HEALTH CARE SYSTEM CHARACTERISTICS ASSOCIATED WITH POSTPARTUM CONTRACEPTIVE UTILIZATION, BIRTH SPACING AND SHORT INTERPREGNANCY INTERVALS AMONG PRIVATELY INSURED WOMEN IN NORTH CAROLINA

Regina Irene Rutledge

A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Health Policy and Management in the Gillings School of Global Public Health.

Chapel Hill
2016

Approved by:

Marisa Elena Domino

Amy Bryant

Stacie Duzetcina

Kristen Hasmiller-Lich

Pam Silberman

ABSTRACT

Regina Irene Rutledge: Health Care System Characteristics Associated with Postpartum Contraceptive Utilization, Birth Spacing and Short Interpregnancy Intervals Among Privately Insured Women in North Carolina
(Under the direction of Marisa Domino)

Objective: To determine if provider characteristics or rural geography affect the timing of postpartum contraceptive, method of postpartum contraceptive, or incidence of short interpregnancy intervals among privately insured women in North Carolina.

Methods: Using administrative claims data from a large, private insurer, we used two-stage residual inclusion and logit modeling to determine when a woman began a contraceptive, the likelihood that the contraceptive she began was a long-acting reversible contraceptive, and how these behaviors affected the probability of a subsequent live birth within 27 months of delivery. Our key independent variables were whether a woman received maternity care from a provider affiliated with an obstetrics/gynecology residency program, the provider's specialty, and whether or not a woman lived in a rural area.

Results: Receiving maternity care from a provider affiliated with an OB/GYN residency program was slightly negatively associated with contraceptive initiation within 3, 6 and 12 months postpartum and had no effect on a woman's probability of using a long-acting reversible method or having a subsequent short interpregnancy interval. Provider specialty did not have an affect on a woman's timing of contraceptive initiation nor the probability of having a short interpregnancy interval. Living in a rural area had no effect on timing to postpartum

contraceptive, type of postpartum contraceptive or probability of having a short interpregnancy interval to subsequent live birth.

Conclusions: While we hypothesized OB/GYN providers and providers associated with an OB/GYN residency program would increase the probability of a woman initiating contraceptives within 12 months and use LARC more often than other providers, our findings did not support this. Among women with consistent insurance coverage during the postpartum period, short interpregnancy intervals were common. Controlling for characteristics associated with her provider, the facility where she received care, and the demographics of the area in which she lives, the strongest predictor of whether a woman would have a short birth interval is the type of contraceptive she uses in the postpartum period. Women using a long-acting method versus a short-acting method were significantly less likely to have a short interpregnancy interval to their next birth.

Key words: contraceptive, postpartum contraception, long-acting reversible contraceptives, interpregnancy intervals, birth spacing

To my parents, Roy and Rhonda Rutledge, for a lifetime of compassionate parenting and relentless encouragement.
(And RosDog).

ACKNOWLEDGEMENTS

This work was made possible by the support of numerous people, none more so than my advisor and Chair Marisa Domino. Thank you for your constant encouragement, guidance, mentorship and most importantly belief in the value of this work. I consider myself immeasurably fortunate to have had the opportunity to learn from you and look forward to calling you colleague in the coming years.

The other members of my committee were also paramount to the success of this project. Amy Bryant, thank you for being a tireless advocate of women's health and reproductive justice. Your clinical eye kept this work grounded in practice and focused on work that can produce meaningful change for women. Stacie Dusetzina, your wisdom, investment in this area of research and wit were critical to my successes. Kristen Hasmiller-Lich, thank you for providing thoughtful feedback, technical guidance and a new way to think about data. Finally, thank you Pam Silberman for putting it all in perspective and encouraging me to produce research with the intent of making meaningful change for our communities.

I am thankful for the collaboration of Blue Cross and Blue Shield of North Carolina during this project. I was particularly fortunate to have had Alice Fortune-Britt as a mentor and liaison during this project.

In addition to my committee, I had the privilege to form strong relationships with two additional faculty members in the department. Mark Holmes, I have thoroughly enjoyed working with you the last couple of years and learning from your sharp mind. You have given me great comfort and confidence that my career can be filled with excellent research, the respect of my

peers, and my fun-loving personality all at once. Morris Weinberger, you are the heart and soul of this program. You provided a space for me to not only become a strong researcher but also a better version of myself. Thank you for seeing the potential in me and fostering it though these years.

I am grateful to have progressed through the doctoral program surrounded by wonderful classmates and future colleagues. I am confident each of you will go on to do incredible things in all areas of health services research. I am thankful to have shared your laughter through these years and look forward to working with you in the coming years.

I was privileged to work as a member of the North Carolina Rural Health Research team during my time at UNC. First and foremost, I want to thank Mark Holmes for offering me such an opportunity to work amongst a talented group of people who believe in having fun. To the faculty and staff, I have had the joy of working with-- George Pink, Kristin Reiter, Kristie Thompson, Sharita Thomas, Julie Perry, Steve Rutledge, Randy Randolph, and Denise Kirk-- thank you for fostering an environment of great work filled with plenty of laughter. Finally, and with the most affection possible, I want to acknowledge my bunkermates. Rebecca Whitaker, Brystana Kaufman, and Dunc Williams- you made coming to work fun. Rebecca, the five-foot dinosaur on my desk was the highlight of my year. Thank you for becoming my kindred soul by challenging me intellectually while speckling in just enough random pop culture references to keep me intrigued. Please take care of Ron. Brystana, you are among the most talented colleagues I have ever met. I know your future is full of bright opportunities and selfishly hope that some will include our collaboration. Dunc, you are among a very special group of people in my life of highest moral caliber. Your commitment to treating people with the highest respect

and dignity inspires me to a be better. Your ability to smoke meat perfectly also make me certain our friendship will be long-lasting.

I want to extend my most heartfelt gratitude to my chosen family and friends. Thank you, Drew Ulrich, for being my best friend though all of my adult life and loving me through all these years. Your support has never waivered. Ben Kirkley, you keep me humble and remind me that life is meant to be enjoyed. To my oldest friends, Tiffany Brogan Pressley, Tiffany Krenz, and Blair and James Weddington, thank you for keeping me grounded and in touch with the real world; Kari Keziah Helms, your snarky humor was poured all over this work from above. Joshua Evans, our lives are forever intertwined and I would not want it any other way. You remind me to live by kindness and compassion while pursuing adventure above all else.

To my friends who have endured the day in and day out of this process, your patience and encouragement has meant the world to me. To Amanda and Todd BenDor, Greg Boyer, Alison and Jason Brenner, Molly and Matt Calabria, Sarah Davis, Chris Dibble, Rebecca Dineen and Gena O'Keefe, Lauren Dunnington, Jenny Epstein, Rose Feinberg, Shoshana Goldberg, Dan Goulet, Bryna Harrington, Miriam Hartmann, Kelly Heath, Jenny and Josh Jones, Dio Kavaliertatos, Nikhil Kaza, Brandon Lewis, Rachel Machta, Derrick Matthews, Stefanie Murray, Suba Narisimhan, Nathan Nickel, Ashley Tyndall and Bill Lester, Emily Vander Schaff and Jim Baker, Laura and Aaron Winn, and Andra Wilkinson-- to each of you, I have unending affection and gratitude. This work has been conducted holding tight to the memory of Jamie Kirk Hahn, whose life and friendship continues to encourage me to have fun, eat good food and pursue justice every day.

In the words of Barney Stinson, "Whatever you do in this life, it's only legendary if your friends are there to see it." Thank you all.

