method of delivery. I hypothesize that even though premature births are usually unexpected, women who have C-Section deliveries are more likely to give birth during the daytime hours. Evidence in previous research tends to support that claim (Mossialos, Allin, Karras, & Davaki, June 2005) (Tollånes, Thompson, Daltveit, & Irgens, 2007) (Grant, 2005), indicating that labor may be slowed in non-emergency situations in order to deliver during more convenient hours. Women who have C-Sections are more likely to have delayed onset of lactogenesis—initial milk production—compared to women who give birth vaginally (Savona, Zanardo, Cadamuro, Cavallin, & Trevisanuto, 2010). Delayed lactogenesis is a significant predictor of shorter average durations of breastfeeding. Conversely, women who have C-Sections also have longer lengths of hospital stays, on average, which may increase their likelihood of breastfeeding compared to women who give birth vaginally. The average length of stay for a C-Section delivery in California in 2004 was 3.3 days,

compared to 1.7 days for vaginal deliveries (Evans, Garthwaite, & Wei, 2008). Furthermore, women who give birth vaginally to a preterm infant are more likely to discharge themselves early (Evans et al., 2008). I can address this threat by narrowing my analysis sample to include those C-Section births that are distributed across the hours of the day in the closest pattern to vaginal births.

## **Methods**

This study has been designated exempt from review by the Committees on Human Subjects of the University of California, San Francisco and the University of California, Berkeley.

### *Data*

The data for this project is made available through my work with the University of California, San Francisco and the California Perinatal Quality Care Collaborative (CPQCC). The CPQCC member NICU's account for roughly 90% of all NICU admits in the State. This dataset is comprised of three components. The foundation of the data is the long-form Vital Statistics files for all NICU admits during the years 2005-2007. A proportion of the infants in the data also have detailed medical information appended to the vital statistics files. This medical information was recorded by physicians upon admission to the NICU, and upon discharge. Institutional information for each hospital in the dataset comes from the California Office of Statewide Health Planning and Development (OSHPD). The full dataset contains 44,963 observations. The segment of the data that contains detailed medical information is 17,039. This more detailed segment was randomly drawn from the larger dataset.

The information included in this dataset is comprehensive. The long form Vital Statistics data includes information on time and place of birth, birth weight, prenatal care, maternal self-reported smoking, maternal census tract and zip code, parental occupation and one and five minute Apgar scores. Apgar scores are clinician reported assessments of an infant's vital signs at one and five minutes post-birth. Ranging from 0-10, Apgar scores are generally agreed to be valid, and are based on skin color, respiratory signals and energy levels (Apgar, 1953). The CPQCC medical information includes detailed history of the infant's stay in the NICU, including any surgeries that were performed, diagnoses of morbidity, weight gain, length of stay, and what the infant was fed upon discharge. The OSHPD data is at the institutional level, and includes information on hospital location, the percent of the hospital population on public insurance or uninsured, staff-to-patient ratios, continuing education units among staff, and various other quality metrics. Table 3 provides descriptive statistics for infants in this dataset.

### *Constructing a Sub-Sample*

In this paper, I will not run every estimation procedure on the entire dataset. Because of the assumptions of the conceptual model, we must exclude births that are "less random".

- For this study, I exclude multiple births—twins, triplets, quadruplets and higher. Multiple births are often expected to be premature, and are more likely to occur during normal business hours. Women with high-risk pregnancies, as all multiple pregnancies are deemed, may be more prepared when the birth occurs, as they are likely well aware of the possibility of not carrying to term. The gestational age at which the multiples are born is inversely proportional to the number of infants being carried. Exclusion of this data reduces the sample size to 14,503 singleton births.
- Some observations are missing information on the CPQCC medical portion of the dataset. This is likely due to measurement error, and is unlikely to be correlated with other explanatory variables. Observations with missing outcome data are not included in the analysis sample.
- I also exclude infants who are discharged to another hospital, or are for any other reason not discharged home. This is usually because infants are transferred to larger hospitals that can accommodate their needs, or are transferred to hospitals closer to the parental home.
- Babies with congenital birth defects are also excluded. This brings the full sample to a size of 12,898 NICU admissions.

Sixty-nine percent of all births in this dataset are via C-Section. This presents unique challenges to the study of time of birth and health outcomes. Simply eliminating all C-Sections from our analysis is not useful; while this would greatly diminish the possibility of selection bias, it would also make our results externally invalid. For this study, I combine theoretical assumptions and statistical methods to construct the most appropriate sub-sample for analysis, balancing the threats to internal and external validity. This unique dataset includes information on labor spontaneity and indications for C-Section. Leveraging these variables allows me to construct a sample for which the time of birth can be considered most natural. Notice I do not use the word “random”, because research shows a non-uniform distribution of time of birth among full-term spontaneous vaginal births (Bernis and Varea, 2011). Since we do not know whether preterm births follow a similar circadian rhythm, the distribution of birth times for spontaneous vaginal deliveries in the full sample will be considered the gold standard in this study. Figure 1 shows the distribution of births across 24 hours for spontaneous vaginal deliveries. Compared to Figure 2, which includes only C-Sections, it is apparent that bunching of C-Section deliveries during normal working hours presents an obstacle to this research. Leveraging the unique indications for C-Section births in this data allows me to isolate the types of C-Sections that are most like the natural distribution of vaginal births. There are three groups of indications for C-Sections: those done as a result of fetal health complications, those as a result of maternal complications (the most common being preeclampsia) and those as a result of obstetrical complications (placenta previa, or unexplained bleeding). Figures 3, 4 and 5 show the time distributions of these three groups. Observation of the distribution supports the claim that those C-Sections performed for the health of the mother are the least likely to exhibit problematic clustering during daytime hours. Adding to this visual analysis, I perform multiple Kolmogorov-Smirnov tests for equality of distribution functions. While none of the samples is statistically similar to the natural distribution of vaginal births, the raw differences between the distributions is used as

further validation that the group of births performed for the health of the mother is the most similar to the vaginal-only group. Therefore, the preferred sub-sample includes only C-Sections in this indication sample. This brings the sample size for the analysis to 7,366 births.

### *Defining the Treatment Variables*

Off-peak hours are defined as the time of day outside normal working hours. Following the work of previous studies, I categorize off-hours deliveries as those occurring between 9pm and 6am. I further narrow this window to 11pm to 4am for “extreme-off-hours” deliveries. I also run analyses using evening hour births between 5pm and Midnight. If the critical time window for beginning milk expression is 4-6 hours, the evening births are potentially the most affected by the lack of lactation support in the nighttime hours.

One of my underlying assumptions is that access to experienced lactation consultants or nurses within the first 4 to 6 hours after birth is critical in establishing a strong milk supply. However, because of the lack of dynamic measurement of breast milk feeding in the dataset, I am unable to fully explore this relationship. The only variable in the data is a categorical variable indicating whether the infant was discharged on full, partial or no breast milk feedings. There is no indication to what proportion the daily feedings were breast milk.

### *Outcome Variables*

The main outcomes of interest are 1) Incidence of Necrotizing Enterocolitis (NEC) or gastrointestinal perforations, 2) Incidence of late-onset sepsis, 3) Length of Stay in the NICU, 4) Incidence of Retinopathy of Prematurity (ROP), 5) Change in weight over the NICU stay, and 6) Change in head circumference over the NICU stay. As a measure of robustness, I also include the incidence of Patent (meaning open) Ductus Arteriosus (PDA) and the proportion of days spent on a ventilator as outcome variables. Past research suggests that these two outcome variables are not associated with breast milk feeding. The former measures a condition present at birth and the latter measures respiratory ailments that are not shown to be associated with feeding method.

### *Statistical Analysis*

All analyses include standard errors clustered at the NICU hospital level. The first stage of the analysis is a multivariable linear regression of Off-Hours birth on the likelihood of receiving any breast milk at discharge. This analysis controls for one and five minute Apgar scores, gestational age in weeks, delivery mode, birth weight, zip code mismatch between the mother’s residence and the hospital, as well as maternal length of stay and maternal education. This analysis is repeated using both Extreme Off-Hours birth and Evening birth as the main explanatory variable of interest.

The reduced form—the potential effect of birth hour on health outcomes—analysis controls for the same set of potential confounders and is repeated for Off-Hours, Extreme Off-Hours and Evening births.

In order to check for heterogeneity of the relationships, the first-stage and reduced form analyses are performed for varying subgroups. I explore potential heterogeneity by birth weight, gestational age, race and ethnicity and maternal age.

## Results

Descriptive statistics of births occurring in peak and off-hours (9pm-6am) are presented in Table 2. Both the full and analysis sample are shown. For the analysis sample, the majority of covariates are balanced across peak and off hour births. However, the proportion of vaginal births is significantly higher during the nighttime hours when focusing solely on the preferred sub-sample. The decrease in significantly different covariates when the analysis sample is separated from the full sample underscores the necessity of knowing the indication for C-Section delivery. For example, Apgar scores in the full sample are significantly lower during the nighttime hours indicating that high risk births are indeed more likely during late-night shifts. This may explain some of the variance in delivery room deaths found in past research.

Table 3 presents descriptive statistics for both the full and analysis samples by feeding type at discharge. The incidence of being discharged on full breast milk feedings is very rare. Supplementation with formula or other high-calorie fortifiers is common. Therefore, I focus here on infants discharged on any breast milk versus infants discharged on only formula. Demographic characteristics that significantly predict being discharged on only formula include: self-identifying as a non-White race, younger maternal age, lower gestational age, being transferred in post-birth and being born via C-Section. These predictors are significant in the full sample as well. Hispanic ethnicity only predicts discharge on full formula in the full sample.

Table 4 presents the results of the first-stage analysis using off-hours of 9pm-6am. No matter how PM hours are defined (see Tables 5 and 6), there is no significant relationship between the hour of birth and breast milk feeding in either the full or analysis samples. Even when altering the outcome variable to designate *only* breast milk, the significance of the findings remains unchanged. Though these first-stage results make an Instrumental Variables approach unfounded, they do reveal some interesting findings. In the preferred sub-sample, being born vaginally increases an infant's likelihood of being discharged on breast milk by 4.3 percentage points. Furthermore, mismatch between the hospital and maternal residential zip code increases the likelihood of breast milk feedings as does each additional day of the mother's length of stay postpartum. For both samples—full and preferred—birth weight is also a positive predictor of breast milk feeding at discharge. The significance of these findings vary slightly between Tables 4-6, with the extreme off-hours model having less significant coefficients and the evening hours model having more. In particular, the evening hours model indicates a positive association between 5 minute Apgar score and likelihood of breast milk feeding. For each one unit increase in Apgar assessment score, the percentage point change in likelihood of breast milk feeding is .4%.

The reduced-form analysis is presented in Table 7. Overall, there is little evidence to suggest a longer-term association between hour of birth and health outcomes in the NICU. There are, though, a couple of significant differences in outcomes as a function of birth hour that are worth noting. The results in Model 6 suggest an increased risk of contracting Necrotizing Enterocolitis among babies born between 5pm and Midnight. Babies born in this time period are 2.2% more likely to exhibit this condition at some point in their NICU stay. Model 6 controls for the full set of potential confounders. Infants born in this time window also experience, on average, lengths of stay that are 1.5 days longer than babies born at any other time of day. Conversely, infants born in the middle of the night (9pm-6am) experience shorter lengths of stay. On average, a baby born during these hours will have a 2.79 day shorter stay than daytime births. The only other significant finding is a decrease in weight gain over the course of the NICU stay for infants born in the 9pm-6am window. The average percentage change in weight for these infants is 7.4 percentage points lower than their daytime counterparts. The average percentage weight change in the preferred sub sample is 110%.

Tables 8-10 explore evidence of heterogeneity in effect size for the first-stage relationship between hour of birth and breast milk feeding. Models are run separately by birth weight category, gestational age, Race/Ethnicity and Maternal Age category. No matter the off-hour definition, there is no evidence to suggest differential effect size by any of these sub-group categories. Much like the first stage results for the full sample, we are unable to isolate any significant relationship.

Tables 11-13 explore heterogeneity in the reduced form analysis. For the 9pm-6am off-hours births (Table 11), women of Non-White race, or those who identify as White and Hispanic, exhibit a larger association between PM births and decreased lengths of stay compared to White mothers. Furthermore, there is a significant positive relationship between PM births and both NEC and GI perforations among White women. Among non-White women, this relationship is negative though not significant. This pattern continues in Table 12, where the coefficient on NEC is larger than in Table 11 indicating an increased risk as the time window for the off-hours grows smaller.

Another distinction of note occurs in Table 12. The magnitude of the length of stay coefficient is much larger for teenage and older mothers than for all other mothers. Among teenage mothers, PM births occurring between 11pm and 4am are associated with a decrease in average stay length of nearly 7 days. For women over the age of 40, this average difference is 4 days less. The magnitude of the coefficient for babies born at less than 32 weeks is also quite large compared to the results in Table 7, Models 3 and 4. The difference among these most medically vulnerable infants is -3 days.

Table 13 alters the definition of PM to include births in the 5pm to Midnight hours. In these models, the most significant change in results comes as a function of race and ethnicity. Among White women only, being born in this time period is associated with an increased risk of not only NEC, but also late-onset sepsis. Percentage changes in weight gain and head growth, however, are greater among PM births to White women.



Another significant finding is the relationship between evening births and NEC among the most fragile infants: those under 2500 grams and those born at less than 32 weeks gestational age. Lastly, the increase in infant length of stay associated with an evening birth is very large (16 more days) for mothers over the age of 40.

## **Discussion**

The hour of birth is not a suitable instrument for breast milk feeding at discharge because of the insignificant first-stage relationship between the two variables. However, even though the initial analysis design was not valid, both the full first-stage models and the reduced form models offer interesting results that deserve further exploration.

Contrary to the qualitative evidence previously collected by this author and others, there appears to be no relationship between a late-night delivery and likelihood of being discharged on any breast milk. However, due to the constraints of the data's binary measurement of breast milk feeding, if the relationship between our variables of interest follows a dose-response pattern we are missing any potential relationship between delivery timing and feeding. As part of the CPQCC collaborative, we have collected more detailed information on intensity of breast milk feeding—what proportion of feedings are breast milk—from mothers in three large NICU's in the Bay Area of California. Very preliminary results support the claim that PM births do not predict breast milk feedings, but that PM births do predict a significantly lower proportion of total feedings that are breast milk.

Breast milk feedings are predicted by various explanatory variables, even after controlling for potential confounders. The relationship between birth weight, Apgar scores and breast milk at discharge indicates that either hospital policy disincentives the more medically vulnerable babies from using breast milk as a first feeding or that mothers are responding to the medical vulnerability by decreasing likelihood of breast milk feeding. Anecdotal evidence collected from both mothers and clinicians suggest that the former explanation is more likely. Some medical directors or others in leadership positions are still undecided on the feeding protocol for the most fragile of infants.

The relationship between C-Sections and breast milk feeding success in this sample mirrors findings in full-term populations all over the world (Vieira, et al., 2011). My findings confirm previous research results, but are the first to show that C-Sections may not only delay the onset of milk production, but that this delay in the early perinatal period produces a longer-term disparity in NICU feeding outcomes. A similarly robust finding is the relationship between maternal length of stay and breast milk feeding. Both C-Section births and initial length of stay for the mother are the result of delivery-room policies (via the hospital or insurance companies) that can be manipulated. In future studies, I plan to leverage both maternal distance from the hospital and maternal length of stay as instruments for breast milk feeding.

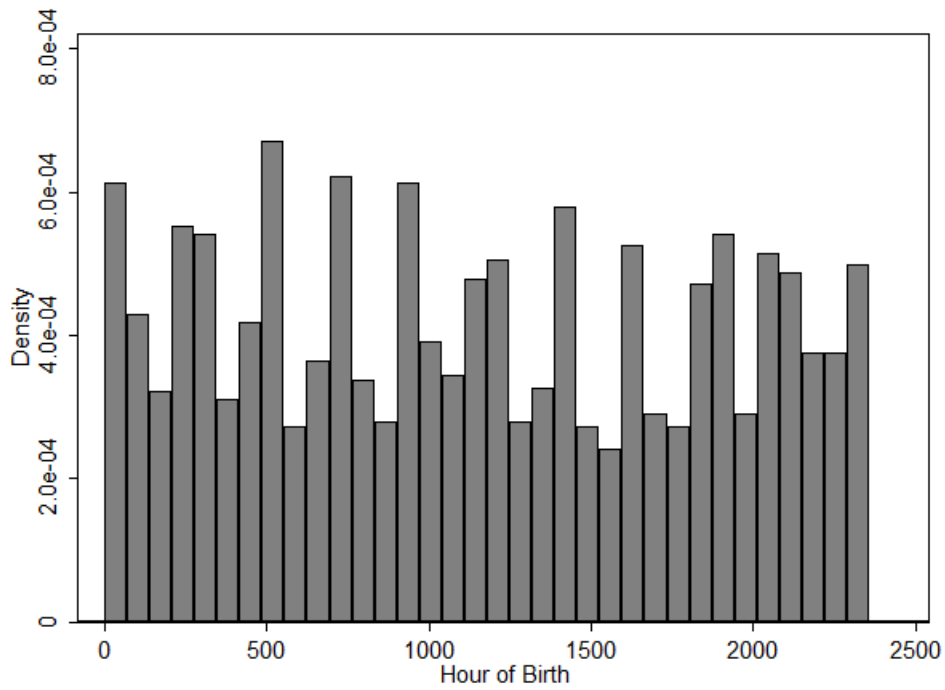
The reduced-form analysis of the potential effect of hour of birth on various health outcomes produces some surprising findings. In terms of NEC, babies born during

the evening hours are more likely to contract this condition than any other delivery time. Why this is, the analysis can not tell us. One hypothesis is that if the breast milk variable were measured more dynamically, this could account for some of the variation in NEC risk. Another explanation is that an intervention in the early hours of life may protect against NEC, and that infants born during the evening hours are less likely to receive this intervention. Previous research suggests that evening hours are a prime time for shift changes, and that critical information about the infant may be overlooked or lost during the handoff. In this data there is no significant relationship between health indicators at birth and later incidence of NEC, suggesting that the innate medical vulnerability of the infant has little to do with eventual outcomes on this measure. Because NEC is one of the most deadly conditions in the NICU, even if it is relatively rare, this result should be further examined in future studies.

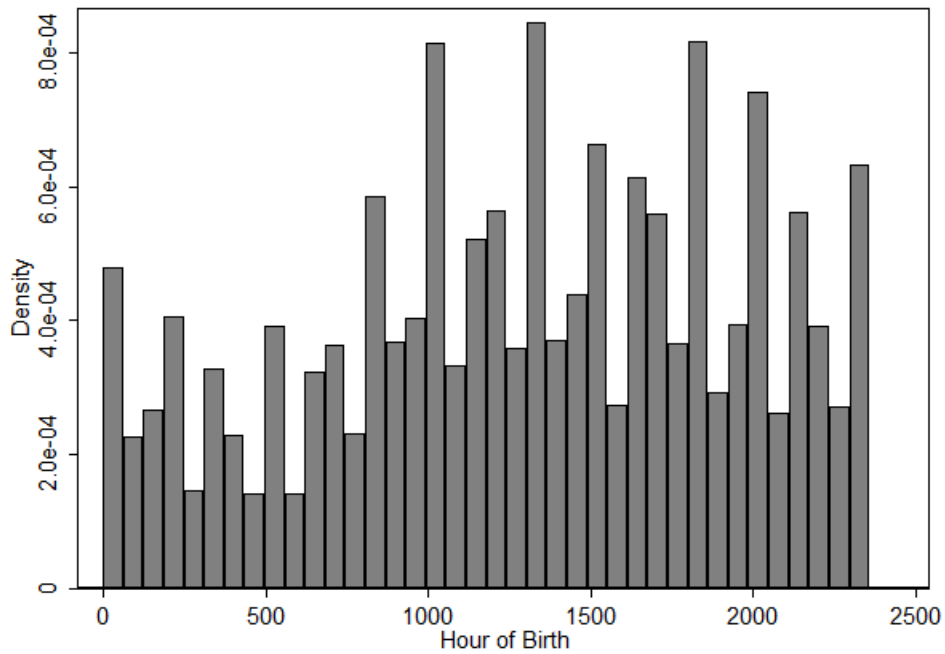
Taken together, the results of this study fail to paint a consistent story. While giving birth in the late night hours is associated with a decreased length of stay for the infant, giving birth in the evening is associated with just the opposite. Relationships that were insignificant in the full sample reduced-form analysis become significant when looking at only White women of non-Hispanic ethnicity. Small magnitudes of association are suddenly quite large when partitioning the sample by maternal age. Overall, there is little evidence to suggest that—besides the consistently significant association between hour of birth and NEC—a late night or early morning hour of delivery is indicative of any longer-term health disadvantage in the NICU population. Despite this lack of association, there are many lessons to be taken from this analysis. Besides exploring the intriguing relationship between hour of birth and NEC, work should be pursued on the policy determinants of breast milk feeding in the NICU, specifically in regards to indications for C-Sections and maternal length of stay.