I never knew how full life could be with a dog in it. RosDog, thanks for being he most neurotic and clingy writing partner possible.

Finally, to my family. Uncle Al, you were the first person I met with a graduate education and taught me to love school. I loved sparring with you over politics, health reform, or whether or not a movie was any good. Your heart and finger wagging is thoroughly wound into this project. Because of you, I have always embraced being weird. Aunt Pat, you are the second mother every person needs in life. Thank you for always showing up to every major event, teaching me that there is nothing better than a handwritten note, and providing so much support during these many years. I also, somewhat poorly, know how to properly set a table because of you.

Ryan, you are the most amazing, brilliant and witty big brother. My life has been made all the better having you in it. You were and remain just the perfect amount of heckler and protector to a sister. You have turned into an incredible friend, husband and father and given the chance to go back, I suppose I would choose to Vote Rutledge. I am very proud of you.

Laura, you are the sister I did not get by birth but thankfully received by marriage. Your sense of fashion is truly among the best I've ever seen. Bradley and Henry, you'll always be my favorites. (Note to any future nieces and nephews: you too will become my favorites upon arrival.)

Robert, the world is very lucky to have you. Thankfully for our family, all contraceptive methods have some risk of failure (see Table 1.3). You have grown up into a hilarious, smart, and warm man with a very bright future. Your career as a professional Spades player, however, is questionable at best. Thank you for keeping me humble and becoming such a good friend.

To my mother, Chief Petty Officer Rhonda Rutledge, USN (R): you have spent your life emulating what it means to be successful, strong, loving and fierce. You were a badass woman before it was socially acceptable. Thank you for raising me to be fearless.

To my father, Chief Petty Office Roy Rutledge, USN (R): you are the father every little girl in this world needs. You taught me to be brave, adventurous, but above all else, compassionate. Thank you for giving me the strongest foundation possible to call home when venturing out into this world.

To both of you, I owe every ounce of my success. Thank you for letting me quit ballet after a couple months, buying me a dangerous chemistry set that would lead to minor flesh wounds, showing up to every softball game and concert, and moving me in the rain every time I asked. You fostered my curiosity for science, learning, travel and public health always. You sacrificed a lot for me to be here and none of that has been lost on me. Thank you for it all and more. I love you both.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

2SRI	Two-stage residual inclusion
ACOG	American Congress of Obstetricians and Gynecologists
AIC	Akaike information criterion
ANC	Antenatal Care
BIC	Bayesian information criterion
COC	Combined oral contraceptive
CDC	Centers for Disease Control and Prevention
CPT	Current Procedural Terminology
Cu-IUD	Copper intrauterine device (e.g. ParaGard)
DMPA	Depot medroxyprogesterone acetate (e.g. Depo-Provera)
FDA	Food and Drug Administration
IIA	Independence of irrelevant Alternatives
IPI	Interpregnancy interval
IPTW	Inverse probability of treatment weights
IRB	Institutional Review Board
IUD	Intrauterine device (can refer to both hormonal and non-hormonal methods)
IUS	Intrauterine System (hormonal intrauterine device)
LARC	Long-acting reversible contraception
Lng-IUD	Levonorgestral intrauterine Device (e.g. Mirena, Skyla)
NCHA	North Carolina Hospital Association
NPI	National provider identifier
OCP	Oral contraceptive pill

PNC	Prenatal care, perinatal care
POP	Progestin only pill
PRAMS	Pregnancy Risk Assessment Monitoring System
RRP	Short interpregnancy interval
SARC	Short-acting reversible contraception
VBAC	Vaginal birth after caesarian
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

Specific Aims

Modern contraceptives have led to a dramatic reduction in unintended pregnancies, teen birth rates, and poor infant outcomes since their introduction (1). Despite highly effective contraceptive interventions, half of all births in the United States are unintended and almost half of these are unwanted(2). Postpartum contraceptive initiation is a critical component of family planning and healthy birth spacing. However, in a recent study in California among women with contraceptive coverage, only 41% of women had a contraceptive claim within 90 days postpartum(3). Short birth intervals are associated with numerous poor outcomes for both women and infants(4). While there are multiple definitions of short birth spacing, this study will use the most common indicator of any higher order pregnancy that is conceived within 18 months of the end of a previous pregnancy. The Centers for Disease Control and Prevention identified the reduction of short interpregnancy birth intervals as a priority area by proposing a national reduction of 10% as a Healthy People 2020 objective(5). Prior studies have investigated the relationship between maternal characteristics, postpartum contraceptive practices and short birth intervals but little evidence exists regarding the relationship between these factors and health system characteristics.

The objective of this dissertation is to examine the relationship between perinatal health care setting characteristics and postpartum contraceptive initiation, short interpregnancy intervals among privately insured women in North Carolina. My long-term goal is to identify the enabling

factors and barriers of health systems that affect women's timely initiation of postpartum contraceptive services. These findings will be used to develop institutional and health insurance policy revisions that could lead to reduced unintended pregnancies, short interpregnancy intervals, premature and low birth weight among women and children in North Carolina. I hypothesize that women who receive perinatal care in an urban setting or in a setting with a residency program in obstetrics and gynecology will be more likely to initiate contraceptives within 12 weeks of delivery. These women will also be more likely to initiate long-acting reversible contraceptives (LARC) rather than short-acting reversible contraceptives (SARC) and subsequently less likely to experience short interpregnancy intervals. The amount of insurance copayment for LARC insertion will be associated with any initiation. Rapid repeat pregnancies will have higher direct healthcare expenditures compared with adequately spaced births. I will use propensity score matching as well as an instrumental variable to address selection bias of both provider choice as well as contraceptive choice. The rationale of this study is to provide evidence to support revisions to existing institutional and insurance policies that may hinder the timely initiation of postpartum contraceptives.

Aim 1: Determine if perinatal health setting characteristics are associated with the timeliness and method of postpartum contraception initiation.

Hypothesis 1.1: Women who receive perinatal care in an urban setting or at within a setting that has an OB/GYN residency program are more likely to initiate any modern contraception within 12 weeks of delivery.

Hypothesis 1.2: Among women who initiate any contraceptive, women receive perinatal care in an urban setting or within a setting that has an OB/GYN residency program are more likely to initiate a long-acting reversible contraceptive.

This aim will use instrumental variables, 2SRI logistic regression analysis and nested multinomial logistic regression.

Aim 2: Assess if timely initiation and method of postpartum contraception are associated with timing of subsequent pregnancy and rate of short interpregnancy interval.

Hypothesis 2.1: Women who do not initiate contraceptives within 12 weeks of delivery are more likely to have a short interpregnancy interval compared with women who initiate any contraceptive.

Hypothesis 2.2. Among women who initiate any contraceptive within 12 weeks, those who initiate a SARC are more likely to have a short interpregnancy interval compared with women who initiate a LARC.

This aim will use instrumental variables, 2SRI logistic regression to measure incidence and timing of rapid repeat pregnancies.

Significance

This study will provide stakeholders with contemporary evidence that can be applied to policies and practices targeting improvements in family planning service provision and health outcomes while reducing healthcare expenditures. It will provide evidence describing the relationship between women, the settings in which they receive perinatal, postpartum contraceptive initiation practices and risk of short interpregnancy interval. Finally, it will use the characteristics, outcomes and costs of a real cohort of women to generate a simulation model to

demonstrate that a private insurance company can reduce poor health outcomes as well as costs to both the company and its members by increasing the proportion of women receiving both timely and long-acting postpartum contraceptive.

North Carolina's pregnancy related outcomes are often worse than the national average and show marked disparities across geographic regions. Many of the key indicators of pregnancy outcome are recorded by offices of vital statistics at the county, state and national level via certificates of live birth and fetal death certificates. The US Standard Birth Certificate includes demographic information on the mother and father of the child (a third partner can be identified for same-sex couples in some states) including place of residence, nativity, education, insurance coverage, maternal risk factors such as obesity and smoking, previous pregnancy outcomes, parity, gravidity. Labor and delivery indicators include location of delivery, attendant information, and, indications of facility transfer, indications of labor complications, and type of delivery. Birth outcomes information includes gestational age, birth weight, NICU admission, respiratory complications, congenital anomalies and proposed breastfeeding practices.(6) North Carolina has higher rates of very low birthweight, low birthweight, smoking during pregnancy, and infant mortality as well as lower maternal educational attainment as compared with the nation (Figure 1.1).

In North Carolina, women who live in micropolitan and rural areas are more likely to experience preterm birth and have low birthweight infants as compared with women in metropolitan areas (Figure 1.2) Pregnant women in non-metropolitan counties are also more like to smoke during pregnancy, be overweight or obese preconceptively, have a history of preterm birth and be grandmultiparous (have at least five previous live births) (Figure 1.2)(7).

While birth certificates offer a wealth of information about the facts regarding births, they do not provide critical information such as the intention or wantedness of pregnancies. Birth certificates do not provide information about the preconceptive contraceptive practices or assess if a potential contraceptive failure occurred. However, in 1987 the Centers for Disease Control and Prevention launched PRAMS, the Pregnancy Risk Assessment Monitoring System, to collect information systematically about aspects of pregnancy not typically included in standardized birth certificates or health records. PRAMS is conducted at the state level; state participation is not mandatory. The states that choose to participate select a sample the birth records for a year as potential participants. Some populations are oversampled so that higher risk groups are appropriate represented. Topics women are surveyed on are demographics, delivery characteristics, influenza vaccination practice, family planning, maternal health history and experiences, prenatal care and insurance coverage(8).

PRAMS remains the most generalizable and comparable dataset for comparing pregnancy intention, wantedness, and postpartum contraceptive initiation. Among postpartum women of North Carolina surveyed in 2008, they were more likely to to report their last pregnancy to be unintended and unwanted pregnancy yet also were not using contraception despite not wanting to become pregnant again. Additionally, North Carolina women who were not using contraceptives in the postpartum period were more likely than the US sample to report their reason for not using contraceptives were already being pregnant (indicating a short interpregnancy interval) or not being able to afford contraceptives. While the US PRAMS sample indicated 5.1% of women did not use postpartum contraceptives because they could not afford them in 2008, more than 12% of North Carolina women sampled they could not afford them(9).

Short birth intervals are associated with poor health outcomes and higher costs to the health care system. The evidence regarding the relationship between short birth intervals and poor maternal and child health outcomes is expansive. The most commonly cited poor health outcomes for women associated with short birth spacing are eclampsia (10,11), anemia (12–14), uterine rupture (15–17), third trimester bleeding (12), premature membrane rupture (10,18), puerperal endometriosis (12,18), placental previa (19), and maternal death (12,20,21). Conde and colleagues conducted one of the largest cross-sectional studies of interpregnancy spacing and maternal health outcomes with 456,889 parous women between 1985 and 1987. Their study suggests uterine rupture was present in 4.8% of women who conceived within 12 months of previous pregnancy but only.9% among women with an interpregnancy interval of more than 24 months(4). Compared with women who had an interpregnancy interval between 18-23 months, women who conceived within 6 months of delivery had an increased risk of mortality (adjusted OR 2.5; 95% CI 1.2-5.4)(4). Table 1.1 below shows the adjusted relative risk of women with adverse maternal outcomes by their interpregnancy spacing interval. Adjustments were made for maternal age, parity, demographics, and health characteristics.

The most commonly cited poor health outcomes for children are low birthweight, preterm birth (18,20–27), small for gestational age (18,22,24,26,27), intrauterine growth restriction (28), stunting (29–33), underweight, low height for age, low weight for height (30,33–37), miscarriage (20,38), fetal death (21,38–40), and neonatal, infant and early childhood mortality (20,21,33,38–40). Preterm birth, low birthweight and small-for-gestational age are all associated with both poor proximal and long-term birth outcomes for infants include physiological malformations, respiratory problems, sensory deficits, cognitive development delays and death(41,42). Table 1.2 shows the adjusted odds of the most common adverse infant outcomes comparing those

conceived within six months of previous delivery and those with birth spacing between 18-23 months.

In 2005, the World Health Organization (WHO) released a comprehensive technical report detailing the poor outcomes associated with short birth intervals. After reviewing the seminal literature and congregating thirty of the world's leading experts on interpregnancy spacing, guidance was introduced recommending an interpregnancy period of no less than 24 months(43). The American Congress of Obstetricians and Gynecologists recommends women in the United States have an interpregnancy period no less than 18 months citing increased risks of preterm birth, low birth weight and small-for-gestational age(44). Evidence suggests that there is a dose-response phenomenon to postpartum spacing and secondary conception. While conception is contraindicated for up to 24 months postpartum, conception within with the first six months postpartum has the highest risk for perinatal mortality, preterm birth, low birthweight, and fetal death is highest(43). The risk for these outcomes remains significantly elevated through months 7-18. According to ACOG, in month 18 postpartum, secondary conception is considered healthy. However, the World Health Organization maintains a more conservative estimate using 24 months postpartum(43,45,46).

Inadequate birth spacing is both common but easily preventable. In 2013, analysis of the National Survey of Family Growth determined that among the second or higher order births within the sample, 35% occurred within 18 months of a previous pregnancy. After controlling for demographic, social and parity characteristics, short birth intervals were significantly associated with adolescent age, being married and pregnancy being unintended. Additionally, researchers estimate that eliminating unintended pregnancies would reduce the proportion of pregnancies

within a short interval from 35% to 23%(47). Low educational attainment and use of less effective contraceptive during the postpartum period are associated with increased risk of unintended short interpregnancy interval(48). A study of women in California found that 47% of pregnancies in the postpartum period were unintended. There are significant variations in unintended pregnancy in the postpartum period across racial and ethnic groups. Unintended rapid repeat pregnancies were significantly associated with being African-American, US-born Latina, unmarried, adolescent, high parity (greater than five live births) and history of recent abuse. Women who were uninsured before pregnancy also had increased odds of having an unintended pregnancy(49).

It is estimated that half of all women leave labor and delivery without any plan for postpartum contraception(46) and that early postpartum contraceptive initiation is key to long-term use and prevention of unintended pregnancy(50). The Centers for Disease Control and Prevention has considered the risks of postpartum contraceptive initiation and established recommendations detailed below in Table 1.3. In this table, it is clear that intrauterine contraceptives, subdermal implants, progestin only pills, and injectable contraceptives are recommended in the postpartum period as the advantages and benefits of initiating the method outweigh the theoretical or proven risk for both breastfeeding and non-breastfeeding women (exceptions in the event of puerperal sepsis). It is not advised for women, both breastfeeding and not, to initiate estrogen-containing contraceptives such as the combined oral pill, the patch or the ring in the early postpartum period due to risks associated with the circulatory system(51).