## Tables and Figures

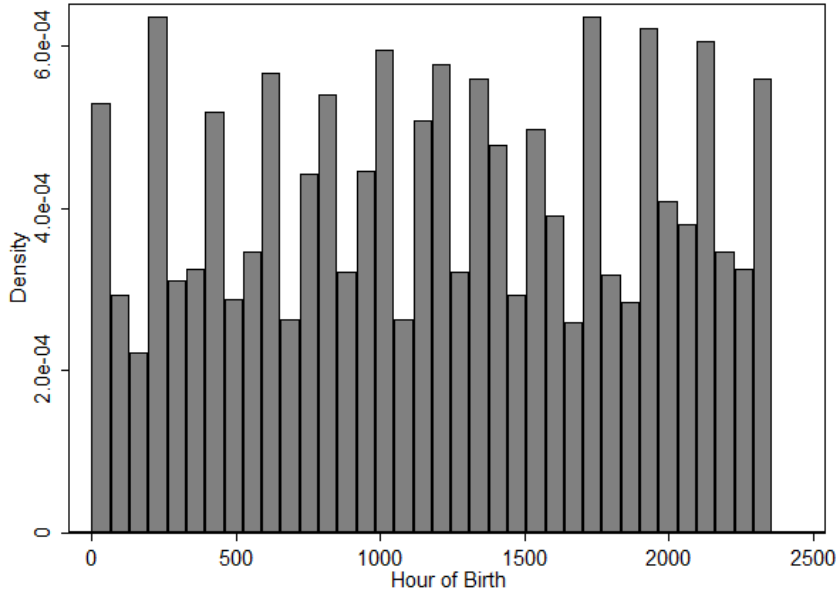
**Figure 1: Distribution of Hour of Birth, All Vaginal Births**



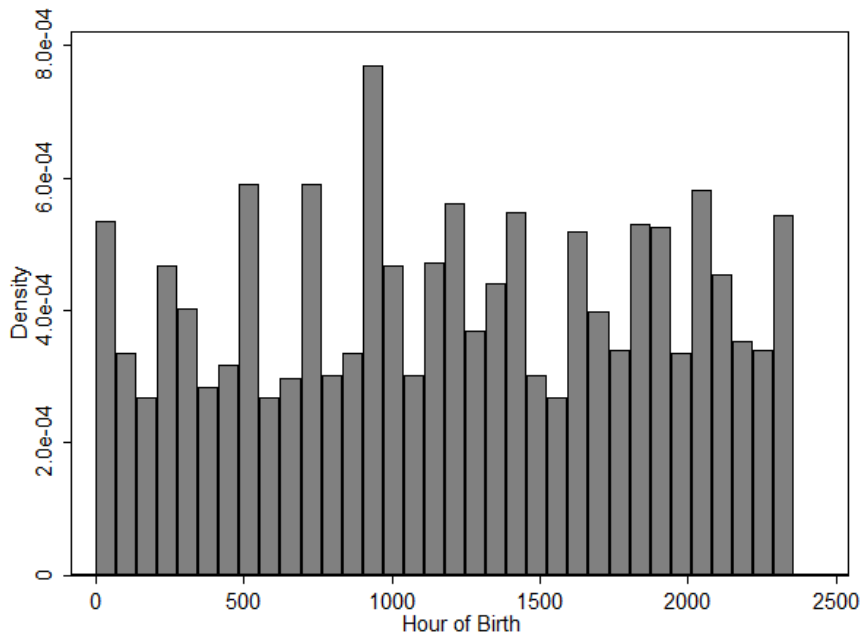
**Figure 2: Distribution of Hour of Birth, All C-Section Births**



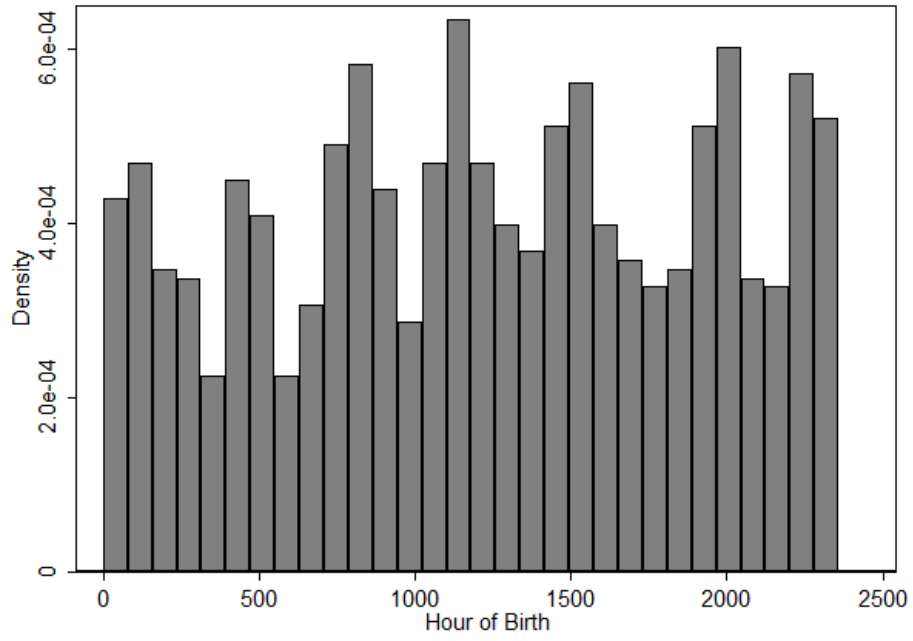
**Figure 3: Distribution of Hour of Birth, Spontaneous Labor, No Fetal Indication for C-Section**



**Figure 4: Distribution of Hour of Birth, Spontaneous Labor, No Maternal Indication for C-Section**



**Figure 5: Distribution of Hour of Birth, Spontaneous Labor, No Obstetrical Indication for C-Section**



**Table 1: K-Smirnov tests of similarity between Vaginal and C-Section Indication Groups**

	K-S Difference vs. Vaginal Birth Distribution
Group 1: No Fetal Complications	-.022
Group 2: No Maternal Complications	-.031
Group 3: No Obstetrical Complications	-.052

**Table 2: Covariates of Working and Off Hour Groups. Standard Errors in Parentheses**

	All Patients N=16812		Preferred Sub-Sample Only N= 7366	
	Working Hours	Off-Hours	Working Hours	Off-Hours
Proportion Non-White	.41 (.01)	.42 (.01)	.44 (.01)	.46 (.01)
Proportion Hispanic (Any Race)	.44 (.01)	.46 (.01)	.51 (.01)	.51 (.01)
Mean Maternal Age	29.83 (.09)	29.49* (.15)	28.03 (.12)	27.87 (.16)
Proportion with any College	.47 (.01)	.46 (.01)	.42 (.01)	.42 (.01)
Mean Gestational Age (Weeks)	28.79 (.03)	28.58** (.06)	27.01 (.05)	26.84 (.07)
Proportion Male Infants	.50 (.01)	.49 (.01)	.54 (.01)	.54 (.01)
Proportion Transferred In	.14 (.004)	.13 (.01)	.19 (.01)	.18 (.01)
Proportion Vaginal Birth	.28 (.004)	.37*** (.01)	.69 (.01)	.73*** (.01)
Mean 1 Minute Apgar Score	6.07 (.06)	5.66*** (.07)	6.64 (.16)	6.52 (.24)
Mean 5 Minute Apgar Score	7.86 (.06)	7.52*** (.07)	8.19 (.17)	8.03 (.24)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)

**Table 3: Covariates by Feeding Type at Discharge. Standard Errors in Parentheses**

	All Patients N=16812		Preferred Sub-Sample Only N= 7366	
	Any Breast Milk	Only Formula	Any Breast Milk	Only Formula
Proportion Non-White	.39 (.01)	.45*** (.01)	.42 (.01)	.45* (.01)
Proportion Hispanic (Any Race)	.49 (.01)	.52* (.01)	.54 (.02)	.53 (.02)
Mean Maternal Age	29.89 (.09)	27.77*** (.14)	28.69 (.16)	26.80*** (.23)
Proportion with Any College	.55 (.01)	.38*** (.01)	.49 (.01)	.33*** (.01)
Mean Gestational Age (Weeks)	28.95 (.037)	28.43*** (.058)	28.21 (.06)	27.86** (.11)
Proportion Male Infants	.50 (.01)	.49 (.01)	.52 (.01)	.53 (.01)
Proportion Transferred In	.14 (.004)	.18*** (.01)	.16 (.01)	.23*** (.01)
Proportion Vaginal Birth	.27 (.01)	.27 (.01)	.68 (.01)	.64** (.01)
Mean 1 Minute Apgar Score	6.73 (.10)	6.56 (.15)	7.40 (.24)	7.30 (.34)
Mean 5 Minute Apgar Score	8.45 (.10)	8.27 (.14)	9.04 (.24)	8.89 (.31)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)

**Table 4: Relationship between hour of birth and any breast milk feeding at discharge; Off-Hours Defined as 9pm-6am. Standard Errors in Parentheses**

	All Patients N=12898		Preferred Sub-Sample Only N= 4681	
	Model 1	Model 2	Model 3	Model 4
Off-Hours Birth	.007 (.009)	.008 (.012)	.021 (.019)	.009 (.013)
1 Minute Apgar Score	--	-.002 (.002)	--	-.001 (.001)
5 Minute Apgar Score	--	.003* (.002)	--	.002 (.002)
Gestational Age (Weeks)	--	.009*** (.002)	--	.002 (.004)
Vaginal Birth	--	.004 (.011)	--	.043** (.02)
Birth Weight (grams)	--	.0001*** (.00002)	--	.0001*** (.00003)
Mother/Hospital Zip Code Mismatch	--	.062*** (.022)	--	.056* (.03)
Maternal Length of Stay (in Days)	--	.002*** (.0006)	--	.005*** (.001)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)



**Table 5: Relationship between hour of birth and any breast milk feeding at discharge; Extreme Off-Hours of 11pm-4am. Standard Errors in Parentheses**

	All Patients N=12898		Preferred Sub-Sample Only N= 4681	
	Model 1	Model 2	Model 3	Model 4
Extreme Off-Hours Birth	.008 (.008)	.009 (.010)	.011 (.017)	.006 (.013)
1 Minute Apgar Score	--	-.0015 (.0017)	--	-.0008 (.002)
5 Minute Apgar Score	--	.004* (.0019)	--	.002 (.002)
Gestational Age (Weeks)	--	.010*** (.002)	--	.002 (.004)
Vaginal Birth	--	.0047 (.012)	--	.042 (.016)
Birth Weight (grams)	--	.0001*** (.00002)	--	.0001 (.00003)
Mother/Hospital Zip Code Mismatch	--	.062*** (.022)	--	.057* (.029)
Maternal Length of Stay	--	.0023*** (.0006)	--	.005*** (.001)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)

**Table 6: Relationship between hour of birth and any breast milk feeding at discharge;  
Evening Hours Defined as 5pm-Midnight**

	All Patients N=12898		Preferred Sub-Sample Only N= 4681	
	Model 1	Model 2	Model 3	Model 4
Evening Hours Birth	.011 (.011)	.008 (.013)	.028 (.019)	.014 (.019)
1 Minute Apgar Score	--	-.003 (.002)	--	-.002 (.002)
5 Minute Apgar Score	--	.004** (.002)	--	.004** (.002)
Gestational Age (Weeks)	--	.007** (.003)	--	-.0002 (.004)
Vaginal Birth	--	.010 (.013)	--	.061*** (.018)
Birth Weight (grams)	--	.0001*** (.00002)	--	.0001*** (.00004)
Mother/Hospital Zip Code Mismatch	--	.058** (.026)	--	.069* (.037)
Maternal Length of Stay	--	.003*** (.0008)	--	.007*** (.001)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)

**Table 7: Relationship between Hour of Birth and Health Outcomes. Models (2), (4) and (6) controlling for Apgar Scores at 1 and 5 minutes, Gestational Age, Delivery Mode, Birth Weight, Zip Code Mismatch and Maternal Length of Stay. Preferred Sub-Sample Only. Standard Errors in Parentheses. N=4025**

Outcome Variable	Off-Hours 9pm-6am		Extreme Off-Hours 11pm-4am		Evening Hours 5pm- Midnight	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Necrotizing Enterocolitis	.004 (.006)	.001 (.007)	.009 (006)	.006 (.007)	.022** (.009)	.022** (.009)
Any GI Perforation	.006 (.005)	.004 (.006)	.006 (.005)	.004 (.005)	-.0004 (.004)	-.003 (.005)
Incidence of Late-Onset Sepsis	.012 (.012)	.011 (.011)	.012 (.011)	.011 (.012)	.012 (.012)	.019 (.013)
Incidence of ROP	.032 (.020)	.031 (.020)	.048** (.019)	.037* (.019)	.023 (.021)	.017 (.019)
Length of Stay (Days)	-2.32* (1.17)	-2.79** (1.29)	-1.40 (1.11)	-1.50 (1.05)	1.25 (.88)	1.50* (.910)
Proportion Weight Gain <sup>(a)</sup>	-.058 (.041)	-.074* (.043)	-.015 (.038)	-.019 (.032)	.050 (.037)	.056 (.035)
Proportion Head Circumference Gain <sup>(a)</sup>	-.011* (.006)	-.014 (.007)	-.008 (.005)	-.008 (.005)	.002 (.006)	.003 (.005)
Incidence of PDA	.006 (.017)	.006 (.018)	.009 (.015)	.013 (.017)	.016 (.017)	.014 (.016)
Percentage of Days on Ventilator <sup>(a)</sup>	.062 (.149)	-.045 (.128)	-.035 (.140)	-.094 (.127)	-.010 (.151)	.011 (.169)

Note: (a) these models were run also controlling for infant length of stay

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)

**Table 8: Relationship between Hour of Birth and Any Breast Milk Feeding at Discharge among Sub-Groups. Full Controls. Preferred Sub-Sample Only. Standards Errors in Parentheses. Off Hours Defined as 9pm-6am**

Outcome Variable	Birth Weight		Gestational Age (Weeks)	Race		Maternal Age	
	<1500 Grams	<2500 Grams	<32 Weeks	White	Non-White Race or Hispanic. Any Race	<18	>40
Any Breast Feeding	.005 (.014)	.013 (.014)	-.004 (.014)	-.009 (.023)	.039 (.027)	.039 (.069)	.035 (.085)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)

**Table 9: Relationship between Hour of Birth and Any Breast Milk Feeding at Discharge among Sub-Groups. Full Controls. Preferred Sub-Sample Only. Standards Errors in Parentheses. Extreme Off Hours Defined as 11pm-4am**

Outcome Variable	Birth Weight		Gestational Age (Weeks)	Race		Maternal Age	
	<1500 Grams	<2500 Grams	<32 Weeks	White	Non-White Race or Hispanic. Any Race	<18	>40
Any Breast Feeding	.002 (.016)	.004 (.014)	-.008 (.016)	-.023 (.022)	.041 (.026)	.016 (.055)	.009 (.084)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)

**Table 10: Relationship between Hour of Birth and Any Breast Milk Feeding at Discharge among Sub-Groups. Full Controls. Preferred Sub-Sample Only. Standards Errors in Parentheses. Evening Hours Defined as 5pm-Midnight**

Outcome Variable	Birth Weight		Gestational Age (Weeks)	Race		Maternal Age	
	<1500 Grams	<2500 Grams	<32 Weeks	White	Non-White Race or Hispanic. Any Race	<18	>40
Any Breast Feeding	.016 (.019)	.013 (.019)	.005 (.020)	.0002 (.022)	.036 (.027)	-.004 (.069)	.122 (.079)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)

**Table 11: Relationship between Hour of Birth and Health Outcomes among Sub Groups. Full Controls. Preferred Sub-Sample Only. Standard Errors in Parentheses. Off Hours Defined as 9pm-6am**

Outcome Variable	Birth Weight		Gestational Age (Weeks)	Race		Maternal Age	
	<1500 Grams	<2500 Grams	<32 Weeks	White Non Hisp	Non-White Race or Hispanic. Any Race	<18	>40
Necrotizing Enterocolitis	.003 (.007)	.006 (.007)	.007 (.008)	.025* (.013)	-.014 (.013)	-.006 (.026)	-.022 (.04)
Any GI Perforation	.0008 (.006)	.004 (.006)	.003 (.006)	.017* (.009)	-.010 (.006)	.024 (.023)	-.009 (.009)
Incidence of Late-Onset Sepsis	.012 (.013)	.011 (.012)	.014 (.013)	.013 (.016)	.008 (.018)	.001 (.039)	-.007 (.057)
Incidence of ROP	.036 (.022)	.031 (.021)	.034* (.018)	.041 (.025)	.016 (.034)	.013 (.063)	.123 (.077)
Length of Stay (Days)	-2.59* (1.36)	-2.78** (1.29)	-2.92** (1.36)	-2.43 (1.88)	-3.53* (1.95)	-6.06 (4.23)	-4.68 (5.23)
Proportion Weight Gain <sup>(a)</sup>	-.076 (.046)	-.076* (.043)	-.078* (.046)	-.073 (.064)	-.079 (.063)	-.178 (.133)	-.176 (.176)
Proportion Head Circumference Gain <sup>(a)</sup>	-.014* (.007)	-.015** (.007)	-.015** (.007)	-.012 (.009)	-.016 (.010)	-.028 (.021)	-.029 (.024)
Incidence of PDA	.001 (.017)	.006 (.018)	.003 (.018)	.028 (.023)	-.016 (.027)	-.078 (.061)	.143* (.080)
Proportion of Days on Ventilator <sup>(a)</sup>	-.041 (.141)	-.043 (.128)	-.041 (.129)	.050 (.20)	-.135 (.172)	1.15 (.826)	-.071 (.253)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)

**Table 12: Relationship between Hour of Birth and Health Outcomes among Sub Groups. Full Controls. Preferred Sub-Sample Only. Standard Errors in Parentheses. Extreme Off Hours Defined as 11pm-4am**

Outcome Variable	Birth Weight		Gestational Age (Weeks)	Race/Ethnicity		Maternal Age	
	<1500 Grams	<2500 Grams	<32 Weeks	White, Non Hisp.	Non-White Race or Hispanic. Any Race	<18	>40
Necrotizing Enterocolitis	.010 (.008)	.012 (.008)	.014 (.009)	.031** (.012)	-.011 (.014)	-.014 (.025)	.029 (.037)
Any GI Perforation	.002 (.005)	.004 (.005)	.004 (.005)	.015** (.007)	-.008 (.005)	.016 (.020)	-.009 (.009)
Incidence of Late-Onset Sepsis	.011 (.013)	.011 (.012)	.015 (.012)	.021 (.017)	-.003 (.017)	-.018 (.037)	-.025 (.048)
Incidence of ROP	.039* (.020)	.037* (.018)	.039** (.018)	.034 (.024)	.035 (.033)	-.019 (.056)	.109 (.072)
Length of Stay (Days)	-1.41 (1.40)	-1.49 (1.06)	-3.01** (1.33)	-.561 (1.58)	-2.65 (1.68)	-6.89* (3.69)	-4.05** (1.24)
Proportion Weight Gain <sup>(a)</sup>	-.020 (.034)	-.019 (.032)	-.021 (.036)	.022 (.047)	-.072 (.050)	-.201* (.121)	.060 (.164)
Proportion Head Circumference Gain <sup>(a)</sup>	-.007 (.005)	-.007 (.006)	-.008 (.005)	-.0013 (.007)	-.016* (.008)	-.029 (.019)	-.013 (.022)
Incidence of PDA	.008 (.018)	.013 (.017)	.012 (.018)	.030 (.022)	-.006 (.024)	-.023 (.046)	.186** (.062)
Proportion of Days on Ventilator <sup>(a)</sup>	-.099 (.142)	-.092 (.128)	-.091 (.129)	-.065 (.140)	-.111 (.209)	1.38 (.843)	-.262 (.367)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)

**Table 13: Relationship between Hour of Birth and Health Outcomes among Sub Groups. Full Controls. Preferred Sub-Sample Only. Standard Errors in Parentheses. Evening Hours Defined as 5pm-Midnight**

Outcome Variable	Birth Weight		Gestational Age (Weeks)	Race		Maternal Age	
	<1500 Grams	<2500 Grams	<32 Weeks	White Non Hisp	Non-White Race or Hispanic. Any Race	<18	>40
Necrotizing Enterocolitis	.020** (.010)	.022** (.009)	.021** (.010)	.019* (.011)	.002 (.001)	-.022 (.030)	.023 (.047)
Any GI Perforation	-.004 (.005)	-.003 (.005)	-.004 (.005)	-.007 (.007)	.001 (.009)	-.023 (.020)	-.011 (.012)
Incidence of Late-Onset Sepsis	.018 (.014)	.018 (.013)	.021 (.014)	.039** (.016)	-.007 (.018)	.047 (.043)	.021 (.056)
Incidence of ROP	.012 (.018)	.017 (.019)	.010 (.019)	.002 (.022)	.030 (.024)	-.081 (.054)	.042 (.078)
Length of Stay (Days)	1.15 (1.00)	1.49 (.94)	-1.43 (1.09)	1.99 (1.31)	.845 (2.02)	1.32 (4.19)	16.10** (5.32)
Proportion Weight Gain <sup>(a)</sup>	.053 (.038)	.057 (.035)	.059 (.036)	.126** (.053)	-.032 (.061)	.023 (.142)	.483* (.252)
Proportion Head Circumference Gain <sup>(a)</sup>	.002 (.006)	.003 (.005)	.004 (.006)	.011* (.006)	-.006 (.011)	.013 (.023)	.071** (.031)
Incidence of PDA	.016 (.017)	.014 (.017)	.016 (.017)	.016 (.020)	.008 (.026)	-.072 (.059)	-.063 (.078)
Proportion of Days on Ventilator <sup>(a)</sup>	.004 (.186)	.010 (.169)	.0008 (.171)	-.102 (.263)	.146 (.320)	-.642 (.415)	-.208 (.183)

\*\*\* = (p<.10); \*\* = (p<.05) \* = (p<.01)



## Essay Two

### *Prenatal Feeding Intentions and Parity Predict Take-Up of the Special Supplemental Food and Nutrition Program for Women, Infants and Children*

#### **Introduction**

Selection bias—the threat that unobserved factors predict take-up of a program and therefore bias the treatment effect estimation—is likely the most damaging critique for many public health program evaluations. While different disciplines define selection bias in slightly different ways—and sometimes classify it into many different forms—the statistical weaknesses that selection bias present are universal (Hernan, et al. 2004). For many public programs, the ideal of randomization into treatment is unethical and impossible. Barring this option, researchers have a wide variety of statistical techniques to employ, each with its own advantages and drawbacks. This paper will review how researchers have applied these methods in the study of a particular US nutrition intervention, and present a conceptual model and empirical analysis highlighting potential sources of bias in this program’s take-up.