A 2005 study using New Mexico's Pregnancy Risk Assessment Monitoring Survey (PRAMS) found that women who had a postpartum visit had three times the odds of initiating a contraceptive during the postpartum period(52). Another 2005 study found that among 712

women who expressed desire for immediate postpartum sterilization, 46% never received it. The most commonly cited factors associated with not receiving requested permanent contraception were young age, being African American or having a vaginal delivery(53). In light of this, the need for timely non-permanent contraceptive options is critical. The traditional timing of the first postpartum visit is considered six weeks however recent research has suggested it should be shortened to three weeks to allow for early initiation of postpartum contraception(54). Receipt of contraception at the first postpartum visit is significantly associated with increased birth interval spacing after controlling for demographic factors(3). As such the same researchers proposed a new paradigm they call the Rules of 3 that suggest i) If a woman is exclusively breastfeeding her infant, a contraceptive method should be used within 3 months postpartum ii) If a woman is partially or not breastfeed at all, a contraceptive method should be used within 3 weeks postpartum. The additional third suggestion is similar but addresses women who have elective or spontaneous abortions and are therefore beyond the scope of this proposal(54).

Short-acting reversible contraceptives have high failure rates, poor adherence and low satisfaction rates. Short-acting reversible contraceptives (SARCs) that require consistent user intervention such as the pill, patch or ring, all have failure rates of at least 9% in the first year of use. While effectiveness rates of 91% are high, these methods account for more than 30% of all contraceptive users in the United States. In any given month, 38% of women using oral contraceptive pills (OCP) miss at least one dose. Nearly 1 million pregnancies can be estimated to occur each year among American women relying exclusively upon oral contraceptive pills as their family planning method of choice; male condoms are only slightly higher at 1.15 million unintended pregnancy events per year(55). Nearly half of oral contraceptive pill users report not

being satisfied with their method; dissatisfaction is highly correlated with misuse and discontinuation with adequate replacement(55). Among women studied in 2011 for the North Carolina Pregnancy Risk Assessment Monitoring System, 29.3% of women in the postpartum period rely on pills to prevent pregnancy.

Long acting reversible contraceptives are highly effective, cost effective and underutilized by women in the North Carolina. Long acting reversible contraceptives (LARCs) include intrauterine contraceptives and subdermal implants. LARCs are more than 99.9% effective once placed by a medical provider and require no patient action until desired removal. Subdermal implants are effective for up to three years and intrauterine devices are effective between 5-15 years, depending on the method chosen. LARCs can be removed at any point by a provider with minimal effects on immediate fertility and no effect on long-term fertility(1). Once placed, a woman has protection from pregnancy that is more effective than nonreversible tubal ligation(56). Evidence shows that women who have a LARC placed and maintain it for six months have satisfaction rates of over 80%, compared to 54% of oral contraceptive pill users(57). In December 2009, the American Congress of Obstetricians and Gynecologists sent waves throughout family planning communities with their overwhelming endorsement of long-acting reversible contraceptives (LARCs). "According to the World Health Organization's evidence-based Medical Eligibility Criteria for contraceptive use, LARC methods have few contraindications, and almost all women are eligible for implants and intrauterine devices. Because of these advantages and the potential to reduce unintended pregnancy rates, LARC methods should be offered as first-line contraceptive methods and encouraged as options for most women"(58). The Congress reaffirmed this document again in 2011 and supplemented

once again in October 2012 with additional explicit supports for adolescents and women in the postpartum and postabortion period(59).

Possibly the most influential reason that LARCs are the most highly effective contraceptive methods is the lack of effort required by users to continue near perfect protection; a number of professionals call LARCs “Forgettable Contraceptives”. A recent study conducted at Washington University in St. Louis, *The Contraceptive Choice Project*, has shed great light on contraceptive satisfaction and continuation rates across both long and short-acting methods. Among 5,000 sexually active women who were given adequate education of all available methods and for whom all expenses were covered, 69.9% of women chose to use a LARC. Women using the LARCs had the highest continuation rates among reversible methods at 87% and were more likely to report being satisfied with their method compared with OCP users(57). Long-acting reversible contraceptives have been specifically identified as the most promising intervention to prevent short interpregnancy interval(60). Figure 1.3 shows the failure rates for each method(61). In 2008, 30% of women in the postpartum period relied on a contraceptive method with a failure rate of greater than 20% within the first year of use(9).

Long-acting methods have also been shown to be more cost-effective than short-acting methods. Trussell and colleagues used a comprehensive Markov model to simulate five year costs of contraceptive by incorporating not only the cost of the method but costs of providers, side effects and failure events into their analysis. They calculated total costs as well as the incremental cost effectiveness of methods over a five-year period. The intrauterine devices are the least costly reversible methods (Cu-IU $647, Lng-IUD $930) will oral contraceptive pills cost $3381 (62).

Most research has focused on maternal characteristics and insurance status as the primary factors associated with postpartum contraceptive initiation. Previous research has focused only on maternal characteristics such as age, race, education attainment, religious affiliation, previous pregnancy, previous abortion and insurance status(2,50,63–65). In a study using New Mexico's PRAMS data, postpartum contraceptive initiation was significantly associated with being between the ages of 20-34, being married, having at least a high school education, being white, and having a postpartum visit(52). However, in a small telephone survey of postpartum women in the United States, being black, not having a college education and a household income of less that $40,000 was significantly associated with increased probability of receiving antepartum contraceptive counseling(50). These differences produced within the same year highlight the need for more rigorous, comprehensive analysis of postpartum contraceptive initiation behaviors as is possible through a large insurance claims dataset. This analysis will include many of the previously examined maternal covariates among a privately insured population while also introducing attributes of providers and health care settings to further explain the relationship between women and the postpartum contraceptive practices.

This study expands upon the limited existing literature that demonstrates contraceptive utilization is associated with provider and perinatal care characteristics. While previous studies have examined the relationship between providers and their contraceptive counseling and prescribing patterns, study populations have been small and often convenience samples. The findings, however, have shared similar trends and have motivated the need for a larger, more comprehensive analysis. Thus far, evidence suggests younger providers, female providers and providers trained in obstetrics and gynecology are most likely to be knowledgeable about

updated contraceptive practice and more likely to provide long-acting methods (66–68). Small, qualitative studies have also found that many family medicine practitioners are not adequately trained in family planning; there are currently multiple national initiatives underway to improve family medicine practitioners' knowledge and skills related to all contraceptives with an emphasis on long-acting methods(69,70). Patient-provider miscommunication about contraceptive effectiveness is believed to be strongly associated with misuse, discontinuation and subsequent unintended pregnancies(67). This research will be among the first large, quantitative projects to assess the role of provider characteristics with respect to postpartum contraceptive initiation and short interpregnancy interval among privately insured women throughout an entire state.

Additionally, there is evidence that characteristics of the facility where women receive perinatal care are also associated with postpartum contraceptive initiation practices. Women who receive perinatal care in rural areas of the United States lack comparable reproductive health services as compared to urban women; factors such as poverty, geographic isolation, insufficient numbers of appropriately trained providers, lack of transportation and lower rates of insurance are all thought to be contributors. Rural women are less likely to receive prenatal and postpartum care(71). Women in rural communities are also more likely to face the inability to acquire prescription contraceptives if local pharmacists refuse to dispense due to their own moral objections(72,73). Women in rural areas are less likely to rely upon reversible contraceptive methods yet more likely to rely on permanent sterilization as compared with women in metropolitan areas(74,75). This may be related to challenges women in rural areas face reliably accessing highly-effective reversible contraceptives.