The policy focus of this paper is the Supplemental Food and Nutrition Program for Women, Infants and Children (WIC). WIC is a fully federally funded program run by local government agencies and non-governmental jurisdictions. The WIC program provides vouchers to low-income women and children for foods classified as nutritious during pregnancy and childhood—including free infant formula. If the mother is not breastfeeding, the majority of a baby’s monthly formula supply will be provided by WIC. If a mother is supplementing breastfeeding with formula, a partial supply of formula will be provided. Until 1990, there were no programmatic incentives for breastfeeding mothers. This changed in 1991, when packages were changed to allow for more and different foods for breastfeeding mothers. If fully breastfeeding, mothers receive extra food vouchers, as well as vouchers for foods not provided to formula feeding mothers--such as tuna fish and carrots--and incentives for continued nursing, such as small gifts for the baby and mother. Breast pumps for milk expression are also available for a low cost rental, or for free, at the majority of WIC sites (California WIC Association, 2009).

WIC is designed for both low and moderate income levels. Eligible families must make less than 185% of the Federal Poverty Level. Income alone is not the sole determinant of WIC eligibility--only babies deemed to be nutritionally “at risk” are eligible, no matter the income requirements. In practice, though, this “at-risk” designation seems to be a formality. The most common entry into the program is a function of participation in other public programs; Food Stamp and Medicaid participants are automatically qualified for WIC (Bitler & Currie, 2004).

The wide-spread reach of the WIC program makes it a critical component in understanding nutrition policy in the United States.

Exact participation and eligibility rates are unavailable, as the inclusion of undocumented immigrants in the eligible pool presents an estimation problem. Reasonable estimates (Urban Institute 2011) of participation range from 30% of all infants, young children and pregnant women to 50% for infants alone. Eligibility rates are estimated between 55% and 65% of the

categorically eligible (pregnant or nursing women and children age zero to five). The coverage rate—the percent of eligible people who enroll—varies widely by state from a low of 42.9% in Nevada to a high of 70.1% in California. Compared to the other large nutritional program in the U.S.—the Supplemental Nutrition Assistance Program (SNAP)—the coverage rate differential by age is expected. Coverage rates for SNAP vary from 34% for elderly eligibles to 90% for eligible children (United States Department of Agriculture, 2011).

Researchers point to many different reasons for the high take-up rate: higher income ceilings, more sources of enrollment information (doctor’s offices, child care facilities, hospitals), more offices per county, and the prevalence of “WIC-only grocery stores” are all potential reasons (Bitler et al., 2003). The increase in enrollment over time has been attributed to programmatic changes such as earlier eligibility during pregnancy, longer certification periods for children and the lack of waiting lists (Institutes of Medicine 2011). Furthermore, WIC is available to all mothers and children who qualify, regardless of citizenship status. It is estimated that approximately 30% of all WIC recipients age 0-4 are native-born children of foreign-born parents. Roughly half of that group was born to undocumented immigrants (Vericker, et al 2010).

### **Common Methods to Address Selection Bias: The “WIC Effect” on Breastfeeding Behavior**

Analysts have many statistical methods at their disposal to address the threat of selection bias. Regression adjustment is the most straightforward approach when faced with unobserved sources of bias. However, even when we can control for an exhaustive list of observable variables, this does not remove our suspicions that unobserved factors are confounding the treatment effect. This approach can only minimize bias, and not erase it (Rosenbaum and Ruben, 1983). A more sophisticated form of regression adjustment is matching—the most popular form in the social sciences is propensity score matching. A propensity score can be theoretically illustrated by:

$$p(x) = \Pr(T = 1 | X = x)$$

In words, the propensity score measures the probability of treatment given a set of characteristics. Propensity scores are usually generated using a probit model in which program participation is the dependent variable and a host of observable demographic characteristics as well as interactions of these variables and higher order terms of certain variables comprise the right hand side. An important first step is the comparison of covariates across the treated and control groups; if there is significant imbalance between the covariates in the treated and control groups, alternative specifications of the propensity score formula should be explored (Morgan and Winship, 2007, p116).

Propensity scores can be used in a variety of ways—as controls, or as matching variables (Rosenbaum and Ruben 1983). Most contemporary applications use these scores as matching variables; subjects are matched on propensity scores, and the difference in the outcome can be attributed to the effect of the program, if the assumptions of propensity score matching hold. In order for propensity score matching estimators to be interpreted as causal, the returns to entering treatment status must not be correlated with likelihood of entering the program conditional on matching propensity scores. Because this is a difficult assumption to placate, researchers must use caution in the interpretation of propensity score effects as anything more than associations.

Propensity score matching estimators do have advantages over standard regression adjustment techniques (Rosenbaum and Ruben, 1983). Propensity score matching allows more flexible modeling of the relationship between the explanatory variables and treatment status. Propensity score matching also allows identification of those outlying observations to which no suitable comparison exists. The main drawback of propensity score matching is the need for large samples—often researchers do not have a sample large enough to produce sufficient power. When samples are too small, the distance between an observation and its nearest suitable match will be too large to satisfy the requirements for a solid propensity score matching approach.

Another popular approach, particularly in the Economics and Policy Analysis literature, exploits random variation in program roll-out. As long as the roll-out of the program is random, we can be assured that the changes in the outcome variable are robust to selection bias. The random rollout requirement is hard to prove, and one can never be certain that unobserved characteristics of the jurisdiction introducing the program are truly uncorrelated. The records to support the claim of random roll-out are often laborious to include in a dataset (governmental transcripts dating back decades, for example), but when available and accessible are extremely helpful. Another drawback of this approach is that this type of analysis uses outcome variables at the jurisdiction levels—this means that the changes at the jurisdiction level--if any--are not necessarily a product of those who took-up the program (Hoynes, et al. 2009).

An alternative form of statistical analysis exploits random variation in a third—or instrumental—variable to mimic randomization of treatment. This third variable must be correlated with the treatment, and must also satisfy what social scientists refer to as the exclusion restriction. This restriction requires that the instrumental variable only affect the outcome via its relationship with the treatment variable (Angrist and Krueger, 2001) (Imbens and Angrist 1994). Finding a suitable instrument is difficult, and the inability to prove that your instrument satisfies the exclusion restriction makes it difficult to defend this approach. However, when a sound instrument *is* found, the IV method is the highly robust to the threat of selection bias. This makes it a very popular approach in the social sciences.

Many of these methods have been used to estimate the effect of WIC on breastfeeding behavior and child health outcomes. Previous research finds that women participating in the WIC program experience shorter average breastfeeding durations than women who do not participate in the program, even when controlling for potential confounders via regression adjustment. Criticisms of this finding center on whether there is positive or negative selection bias into the program. If women who are more likely to breastfeed are also more likely to enter the program, then the magnitude of previous associations is understated. If women who are the least likely to breastfeed are the most likely to enter the program, then the magnitude is overstated. A claim made in many government reports is that women who are the least likely to breastfeed enroll in WIC. The United States Department of Agriculture, which runs the WIC program, expressed this sentiment itself:

*“Women on WIC may have lower breastfeeding rates because breastfeeding is less common among women with lower incomes and less education, and WIC serves this population”*

(Government Accountability Office, 2006)

Few studies rigorously estimate the impact of WIC on likelihood of breastfeeding, given the daunting methodological challenges. Using regression adjustment, previous research has found decreased duration of breastfeeding (Ryan & Zhou, 2006) (Jacknowitz et al., 2007) (Chatterji et al., 2002) among WIC mothers, compared to non-WIC mothers. The 2006 Ryan and Zhou study approached this issue using the Ross Laboratories Mothers Survey (RLMS) data for the period spanning 1978-2003; the RLMS is a proprietary dataset relying on maternal recall of infant feeding in the hospital (initiation) and at each month of age up to 6 months (duration). The results of this study indicate that WIC participation had an average treatment effect of a 23.6% decrease in the likelihood of breastfeeding initiation. Furthermore, Ryan and Zhou estimate that the gap between WIC and non-WIC mothers increased over the 25 years. Given that the food packages changed little over this period, changing demographics of the program may underlay the widening of the gap. As formula prices in the US rose rapidly—far faster than the rate of inflation—more women inclined to formula feed may have joined the WIC program. In other words, the costs of not participating became higher for those least likely to breastfeed. The Ryan and Zhou study does little to address threats of selection bias besides controlling for observable confounders associated with both WIC participation and breastfeeding. It does, however, adequately describe the trends over a 25 year period of high growth in the WIC population, as well as identifying independently significant predictors of formula feeding such as African-American race, low maternal education, low maternal age and first-time births.

Other research on time trends in breastfeeding among the WIC population finds that WIC *increased* breastfeeding rates in the 1990's. Applying regression adjustment to a data set comprised solely of WIC participants, Oliviera and Gundersen find increased breastfeeding rates coinciding with food package changes meant to incentivize breastfeeding (Oliviera & Gundersen, 2000). However, this increase may also be explained by the changes in the demographics of the program over this time period. Hispanic women make up a larger proportion of the WIC population now than they did in 1990 (Joyce et al., 2008). Mothers of Hispanic origin, especially recent immigrants, are more likely to breastfeed than any other racial or ethnic group (Gibson, et al 2005).

Jacknowitz, Novillo and Tiehan (2007) approach the issue of WIC and breastfeeding using the Early Childhood Longitudinal Study-Birth Cohort—a nationally representative sample of children born in 2001. Their findings suggest a 5.6% decrease in the likelihood of reaching 4 months of exclusive breastfeeding among the WIC population, compared to the non-WIC population. However, they do find a protective effect of WIC on early introduction of cow's milk. Jacknowitz and her team control for a wide array of covariates, but acknowledge the limitations in the regression adjustment approach as an answer to potential selection issues.

Chatterji and her research colleagues (2002)—using the Children of the National Longitudinal Study of Youth data set—attempt to address some of these methodological challenges by estimating fixed-effects models (mother fixed-effects) to isolate the effect of WIC participation on breastfeeding behaviors. Their results indicate a modest but significant decrease in the duration of breastfeeding associated with participation in the WIC program (-.17 weeks) but no significant difference in the likelihood of initiating breastfeeding associated with prenatal WIC participation. In 2004, Chatterji and Brooks-Gunne analyzed the Fragile Families data and found conflicting results—their research indicated a positive effect of prenatal WIC participation on initiation and a null effect on duration. This is not surprising, though, given the relative

homogeneity of the Fragile Families respondents—all of whom were unmarried, low-income, urban mothers. This suggests that compared to eligible non-WIC mothers, WIC mothers are more likely to initiate breastfeeding but that those who do are at no advantage in terms of duration.

Studies employing propensity score methods to study the relationship between WIC and breastfeeding are rare—the first published paper to use this approach was published in 2010. In this paper, the researchers conclude that propensity score matching is preferred to Ordinary Least Squares, and that the negative relationship between breastfeeding and WIC participation is “likely spurious” (Jiang, et al. 2010). The spurious association is hypothesized to be a result of the socio-economic characteristics of the population WIC serves.

There are currently no published papers employing program roll-out or other IV approaches to study breastfeeding and WIC. This is likely due to the fact that breastfeeding data has not been regularly collected in large studies, or in vital statistics databases. There are papers using program roll-out to study the WIC effect on other child health outcomes; a summary of these findings is available in Appendix A.

### **A Conceptual Model of WIC Take-Up as a Function of Feeding Method and Parity**

There is no consensus on how large a role unobserved maternal factors play in the decision to take-up WIC. Understanding this relationship is the first step in rigorously estimating a treatment effect of WIC—modeling take-up also allows us to highlight policy leverage points that could increase take-up amongst eligible women.

While there is no published theoretical model specific to WIC take-up, there is a history of Food Stamp participation models upon which to draw. However, the WIC program and the Food Stamp (SNAP) program are different enough to require a new model. For one, while eligibility for WIC is a function of income (less than 185% FPL) and household size, the value of the benefit does not differ among the range of eligible incomes. Unlike food stamps, the marginal benefit for children is constant. Each child contributes an additive benefit to the family—up until the age of 5, at which point they become ineligible. In other words, three children contribute three-times the benefit as one child. Further, while food stamp models tend to focus on the optimization of labor hours, WIC recipients are less likely to be working than food stamp recipients, especially among the WIC population most likely to experience any negative treatment effect of WIC on breastfeeding duration. WIC also differs in terms of re-certification procedures. Women must physically pick up their food vouchers every 1-3 months, oftentimes bringing in their children for visits with dietitians or counselors. Postpartum women must also be weighed and participate in counseling themselves. WIC vouchers are, for 95% of the country, paper coupons as opposed to food stamps’ electronic debit cards (California WIC Association). This may affect the stigma of using WIC—though that stigma may be outweighed by the availability of WIC-only stores. WIC-only stores are small corner stores that only accept WIC vouchers and only stock WIC items.

Given these differences, I adapt food stamp participation models by beginning with a classic welfare participation model (Moffitt 1983).

$$(1) \quad P_t = f(U(Y_{t,p}) - U(Y_{t,np}) - C(M_t, S_t))$$

Equation 1 shows that participation (P) in time (t) is a function of the utility of participating in time (t) minus the utility of *not* participating in time (t) minus the costs (C) of participation. The costs of participation are a function of logistical costs (M) and stigma (S). Blank and Ruggles (1994) take this basic model and add expectations of future income.

$$(2) \quad P_t = f(U(Y_{t,p}) - U(Y_{t,np}) - C(M_t, S_t)), \sum_{j=t+1, T} \sigma_j E[Y_{j,np}])$$

The expectation term in Equation 2 is the sum of the weighted ( $\sigma$ ) future incomes in period (j). When I decompose the different terms of Equation 2, WIC-specific aspects of the model emerge.

Equations 3a through 3c show a focused version of the  $f(U(Y_{t,p}) - U(Y_{t,np}))$  term in Equations 1 and 2.

$$(3a) \quad Y_{t,p,f} = L_{t,p,f} + B_{t,p,f} + Yoth_{t,p,f} + \Delta A_{t,t-1}$$

$$(3b) \quad Y_{t,p,f=1} = L_{t,p,f=1} + (.25)B_{t,p,f} + R_{t,p,f=1} + Yoth_{t,p,f=1} + \Delta A_{t,t-1}$$

$$(3c) \quad Y_{t,p,f=.5} = L_{t,p,f=.5} + (.5)B_{t,p,f} + Yoth_{t,p,f=.5} + \Delta A_{t,t-1}$$

The three equations represent the three possible income scenarios. WIC has three different food packages, and the index (f) signifies either formula feeding, breastfeeding (f=1) or partial breastfeeding (f=.5). For all three scenarios, (L) equals household income at time (t) if

participating; ( $Y_{oth}$ ) equals “other” household income at time (t) if participating and  $\Delta A_{t,t-1}$  represents the change in assets (savings) between time (t) and the previous time period. The term (B) represents the WIC benefits, which are half the market value (.5) when f=.5 and a quarter of the market value (.25) when f=1. The term (R) is equal to the other benefits only available to fully breastfeeding mothers. This may include discounted breast pumps, extra food, and small token gifts. These equations suggest that an increase in benefits, a decrease in income or assets and an increase in “other” benefits will increase the likelihood of participation, holding costs equal.

Recall that the cost term from Equation 2 is  $C(M_t, S_t)$ . We can decompose this cost term into logistical and stigma factors.

$$(4a) \quad M_t = g'(CH_t, LOC_t, OFC_t, APP)$$

$$(4b) \quad M_{t+1...T} = g(CH_t, LOC_t, OFC_t)$$

Borrowing from the approach of Blank and Ruggles (1994), I can illustrate two different sets of costs: the initial application costs and the ongoing participation costs. The terms within the function differ from the food stamps models, as WIC offices serve more like community health centers than standard social services hubs. The term (CH) represents the number of WIC-participating children in the household. Each child must be physically brought to the WIC office in regular intervals in order to pick up the food vouchers. This could be highly stressful, and may be exacerbated by the term (OFC), which refers to office characteristics such as average length of wait, average appointment length, child-friendliness and staff personalities. The (LOC) term represents geographic distance between the WIC clinic and the family, while the (APP) term represents the initial application process.

The contribution of stigma to the overall costs of participating can also be deconstructed. Equation 5 represents stigma as a function of the office characteristics on the last visit, as well as the difference between the participant’s stigma and their peer-group stigma. The larger the difference between personal and peer stigma, the larger the costs (Blank 1994).

$$(5) S_t = S_{t-1} + h(OFC_{t-1}, \overset{\cup}{S}_{t-1} - S_{t-1}, WOS_t)$$

Equation 5 also revisits the availability of WIC-only stores (WOS) as a contributor to stigma costs. This is based on the theory that being around *only* WIC-users when using the food vouchers is preferable to using the vouchers in a regular grocery store.

WIC benefits, unlike food stamp benefits, are a function of only two things: the number of eligible children in the household and the feeding method for eligible infants.

$$(6) B_{t,p,f} = f(CH_t + \delta_{t,p,f})$$

In Equation 6,  $\delta$  represents a mother’s decision to feed her baby any combination of breast milk and formula. This leads to a difficult question: what determines that decision? Equation 7 breaks the  $\delta$  term into two components—a set of endogenous preferences and set of biological capabilities.

$$(7) \delta_{t,f} = f(\varepsilon_{t,f}, Z_{t,f})$$

( $\varepsilon$ ) represents the “feeding environment”—the cultural beliefs, past experiences, knowledge and peer support for the mother. The (Z) term includes incidence of delayed lactogenesis (low milk supply), as well as the realities of adoptive mothers, mothers with physical impairments and other medical barriers that make breastfeeding more difficult (or impossible). It follows that participation is then a function of feeding decisions, since benefits are a function of feeding decisions.

### Exploring Sources of Selection Bias in the WIC Program: Data Analysis

The two determinants of benefits for eligible women holding all else equal are: the number of children under age 5 in the family, and the chosen feeding method. This suggests that the likelihood of benefits outweighing the costs of participating will be higher for women who intend to formula feed. As for parity, a simple conceptual model can not tell us whether the added burden of enrolling another child will outweigh the added benefit that child will bring to the household income.

The market value of the formula feeding package is four times that of the breastfeeding package. This suggests that the likelihood of benefits outweighing the costs of participating will be higher for women who intend to formula feed. I hypothesize that women who are firmly committed to breastfeeding are less likely to enter into the program, thereby introducing negative selection bias into studies of WIC and breastfeeding. I further hypothesize that this relationship will be modified by parity—as families grow, those who intend to breastfeed will be either less or more likely to enter the program. Mothers of multiple children may be less likely to enter the program, because of their knowledge of the benefits and what I contend could be the decreasing marginal benefit of adding another WIC child. This runs counter to standard logic; a woman with three children under five would receive three-times the benefit as a first time mother. Yet, women with

two or more children also face higher time costs than first-time mothers; women on the breastfeeding food package may face more rapidly declining marginal utility of an additional unit of food benefit. The multiplying costs coupled with the low value of the package may, at some parity point, produce a negative net benefit. If this is true, previous estimates of the WIC breastfeeding effect on multiparous women will be more overstated than the estimates for primiparous women.

An alternative explanation for a decreasing likelihood of entering the program for breastfeeding multiparous mothers could be explained by the persistence of maternal behavior across births. If WIC does have a causal effect on breastfeeding duration for the first child, then any association for subsequent infants is a function of the causal relationship from birth number one. While I can not directly test these hypotheses with the data at hand—because I lack information on whether previous children participated in the WIC program—the analyses here are intended to explore heterogeneity of effect size by parity as a descriptive exercise.

The greatest methodological challenge to estimating a WIC effect is the correct specification of who is “likely” to breastfeed. Past studies have relied on observable demographic characteristics to construct a risk profile. Instead, I will exploit prenatal attitudes towards breastfeeding, as well as prenatal perceptions of support structures. By doing this, I can identify those who are more or less likely than the average woman to breastfeed. I can also compare the fit of this attitudinal model to standard models that use only the demographic characteristics and compare which approach is a better predictor of future behavior.

This will be informative for future research on WIC and Infant Health. The exploration of heterogeneity will also be highly informative; discovering the source of the breastfeeding disparity between WIC and non-WIC women could highlight potential policy leverage points for increasing breast milk feeding rates among WIC clients.