For these reasons, there is an established gap in the literature describing the relationship between perinatal care provider, care setting, timely association of postpartum contraceptive initiation and short interpregnancy interval. There is clear evidence that in North Carolina, postpartum contraceptive initiation and birth spacing are problematic and may be contributing to poor birth outcomes described in the literature.

Innovation

The novelty of this study is that the key factors of interest are characteristics of the providers and settings in which women receive perinatal and delivery care. This research will look at women as active participants within health systems and examine the role between health care setting characteristics and postpartum contraceptive initiation while controlling for common demographic factors such as age, education, marital status and parity - all traits associated with contraceptive utilization. Much of the contemporary research regarding postpartum contraceptive initiation has exclusively studied maternal characteristics, insurance coverage and pregnancy intentions. The proposed study uses only insured women, controls for personal and social characteristic, and views short interpregnancy interval as a poor health outcome for both women and children, regardless of intention. This allows analyses to be tailored to the perinatal health care setting and provider characteristics that may be instrumental in a woman's timely initiation of postpartum contraceptive. Furthermore, this analysis will provide a foundation upon which a major insurance network can explore the factors that may support or inhibit timely postpartum contraception and build evidence that may be used in future quality improvement efforts.

Additionally, the timeliness of this research is ideal. The Affordable Care Act recently enacted new laws affecting contraceptive coverage and out-of-pocket expenses for women on

August 1, 2012. Under the new legislation, insurance plans are required to cover all FDA approved contraceptive methods with no copayment (this includes pills, patches, rings, injectables, diaphragms, cervical caps and permanent sterilization)(76). This legislation has been contested across the country by employers and insurance plans citing religious and moral objection; the U.S. Supreme Court ruled that some religious employers and closely-held for-profit companies can withhold contraceptive benefits from their employers(76). One caveat and often described as a "loophole" to this legislation that has been seen in practice from insurance plans across the country is a large out-of-pocket copayment for long-acting reversible contraceptive "insertion fees". Copayment information for various plans and methods are available within this dataset and can be examined for discontinuity trends that may be the result of changing legislation. In particular, there may be obvious shifts in contraceptive practices after the legislation on August 1, 2012 such as increased utilization of any method or methods that previously has higher out-of-pocket expenses. I will need to consider and adjust for this potential discontinuity pattern should the data show significant shifts via a fixed effect model.

Tables and Figures

Table 1.1 Adjusted Relative Risk and 95% Confidence Intervals of Adverse Maternal Events by Interpartum Spacing Interval

	Postpartum Interval, in months					
	0-5	**6-11**	**12-17**	**18-23**	**24-59**	**≥60**
Third trimester bleeding	1.73* (1.42-2.24)	1.03 (0.91 - 1.16)	1.01 (0.88 - 1.14)	1	1.04 (0.96 - 1.14)	1.12 (1.00 - 1.24)
Premature rupture of membranes	1.72* (1.53 - 1.93)	1.04 (0.96 - 1.12)	1.02 (0.93 - 1.12)	1	1.08 (0.98 - 1.19)	1.03 (0.93 - 1.14)
Puerperal endometritis	1.33* (1.22 - 1.45)	1.04 (0.94 - 1.14)	1.08 (1.00 - 1.17)	1	0.99 (0.94 - 1.04)	1.04 (0.94 - 1.15)
Anemia	1.30* (1.18 - 1.43)	1.03 (0.95 - 1.12)	1.02 (0.96 - 1.09)	1	1.04 (0.99 - 1.10)	1.01 (0.97 - 1.05)
Maternal death	2.54* (1.22 - 5.38)	1.11 (0.53 - 2.28)	1.03 (0.56 - 2.22)	1	1.14 (0.63 - 2.41)	1.07 (0.71 - 2.71)

Source: Conde et al. (21)

Table 1.2 Adjusted Odds Ratio and 95% Confidence Intervals of Adverse Infant Events by Interpartum Spacing Interval

Table 3. Adjusted Odds Ratio and 95% Confidence Intervals of Adverse Infant Events by Interpartum Spacing Interval

	Postpartum Interval, in months	
	0-6	**18-23**
Low birthweight (<2501 grams)	1.4 (1.24-1.58)	1
Preterm birth (<37 weeks gestation)	1.61 (1.39-1.86)	1
Small for gestational age	1.26 (1.18-1.33)	1

Source: Conde et al. (21)

Table 1.3 Summary of recommendations and risk classifications* for hormonal contraceptive methods and intrauterine devices during the postpartum period

	COC/P/R	POP	DMPA	Implant	LNG-IUD	Cu-IUD
Postpartum (nonbreastfeeding women)						
a. <21 days	4	1	1	1		
b. 21 days to 42 days						
i. With other risk factors for VTE (such as age ≥35 years, previous VTE, thrombophilia, immobility, transfusion at delivery, BMI ≥30, postpartum hemorrhage, postcesarean delivery, preeclampsia or smoking)	3†	1	1	1		
ii. Without other risk factors for VTE	2	1	1	1		
c. >42 days	1	1	1	1		
Postpartum (breastfeeding women§)						
a. <21 days	4	2	2	2		
b. 21 to <30 days						
i. With other risk factors for VTE (such as age ≥35 years, previous VTE, thrombophilia, immobility, transfusion at delivery, BMI ≥30 kg/m^2, postpartum hemorrhage, postcesarean delivery, preeclampsia or smoking)	3†	2	2	2		
ii. Without other risk factors for VTE	3	2	2	2		
c. 30--42 days						
i. With other risk factors for VTE (such as age ≥35 years, previous VTE, thrombophilia, immobility, transfusion at delivery, BMI ≥30, postpartum hemorrhage, postcesarean delivery, preeclampsia or smoking)	3†	1	1	1		
ii. Without other risk factors for VTE	2	1	1	1		
d. >42 days	2	1	1	1		
Postpartum (breastfeeding or nonbreastfeeding women, including postcesarean delivery)						
a. <10 min after delivery of the placenta					2	1
b. 10 min after delivery of the placenta to <4 weeks					2	2
c. ≥4 weeks					1	1
d. Puerperal sepsis					4	4

Abbreviations: COC = combined oral contraceptives; P = combined hormonal patch; R = combined vaginal ring; POP = progestin-only pill; DMPA = depot medroxyprogesterone acetate; IUD = intrauterine device; LNG-IUD = levonorgestrel-releasing IUD; Cu-IUD = copper-bearing IUD; VTE = venous thromboembolism; CHC = combined hormonal contraceptive; BMI = body mass index (weight [kg] / height [m^2]).

* Categories: 1 = a condition for which there is no restriction for the use of the contraceptive method, 2 = a condition for which the advantages of using the method generally outweigh the theoretical or proven risks, 3 = a condition for which the theoretical or proven risks usually outweigh the advantages of using the method, 4 = a condition that represents an unacceptable health risk if the contraceptive method is used.

† Clarification: For women with other risk factors for VTE, these risk factors might increase the classification to a "4"; for example, smoking, deep venous thrombosis/pulmonary embolism, known thrombogenic mutations, and peripartum cardiomyopathy.

§ The breastfeeding recommendations are divided by month in *U.S. Medical Eligibility Criteria for Contraceptive Use, 2010*. They have been divided by days for purposes of integration with the postpartum recommendations.