### *Description of the Data*

The data for this analysis comes from the Infant Feeding Practices Study II (IFPS2), a joint venture of the Centers for Disease Control and Prevention (CDC) and Food and Drug Administration (FDA). Between May and December of 2005, around 4,000 women began participating in the survey—by the end of 15 months, 2,000 women and their babies had completed the process. Participants were asked to complete one prenatal survey and ten postnatal surveys mailed at approximately one-month intervals. Given the varying due dates of the women in the cohort, the study concluded when the infants were 15-18 months old. Only women who gave birth after 37 weeks gestational age to infants weighing greater than 5 pounds were allowed to continue postnatally. The original sample was randomly selected from an existing National Consumer Opinion Panel of 500,000 women, in order to maximize participation through the end of the study. In turn, the demographics of the sample are not entirely representative of the US population. Mothers of non-white race and Hispanic ethnicity were underrepresented, as were women with less than a High School diploma and those who worked outside the home for pay (Fein, et al. 2007). Furthermore, there is reason to believe that those who dropped out of the study are systematically different than those who completed the study. Demographic analysis of those lost to attrition was performed, and confirmed that mothers of color, those making less than 185% of the Federal Poverty Level for her particular family size, and those with less than a college education were more likely to be lost to attrition or



disqualification (based on prematurity or low birth weight). Implications of this attrition are discussed at the end of this paper. There were multiple sets of questions, organized around thematic modules for the mothers who participated in the IFPSII, and not every question was asked at every age. The modules covered infant feeding, infant health, maternal attitudes, sleeping arrangements, nutrition, employment and demographics. For the purposes of my study, the data is restricted to all income-eligible women (those making under the income eligibility ceiling for 2005 or 2006 conditional on household size). Descriptive Statistics of the sample are available in Table 1. Because this study uses public data, this analysis was judged to be exempt from Human Subjects Review by the Institutional Review Board at the University of California, Berkeley. All data analyses took place between January and December of 2012.

### *Outcome Variable*

The first outcome of interest is whether a child was enrolled in WIC anytime during the first 6 months of life. I constrain WIC participation to this early period, given that the relationship between WIC and breastfeeding cessation is more salient during the months prior to introduction of solid foods

If a woman, and not the child, was enrolled in the WIC program, this is not counted as WIC participation. While it is possible for a breastfeeding mother to enroll herself and not her child, the data shows that this situation accounts for only 10% of all WIC enrollees. These mothers do appear to have significantly longer breastfeeding durations, though, implying that women who know they don't need the formula are opting to enroll themselves for the mother-only benefits. Because of the small size of this group, I do not include them here.

In order to show the impact of including prenatal attitudes in effect estimation, I also present analyses modeling the association between WIC and actual breastfeeding duration. In this model, the outcome variable is breastfeeding duration in weeks.

Under the assumption that there is no selection bias in the decision to take up the program, this disparity between WIC and non-WIC mothers would be interpreted as a treatment effect.

### *Predictor Variables*

Of particular importance for testing the model of WIC take-up is a set of prenatal attitudinal questions measuring different factors of breastfeeding readiness. Because this data has no valid measures of the ( $Z$ ) term from Equation 7, I focus on the factors comprising ( $\varepsilon$ ). The categories of relevant factors in the data are: confidence in breastfeeding abilities, knowledge of breastfeeding benefits, comfort in nursing in public and familial support. For the confidence, comfort and familial support questions, responses are recorded via a 5 or 7-step Likert scale. For the knowledge questions, participants are asked to compare the benefits of breast and formula feeding, or asked to agree/disagree with facts about breastfeeding.

### *Statistical Analysis*

The statistical analysis presented here is not a solution to the problem of endogeneity in WIC evaluation. Rather, it is a set of straightforward multivariate analyses intended to minimize selection bias via innovative measures of unobservable determinants of WIC take-up.

To estimate the model of WIC take-up as a function of feeding choice, I first calculate the “proclivity score” using the attitudinal predictor variables. The proclivity score is modeled as a linear regression in Equation 8.

$$(8) \text{ExpBF} = \beta_0 + [\beta_1 \text{CONF} + \beta_2 \text{COM} + \beta_3 \text{BEL} + \beta_4 \text{PAT} + \beta_5 \text{GMA}] + [\beta_6 \text{SES} + \beta_7 \text{RACE} + \beta_8 \text{ETH} + \beta_9 \text{EDUC} + \beta_{10} \text{MAR}]$$

The expected duration (in months) of breastfeeding, BF, is modeled as the linear combination of the predictor variables. Expected duration is how long a mother plans to breastfeed her child before cessation. Note that this variable is measured in months, while the actual duration of breastfeeding (collected at the end of the panel study) is measured in weeks. The (CONF) term refers to confidence, (COM) to comfort with public nursing, (BEL) to knowledge and beliefs, (PAT) to paternal support and (GMA) to grandmother support. In order to compare the usefulness of this approach, in contrast to using only demographic characteristics, I also estimate the first phase model using the second set of variables, including maternal income, race, ethnicity, education and marital status. The final proclivity score is a combination of both variable sets.

$$(2) \text{WIC} = \beta_0 + \beta_1 \text{ExpBF} \hat{F}$$

In the second phase of this approach (equation 2), I use the proclivity score from the first phase to predict take-up of WIC. Technically, my approach is the same as including all of the right hand side variables from equation (1) in a prediction model of WIC take-up. However, I choose to present equation (2) in this way for ease of interpretation. The direction of the relationship between proclivity to breastfeed and take-up illustrates the direction of the selection bias. I then run this model for separate subgroups based on marital status, education and parity.

The final phase (equation 3) models breastfeeding duration in weeks as a linear function of WIC participation and proclivity score.

$$(3) \text{DURATION} = \beta_0 + \beta_1 \text{ExpBF} \hat{F} + \beta_2 \text{WIC}$$

I also model equation 3 using initiation as an outcome variable. This serves as a robustness check, since participation in WIC among the analysis sample comes after the decision to begin breastfeeding. This can also shed light on any persistence of past WIC experience for multiparous mothers. A negative relationship between later WIC participation and initiation at birth adds further credence to the main hypothesis. If I am adequately controlling for selection bias with the proclivity score from equation 1, then any significant relationship should become insignificant once that variable is added. If the persistence of WIC participation is salient across births, then controlling for prenatal proclivity among second and third time mothers would be less useful at erasing any association.

## Results

Table 2 presents the coefficients from the linear regression of predictor variables on the expected duration of breastfeeding. All attitudinal variables were standardized (mean 0, standard deviation of 1) before analysis. For the attitudinal variables, a positive coefficient indicates that an increase in the respondent's confidence, comfort or perceived familial support corresponds to an increase in the amount of time the respondent hopes to breastfeed. In the first column of results, for example, for every one standard-deviation increase in confidence from the mean the expected increase in a mother's planned breastfeeding duration is .28 months. The magnitude of the difference is largest for the paternal support question in the purely attitudinal model. The respondent's mother's level of support is also highly salient and robust to saturating the model.

The results in Table 2 suggest that attitudinal responses are better predictors of breastfeeding commitment than demographic characteristics. The proportion of the variance in breastfeeding commitment explained in the attitudinal model is 1.5 times that of the pure demographic model. Even when combining both sets of factors, certain attitudinal characteristics remain salient: Comfort in nursing in front of "not close friends", as well as both indicators of familial support are robust to the inclusion of demographic variables. Taken alone, only maternal education, divorce and Hispanic ethnicity are significant among the demographic variables; this significance remains unchanged when the predictor variables are combined.

Table 3 addresses the direction of the selection bias into the WIC program. Among all eligible women, for every one-unit increase in proclivity score, I find a corresponding decrease of 3% in take-up. The range of fitted values is roughly 10 (with a mean of 4.03, a median of 4.13 and a standard deviation of 1.42) meaning that the difference in WIC take-up between the most and least committed to breastfeeding is approximately 30%. In other words, among all income-eligible women, the likelihood that women most highly committed to breastfeeding will enroll their infants in the WIC program is 30% lower than women most committed to formula feeding. This negative relationship is highly significant among second and third time mothers, but the results are inconclusive for first-time mothers.

Subgroup analysis based on education, ethnicity, race and marital status revealed no significant patterns and is not included here.

The second part of the data analysis—focusing on the estimated treatment effects of WIC—reveals interesting patterns. Table 4 shows the estimated treatment association between WIC and actual breastfeeding duration, controlling for prenatal proclivity to breastfeed<sup>2</sup>. For the whole sample, the WIC association is negative and significant, even after controlling for prenatal breastfeeding proclivity. For first time mothers, none of the coefficients are statistically significant; prenatal intentions are not an adequate predictor of their WIC take-up, or even their future breastfeeding duration. For multiparous mothers, the negative relationship between WIC and breastfeeding remains robust even after inclusion of the proclivity score. The decrease in the magnitude of the coefficient from column 5 to column 6 suggests that second and third time mothers are likely negatively selecting into WIC and estimates of the WIC effect in this population are likely overstated in past research. Yet, the significance of the coefficient on WIC participation remains unchanged after controlling for proclivity score.

Table 5 offers insight into the robustness of our results from Table 4. Women who later participate in the WIC program are 6 percent less likely to initiate breastfeeding at birth. After controlling for proclivity to breastfeed, this relationship becomes insignificant. This pattern repeats for second and third time mothers, but not for first time mothers whose initiation behavior is unrelated to WIC participation. For all groups of mothers, initiation is highly predicted by prenatal proclivity score.

Further illustration of this complexity is found graphically in Figures 1 and 2. The proclivity scores are grouped into 5 equally sized groups for each parity category. Figures 1 and 2 show the mean breastfeeding duration for WIC and Non-WIC mothers, controlling for income eligibility, by proclivity group. Group Five is the most prenatally committed to breastfeeding, while Group 1 is the least committed. Figure 1 is for first time mothers, and Figure 2 is for second and third time mothers. The overall negative association between WIC and breastfeeding duration for first time mothers is driven by the women in Group Five, while for second and third time mothers the negative association is mainly driven by women in Group Three. This runs counter to the contention that the women “least likely to breastfeed” are driving overall negative associations.

## **Discussion**

There are several strengths to my analysis. The richness of the IFPS2 dataset allows me to leverage both attitudinal and demographic characteristics in the study of breastfeeding behavior. Further, the longitudinal aspect of the data allows me to isolate WIC participation in the critical first 6 months of life, when the relationship between WIC and infant feeding method is at its most relevant.

This paper is the first in the literature on the WIC program and breastfeeding to explore the direction of selection bias into the program. While other studies attempt to control for unobserved predictors of breastfeeding by using observable characteristics when studying the impact of this program on infant feeding choice, my results indicate that attitudinal responses are more powerful predictors of prenatal breastfeeding commitment. My results also indicate that--using a more fully formed model of prenatal intentions--prenatal commitment to breastfeeding is negatively associated with take-up of the WIC program. This result is only salient among second and third time mothers.

The results of this paper suggest that the negative associations from previous studies of the impact of WIC on breastfeeding duration may be overstated, even when controlling for demographic predictors of breastfeeding commitment. However, the direction of the bias among first-time mothers is still inconclusive. Second and third time mothers may have more experience with the WIC program, and are therefore more likely to correctly calculate the costs and benefits of participation inherent in the conceptual model of take-up. This may lead multiparous, pro-breastfeeding mothers to regard WIC participation as “not worth it”. This result implies that program evaluation of maternal and child health policy must treat first births and subsequent births differently in terms of treatment effects. First time mothers could be more “randomly” assigned into the WIC program, as there is no significant evidence that either negative or positive selection bias exists in this population.

## *Limitations*

There are limitations to this study. The IFPS2 data is not representative of the national population. The majority-White respondents (see Table 1) are more educated and more affluent than the population of new mother's nation-wide. Furthermore, those lost to attrition are more likely to be non-White race, low SES and less educated than those who completed the entire survey timeline. The implications of this non-random sample and attrition for my findings are not conclusive. Given that we find such a significant, negative relationship between breastfeeding intentions and WIC take-up in this sample, it is unclear what the inclusion of those more likely to be eligible for WIC into our estimation would do to our results.

My study is also limited by the number of respondents, particularly in the subgroup analysis. With extremely small sample sizes, such as the group of 82 income-eligible, first-time mothers, we do not know whether our insignificant results are a product of the true variance of that group or a product of the sample size.

I further recognize that the regression models in this study may be over-simplified in their specification. Specifically, there may be controversy as to whether a linear model is appropriate when using the attitudinal responses scales, as this approach assumes an interval scale of measurement where the difference between a "1" and "2" response is consistent with the difference between a "6" and "7" response. For the purposes of this paper, I contend that these models are a good preliminary exercise in understanding the relationship between prenatal commitment to breastfeeding and WIC take-up. Future work will more rigorously model the form of this relationship, thereby increasing the accuracy of the estimates.

## *Implications for Future Research and Policymaking*

The WIC program provides vouchers for infant formula to its clients. Simultaneously, the program promotes breast milk as the healthiest feeding choice. Increasing the rate of breastfeeding among low-income, medically vulnerable populations is a stated goal of the U.S. Government (United States Department of Health and Human Services, 2011). The probability of a mother breast feeding is not only a function of internal characteristics; it is also a function of the costs of *not* breastfeeding. Either by government action or inaction, the availability and cost of breast milk substitutes is a function of public policy.

WIC's subsidization of Infant Formula may provide strong incentives for a mother to stop breastfeeding. However, because of the cost savings of the infant formula rebate program built into WIC, it is able to serve more women and children than it might otherwise. The policy tradeoff is how to maximize the likelihood of breastfeeding in the WIC population while balancing the need to expand program coverage. Furthermore, WIC may also provide other health benefits to women and children that overshadow the potential decrease in breastfeeding in this population. A counterfactual world without WIC presents multiple options for women who cannot afford formula: they *could* substitute towards breastfeeding, but could also substitute towards cow's milk or other cheaper, unhealthy options (such as watering down infant formula to make it last longer or concocting homemade formulas). A woman in this counterfactual world who is undecided about what to feed her infant could be tipped towards breastfeeding, but a woman fully committed to formula feeding who did not qualify for food stamps would be much worse off were WIC not to exist.

Evaluating the efficacy of public programs is essential to good governance--policies are a social determinant of child health inequities. Selection Bias is the most salient methodological challenge facing evaluators of public programs. The direction of the bias can differ by variables that determine likelihood of program take-up. Evaluations of public programs can be strengthened by conceptual modeling of the take-up decision, in order to highlight any potential sources of selection bias. Empirical modeling of the WIC program, for example, uncovers that benefits are strictly a function of two inputs--parity and feeding method--and that selection bias direction could be influenced by these two things. My analysis reveals the extent to which prenatal beliefs about the benefits of the program might influence take-up in the future. Since the benefits of the particular program in this paper are a function of beliefs about breastfeeding, study designs in this field should include a battery of validated attitudinal response variables that can be used as predictors of future behaviors. If surveys such as this are available internationally, comparative studies of the association between prenatal beliefs and future health behaviors can be pursued.

The policy question at the heart of all WIC analyses is whether the program provides disincentives for breastfeeding with the allocation of free formula. While my analysis here does not lay the controversy to rest, it does support the conclusion that women more likely to breastfeed and with more knowledge of WIC benefits may find the program not worth the costs of participation. If, as the Institute of Medicine contends, it is a public health goal to increase the reach of the WIC program, policy changes must either increase the attractiveness of the program for breastfeeding committed mothers or decrease the costs of participating for women with more than one child at home. This may mean increasing the amount of food benefits, increasing the variety of food products available to breastfeeding mothers or decreasing the burden of re-certification or voucher pick-up for breastfeeding, multiparous mothers. Furthermore, the finding that the negative association between WIC and breastfeeding duration for multiparous women is driven by the "undecided" mothers and for primiparous women is driven by the "highly committed" group implies a need to target breastfeeding interventions to these groups as close to birth as possible. An attitudinal battery for prenatal WIC participants or for new postnatal enrollees, such as the one in the IFPS2, could be useful in identifying women at-risk of early breastfeeding cessation.

## Tables and Figures

**Table 1: Demographic Statistics for the Infant Feeding Practices Survey II; All WIC-Eligible First, Second and Third Time Mothers Included.**

	<b>First-Time Mothers: Analysis Sample</b>  N=153	<b>Second and Third Time Mothers: Analysis Sample</b>  N=500	<b>All Mothers with Child Enrolled in WIC during <i>first year</i></b>  N=785
<b>Percent of Income-Eligible who Enroll in WIC during first 6 months</b>	70	40	95
<b>Median Age</b>	25	29	25
<b>Percent White Race, Not Hispanic</b>	85	85	80
<b>Percent Black Race, Not Hispanic</b>	6	4	7
<b>Percent Hispanic, Any Race</b>	6	7	9
<b>Percent Married</b>	50	80	59
<b>Percent College Graduates</b>	22	40	31

**Table 2: Comparing the Predictive Power of Attitudinal vs. Observable Characteristics.**  
**Dependent Variable: Predicted Months of Breastfeeding. Standard Errors in Parentheses. N=559**

	<b>Attitudinal Factors Only R<sup>2</sup>=.15</b>	<b>Observable Characteristics Only R<sup>2</sup>=.03</b>	<b>Combined R<sup>2</sup>=.18</b>
<b>Confidence in Breastfeeding</b>	.283** (.104)	--	.294** (.109)
<b>Comfort in Nursing in Front of Close Female Friends</b>	.341 (.172)	--	.271 (.159)
<b>Comfort in Nursing in Front of Close Male Friends</b>	.009 (.196)	--	.087 (.206)
<b>Comfort in Nursing in Front of Not Close Friends</b>	.474** (.182)	--	.506** (.158)
<b>Baby's Father's Stated Support for Breastfeeding</b>	.689*** (.110)	--	.578*** (.141)
<b>Respondent's Mother's Stated Support for Breastfeeding</b>	.329** (.103)	--	.266** (.129)
<b>Household Income Bracket</b>	--	-.046 (.048)	-.006 (.047)
<b>Maternal Education Bracket (No HS Grad, HS Grad, Some College, College Grad)</b>	--	.622** (.214)	.446** (.210)
<b>Marital Status= Single (vs. Married)</b>	--	-1.112 (.833)	-1.00 (.816)
<b>Marital Status = Divorced (vs. Married)</b>	--	-1.283** (.427)	-.826* (.421)
<b>Hispanic Ethnicity</b>	--	1.731** (.853)	1.49* (.835)
<b>Black Race (vs. White)</b>	--	-.522 (.780)	.049 (.769)
<b>Asian Race (vs. White)</b>	--	.912 (.837)	.919 (.824)

\* P<.10, \*\* P<.05, \*\*\* P<.001



**Table 3: Take-Up of the WIC Program as a Linear Probability Function of Proclivity Score with Subgroup Analysis. Standard Errors in Parentheses**

	<b>All Mothers N=653</b>	<b>First-Time Mothers N=153</b>	<b>Second-Time Mothers N=293</b>	<b>Third-Time Mothers N=207</b>
Proclivity Score	-.032** (.012)	.013 (.034)	-.059** (.020)	-.061** (.027)
R <sup>2</sup>	.032	.022	.022	.043

\* P<.10, \*\* P<.05, \*\*\* P<.001

**Table 4: Difference in Average Breastfeeding Duration in Weeks Between Income-Eligible WIC and Non-WIC Mothers. Standard Errors in Parentheses.**

	<b>All Mothers N=653</b>	<b>All Mothers N=653</b>	<b>First-Time Mothers N=153</b>	<b>First-Time Mothers N=153</b>	<b>Second and Third Time Mothers N=500</b>	<b>Second and Third Time Mothers N=500</b>
<b>Participating in WIC Program</b>	-8.356*** (1.211)	-7.583*** (1.146)	-.211 (2.856)	-.342 (3.513)	-8.618*** (1.142)	-7.916*** (1.330)
<b>Proclivity Score</b>	--	3.921*** (.492)		1.795 (1.144)		4.124*** (.447)

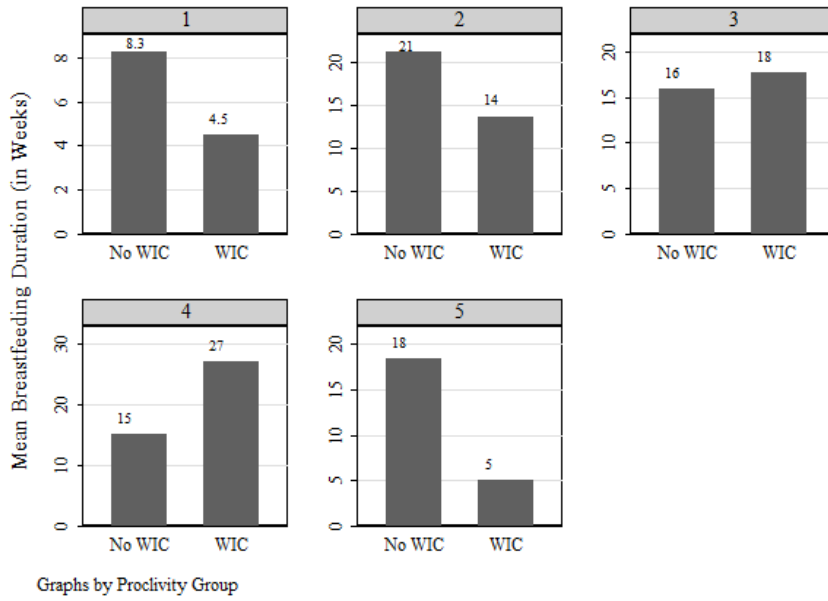
\* P<.10, \*\* P<.05, \*\*\* P<.001

**Table 5: Difference in Probability of Initiating Breastfeeding Between Income-Eligible WIC and Non-WIC Mothers. Standard Errors in Parentheses.**

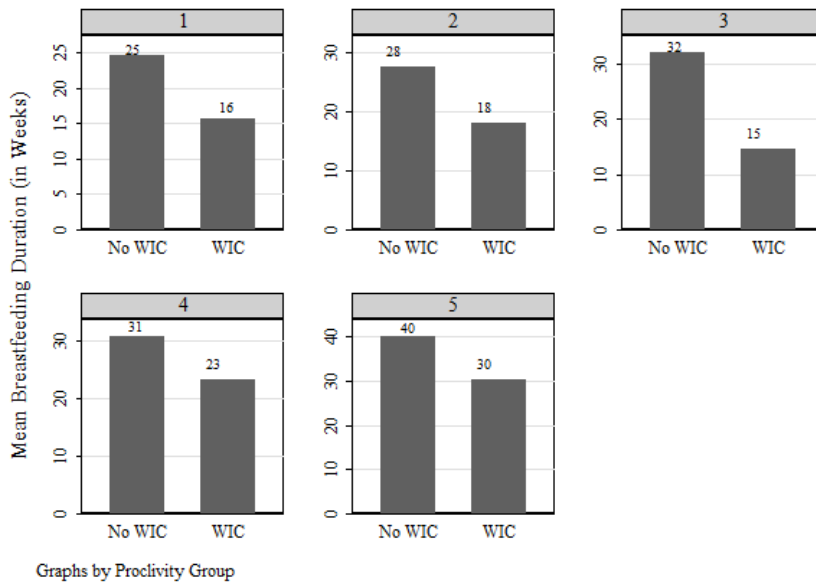
	All Mothers N=653	All Mothers N=653	First-Time Mothers N=153	First-Time Mothers N=153	Second and Third Time Mothers N=500	Second and Third Time Mothers N=500
<b>Participating in WIC Program</b>	-.062* (.031)	-.027 (.021)	-.015 (.084)	-.004 (.055)	-.107*** (.031)	-.029 (.029)
<b>Proclivity Score</b>		.043*** (.011)		.058** (.022)		.024*** (.005)

\* P<.10, \*\* P<.05, \*\*\* P<.001

**Figure 1: Average Breastfeeding Duration by WIC Participation and Proclivity Group: First-Time Mothers**



**Figure 2: Average Breastfeeding Duration by WIC Participation and Proclivity Group: Second and Third Time Mothers**



### Essay 3

#### *Maternal Determinants of Breast Milk Feeding in a California Level III Neonatal Intensive Care Unit*

#### **Introduction: Disparities by Race, Class and Education exist in NICU Breast Milk Feeding**

Despite the generally acknowledged superiority of breast milk feeding in the neonatal intensive care unit (NICU), significant disparities within and among hospitals indicate that the opportunities for breast milk feeding vary as a function of both hospital policy and familial constraints. The American Academy of Pediatrics (AAP) did not specifically mention the need to increase rates of breast milk feeding among premature infants until the 1997 report from the Work Group on Breastfeeding (American Academy of Pediatrics, 1997). At the time of the AAP report, there were few estimates of NICU breast milk feeding in the empirical literature. One study, conducted before the AAP call to action, found that only 25% of NICU admits were receiving breast milk at any given time (Hurst, et al 1998). Results from a 1998 study of one of the “most successful” hospitals in the country reported a breast milk feeding rate of 59% (Hylander, et al., 1998).