Source: CDC (51)

Figure 1.1 Perinatal Risk Factors and Outcomes in North Carolina and the United States, 2013

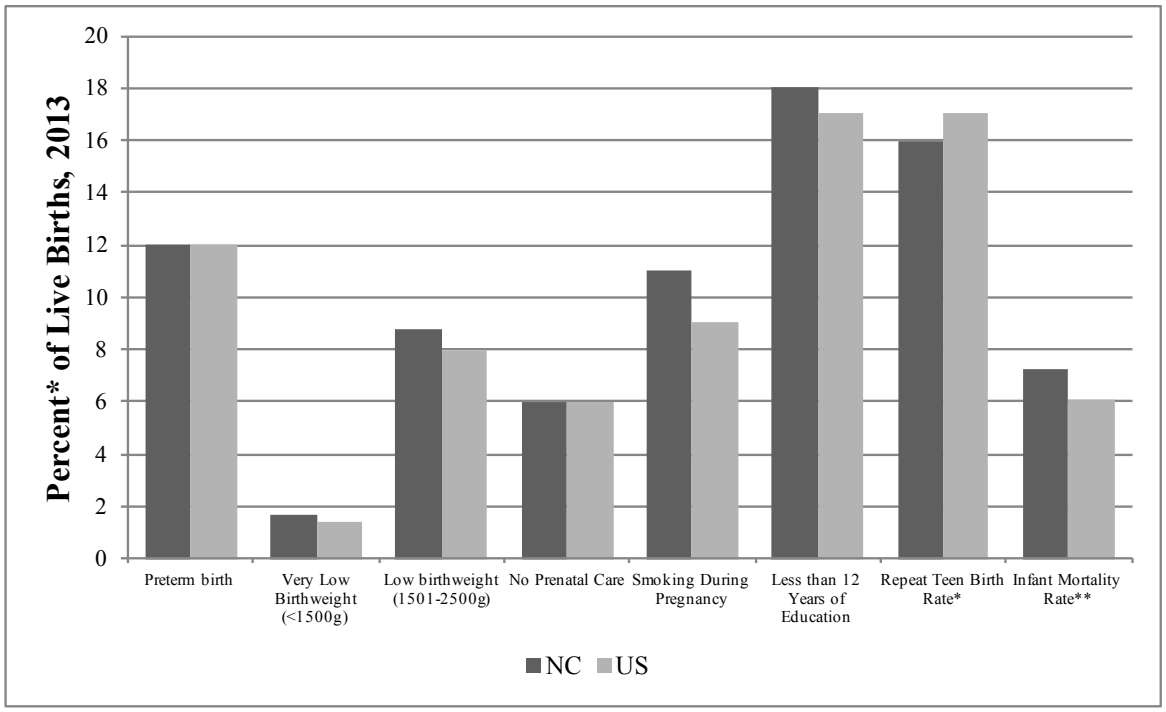


Figure 1.2 Pregnancy Risk Factors and Outcomes in North Carolina by Urbanicity, 2013

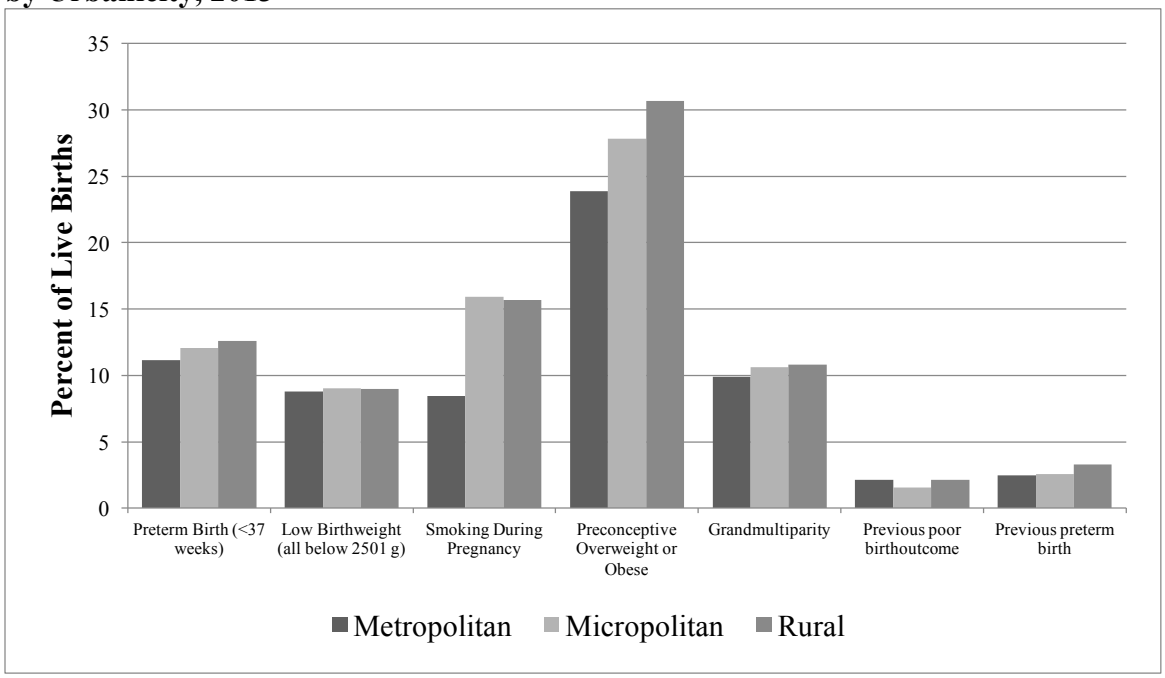
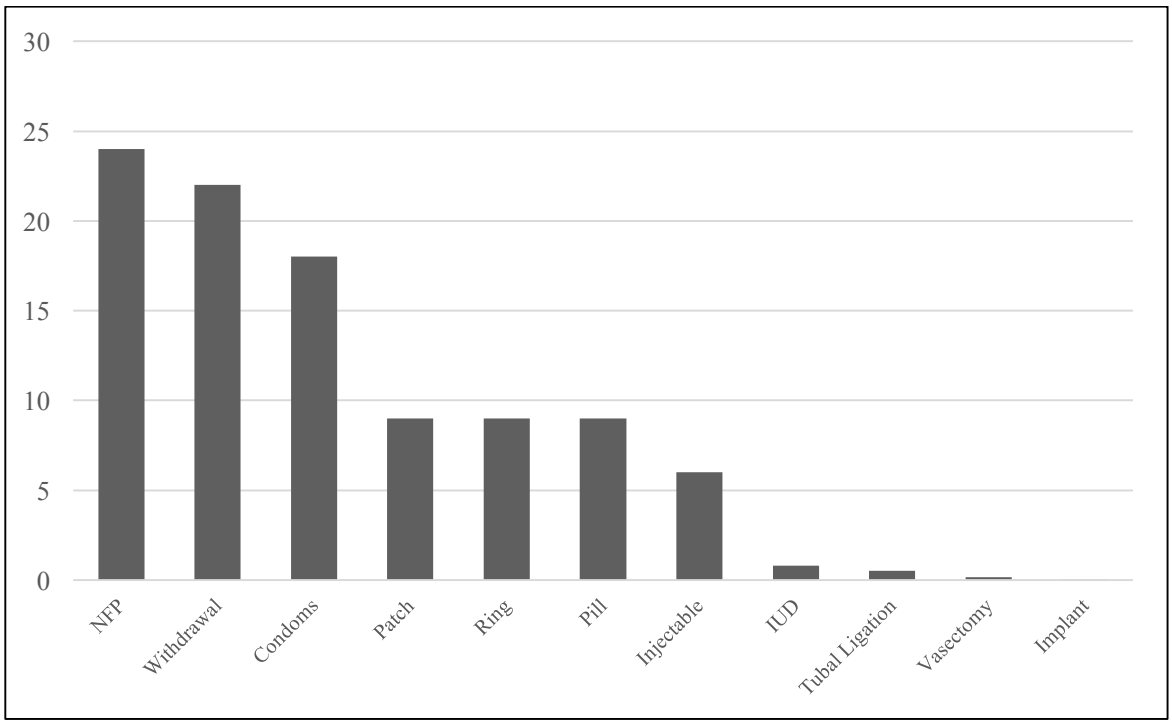


Figure 1.3 Twelve Month Contraceptive Failure Rates, by Method



Source: Contraceptive Technology (61)

CHAPTER 2: PROPOSED APPROACH

Overview and Rational

This research will address how key health system characteristics are associated with postpartum contraceptive initiation, initiation of highly effective contraceptive methods and the incidence of short interpregnancy interval among privately insured women in North Carolina. Prior literature has emphasized the role of individual characteristics as the key predictors of postpartum contraception initiation; this study will explore if health setting characteristics are strong predictors of postpartum contraceptive initiation and method of initiation after controlling for individual characteristics.