The latest research indicates improvement over the last 15 years. A recent quality improvement initiative in California shows baseline rates--before the study intervention--of breast milk feeding in the NICU hovering around 60% (Lee, et al. 2012). A slightly older statewide study in Massachusetts found similar rates--there, 70.1% of infants between 32 and 36 weeks gestational age and 62.1% of infants less than 32 weeks were fed any breast milk (Merewood, et al 2006). Premature babies are now at an advantage in terms of breast milk feeding duration as opposed to full term infants (Colaizy and Morriss, 2008). Though the initiation rates of NICU-admits and non-admits is nearly equal, the duration of breast milk feeding for NICU admits is, on average, significantly longer than non-admits. NICU admits are 10% more likely to breast milk feed until 4 months of age. While conventional wisdom would lead one to hypothesize that the situational constraints of boarding in a NICU would provide a larger barrier to breast milk feeding than the normal discharge home, the opposite is supported by research evidence.

Despite the overall increase in likelihood of breast milk feeding in the NICU, pervasive disparities by race, ethnicity and class tend to mirror the inequitable patterns in the full term population. There is an increased risk of premature birth among women who identify as Black or Hispanic, even after controlling for income (Howard, D.L., 2006). Once an infant is admitted to the NICU, African-American or Black race continues to be an independently significant risk factor for exclusive formula feeding (Lee and Gould, 2009). Older, white, more affluent mothers of low birth weight infants are more likely to initiate and sustain breast milk feeding, according to past research (Furman, et al., 1998 and 2002). An absence of prenatal care, low maternal education and maternal smoking are also associated with a decreased likelihood of breast milk feeding (Killersreiter, B. et al., 2001). Women who are traditionally less likely to breast milk feed may be more susceptible to potential effects of provider encouragement, according to past research. A nationally representative survey in 2001 found that women of color and those at the lower end of the SES spectrum had four-fold gains in the likelihood of breast milk feeding her

low birth weight infant compared to those who could recall no provider encouragement (Lu, et al. 2001).

In addition to within-hospital disparities, there also exist between-hospital variation systematically correlated with hospital-level characteristics. Though few studies have focused solely on hospital-level determinants of patient-level feeding behavior in the NICU, there is a base of full-term literature from which to draw. The general consensus of these studies is that the “site of care” (i.e. the hospital fixed effect) is an independent predictor of individual likelihood of breast milk feeding (Powers, et al., 2003). Hospitals with high success rates of breast milk feeding have a positive association with patient-level feeding outcomes even after controlling for the population demographics and risk profiles (Powers, et al., 2003). Specific hospital-level recommendations to improve breast milk feeding rates often center on the full implementation of the Baby Friendly Hospital Initiative (Phillipp, et al., 2001), (Merewood, et al., 2003). A synthesis of Baby Friendly Hospital Initiative studies released in 2012 outlined three overarching, guiding principles that emerged from evaluations of successful hospital practices (Nyqvist, et al., 2012). These three principles were:

- “1. The staff attitude to the mother must focus on the individual mother and her situation.*
- 2. The facility must provide family-centered care, supported by the environment.*
- 3. The health care system must ensure continuity of care, that is, continuity of pre-, peri-, and postnatal care and post-discharge care.”*

In addition to these meta-principles, other research has identified specific successful practices, such as: full integration of maternal postpartum care into the NICU; presence of Lactation Consultants 7 days per week, 24 hours per day; explicit written procedures for breast milk pumping; integration of breast milk pumping into medical chart information and staff-wide promotion of skin-to-skin contact (Maastrup, et al., 2011), (Merewood, et al., 2005)

Past qualitative research on the determinants of breast milk feeding in the NICU informed this study. Past research conducting interviews with parents of a child in the NICU illuminated themes we later captured in the development of our survey tool. A 2006 study found that parents of children in the NICU had to confront “altered expectations” of breastfeeding upon the unexpected premature delivery (Bernaix, et al., 2006). If a premature delivery was somewhat expected, either through early designation of a high-risk pregnancy, the presence of multiples, or through interaction with a community with high premature birth risk, mothers were more inclined to research breast milk feeding information during pregnancy and indicate they felt “more prepared” (Bernaix, et al., 2006). Other qualitative studies point to a mother’s concerns with adequate supply, as well as “problems with the mechanics of breastfeeding a preterm infant” as potential barriers to breast milk feeding (Kavanaugh, et al., 2005). In 1989, a study found that social support was a key determinant of breast milk feeding the premature infant. Mothers who reported little to no social support or peer role modeling of breast milk feeding were 6 times less likely to breast milk feed their premature child than those who reported high levels of support (Kaufman, et al., 1989). This study also found that a mother’s own mother, as well as her female relatives and very close friends, were the most powerful group of referants in terms of likelihood of breast milk feeding. Compared to the influence of health professionals, the kin connections were much more important.

The objective of this study was to explore the determinants of breast milk feeding in a large Level III NICU. The survey study in this paper is one part of a larger research collaborative that also included one-on-one maternal interviews and multiple clinician focus groups.

### **Theories of Breast Milk Feeding**

Past studies have applied theories of decision making to the choice to breast or formula feed among full term families. Review of this literature informed the design of our survey instrument. The two most appropriate theories of decision-making pertinent to our study are Social Cognitive Theory (including Self Efficacy theory) and the Theory of Reasoned Action.

In general terms, Social Cognitive Theory posits that a person not only learns by watching others (Bandura, 1997 CITE), but is an agent in actively seeking out information and role models. The positive feedback received by doing what those around you do is strengthened when one identifies closely with those modeling the behavior. Role models may be found at the interpersonal level--such as family and friends--or at the social level. The reinforcement of ones decision can be negative as well. In terms of feeding decisions, personal relationships and modeling might drive the decision to breast feed but social constraints might determine the choice to formula feed, as was the case in a 1999 study in Canada (Williams, et al., 1999). In this study, the reasons for breastfeeding cessation varied by cultural background. White women were more likely to identify social constraints while non-White women were more likely to cite interpersonal role modeling as the major contributor to early introduction of infant formula. Social Cognitive Theory is closely related to another major theory in feeding studies--Self Efficacy theory. Studies exploring self efficacy focus on a mother's confidence in her abilities and how this level of confidence is related to outcomes (Blythe, et al. 2002). A major component of self-efficacy is, according to theorists in this field, social feedback and support. All of these factors: social constraints, peer effects and maternal confidence were incorporated into our study.

The second major theory influencing our work is the Theory of Reasoned Action. Identified by Ajzen and Fishbein (1977), the Theory of Reasoned Action can be illustrated by the following simple equation:

$$BI = (AB)W_1 + (SN)W_2$$

Where BI is an individual's behavioral intention. The behavioral intention, according to the model, is a function of an individual's attitudes and beliefs about a particular behavior (AB) and subjective norms (SN) multiplied by empirically derived weights. Ajzen and Fishbein, along with numerous social psychologists who built on their work, claim that actual behavior is a product of a person's intent to perform that behavior. The model shows that, in terms of infant feeding, a woman's decision to breastfeed is based on both her pre-existing attitudes towards breastfeeding as well as societal or environmental norms. The relative weight of her innate attitudes versus what others around her might think of her decision will vary between women (Elder et al. 1999). The Theory of Reasoned Action suggests that a woman's social support network can influence her decision to breastfeed (Losch et al. 1995); indeed, past research finds

particularly large weighting of her own mother's and her partner's advice and attitudes in a woman's decision-making (Scott, et al. 2001).

## Hypotheses

Based on the extant literature and application of the above theories, we hypothesized that the following factors would increase both exclusivity and likelihood of breast milk feeding.

- 1 More positive pre-existing beliefs and attitudes towards breastfeeding
- 2 More peer breastfeeding role models, including a woman's own mother
- 3 Fewer logistical constraints--i.e., fewer children at home, a shorter commute to the hospital
- 4 Positive initial experiences with breast milk expression soon after birth

## Methods

### *Setting and Participants*

This project was approved by the Committee on Human Subjects at the University of California, San Francisco (UCSF). A Memorandum of Understanding (MOU) between the University of California, Berkeley and UCSF allows me to use this data in my dissertation. This project was also approved by the Institutional Review Board (IRB) of the Alta Bates Summit Medical Center in Berkeley, California.

The setting for this study was the NICU at the Alta Bates Summit Medical Center (ABSMC) Ashby Campus. This NICU is a Level III NICU, operating with roughly 55 beds and 200 staff members. A Level III NICU is one which cares for the most medically vulnerable infants in a region; for this reason, the participants in our study came from a wide geographical area. The NICU at Alta Bates serves many families who give birth at hospitals with lower grade NICU's and are then transferred to their facility when the birth hospital can not provide the level of care needed.

*“Level III (subspecialty) NICUs are defined by having continuously available personnel (neonatologists, neonatal nurses, respiratory therapists) and equipment to provide life support for as long as needed. Level III NICUs are differentiated by their ability to provide care to newborn infants with differing degrees of complexity and risk. Newborn infants with birth weight of more than 1000 g and gestational age of more than 28 weeks can be cared for in level IIIA NICUs. These facilities have the capability to provide conventional mechanical ventilation for as long as needed but do not use more advanced respiratory support such as high-frequency ventilation. Other capabilities that may be available are minor surgical procedures such as placement of a central venous catheter or inguinal hernia repair.”*

(American Academy of Pediatrics, 2004)

ABSMC serves a diverse clientele. While the immediate surrounding neighborhood of the hospital is a mix of college-housing and affluence, ABSMC serves some of the most medically vulnerable patients in the San Francisco Bay Area. ABSMC is the largest Level III

NICU on the eastern side of the Bay Area and therefore transfers in babies from high SES suburbs (such as Walnut Creek and Orinda) and low SES pockets of Oakland, Richmond and environs.

In order to be eligible to participate in this study, mothers were required to give birth extremely prematurely--defined in our study as less than 32 weeks gestational age. If a precise gestational age was not available, gestational age was based on clinician estimation after delivery. Due to IRB requirements, eligible participants were required to be over the age of 18. Furthermore, translation constraints required the mother to speak and read either English or Spanish.

This study took place between February of 2011 and May of 2012. During the study, 157 eligible mothers had infants admitted to the NICU. Of the 157 eligible, 30 participants were enrolled in the study. Study personnel were alerted to the admission of an eligible family by the staff dietitian. Personnel traveled to the hospital semi-randomly Monday-Friday at varying times of day in order to not introduce systematic bias into the sample. Originally, the protocol required personnel to approach the eligible mother for consent after the mother had been discharged home and when she was on the NICU floor to visit in the early days of her child's life. This soon proved difficult to time, and the protocol was amended to provide first contact between personnel and mothers while the mother was still a patient at the hospital. Because of this protocol shift, only mothers who gave birth at Alta Bates, or were transferred themselves as patients before delivery, were eligible to complete the study. Fifty percent of the eligible mothers were randomly approached to participate. The final response rate was 38%. No mothers actually declined to participate because of study-related issues; the vast majority of women who did not participate declined due to illness or other extenuating circumstances. Study staff feel assured that the sample was representative of the NICU population, with one important exception. Due to the nature of the study protocol and the timing of the first approach, we were much more likely to enroll C-Section births than vaginal births because of the relatively longer hospital stays of the former. C-Section births are independently associated with decreased initiation and duration of breast feeding (Rowe-Murray and Fisher, 2002). We discuss the implications of this in the concluding section of this paper.

The mean age of the study participants was 30.6 with a range of 18 to 45. Over 50% of the mothers participated in food assistance programs such as the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) or the Supplementary Nutrition Assistance Program (SNAP, formerly Food Stamps). One-third of the women in our study identified as Hispanic or Latina. Nearly half (13/30) identified as African-American or Black. Fourteen women in our sample spoke a language other than English at home, with the majority of those women speaking Spanish as their first language. The majority of women in our study were renting their homes and indicated extremely low monthly incomes (0-1500 dollars per month). The majority were also on public insurance (Medicaid). Over half of the women were married or in a long-term committed relationships and most had adequate or "somewhat adequate" prenatal care. The average number of previous pregnancies was 3 and the average number of previous live births was 1.1.



Infant medical data indicated a mean birth weight of 1039.5 and a mean gestational age of 27 weeks. Mean one-minute Apgar scores was 4 while the mean five-minute Apgar score was 6. All but one of our mothers gave birth via C-Section. Five of the 30 mothers in our study gave birth to multiples. In this case, the medical records included in our study were for those of baby “A”.

### *Development of the Survey Instrument*

Study personnel used theories from previous research to construct a multi-faceted survey tool that addressed four broad categories of breast milk feeding determinants:

- 1 Pre-existing Attitudes and Beliefs. What do women already believe about the benefits of breast milk feeding? How convenient do they feel breast milk to be, as opposed to formula, for themselves and their families? How do they feel breast milk feeding fits in to their lifestyles, in terms of work and social commitments?
- 2 Education about breast milk. From whom/where are women receiving their information? Is one source of information more powerful in terms of predicting future breast milk feeding behavior? Are certain socio-demographic groups receiving information from certain sources?
- 3 Logistical constraints. How do women interact with the breast milk pumping equipment? How does maternal distance from the hospital predict breast milk exclusivity? How does a woman’s perception of supply at birth predict later breast milk feeding behavior?
- 4 Social Support and Peer Effects. Does the number of friends and family who have given birth prematurely or who have breast fed their own children predict a mother’s likelihood of breast milk feeding? Does a woman’s mother’s breast feeding behavior have a generational effect on likelihood?

Once these categories of potential determinants were agreed upon, study personnel created a battery of questions as a pilot survey. For category (1), we employed a truncated version of the Iowa Infant Feeding Attitude Scale (de la Mora, et al., 1998) a validated set of attitudinal response questions used in previous research. Previous research finds that this attitudinal scale is highly reliable, with a Cronbach’s Alpha ranging from .86 to .85. For the remaining categories of variables we developed original questions. Questions pertaining to category (2) delineated between sources of information *before* and *after* delivery. Information on length of breastfeeding previous children was also collected. For category (3), we rely on maternal perceptions of supply adequacy, as well as her pre-delivery and post-delivery beliefs about milk expression. While category (4) is somewhat addressed in the questions concerning sources of information, we also ask whether the respondent herself was breastfed and how many close friends or family members she knows who have breastfed or who have given birth prematurely. All demographic information was collected in the last part of the survey.

The draft instrument was circulated among colleagues at UCSF and UC Berkeley, as well as clinicians at ABSMC, and their edits were considered and incorporated. A professional

translation service then created a Spanish version of the final survey. The full survey instrument is available in Appendix B of this dissertation.

### *Procedure*

Eligible mothers were flagged for eligibility by the staff dietitian or lactation consultant. After this alert, study personnel approached the mother within the first two or three days after the birth. Study personnel did not approach the mother if birth had occurred in the last 24 hours, if the mother was in the ICU, or if the staff on duty reported a highly precarious medical diagnoses for the infant or mother. Written consent was obtained after a thorough verbal walk-through of the consent documents. Mothers also signed waivers indicating permission to obtain the infant medical records upon discharge. Mothers were then left with the paper survey for roughly 30-40 minutes to allow ample time to complete. Surveys were either collected immediately by study personnel, or dropped in a locked security box in the NICU family room at the mother's convenience. Study participants who completed the survey were offered a ten dollar gift card to a local chain department store as a token of appreciation.

Each completed survey was later linked to the infant's medical chart information after the infant was discharged home. Dyads were disqualified if the infant was discharged to another facility. Study personnel then recorded pertinent information from the medical chart into the study database. Maternal self-report of age, race and ethnicity were sometime incongruous with the infant medical chart. In these cases, maternal self-report was used. Medical information collected included the following variables:

- Birth Weight
- Gestational Age
- Insurance Type
- Parity (Number of live births)
- Gravida (Number of Pregnancies)
- Adequacy of Prenatal Care (as determined by social worker charts)
- Location of birth
- Incidence of Multiple Births
- Delivery Type
- One and Five Minute Apgar Scores
- Incidence of Necrotizing Enterocolitis (NEC)
- Highest grade of Intra Ventricular Hemmorage (IVH)
- Incidence of Surgery
- Minutes Breastfed on second-to-last day in NICU
- Volume of breast milk fed (ml)
- Volume of infant formula fed (ml)

Using the last two variables, we constructed a "proportion breast milk" formula that was used as an outcome variable in the analysis. We also constructed a "distance" variable defined as the number of miles between ABSMC and the geographical center of the maternal home zip code.

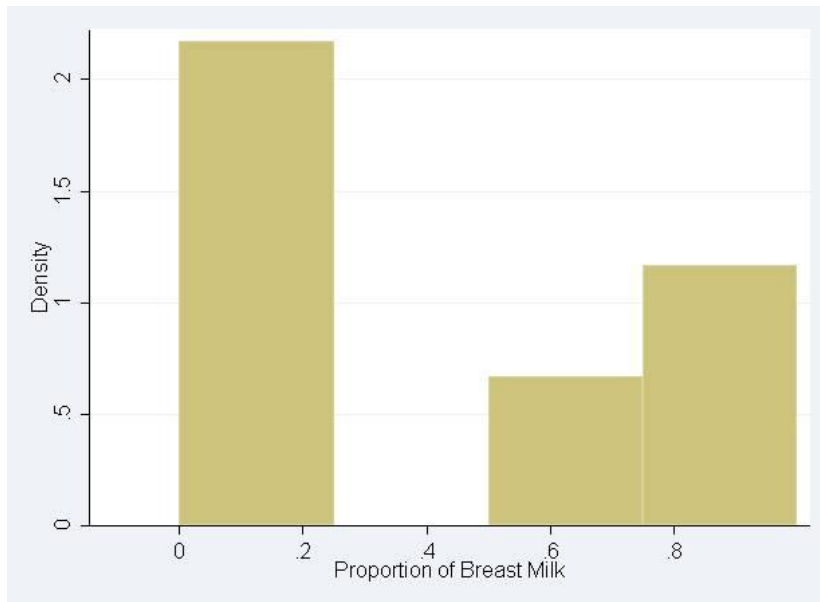
## Data Analysis

All data analyses were performed using anonymized data on a secure UCSF server running Stata SE Version 12 (Stata Corp., 2011). Because of the small sample size and rarity of the health conditions studied, we did not have the statistical power necessary to perform hypothesis testing on the relationship between breast milk intake and health outcomes. The main focus of the data analyses was exploring significant predictors of breast milk exclusivity at discharge. Summary statistics of all survey responses and medical chart variables were constructed. After this, we performed cross-tabulations of socio-economic, educational, geographic, attitudinal and support variables against breast milk exclusivity to deduce which variables indicated the strongest proclivity to breast milk feed. When feasible, Student's t-test's were performed to explore statistical significance of determinants of breast milk feeding as a binary or continuous outcome. When the explanatory variable was continuous, we produced bivariate OLS coefficients. P-values are reported at an alpha-critical level of .90 (one-tailed test), and we chose not to set a threshold for statistical significance.