Conceptual Model

This project will utilize an adaptation to the Anderson Health Services Research Model. The model, originally developed in the 1960's, explores health care utilization by examining the interactive relationships between environmental, population, and behavioral factors and health outcomes(77). The author expanded upon this model again in 1995 describing how each of the predetermining factors were associated with potential, realized, equitable and inequitable access to health services(78). For this study, I will primarily examine how environment (urbanicity) and enabling resources (perinatal care facility and provider) affect health behaviors (initiating postpartum contraceptive) that lead to health outcomes (short interpregnancy interval). I will control for as many predisposing characteristics as possible including maternal age, parity,

education, partnership status, and employment status; these individual level predisposing characteristics described in the model have already been thoroughly researched and shown associations with contraceptive initiation and birth outcomes as described above as described previously.

Environment: Women live and receive healthcare within an environmental context. In accordance with the literature, women in rural communities are less likely to receive adequate reproductive health care(71,75). I will model how a woman's geographic environment, though distal to her postpartum contraceptive practices, may play a significant role in her perinatal care. I predict women who enter thee conceptual pathway from a rural community will have poorer outcomes, even while holding all other factors constant.

Predisposing Characteristics: Previous research has demonstrated strong relationships between maternal characteristics and contraceptive initiation and rapid repeat pregnancies. The most commonly cited predisposing characteristics in literature are maternal age, parity, education status, income and employment status.(2,50,63,64). Given the abundance of literature and the health services focus of this research, I propose to use women's predisposing characteristics as control variables on the conceptual pathway. I accept their great importance in predicting a woman's contraception practices but will use them

Enabling Resources: The primary basis of this research project is to assess how variations in enabling recourses affect health behaviors and health outcomes. I will explore how when women of similarly predisposed characteristics interact with perinatal health care facilities and providers their health behaviors and outcomes vary. The literature has substantiated that facility and provider characteristics are associated with contraceptive counseling and care practices; this

analysis will consider each component of the facility and provider individually and together to assess what types of perinatal care experiences best support timely initiation of postpartum contraceptives.

***Need*:** Postpartum contraceptive needs, both real and perceived, play a role in women's decision to initiate a contraceptive method. Individual need is a factor determined by natural return to fertility, sexual activity, and breastfeeding practices. It has been estimated that among non-breastfeeding women, fertility returns on average within six weeks, though some women may ovulate within 3 weeks(79). While breastfeeding may reduce fertility, there is not clear evidence as to the degree and length of natural protection against pregnancy due to highly variable breastfeeding practice(80). Periodic abstinence is also a means of contraception though the duration of use is highly variable and often unpredictable(81). Given such variation, I will view need to initiate postpartum contraception as determined by the current ACOG standards of

Health Behaviors: This analysis will explore three health behaviors known to influence short interpregnancy interval. I will explore how perinatal care setting and providers are associated with return for postpartum care as well as any initiation of a contraceptive and its adherence. Usually, these three behaviors are considered to progress in a linear fashion; encountering a health provider, initiating a contraceptive method, and adhering or discontinuing that method. This model will explore how perinatal care characteristics are associated with these behaviors.

Outcomes: The primary outcomes of interest in this study are the incidence of short interpregnancy interval, the interpregnancy pregnancy interval, birth outcomes of secondary pregnancy and related healthcare expenditures. I propose these outcomes are directly related to health behaviors but are also influenced indirectly by a woman's predisposing characteristics and enabling resources.

Figure 2.1 shows the the proposed pathways using the Anderson model.

Data Sources and Population

This study used professional, facility and pharmaceutical administrative claims from a large, private insurer in North Carolina. The professional and facility claims contained information on diagnoses and procedures as well as information on providers such as their name, specialty, place of business, and National Provider Identifier (NPI). Provider specialty was denoted as the primary specialty associated with a provider's NPI. Table 2.1 defines the provider specialty groups used in analysis that primarily included Obstetricians/Gynecologists and Family Medicine providers. The pharmaceutical claims provided the name of the drug filled, dosage and refill status. In addition to claims, we also used a membership file that provided information on the insured person including date of birth, ZIP code of residence, employment status and insurance coverage information. Due to the limited individual level characteristics included in the membership file, we also used ZIP code level demographics from the 2010-2014 5-Year Census' American Community Survey such as race/ethnicity proportion, poverty indicators and educational information. Finally, we determined each ZIP code's rurality status using the Rural Urban Commuting Area (RUCA) codes (82).The RUCA classifications include four groups: urban, large rural, small rural and isolated rural.

Proposed Analyses

Aim 1 Hypotheses 1.1: Women who receive perinatal care in an urban setting or at within a setting that has an OB/GYN residency program are more likely to initiate any modern contraception within 12 weeks of delivery.

This hypothesis will be tested using a 2SRI logistic regression model to predict the probability of timely initiation of any modern contraceptives given urban perinatal care site, presence of an OB/GYN residency program and the interaction of the two together. The first stage, described above when addressing selection bias, uses instrumental variables to address potential selection bias of perinatal care site and contraceptive method. The second stage uses a logit model with the endogenous variables and residuals from the first stage to estimate the probability of a woman initiating any contraceptive method within 12 weeks of delivery. Goodness of fit and specification tests will be included to ensure the model is appropriate constructed to the data; these include but are not limited to a Wald test to determine if coefficients are not equal to zero in the model (such as urban or OB/GYN practice), the LaGrange Multiplier tests to determine if adding variable jointly (such as urban and OB/GYN practice) significantly improves the model, and an AIC/BIC test to assess if higher ordered terms (such as quadratic age) or interaction terms (such as age*urban) would improve model fit.

Equation 1.1

$$P(Contraceptive\ Initiation) = \frac{1}{1 + e^{-X\beta}}$$

$$\begin{aligned} where\ x\beta = \beta_0 + \ & \beta_1(Urban\ Facility) + \beta_2(ObGyn\ Residency) \\ & + \beta_3(Urban * ObGyn\ Residency) + \quad \beta_4(Maternal\ Characteristics) \\ & + \beta_5(Social\ Characteristics\ of\ Zip\ Code) \\ & + \beta_6(Delivery\ Facility\ Characteristics) + \beta_7(Provider\ Characteristics)) \\ & + \beta_8(Contraceptive\ Choice) + \beta_9(Perinatal\ Care\ Site\ Choice) \end{aligned}$$

Aim 1 Hypothesis 1.2: Among women who initiate any contraceptive, women receiving perinatal care in an urban setting or at within a setting that has an OB/GYN residency program are more likely to initiate a long-acting reversible contraceptive within 12 weeks postpartum.