## Results

The mean amount of breast milk received in the 24 hours prior to discharge was 137 ml. A proportion measure indicates how much of an infants total consumed liquid is human breast milk. Using a proportion measure of breast milk feeding, the average in this sample was .37. . Figure 1 suggests that the overall average is driven by those women with extremely high proportions of breast milk (greater than .5). The majority of respondents had proportion measures between 0 and .2.

**Figure 1: Distribution of Breast Milk Proportion Measures (N=30)**



### *Demographic Predictors*

Non-Black mothers in our study had average proportions of breast milk nearly twice that (.48) of mothers who identified as black (.25). The difference in these proportions was statistically significant ( $p < .05$ ), as was the difference between Hispanic (.45) and non-Hispanic mothers (.33,  $p < .10$ ). Disparities by income are also large in magnitude and statistically significant ( $p < .10$ ). Those in the lowest income bracket had an average breast milk proportion of .19 compared to a .50 average in all other brackets combined. College education was also positively correlated ( $p < .10$ ) with a higher breast milk proportion (.43 for those with any college vs. .23 for those with no college). The OLS bivariate coefficient of age in a predictive model of proportion breast milk fed was .02 with a standard error of .008 ( $p = .004$ ). The addition of a quadratic age term into the predictive model suggests that the returns to breast milk feeding from age decline near the top of the age range in our sample.

### *Attitudes and Beliefs*

Table 1 shows the distribution of agreement with the validated prompts in the Iowa Infant Feeding Attitude Scale. Responses were generally clustered at the positive end of the spectrum of breastfeeding attitudes. Mothers in our study mostly agreed that the nutritional benefits of breast milk lasted beyond weaning and that it increases mother-infant bonding. Mothers were also, on average, likely to agree or strongly agree that breast milk was the ideal food for infants and that it held cost benefits over formula.

Mothers were more split on issues of breast milk feeding and lifestyle. Though half the number of women agreed that formula feeding was more convenient than breastfeeding than disagreed, many remained neutral on the topic. The same distribution is seen in terms of mothers who work outside the home. There was also a large proportion of neutral responses when mothers were asked about the fathers feeling left out if a mother breast feeds.

We used variation in the lifestyle prompts to explore associations with breast milk outcomes at discharge. Mothers whose responses were negative towards breast feeding, or neutral, were compared against those whose responses were positive towards breastfeeding. We combined the numerical value of the Likert-Scale responses in the lifestyle categories and then averaged, so that each respondent was given a single lifestyle score. Mothers whose average was less than or equal to three were compared to those whose average was greater than three. The findings in Table 2 suggest that while negative lifestyle attitudes predict a decrease in exclusivity, it predicts a greater likelihood of receiving any breast milk.

**Table 1: Iowa Infant Feeding Attitude Scale Responses**

	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neutral</b>	<b>Agree</b>	<b>Strongly Agree</b>
<b>The nutritional benefits of breast milk last only until the baby is weaned</b>	15	6	1	1	3
<b>Formula feeding is more convenient than breastfeeding</b>	8	6	8	3	4
<b>Breastfeeding increases mother-infant bonding</b>	5	0	3	3	17
<b>Formula feeding is the better choice if the mother works outside the home</b>	6	9	4	3	4
<b>Breast milk is the ideal food for babies</b>	4	0	4	4	17
<b>Fathers feel left out when a baby is breast fed</b>	5	10	8	1	2
<b>A mother who occasionally drinks alcohol should not breastfeed her baby</b>	6	4	7	4	8
<b>Breastfeeding is less expensive than formula</b>	2	0	1	5	18

**Table 2: Lifestyle Attitudes and Breast Milk Outcomes (Standard Errors)**

	Negative or Neutral Lifestyle Responses	Positive Lifestyle Responses	P-value
<b>Proportion of Feeding that was Breast Milk (ml)</b>	.25 (.18)	.41 (.11)	.23
<b>Proportion of infants receiving <i>any</i> breast milk</b>	.72 (.13)	.52 (.11)	.13

Part of a woman’s attitudes and beliefs stem from her past breastfeeding experience. Sixty-percent of the mothers in our study were multiparous, and the majority (17/18) of multiparous mothers had breastfed their older children. We were only able to compare the outcomes of primiparous versus multiparous mothers, as there was too little variation in breastfeeding behavior in the multiparous to compare those who breastfed previously and those who didn’t. The results in Table 3 indicate a negative association between having other children at home and providing breast milk for the NICU infant.

**Table 3: Parity and Breast Milk Outcomes (Standard Errors)**

	Primiparous	Multiparous	P-value
<b>Mean Proportion of Feeding that was Breast Milk (ml)</b>	.50 (.16)	.30 (.12)	.16
<b>Proportion of infants receiving <i>any</i> breast milk</b>	.73 (.13)	.52 (.10)	.13

A mother’s pre-existing attitudes and beliefs can be partially captured by their pre-delivery plans for feeding. Of the 30 mothers in our study, only one considered herself undecided before she came to the hospital. 16 out of the 29 who had made plans planned on exclusive breast milk, 4 planned on exclusive formula and 10 on a mix of both. A mother’s plan for feeding did predict eventual breast milk outcomes.

**Table 4: Feeding Plans and Breast Milk Outcomes (Standard Errors)**

	<b>Planned on Exclusive Breast Milk Feeding</b>	<b>Planned on Some <i>or</i> Exclusive Formula</b>	<b>P-value</b>
<b>Mean Proportion of Feeding that was Breast Milk (ml)</b>	.44 (.14)	.30 (.14)	.23
<b>Proportion of infants receiving <i>any</i> breast milk</b>	.45 (.16)	.46 (.14)	.48

Our survey instrument also collected information on pre-delivery beliefs about the difficulty of breast milk feeding. Respondents were allowed to choose multiple beliefs. Table 5 shows the distribution of tallies for each belief statement.

**Table 5: Beliefs about Breast Milk Feeding Pre-Delivery**

	<b>I thought it would be difficult</b>	<b>I thought it would be easy for me</b>	<b>I thought it would be inconvenient</b>	<b>I didn't really think about it</b>	<b>I thought it wouldn't be too hard</b>	<b>I thought it would be painful</b>
<b>Frequency</b>	13	10	3	4	5	7

We collapsed these categories into positive and negative beliefs; using these collapsed categories, we then designated each mother as “leaning positive” or “leaning negative”. Table 6 shows the association between these leanings and breast milk outcomes.

**Table 6: Pre-Delivery Beliefs and Breast Milk Outcomes (Standard Errors)**

	<b>Leaning Positive (n=12)</b>	<b>Leaning Negative( (n=11)</b>	<b>P-value</b>
<b>Proportion of Feeding that was Breast Milk (ml)</b>	.34 (.17)	.36 (.15)	.46
<b>Proportion of infants receiving any breast milk</b>	.36 (.15)	.37 (.17)	.52

*Education about Breast Milk*

Participants were asked questions relating to pre-delivery sources of information about breast milk; mothers were allowed to choose multiple sources. For this analysis, we grouped the pre-delivery sources into four categories: Doctors and Nurses (including Doctor’s Appointments); Other nutrition staff (including dietitians, WIC staff and lactation consultants and childbirth educators); Family and Friends; and Non-Personal sources (Internet, TV, Books and Magazines).

The majority of the information received before birth was from other nutrition staff--most commonly the information in this category was from a WIC counselor. There were 64 mentions in this category and 59 in the “Doctors and Nurses” grouping. Mothers were slightly more likely to receive information from non-personal sources such as the internet, books or magazines than from personal sources such as family and friends.

Using these source groupings, we analyzed which source of information was the most predictive of future behavior. Because most women checked boxes in multiple categories, per the survey instructions, we had to develop a clear way to understand from which source a mother received the most information. For each respondent, we tallied the number of sources checked within each category and assigned each woman to one of four groups based on the source categories. We adjusted for the fact that there were more sources listed on the survey for some categories than others by weighting accordingly. In three cases, the numbers of tallies were equal among categories. In this case, we randomly assigned the mother to one of her most mentioned categories. Table 6 shows the breakdown of the category frequencies; each woman can only be in one category.



**Table 6: Distribution of Most Frequent Sources of Breastfeeding Information Pre-Delivery**

	Doctors and Nurses	Other Nutrition Staff	Family and Friends	Non-Personal Sources
Frequency (N=29)	11	7	3	9

Table 6 suggests that the majority of women receive the most information from doctors or nurses, followed by non-personal sources, other nutrition staff and family/friends. Most women receive information from all of these sources, but the findings in this study indicate that the majority of the information is likely coming from the medical field. We also investigated whether the main source of information varied systematically along demographic indicators. The distribution by race, ethnicity and income mirrored that of the full sample.

Grouping the four categories into two--medical and “non-medical” sources--we explored whether there was an association between breast milk outcomes at discharge and source of information. Results in Table 7 indicate slightly lower breast milk exclusivity among those whose pre-delivery majority source of information is non-medical. Results also indicate a slight decrease in exclusivity as the total number of sources increases.

**Table 7: Source of Information and Breast Milk Outcomes (Standard Errors)**

	“Medical”	“Non-Medical”	P-value
Mean Proportion of Feeding that was Breast Milk (ml)	.37 (.13)	.33 (.16)	.16
Proportion of infants receiving <i>any</i> breast milk	.33 (.16)	.50 (.14)	.22

Post-delivery, 90% of the information received about breast milk feeding came from medical professionals--most often from the mother’s nurse or the baby’s nurse. Few women received information post-delivery from non-personal sources.

### *Logistical Constraints*

Logistical constraints in our study include: Geography, Maternal Perception of Breast Milk Supply and Interaction with the Pumping Supplies. Our survey instrument collected zip code information for each respondent; using this variable, we created a new variable called “distance” which measured the number of miles between the epicenter of the zip code and ABSMC. The mean of this distance measure was 16.3 miles with a range of 2.5 to 42.4. Table 8 shows the beta coefficient from a bivariate OLS estimate using distance as the explanatory variable and our breast milk outcomes as dependent variables.

**Table 8: Bivariate OLS Regression Coefficients; Distance on Breast Milk Outcomes (Standard Errors)**

	Distance	P-value
<b>Proportion of Feeding that was Breast Milk (ml)</b>	-.001 (.18)	.88
<b>Proportion of infants receiving any breast milk</b>	-.002 (.01)	.81

While the coefficient on the distance measure is negative, it is highly unstable. To look at the issue of distance another way, we coded zip codes greater than the mean distance as “far” and those less than the mean as “near”. Table 9 shows the results from this approach.

**Table 9: Distance as a Binary Variable and Breast Milk Outcomes (Standard Errors)**

	“Near”	“Far”	P-value
<b>Proportion of Feeding that was Breast Milk (ml)</b>	.31 (.14)	.42 (.14)	.28
<b>Proportion of infants receiving any breast milk</b>	.36 (.15)	.54 (.14)	.19

The general direction of the distance effect is positive--women who live further away are more likely to breast milk feed and have higher exclusivity measures. Since this runs counter to conventional wisdom, we investigated whether demographics might systematically vary as a function of distance. We found that distance was not distributed randomly--women in the highest income brackets tended to live *nearer* to the hospital. Because income is positively correlated with breast milk feeding, this does not address our previous findings. There was no discernible patterns by race, but there was by ethnicity. Women who lived further away were more likely to identify as Hispanic, which is a positive predictor of breast milk feeding. Further discussion on the implications of our distance measure is found in the concluding section of this paper.

Logistical constraints also include maternal feelings about her breast milk supply, as well as her experience with breast milk pumping. All 30 of our mothers had attempted pumping by the time of study enrollment. Women were nearly split on whether the amount of milk produced as “enough” for her child. Fourteen of 30 women felt it was the “right” amount, 9 felt it was not enough and the rest felt it was either too much or did not know. There as a slight (2%) increase in mean exclusivity for those who felt their amount was either “right” or “too much” compared to those who felt they were not producing enough. However, at the time of discharge, a larger

proportion--fifty-percent--of women in the “not enough” category were feeding their infant any breast milk.

Most of the women in our study either “did not mind” or “enjoyed” pumping. Twenty-four out of 30 women had positive interactions with pumping while the remaining did not like it. Interestingly, negative attitudes towards breast milk pumping positively predicted both exclusivity and likelihood of any breast milk feeding (Table 10).

**Table 10: Pumping Experience and Breast Milk Outcomes (Standard Errors)**

	<b>Negative Pumping Experience</b>	<b>Positive Pumping Experiences</b>	<b>P-value</b>
<b>Proportion of Feeding that was Breast Milk (ml)</b>	.68 (.23)	.30 (.10)	.08
<b>Proportion of infants receiving any breast milk</b>	.75 (.22)	.41 (.11)	.09

*Social Support and Peer Effects*

The final theme in our survey results concerns social support for breast milk feeding as well as evidence of peer effects. Three questions in our instrument addressed this theme, the first being whether the respondents own mother breastfed her. Of the 30 women in our study, 27 answered the question. Sixteen of those 27 women were themselves breastfed, while 9 were not and 3 did not know. We collapsed the “did not know” responses into the “No” category. We do this because the pathway between a woman being breastfed herself and her own breastfeeding behavior is likely via role modeling and family discussion or support. Though biological pathways between generations are possible, the research on this phenomenon is still evolving.

**Table 11: Respondent’s Maternal Breastfeeding Behavior and Breast Milk Outcomes (Standard Errors)**

	<b>Respondent was Breastfed</b>	<b>Respondent was not Breastfed or Doesn’t Know</b>	<b>P-value</b>
<b>Proportion of Feeding that was Breast Milk (ml)</b>	.44 (.13)	.28 (.14)	.20
<b>Proportion of infants receiving any breast milk</b>	.57 (.13)	.31 (.14)	.09

Table 11 suggests a large, positive association between both outcome measures and the respondent’s mother’s breastfeeding behavior.

Our survey instrument also asked mothers to estimate how many close friends or family had breastfed their children, as well as how many had given birth prematurely. All numerical responses were truncated at 10. Non-numerical responses were enumerated in the following way: a “couple” was transformed to 2, a “few” to 3 and “many” to ten. The mean number of peers who breastfed was 6.5 and the mean number of peers who had given birth prematurely was 1.6.

We transformed the continuous variables into a binary variable in the same manner as distance using the mean as a division point. The variance around the mean of the peer prematurity frequency was too tightly distributed for statistical analysis to be practical. Table 12 presents the results of t-test estimates only for the peer breastfeeding measure.

**Table 12: Number of Peers Who Breastfed; Binary Variable (Standard Errors)**

	Few Peers who Breastfed	Many Peers who Breastfed	P-value
<b>Proportion of Feeding that was Breast Milk (ml)</b>	.38 (.13)	.54 (.15)	.21
<b>Proportion of infants receiving any breast milk</b>	.34 (.13)	.41 (.15)	.36

In our sample, women who had a greater than average amount of peers who breastfed had higher exclusivity measures and were also more likely to feed any breast milk to their infants.

## Discussion

Since the AAP call to action in 1997, rates of breast milk feeding have increased among NICU patients. However, even with the gains overall, disparities by race, class and education persist among premature and full term infants alike. Our findings confirm these demographic disadvantages. Understanding what demographic variables predict breast milk feeding at discharge can be useful to clinicians in identifying at-risk patients.

Caution should be exercised, though, in interpreting these demographic variables as independent predictors. The focus of this study was in unwrapping the underlying reasons why certain demographic variables might be correlated with poor breast milk feeding rates. The small sample size in our study precluded us from being able to control for these variables simultaneously and maintain statistical power.

This study expands on the literature of breast milk feeding in the NICU in many ways. Our paper is the first in the field to apply these particular theories of health behaviors and decision-making to infant feeding in the NICU. We used these theories to develop a survey instrument particular to the unique experience of the NICU family. Our theories about maternal

attitudes lead us to believe that pre-delivery positive beliefs would be positively correlated with breast milk outcomes. This was not supported in the data. There seemed to be very little discernible association between attitudes, beliefs or sources of information and breast milk exclusivity. There were a couple of surprising findings--first, women who received the majority of their information from non-medical sources were more likely to feed any breast milk to her infant, but there was no substantive association between the source of information and exclusivity. Second, first-time mothers were much more likely to breast feed and had higher average proportions of breast milk compared to more experienced mothers. This latter finding was especially interesting, given that theories of health behavior centering on experience would lead one to assume that experience with past breast feeding makes a woman more likely to do it a second or third time around. Perhaps the added work of additional children at home makes expression and transport of breast milk much more costly in terms of time and energy; this logistical constraint could overshadow the theoretically positive association between past experience and present behavior.

Ours is the first qualitative study in the NICU infant feeding literature to measure breast milk as a continuous variable; exclusivity is a little-researched outcome in the NICU. If breast milk as a medical treatment follows a dose-response curve, then collecting information of this type is important. Many times in our results the direction of the relationship between our explanatory variables and our breast milk outcomes was discordant. That is, there were variables that were negatively correlated with breast milk as a binary variable and positively correlated with breast milk as a continuous variable and vice versa. This deserves further investigation, as it has implications not only for the NICU population, but the full term population as well. Our findings, if generalizable, mean there may be certain factors that instigate initiation and others that prolong breastfeeding.

The addition of geography measures to this type of study is pertinent to the NICU experience. The process of travel and visitation is unique. Our results trended away from what we hypothesized. While we expected that mothers living further away would be less likely to provide breast milk for their infants, we found the opposite to be true. Further investigation found that distance was systematically related to Hispanic ethnicity. Another logistical constraint that ran counter to our hypotheses was that of pump interaction. Instead of negative feelings predicting lower breast milk exclusivity, we found that women who expressed negative feelings about pumping were actually *more* likely to breast milk feeding and--if they did so--provided greater exclusivity for her infant. This was perhaps the most surprising finding in our study. We posit that perhaps the lower expectations in early life make sustaining breast milk feeding more viable. We found similarly surprising results concerning a mother's plans for breastfeeding--those who wanted to breastfeed exclusively pre-delivery *did* enjoy greater exclusivity but were at no advantage when breast milk feeding was a binary outcome.

The largest differences in breast milk outcomes were found in the social support and peer effect categories. In line with the extant literature, the breastfeeding behavior of a woman's own mother was highly predictive of that woman's breast milk feeding. This finding held true for both the continuous and binary outcome measures. A similarly large magnitude of difference was evident in the peer effect model.

There are limitations to this pilot study. Future work that increases sample size can look at variation of the response categories by race, ethnicity, language and socio-economic status, which can illuminate whether different groups of women experience heterogeneous effects of the many factors that predict breast milk feeding. Further, our study over-represents C-Section

births, due to our approaching women while still in-hospital. C-Section stays are traditionally 1-3 days longer than vaginal birth stays (see Paper 1 in this dissertation) and may also be higher-risk. Future work should work more diligently to represent the experience of women who give birth vaginally. However, since C-Sections are historically negatively associated with breast milk feeding, even when controlling for a host of potential confounders, it is unclear what the effect of this over-representation is on our findings.

Taken together, the results of this pilot study underscore the complexity of the NICU experience. Not only must mothers learn to feed their infants, they must do so while physically separated from their child for long stretches of time. And yet, even with these obstacles and stressors, NICU mothers are now more likely to breastfeed than their full-term counterparts. As more attention is paid in the US to health disparities and social disadvantage, studies such as ours are critical to understanding the intricacies of early-life nutrition intervention.

### **Conclusion to the Three Essays**

As a whole, the three essays in this dissertation point to the complicated story of maternal decision making in a child's early days. Essays 1 and 3 show the unique barriers to breast milk feeding among mothers of society's most medically vulnerable children. Essay 2 addresses another health disadvantage—being born into poverty or near-poverty. The results of these papers underscore the potential effects of policy on health and social inequalities at all levels of governance—from the hospital room to Congress. These papers show how something as personal as a woman's decision to breastfeed her child is shaped by forces beyond her control, and how well-meaning programs and policies might result in deleterious outcomes for clients. It is my hope that this research plays even a small part in advancing the National conversation on equality of opportunity for health—not only in infancy, but over the life course.

## References

### Introduction

- American Academy of Pediatrics. (2009). *Starting Solid Foods*. Washington, DC: American Academy of Pediatrics.
- Amir, L. H., & Donath, S. (2007). A Systematic Review of Maternal Obesity and Breastfeeding Intention, Initiation and Duration. 7 (9).
- Anderson, J. W., Johnstone, B. M., & Remley, D. T. (1999). Breastfeeding and Cognitive Development: A Meta-Analysis. 70 (4).
- Anderson, P. M., Butcher, K. F., & Levine, P. B. (2003). Economic perspectives on childhood obesity . *Economic Perspectives*, 27
- Baker, J. C. (1985). The international infant formula controversy: A dilemma in corporate social responsibility. *Journal of Business Ethics*, 4(3), 181-190.
- Baker, M., & Mulligan, K. (2008). Maternal employment, Breastfeeding and Health: Evidence from Maternity Leave Mandates. 27 (4).
- Baxter, J., Cooklin, A. R., & Smith, J. Which mothers wean their babies prematurely from full breastfeeding? an Australian cohort study. Blackwell Publishing Ltd.
- Beaudry, M., Durfour, R., & Marcoux, S. (1995). Relation Between Infant Feeding and Infection During the First Six Months of Life. *The Journal of Pediatrics* (126), 191-197.
- Benefo, A., Tsui, J., Johnson, J. (2008). Ethnic differentials in child spacing ideals and practices in Ghana. *Journal of Biosocial Science* 26. 311-326.
- Bergman, N. (2007). Breastfeeding and Perinatal Neuroscience. In C. W. Genna, *Supporting Sucking Skills in Newborn Infants*. New York City: Jones and Bartlett.
- Bonuck, K., Freeman, K., & Trombley, M. (2005). Country of Origin and Race/Ethnicity: Impact on Breastfeeding Intentions. 21 (3).
- Burchard, E. G., Ziv, E., Coyle, N., Gomez, S. L., Tang, H., Karter, A. J., et al. (2003). The importance of race and ethnic background in biomedical research and clinical practice. *New England Journal of Medicine*, 348(12), 1170-1175.
- Ebstein, R. P., Israel, S., Chew, S. H., Zhong, S., & Knafo, A. (2010). Genetics of human social behavior. *Neuron*, 65(6), 831-844.
- Evenhouse, E., & Reilly, S. (2005). Improved estimates of the benefits of breastfeeding using sibling comparisons to reduce selection bias. *Health Services Research*, 40(6p1), 1781-1802.



- Ferber, S. G., & Makhoul, I. R. (2004). The Effect of Skin-to-Skin Contact (Kangaroo Care) Shortly After Birth on the Neurobehavioral Responses of the Term Newborn: A Randomized, Controlled Trial. *Pediatrics* (113), 858-865.
- Figlio, D. Hamersma, S., Roth, J. (2009). Does Prenatal WIC Participation Improve Birth Outcomes? New Evidence from Florida. *Journal of Public Economics* 93(2009)
- Flier, J. S., Underhill, L. H., & McEwen, B. S. (1998). Protective and damaging effects of stress mediators. *New England Journal of Medicine*, 338(3), 171-179.
- Francis, D. D. (1999). Variations in maternal care form the basis for a non-genomic mechanism of inter-generational transmission of individual differences in behavioral and endocrine responses to stress. *Science* , 286 (5442), 1155-8.
- Gordon-Larsen, P., Adair, L. S., Nelson, M. C., & Popkin, B. M. (2004). Five-year obesity incidence in the transition period between adolescence and adulthood: The national longitudinal study of adolescent health. *American Journal of Clinical Nutrition*, 80(3), 569-575.
- Greco, L. (1988). Case Control Study on Nutritional Risk Factors in Celiac Disease. *Journal of Pediatric Gastroenterology and Nutrition* (17), 395-99.
- Gschanesa, A., Eggenreichb, U., Windischa, M., & Crailsheimc, K. (1998). Early postnatal stimulation influences passive avoidance behaviour of adult rats. *Behavioural Brain Research* (2), 91-98.
- Gunnar, M. R., & Nelson, C. A. (1994). Event-related potentials in year-old infants: Relations with emotionality and cortisol. *Child Development*, 65(1), 80-94.
- Hirschman, C., & Butler, M. (1981). Trends and differentials in breast feeding: An update. *Demography*, 18(1), pp. 39-54.
- Knodel, J., & Kintner, H. (1977). The impact of breast feeding patterns on the biometric analysis of infant mortality. *Demography*, 14(4), pp. 391-409.
- Koletzko, S. (1989). Role of Infant Feeding Practices in Development of Crohn's Disease in Childhood. *British Medical Journal* (298), 1617-18.
- Kramer, M. S., Chalmers, B., Hodnett, E. D., Sevkovskaya, Z., Dzikovich, I., Shapiro, S., et al. (2001). Promotion of breastfeeding intervention trial (PROBIT): A randomized trial in the republic of belarus. *JAMA: The Journal of the American Medical Association*, 285(4), 413-420.
- Kramer, M. S., Guo, T., Platt, R. W., Shapiro, S., Collet, J., Chalmers, B., et al. (2002). Breastfeeding and infant growth: Biology or bias? *Pediatrics*, 110(2), 343-347.
- Kramer, M. S., Matush, L., Vanilovich, I., Platt, R. W., Bogdanovich, N., Sevkovskaya, Z., et al. (2009). A randomized breast-feeding promotion intervention did not reduce child obesity in belarus. *Journal of Nutrition*, 139(2), 417S-421.
- L. Wright, A. (1989). Breastfeeding and Lower Respiratory Tract Illness in the First Year of Life. *British Medical Journal* (299), 946-949.

- Li, J., Kendall, G., Henderson, S., Downie, J., Landsborough, L., & Oddy, W. (2008). Maternal psychosocial well-being in pregnancy and breastfeeding duration. *Acta Paediatrica*, *97*(2), 221-225.
- Li, R., Darling, N., Maurice, E., Baker, L., & Grummer-Strawn, L. M. (2005). Breastfeeding Rates in the United States by Characteristics of the Child, Mother, or Family: The 2002 National Immunization Survey. *115*, 31-37.
- Li, R., Zhao, Z., Mokdad, A., Barker, L., & Grummer-Strawn, L. (2003). Prevalence of breastfeeding in the united states: The 2001 national immunization survey. *Pediatrics*, *111*(5), 1198-1201.
- Lu, M. C., & Halfon, N. (2003). Racial and ethnic disparities in birth outcomes: A life-course perspective
- Lyons, D., Parker, K., Katz, M., & Schatzberg, A. (2009). Developmental cascades linking stress inoculation, arousal regulation, and resilience. *Frontiers of Behavioral Neuroscience* , 3 (32), Epub.
- Macriá, S., & Würbe, H. (2006). Developmental plasticity of HPA and fear responses in rats: A critical review of the maternal mediation hypothesis. *Hormones and Behavior* , 50 (5), 667-680.
- Manchester, C. F., & Mumford, K. J. (2009). How costly is welfare stigma? separating psychological costs from time costs Available at SSRN,
- Maria V.#Gibson, Vanessa A.#Diaz, Arch G.#Mainous, & Mark E.#Geesey. (2005). Prevalence of breastfeeding and acculturation in hispanics: Results from NHANES 1999–2000 study. *Birth: Issues in Perinatal Care*, *32*(2), 93-98.
- Marmot, M. (2009). Action on Health Disparities in the United States. *Journal of the American Medical Association* , 301 (11), 1169-1171.
- McNeilly, A., Glasier, A., Howie, P., Houston, M., Cook, A., Boyle, H. (2008). Fertility After Childbirth: Breastfeeding Associations with Pregnancy. *Clinical Endocrinology* *19*(2). 117-163
- Melton, L. (2000). *There's More to Herdity than Genes*. London, England: Mill Hill Essays.
- Nath, D., Land, K., Singh, K. (2008) The role of breast-feeding beyond postpartum amenorrhea on the return of fertility in India: a life table and hazards model analysis. *Journal of Biosocial Science* *26*. 191-198
- Obermeyer, C. M., & Castle, S. (1997). Back to nature? historical and cross-cultural perspectives on barriers to optimal breastfeeding. *Medical Anthropology*, *17*, 39-63.
- Oddy, W. H., Li, J., Landsborough, L., Kendall, G. E., Henderson, S., & Downie, J. (2006). The association of maternal overweight and obesity with breastfeeding duration. *The Journal of Pediatrics*, *149*(2), 185-191.
- Oliviera, V., & Hanson, K. (2009). Economic linkages between the WIC program and the farm sector: An economic research brief. No. 12. United States Department of Agriculture.
- Oliviera, V., & Prell, M. (2004). Sharing the economic burden: Who pays for WIC's Infant Formula? *Amber Waves*, Volume 3

- Palmer, B. (1998). The Influence of Breastfeeding of the Development of the Oral Cavity: A Commentary. 14 (93).
- Pediatrics, American Academy of. (2005). Breastfeeding and the use of human milk. *Pediatrics* (100), 496-506.
- Pisacane, A. (1992). Breastfeeding and Urinary Tract Infections. *The Journal of Pediatrics* (120), 87-88.
- Poulton, R., Caspi, A., Milne, B. J., Thomson, W. M., Taylor, A., Sears, M. R., et al. (2002). Association between children's experience of socioeconomic disadvantage and adult health: A life-course study. *The Lancet*, 360(9346), 1640-1645.
- Prema, K., Naidu, A., Neelakumari, N., Ramalakshmi, S. (1981). Nutrition-Fertility Interaction in Low-Quandt, S. A. (1998), Ecology of breastfeeding in the United States: An applied perspective. *American Journal of Human Biology*, 10: 221–228.
- Romero-Corral, A., Somers, V. K., Sierra-Johnson, J., Thomas, R. J., Collazo-Clavell, M. L., Korinek, J., et al. (June 2008). Accuracy of body mass index in diagnosing obesity in the adult general population. 32 (6).
- Sacker, A., Quigly, M. A., & Kelly, Y. J. (2003). Breastfeeding and Developmental Delay: Findings from the Millenium Cohort Study. 118 (3).
- Sanderson, M., & Emanuel, I. The intergenerational relationship between mother's birthweight, infant birthweight and infant mortality in black and white mothers. Blackwell Publishing Ltd.
- Scott, S., & Duncan, C. J. (1999). Malnutrition, pregnancy, and infant mortality: A biometric model. *Journal of Interdisciplinary History*, 30(1), pp. 37-60.
- Singh, G. K., & Yu, S. M. (1995). Infant mortality in the United States: trends, differentials, and projections, 1950 through 2010. *American Journal of Public Health* , 85 (7), 957-964.
- Stocker, C. J., Arch, J. R. S., & Cawthorne, M. A. (2005). Fetal origins of insulin resistance and obesity. *Proceedings of the Nutrition Society*, 64(02), 143.
- Surtees, P., Wainwright, N., Day, N., Brayne, C., Luben, R., & Khaw, K. (2003). Adverse experience in childhood as a developmental risk factor for altered immune status in adulthood. *International Journal of Behavioral Medicine*, 10(3), 251-268.
- Tanner, J. M., & Thomson, A. M. (1971). Standards for birthweight at gestation periods between 32 and 42 weeks, allowing for maternal height and weight. *Archives of Diseases in Childhood*, 455, 566.
- Taylor, A. (1998). Violations of the international code of marketing of breast milk substitutes: Prevalence in four countries. *BMJ*, 316(7138), 1117-1122.
- Udall, J. N. (1985). Liver Disease in alpha-1 Antitrypsin Deficiency: A Retrospective Analysis of Early Breast vs. Bottle Feeding. *Journal of the American Medical Association* (253), 2679-82.

United States Census Bureau. (2009). "B02001. RACE - universe: TOTAL POPULATION". 2009 american community survey 1-year estimates. Retrieved January 10, 2011, from

United States Department of Health and Human Services. (2011). *The surgeon General's call to action to support breastfeeding*. Office of the Surgeon General.

Weimar, J. (2001). *The Economic Benefits of Breastfeeding: A Review and Analysis*. Washington, D.C.: U.S Department of Agriculture, Food Assistance and Nutrition.

Wright, A. L., & Schanler, R. J. (2001). The resurgence of breastfeeding at the end of the second millennium. *The Journal of Nutrition*, 131(2), 421S-425S.

### **Essay One**

Affonso D., Wahlberg V., & Persson B. (1989). Exploration of mother's reactions to the kangaroo method of prematurity care. *Neonatal Network*, 7(6):43-51.

Anderson, P., Doyle, L. W., & and the Victorian Infant Collaborative Study Group. (2003). Neurobehavioral outcomes of school-age children born extremely low birth weight or very preterm in the 1990s. *JAMA: The Journal of the American Medical Association*, 289(24), 3264-3272.

Bauchner, H., Leventhal, J. M., & Shapiro, E. D. (1986). Studies of breast-feeding and infections. *JAMA: The Journal of the American Medical Association*, 256(7), 887-892.

Bernis, C., & Varea, C. (2011). Hour of birth and birth assistance: From a primate to a medicalized pattern? *American Journal of Human Biology*, 24(1), 14-21

Berseth, C. L., Bisquera, J. A., & Paje, V. U. (2003). Prolonging small feeding volumes early in life decreases the incidence of necrotizing enterocolitis in very low birth weight infants. *Pediatrics*, 111(3), 529-534.

Blaymore Bier, J., Ferguson, A.E., Morales, T., Llebbling, J.A., Archer, D., Oh, W., & Vohr, B. (1996). Comparison of Skin-to-Skin Contact with Standard Contact in Low-Birth-Weight Infants Who Are Breast-Fed. *Journal of the American Medical Association*, 150(12), 1265-1269

Coffey, L. C., Skipper, J. K., & Jung, F. D. (1988). Nurses and shift work: Effects on job performance and job-related stress. *Journal of Advanced Nursing*, 13(2), 245-254.

Davanzo, R., Ronfani, L., Pierpaolo, B., and Demarini, S. (2009). Breast feeding very-low-birthweight infants at discharge: a multicentre study using WHO definitions. *Paediatric and Perinatal Epidemiology*, 23(6), 590-596

De Silva, A., Jones, P., & Spencer, S. (2004). Does human milk reduce infection rates in preterm infants? A systematic review. *Archives of Disease in Childhood Fetal and Neonatal Edition*, 89(6), F509-13.

Espy, K. A., & Senn, T. E. (2003). Incidence and correlates of breast milk feeding in hospitalized preterm infants. *Social Science & Medicine*, 57(8), 1421-1428.

- Evans, W. N., Garthwaite, C., & Wei, H. (2008). The impact of early discharge laws on the health of newborns. *Journal of Health Economics*, 27(4), 843-870.
- Fitzpatrick, J. M., While, A. E., & Roberts, J. D. (1999). Shift work and its impact upon nurse performance: Current knowledge and research issues. *Journal of Advanced Nursing*, 29(1), 18-27.
- Gooding, J., Cooper, L.G., Blaine, A., Franck, L., Howse, J., & Berns, S. (2003). Family Support and Family-Centered Care in the Neonatal Intensive Care Unit: Origins, Advances, Impact. *Seminars in Perinatology*, 14(2), 218-222
- Groh-Wargo, S., & Sapsford, A. (2009). Enteral nutrition support of the preterm infant in the neonatal intensive care unit. *Nutrition in Clinical Practice*, 24(3), 363-376.
- Heller G., Misselwitz B., & Schmidt S. (2000). Early neonatal mortality, asphyxia related deaths, and timing of low risk births in Hesse, Germany, 1990-8: observational study. *British Medical Journal*, 321(7256): 274-275.
- Hylander, M. A., Strobino, D. M., & Dhanireddy, R. (1998). Human milk feedings and infection among very low birth weight infants. *Pediatrics*, 102(3), e38-e38.
- Klassen, A. F., Lee, S. K., Raina, P., Chan, H. W. P., Matthew, D., & Brabyn, D. (2004). Health status and health-related quality of life in a population-based sample of neonatal intensive care unit graduates. *Pediatrics*, 113(3), 594-600.
- Lee, H. C., & Gould, J. B. (2009). Factors influencing breast milk versus formula feeding at discharge for very low birth weight infants in California. *The Journal of Pediatrics*, 155(5), 657-662.e2.
- Lee, H.C., Martin-Anderson, S., Lydon, A., and Dudley, A. (2012) Clinician Perspectives on Opportunity for Breast Milk Feeding in the Neonatal Intensive Care Unit. *Breastfeeding Medicine*. Forthcoming
- Lucas, A., & Cole, T. J. (1990). Breast milk and neonatal necrotising enterocolitis. *The Lancet*, 336(8730-8731), 1519-1523.
- Lucas, A. (2005). Long-term programming effects of early nutrition-implications for the preterm infant. *Journal of Perinatology*, 25, 2-6.
- Malkin, J. D., Broder, M. S., & Keeler, E. (2000). Do longer postpartum stays reduce newborn readmissions? analysis using instrumental variables. *Health Services Research*, 35(5 Pt 2), 1071-1091.
- McCarton C.M., Brooks-Gunn J., Wallace I.F., et al. (1997). Results at age 8 years of early intervention for low-birth-weight premature infants. *Journal of the American Medical Association*, 277 :126- 132
- McInnes, R. J., & Chambers, J. (2008). Infants admitted to neonatal units and interventions to improve breastfeeding outcomes: A systematic review 1990-2007. *Maternal & Child Nutrition*, 4(4), 235-263.

- Merewood, A., Brooks, D., Bauchner, H., MacAuley, L., & Mehta, S. D. (October 2006). Maternal birthplace and breastfeeding initiation among term and preterm infants: A statewide assessment for Massachusetts. *Pediatrics*, 118(4), e1048-e1054.
- Merewood, A., Philipp, B. L., Chawla, N., & Cimo, S. (2003). The baby-friendly hospital initiative Increases breastfeeding rates in a US neonatal intensive care unit. *Journal of Human Lactation*, 19(2), 166-171.
- Merten, S., Dratva, J., & Ackermann-Liebrich, U. (2005). Do baby-friendly hospitals influence breastfeeding duration on a national level? *Pediatrics*, 116(5), e702-e708.
- Moore, T., Hanson, C., & Anderson-Berry, A. (2011) Colonization of the Gastrointestinal Tract in Neonates. *Infant, Child and Adolescent Nutrition*, 3(5), 291-294
- Mossialos, E., Allin, S., Karras, K., & Davaki, K. (June 2005). An investigation of caesarean sections in three greek hospitals. *The European Journal of Public Health*, 15(3), 288-295.
- Nyqvist, Kirstin H., (1997). Successful breast feeding in spite of early mother-baby separation for neonatal care. *Midwifery*, 13(1), 24-34
- Örtenstrand, A., Westrup, B., Broström, E. B., Sarman, I., Åkerström, S., Brune, T., et al. (2010). The Stockholm neonatal family centered care study: Effects on length of stay and infant morbidity. *Pediatrics*
- Rogers, A.E. (2004). "Work Hour Regulation in Safety-Sensitive Industries," in Keeping Patients Safe: Transforming the Work Environment of Nurses, ed. A. National Academies Press, 314-358
- Rojas M.A., Kaplan M., Quevedo M., Sherwonit E., Foster L.B., Ehrenkranz R.A., & Mayes L. (2003). Somatic growth of preterm infants during skin-to-skin care versus traditional holding: a randomized, controlled trial. *Journal of Developmental and Behavioral Pediatrics*, 24(3), 163-168
- Savona, V., Zanardo, V., Cadamuro, C., Cavallin, F., & Trevisanuto, D. (2010). Effects of elective cesarean section on lactogenesis: 438. *Pediatric Research*,
- Scott, S., & Duncan, C. J. (1999). Malnutrition, pregnancy, and infant mortality: A biometric model. *Journal of Interdisciplinary History*, 30(1), pp. 37-60.
- Stein, R. E. K., Siegel, M. J., & Bauman, L. J. (July 2006). Are children of moderately low birth weight at increased risk for poor health? A new look at an old question. *Pediatrics*, 118(1), 217-223.
- Stephansson O., Dickman P.W., Johansson A.L., Kieler H., & Cnattingius S. (2000). Time of birth and risk of intrapartum and early neonatal death. *Epidemiology*, 14(2), 218-222
- Stock, J. H., & Trebbi, F. (2003). Retrospectives: Who invented instrumental variable regression? *The Journal of Economic Perspectives*, 17(3) 177-194.

- Tollånes, M. C., Thompson, J. M. D., Daltveit, A. K., & Irgens, L. M. (2007). Cesarean section and maternal education; secular trends in Norway, 1967–2004. *Acta Obstet Gynecol Scand*, 86(7), 840-848.
- Vieira, T., Vieira, G., Giugliani, E., Mendes, C., Martins, C., & Silva, L. (2010). Determinants of breastfeeding initiation within the first hour of life in a Brazilian population: cross-sectional study. *BMC Public Health*, 10, 760.
- Vohr, B. R., Poindexter, B. B., Dusick, A. M., McKinley, L. T., Higgins, R. D., Langer, J. C., et al. (October 2007). Persistent beneficial effects of breast milk ingested in the neonatal intensive care unit on outcomes of extremely low birth weight infants at 30 months of age. *Pediatrics*, 120(4), e953
- Whetsell, Jennifer F. (2003). Changing the Law, Changing the Culture: Rethinking the Sleepy Resident Problem. *Annals of Health Law*, 12(1), 23-73

## Essay Two

- Angrist, J., & Krueger, A. (2001) Instrumental variables and the search for identification: From supply and demand to natural experiments, *Journal of Economic Perspectives*, 15(4), 69–85.
- Behrman, J.R., & Rosenzweig, M., (2004) Returns to birth weight. *Journal of Economics and Statistics*, 86(2), 586-601
- Bitler, M., & Currie, J. (2004). Medicaid at Birth, WIC Take-Up and Children's Health Outcomes. Los Angeles, CA: RAND.
- Bitler, M. P., Currie, J., & Scholz, J. K. (2003). WIC eligibility and participation. *Journal of Human Resources*, 38(4), 1139-1179.
- Blank, R. & Ruggles, P. (1996). When Do Women Use Aid to Families with Dependent Children and Food Stamps? The Dynamics of Eligibility Versus Participation. *Journal of Human Resources* 31(1), 57-89
- California WIC Association. (2010). WIC Facts and Figures. Retrieved October 1, 2010, from [www.calwic.org](http://www.calwic.org): <http://www.calwic.org/facts.aspx>
- Chatterji, P., Bonuck, K., Dhawan, S., & Deb, N. (2002). WIC Participation and the Initiation and Duration of Breastfeeding. Discussion Paper: Institute for Research on Poverty. Available at [<http://irp.wisc.edu/publications/dps/pdfs/dp124602.pdf>]. Accessed [June 1, 2010]
- Chatterji, P., & Brooks-Gunne, J. (2004). WIC Participation, Breastfeeding Practices, and Well-Child Care Among Unmarried, Low-Income Mothers. *American Journal of Public Health* 94 (8), 1324-1327.
- Fein, S. (2007). Infant Feeding Practices Survey II. United States Food and Drug Administration, Centers for Disease Control and Prevention and Department of Health and Human Services.
- Figlio, D. Hamersma, S., Roth, J. (2009). Does Prenatal WIC Participation Improve Birth Outcomes? New Evidence from Florida. *Journal of Public Economics* 93(2009)

- Gibson, M.V., Diaz, V.A., Mainous, A.G., & Geesey, M.A., (2005). Prevalence of breastfeeding and acculturation in Hispanics: Results from NHANES 1999–2000 study. *Birth: Issues in Perinatal Care*, 32(2), 93-98.
- Government Accountability Office. (2006). Some Strategies Used to Market Infant Formula May Discourage Breastfeeding. Washington, D.C.
- Gueorguieva, R., Morse, S., & Roth, J. (2009). Length of Prenatal Participation in WIC and Risk of Delivering a Small for Gestational Age Infant: Florida, 1996–2004. *Maternal and Child Health Journal* 13(4), 479-488
- Hernan, M., Hernandez-Diaz, S., & Robins, J. (2007). A Structural Approach to Selection Bias. *Epidemiology*.15, 615-625
- Hoynes, H., Page, M., & Stevens, A. (2009). Is WIC a better start? Evaluating WIC's impact on health using program introduction. Working Paper 15589 National Bureau of Economic Research.
- Imbens, G., & Angrist, J. (1994) Identification and estimation of local average treatment effects, *Econometrica* 62, 467–476
- Institutes of Medicine (2011) Updating the USDA National Breastfeeding Campaign Workshop Summary. Available at [<http://www.iom.edu/Reports/2011/Updating-the-USDA-National-Breastfeeding-Campaign-Workshop-Summary.aspx>] Accessed [December 1st 2011]
- Jacknowitz, A., Novillo, D., & Tiehen, L. (2007). Special Supplemental Nutrition Program for Women, Infants, and Children and Infant Feeding Practices. *Pediatrics* 119(2), 281-289
- Jiang, M., Foster, E., & Gibson-Davis, C. (2010). The Effect of WIC on Breastfeeding: A New Look at an Established Relationship. *Children and Youth Services Review* 32(2), 264-273
- Joyce, T., Racine, A., & Yunzal-Butler, C. (2008). Reassessing the WIC effect: Evidence from the pregnancy nutrition surveillance system. *Journal of Policy Analysis & Management*, 27(2), 277-303.
- MDRC (2007). Fast Fact: Food Stamp Participation Rate among Eligible Working Poor Remained Flat, 1994-2004. Available at [[http://www.mdrc.org/area\\_fact\\_32.html](http://www.mdrc.org/area_fact_32.html)]. Accessed [December 1st, 2011]
- Moffitt, R., (1983). An Economic Model of Welfare Stigma. *American Economic Review* 73(5), 1023-35
- Morgan, S., & Winship, C. (2007). Counterfactuals and Causal Inference: Methods and Principles for Social Research. Cambridge University Press. London, England.
- Oliviera, V., & Gundersen, C. (2000). WIC and the nutrient intake of children. Report No. 33803. United States Department of Agriculture, Economic Research Service.



- Rosenbaum P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70(1), 41-55.
- Ryan, A. S., & Zhou, W. (2006). Lower Breastfeeding Rates Persist Among the Supplemental Nutrition Program for Women, Infants and Children Participants 1978-2003. *Pediatrics* 117(4), 1136-1146
- Tanner, J. M., & Thomson, A. M. (1971). Standards for birthweight at gestation periods between 32 and 42 weeks, allowing for maternal height and weight. *Archives of Diseases in Childhood*, 455, 556.
- Urban Institute (2011). Nutrition Assistance Program Report Series, Office of Research and Analysis Special Nutrition Programs. Report Number WIC-11-ELIG
- United States Department of Agriculture (2011). Trends in supplemental nutrition assistance program eligibility and enrollment, 2002-2009. Available at [http://www.fns.usda.gov/Ora/menu/Published/recentreleases.htm/Trends2002-09.pdf]
- Vericker, T., Fortuny, V., Finegold, K., & Ozdemir, S.B. (2010). Effects of Immigration on WIC and NSLP Caseloads. Urban Institute Report No. 41221

### **Essay Three**

- Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin; Psychological Bulletin*, 84(5), 888.
- American Academy of Pediatrics (2004) Levels of Neonatal Care. *Pediatrics* 2006; 118: e1399– e1405.
- American Academy of Pediatrics, Work Group on Breastfeeding.(1997) Breastfeeding and the use of human milk. *Pediatrics*. 100:1035–1039
- Bernaix, L. W., Schmidt, C. A., Jamerson, P. A., Seiter, L., & Smith, J. (2006). The NICU experience of lactation and its relationship to family management style. *MCN: The American Journal of Maternal/Child Nursing*, 31(2), 95.
- Blyth, R., Creedy, D. K., Dennis, C. L., Moyle, W., Pratt, J., & De Vries, S. M. (2002). Effect of maternal confidence on breastfeeding duration: An application of breastfeeding self - efficacy theory. *Birth*, 29(4), 278-284.
- de la Mora, Arlene, et al. The Iowa Infant Feeding Attitude Scale: Analysis of Reliability and Validity. *Journal of Applied Social Psychology* 29.11 (2006): 2362-2380.
- Elder, J. P., Ayala, G. X., & Harris, S. (1999). Theories and intervention approaches to health-behavior change in primary care. *American journal of preventive medicine*, 17(4), 275- 284.
- Furman, Lydia, Nori Minich, and Maureen Hack. "Correlates of lactation in mothers of very low birth weight infants." *Pediatrics* 109.4 (2002): e57-e57.
- Howard DL, Marshall SS, Kaufman JS, Savitz DA. Variations in low birth weight and preterm delivery among blacks in relation to ancestry and nativity: New York City, 1998–2002.

- Hurst, N. M., Myatt, A. and Schanler, R. J. (1998), Growth and Development of a Hospital-based Lactation Program and Mother's Own Milk Bank. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, 27: 503–510. doi: 10.1111/j.1552-6909.1998.tb02616.x
- Hylander MA, Strobino D, Dhanireddy R. Human milk feedings and infection among very low birth weight infants. *Pediatrics*.1998;102(3) . Available at: <http://www.pediatrics.org/cgi/content/full/102/3/e38>
- Kaufman, K. J., & Hall, L. A. (2007). Influences of the social network on choice and duration of breast - feeding in mothers of preterm infants. *Research in nursing & health*, 12(3), 149-159.
- Kavanaugh, K., Mead, L., Meier, P., & Mangurten, H. H. (2006). Getting enough: mothers' concerns about breastfeeding a preterm infant after discharge. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, 24(1), 23-32.
- Killersreiter, B., Grimmer, I., Bühner, C., Dudenhausen, J. W., & Obladen, M. (2001). Early cessation of breast milk feeding in very low birthweight infants. *Early human development*, 60(3), 193-205.
- Lee, H.C. et al. A Quality Improvement Project to Increase Breast Milk Use in Very Low Birth Weight Infants (2012). *Pediatrics*. E-pub ahead of print. Available at: <http://pediatrics.aappublications.org/content/early/2012/10/30/peds.2012-0547.full.pdf+html>
- Lee, HC. and Gould, JB. Factors Influencing Breast Milk versus Formula Feeding at Discharge for Very Low Birth Weight Infants in California . *The Journal of Pediatrics*. 155(5), November 2009, Pages 657–662.e2
- Losch, M., Dungy, C. I., Russell, D., & Dusdieker, L. B. (1995). Impact of attitudes on maternal decisions regarding infant feeding. *The Journal of pediatrics*, 126(4), 507.
- Lu, Michael C et al. Provider encouragement of breast-feeding: evidence from a national survey. *Obstetrics & Gynecology* 97.2 (2001): 290-295.
- Maastrup, R. "Breastfeeding support in neonatal intensive care: a national survey." *J Hum Lact* August 2012 vol. 28 no. 3 370-379. <<http://www.ncbi.nlm.nih.gov/pubmed/22674965>>
- Merewood, A. et al. (2006) Maternal Birthplace and Breastfeeding Initiation Among Term and Preterm Infants: A Statewide Assessment for Massachusetts. *Pediatrics* 118(4): e1048 -e1054 (doi: 10.1542/peds.2005-2637)
- Merewood, A., Mehta, S. D., Chamberlain, L. B., Philipp, B. L., & Bauchner, H. (2005). Breastfeeding rates in US Baby-Friendly hospitals: results of a national survey. *Pediatrics*, 116(3), 628-634.
- Merewood, A., Philipp, B. L., Chawla, N., & Cimo, S. (2003). The baby-friendly hospital initiative increases breastfeeding rates in a US neonatal intensive care unit. *Journal of Human Lactation*, 19(2), 166-171.
- Nyqvist, K. H., Häggkvist, A. P., Hansen, M. N., Kylberg, E., Frandsen, A. L., Maastrup, R., ... & Haiek, L. N. (2012). Expansion of the Ten Steps to Successful Breastfeeding into Neonatal Intensive

Care Expert Group Recommendations for Three Guiding Principles. *Journal of Human Lactation*, 28(3), 289-296.

Philipp, B. L., Merewood, A., Miller, L. W., Chawla, N., Murphy-Smith, M. M., Gomes, J. S., ... & Cook, J. T. (2001). Baby-friendly hospital initiative improves breastfeeding initiation rates in a US hospital setting. *Pediatrics*, 108(3), 677-681.

Powers, N. G., Bloom, B., Peabody, J., & Clark, R. (2003). Site of care influences breastmilk feedings at NICU discharge. *Journal of Perinatology*, 23(1), 10-13.

Rowe - Murray, H. J., & Fisher, J. R. (2002). Baby friendly hospital practices: cesarean section is a persistent barrier to early initiation of breastfeeding. *Birth*, 29(2), 124-131.

Scott, J. A., Landers, M. C., Hughes, R. M., & Binns, C. W. (2001). Psychosocial factors associated with the abandonment of breastfeeding prior to hospital discharge. *Journal of Human Lactation*, 17(1), 24-30.

StataCorp. 2011. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP.

Williams, P. L., Innis, S. M., Vogel, A. M., & Stephen, L. J. (1999). Factors influencing infant feeding practices of mothers in Vancouver. *Canadian journal of public health. Revue canadienne de sante publique*, 90(2), 114.

## Appendix A: WIC and Other Child Health Outcomes (Essay Two)

The modern relevancy of WIC depends on the differences between infant nutritional deficiencies in the 1970's and today, and whether child health is indeed improved by participation in the program. The majority of studies on WIC and well-being concern birth weight, obesity and malnutrition in both children and their mothers. In the 1980's, numerous researchers worked to evaluate the efficacy of the WIC program in terms of birth outcomes. In 1984, Kennedy and Kotelchuck, using a case-control approach matching on a host of demographic characteristics, estimated an average treatment effect of 107 grams for WIC-mothers versus non-WIC mothers. This effect was stronger for non-white and low-educated mothers. This approach, however, is vulnerable to selection bias on unobservable characteristics—a problem endemic in the study of WIC and infant well-being. More recent research has attempted to address the threats of selection on unobservables by exploiting the random roll-out of the program as an instrument for WIC uptake. In 2009, Hoynes, Page and Stevens assessed that, using the variation in roll-out by county, WIC increased mean birth weight among eligible women by approximately 10 grams (Hoynes et al., 2009). The estimated impact of the WIC program on child well being is only as valid as the outcome measured. In this case, the increases in birth weight associated with the program, while statistically significant, are small considering the average birth weight of a child in the 1970's was roughly 3500 grams (Tanner & Thomson, 1971). There is also reason to doubt the validity of birth weight as a measure of health outcomes for infants in the normal weight range, as the majority of work on birth weight and life course outcomes focuses on “very low birth weight” infants (<1500 grams). The work of Behrman and Rosenzweig (2004) finds that the impact of birth weight on child and adult health varies across the weight spectrum, and that care should be taken when interpreting birth weight as a health outcome in and of itself (Behrman & Rosenzweig, 2004)

In 2009 Figlio, Hamersma and Roth, estimated that WIC had a statistically insignificant effect on mean birth weight and gestational age, but did reduce the likelihood of adverse birth outcomes such as the probability of having a low birth weight baby (Figlio et al., 2009). This study used longitudinal data from Florida to focus on families tightly distributed around the eligibility cutoff point. The researchers, similar to Hoynes and her group, exploit random changes to the program that only affected families around this eligibility threshold. Gueorguieva, Morse and Roth (2008) found a small but significant negative relationship between length of prenatal WIC participation and risk of delivering a small for gestational age (SGA) infant. In 2007, El-Bastawiisi and colleagues in Washington State found a protective effect of prenatal WIC participation against birth complications and fetal death, most significantly for women labeled “high-risk”. This included women with prior abortions, those receiving no or inadequate prenatal care, and those with less than a 12<sup>th</sup> grade education. The results from these papers indicate that prenatal WIC participation may guard against unhealthy pregnancies, and that the effect of WIC may be strongest among those who are more likely to experience poor birth outcomes.

These studies focus on the relationship between prenatal WIC participation and birth outcomes. Quasi-Experimental studies focusing on the long-term health effects of childhood WIC participation are scant, but work published in 2004 found a decreased likelihood for childhood obesity *after* age five associated with WIC participation at age four (Bitler & Currie, 2004). The authors exploited state-level variation in Medicaid and WIC cutoffs to isolate causal

impacts—they instrument for WIC participation in year four using Medicaid cutoffs in year one. The mechanisms for the negative relationship between WIC and obesity are posited to rely on the monthly visits to the WIC clinic, especially in so far as those visits increase the likelihood of well-child pediatric visits. According to Janet Currie, in an earlier work, the food provisions of the WIC program are “merely a carrot” to get families speaking to health care workers (Currie, 1994).

## **Appendix B: Survey Instrument (Essay Three)**

We thank you for participating in this survey of mothers who have delivered their baby(ies) prematurely. The goal of our study is to learn more about nutrition, specifically regarding breast milk, for premature infants. This is a two-part survey, the first part which is in your hands, and the second to be completed just before your baby(ies) are discharged home. The survey responses are anonymous and you are free to skip any questions or quit at any time. All identifying information will be erased after this survey is combined with your child's medical information, and our research will never include your or your child's name. We ask that you complete the current survey in the next day or two, place it in the envelope provided and return it to the person who gave it to you (the study coordinator at your hospital) or place in a U.S. mailbox. If you should have any questions regarding our research study, please contact Dr. Henry Lee at (650)580-2963 or email [LeeHC@peds.ucsf.edu] or Ms. Sarah Martin-Anderson at (510)863-4657 or email [sarahm\_a@berkeley.edu].

Thank you for participating in our survey study!

**Please note: If you have given birth in the past, please respond regarding the children you have just recently delivered.**

- For each of the following statements, indicate how much you agree or disagree by circling the number that is closest to how you feel. (1=strong disagreement, 2=disagreement, 3=neutral, 4=agree, 5=strong agreement)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The nutritional benefits of breast milk last only until the baby is weaned	1	2	3	4	5
Formula feeding is more convenient than breastfeeding	1	2	3	4	5
Breastfeeding increases mother-infant bonding	1	2	3	4	5
Formula feeding is the better choice if the mother works outside the home	1	2	3	4	5
Breast milk is the ideal food for babies	1	2	3	4	5
Fathers feel left out when a baby is breast fed	1	2	3	4	5
A mother who occasionally drinks alcohol should not breastfeed her baby	1	2	3	4	5
Breastfeeding is less expensive than formula	1	2	3	4	5

The following questions refer to thoughts, decisions and actions BEFORE you came to the hospital to deliver your baby:

2. BEFORE you delivered your baby, which of the following people talked to you about the need to pump breast milk for your premature baby? Check all that apply.

- Your Doctor
- A Nurse
- Your baby's doctors
- WIC Staff
- Lactation consultant
- Nutritionist / Dietitian
- Social Worker
- Childbirth Educator

3. BEFORE you came to the hospital, where had you learned about breast milk? Check all that apply.

- I didn't know much about breast milk
- From my mother
- From my sister
- From another family member (aunt, cousins, etc)
- From a friend
- From doctor's appointments
- From a class for future mothers
- From magazines
- From books
- From the internet
- From advertisements for infant formula
- From TV
- From school
- From a WIC Staff Member
- Other (Please Name): \_\_\_\_\_



4. BEFORE you came to the hospital to deliver your baby, what had you decided to feed your baby?

- I was planning on feeding my baby just breast milk
- I was planning on feeding my baby just formula
- I was planning on feeding my baby both breast milk and formula
- I had not decided what to feed my baby

5. BEFORE you came to the hospital to deliver your baby, what did you think about the process of breast milk feeding? Check all that apply.

- I thought it would be difficult
- I thought it would be easy for me
- I thought it would be inconvenient
- I didn't really think about it
- I thought it wouldn't be too hard
- I thought it would be painful

**The following questions refer to thoughts, decisions and actions AFTER you came to the hospital to deliver your baby:**

6. What are some of the things that helped you decide what to feed your baby? Check all the apply.

- Conversations with friends
  - Conversations with family
  - Conversations with my child's other parent
  - Things I've read in the newspaper
  - Scientific articles
  - Advertisements for infant formula
  - TV / News
  - Classes
  - Conversations I had with a doctor after coming to the hospital
  - Conversations with nurses or other staff at the hospital
  - Conversations with WIC Staff
  - Other (PLEASE SPECIFY):
- 

7. AFTER you delivered your baby, which of the following people talked to you about the need to pump breast milk for your premature baby? Check all that apply.

- Your doctor
- Your own (mother's) Nurse
- Your baby's Nurse
- Pediatrician or Neonatologist
- Lactation consultant
- Nutritionist / Dietitian
- Social Worker
- WIC Staff

8. NOW, what do you think about breast milk compared to infant formula for babies born at FULL TERM (9 months)?

- I don't know much about breast milk
- I think infant formula is better than breast milk for term babies
- I think breast milk is better than infant formula for term babies

9. NOW, what do you think about breast milk compared to infant formula for babies born PREMATURELY?

- I don't know much about breast milk
- I think infant formula is better than breast milk for premature babies
- I think infant formula affected premature babies the same as for term babies
- I think breast milk is better than infant formula for premature babies

10. Have you pumped breast milk for your baby?

- No → SKIP to question 14
- Yes

11. How do you feel about the amount of milk that you are producing?

- It doesn't seem like enough milk for my baby
- It seems about right for my baby
- It seems like more milk than my baby needs
- I don't know

12. How do you feel, overall, about pumping breast milk?

- I don't like pumping, but I know I will continue doing it
- I don't mind pumping
- I enjoy pumping
- I don't like doing it and I want to quit

13. About how many times a day are you pumping breast milk? \_\_\_\_\_

14. Did your mother breastfeed you?

- Yes
- No
- I don't know

15. How many close family members or friends do you know who have breastfed their children?

\_\_\_\_\_

16. How many close family members or friends do you know who have delivered a baby prematurely? \_\_\_\_\_

17. Do you have other children (apart from the baby or babies you just delivered)?

- No → SKIP to question 20
- Yes

18. Did you provide breast milk for any of your other children?

- Yes
- No

19. For how long did you breastfeed your other children? (Example for multiple children: *18 months; 3 weeks; 2 years*)

\_\_\_\_\_

20. Do you have any medical conditions that prevent you from providing breast milk?

- Yes If yes, which condition? \_\_\_\_\_
- No

21. Have you been able to nurse your child at the breast?

Yes → SKIP to question 23

No

22. If not, what are the reasons you have not been able to nurse your child at the breast? Check all that apply

My child is still too weak to nurse at the breast

I am not comfortable with it yet

Nobody has asked me if I want to

I don't know

Other (Please Specify): \_\_\_\_\_

23. Have you been able to have skin to skin contact (kangaroo care) with your baby since they were admitted to the NICU?

Yes → Skip to question 25

No

24. If not, what are some reasons why you have not been able to have skin to skin contact with your baby?

Baby is still too weak

I am still too weak

I am not comfortable with it yet

I am scared to do that

Nobody has asked me to do that

25. How old were you on your last birthday? \_\_\_\_\_

26. Do you or your other children participate in the Supplemental Nutrition Program for Women, Infants and Children (WIC)?

- Yes, I (the mother) am currently enrolled
- Yes, at least one of my other children are currently enrolled
- No, none of my family is enrolled

27. Does your family currently receive food stamp benefits (FSN or SNAP program)

- Yes
- No
- Don't Know

28. Are you Spanish/Hispanic/Latino?

- Yes
- No

29. What is your race? (Mark all that apply)

- White
- Black or African American
- American Indian or Alaska Native
- Asian or Pacific Islander
- Other race: \_\_\_\_\_

30. Do you speak a language other than English at home?

- Yes → What language? \_\_\_\_\_
- No

31. Do you currently rent or own your home?

- Rent
- Own
- Other: \_\_\_\_\_

32. Where were you born? (Write City and State. If born outside the USA, write the country)

---

33. In what zip code do you currently live? \_\_\_\_\_

34. What is your marital status?

- Never married
- Married / in a relationship
- Widowed
- Divorced
- Separated

35. What is the highest degree or level of school you have completed?

- Less than high school
- High school diploma
- Some college
- College degree
- Post-graduate degree

36. What category best describes your MONTHLY income? Include all wages, unemployment insurance payments, paid family leave, or government cash benefits (SSI or TANF). Do not include food stamps, medical subsidies or other non-cash benefits.

- 0-1,500
- 1,501-2,500
- 2,501-4,000
- 4,001-6,500
- 6,501-9,000
- 9,001 or More

That's the end. Thank you for participating in this survey!