The test of this hypothesis will use a 2SRI nested multinomial logistic regression model, which accounts for choice in a sequential manner. The first stage, described above when addressing selection bias, uses instrumental variables to address potential selection bias of perinatal care site and contraceptive method. The second stage uses a nested multinomial model with the endogenous variables and residuals from the first stage to estimate the probability of a woman initiating a particular method of contraceptive within 12 weeks. The first nest of the model assesses whether a woman initiates a long-acting or short-acting reversible contraceptive. The second nest beneath this decision and determines which contraceptive method was initiated (pill, patch, ring, injectable, subdermal implant, intrauterine device). The nested multinomial model allows for multiple categorical outcomes while relaxing some of the parameters of the Independence of Irrelevant Alternatives (IIA), allowing nested outcomes to be correlated. This model can be used to estimate the probability of a woman initiating any postpartum contraception as well the type. In the multinomial model, j indicates the category and I indicates the individuals. Only characteristics of the individual, not the choices, are determinant in the model. Figure 2.2 shows the proposed nested structure of the multinomial model.

Equation 1.2

$$p_{ij} = \frac{e^{X_i\beta_j}}{1 + \Sigma_{k=2}^{J} e^{X_i\beta_j}}$$

$$\begin{aligned} where\ x\beta = \beta_0 + \ & \beta_1(Maternal\ Characteristics) \\ & + \beta_2(Social\ Characteristics\ of\ Zip\ Code) \\ & + \beta_3(Prenatal\ Care\ Facility\ Characteristics) \\ & + \beta_4(Provider\ Characteristics)\ ) + \beta_5(Contraceptive\ Choice) \\ & + \beta_6(Perinatal\ Care\ Site\ Choice) \end{aligned}$$

In the first stage of the model, j represents the dichotomous variable of LARC or SARC (1=LARC, 0=SARC). In the second level, the nested level, the j categories represent the various modern methods available (Lng-IUD, Cu-IUD, Implant, COC/POP, patch, ring, DMPA). For this study, the methods of interest (k) include the LARCs, both intrauterine device options and subdermal implant and the SARCS, oral contraceptive pills (COC/POP), hormonal patch, hormonal ring, or injectable (DMPA). The referent category will be oral contraceptive pills as they are the most commonly used modern contraceptive. This nested multinomial method will be used to generate predicted probabilities and the most precise standard errors possible through 1,000 bootstrapping repetitions. Bootstrapping is imperative in multinomial models to measure the precision of a differential effect as the model does not account for any coefficient variation. Various tests will be conducted to determine if this model appropriately fits the dataset. The first priority will be to test for Independence of Irrelevant Alternatives (IIA) which requires that the ratio of probabilities is constant even if a category is dropped; the standard Haussmann test is an appropriate test for IIA. If the IIA test fails, I will reconsider how variables are nested and explore alternatives that pass the IIA test and are able to answer the research question. In particular, if the nested model fails with the six contraceptive methods, I will regroup the methods dichotomously to SARC and LARC.

Aim 2 Hypothesis 2.1: Among women who initiate any modern contraceptive within the first 12 weeks postpartum, women who initiate a SARC within 12 weeks of delivery are more likely to have a short interpregnancy interval compared with women who initiate a LARC.

A 2SRI logistic regression will be used to test this hypothesis similarly to Aim 1. The first stage, described above when addressing selection bias, uses instrumental variables to

address potential selection bias of perinatal care site and contraceptive method. The second stage uses a logit model with the endogenous variables and residuals from the first stage and estimates the probability of short interpregnancy interval. Goodness of fit and specification tests will be included to ensure the model is appropriate constructed to the data; these include but are not limited to a Wald test to determine if coefficients are not equal to zero in the model, the LaGrange Multiplier tests to determine if adding variables jointly significantly improves the model, and an AIC/BIC test to assess if higher ordered terms or interaction terms would improve model fit.

Equation 2.1

$$P(RRP = 1|Conraceptive\ Method) = \frac{1}{1 + e^{-x\beta}}$$
$$where\ x\beta = \beta_0 + \beta_1(Maternal\ Characteristics) +$$
$$\beta_2(Social\ Characteristics\ of\ Zip\ Code) + \beta_3(Prenatal\ Care\ Facility\ Characteristics) +$$
$$\beta_4(Provider\ Characteristics) + \beta_5(Contraceptive\ Choice) +$$
$$\beta_6(Perinatal\ Care\ Site\ Choice) + \beta_7(LARC)$$

Tables and Figures

Table 2.1 Key Measures and Definitions

Interpregnancy Intervals	
Interpregnancy interval	The time (months) between two live births
Short interpregnancy interval	An interpregnancy interval of <27 months
Contraceptive Use	
Contraceptive initiation	The first postpartum medical or pharmaceutical claim associated with beginning contraceptives; e.g. CPT code 58300- Insertion of an intrauterine device or prescription filled for oral contraceptive method
Contraceptive non-use	No recoded claim for any contraceptive method within 24 months of delivery
Short-acting reversible contraception	Includes hormonal pills, patch, vaginal ring and injectable
Long-acting reversible contraceptive	Includes both the hormonal and copper intrauterine devices as well as the subdermal implant
Permanent sterilization	Includes both tubal ligation and occlusion
Contraceptive type	Mutually exclusive categories of non-use, SARC, LARC, permanent
Provider Characteristics	
Provider Specialty Designation	The specialty code of the provider who received the payment for the maternity care
Provider Specialty	For this study, we categorized providers into the five largest groups: Obstetricians and Gynecologists, Family Medicine, Certified Nurse Midwives (CNM), Pediatrics and Multispecialty Practice. During analysis, we did not interpret the findings associated with women seen by CNMs due to a very small sample. Additionally, Multispecialty Practice designation did not provide sufficient information for comparison with our referent group, OB/GYNs; it remained in the model as a covariate however could not be meaningfully interpreted given the lack of detailed information.
Residency Affiliation	Using the Accreditation Council for Graduate Medical Education directory, we identified those hospitals and practices associated with an OB/GYN residency training program. We allocated all providers at that site as "affiliated" to an OB/GYN residency program, regardless of specialty.

Distance to nearest OB/GYN residency program	The distance (miles) from a woman's ZIP code centroid to the nearest accredited OB/GYN residency program; for multi-clinic practices, the central hospital was used as the end point
Provider's LARC prescribing preference	Among all non-permanent contraceptive prescriptions attributed to a provider, the proportion that are for a long-acting reversible contraceptive
Demographic Characteristics	
Maternal age	A woman's age on the day of delivery (years)
Group health plan	Binary indictor of whether a woman was enrolled in a group based insurance plan or individual plan
Rural	Residential zip code with RUCA classification of large rural, small rural or isolated rural
Relative parity	The number of live births a woman has within the data time frame
White %	The percent of a zip code identifying as White per Census estimates
Black %	The percent of a zip code identifying as Black per Census estimates
Native American/American Indian %	The percent of a zip code identifying as Native American/American Indian per Census estimates
Asian %	The percent of a zip code identifying as Asian per Census estimates
Native Hawaiian/Pacific Islander %	The percent of a zip code identifying as Native Hawaiian/Pacific Islander per Census estimates
Hispanic %	The percent of a zip code identifying as Hispanic per Census estimates; includes ALL races
Females over 25 without high school degree/GED %	The percent of women in a zip code over age 25 without a high school diploma or GED equivalency per Census estimates

Figure 2.1 Anderson Model of Postpartum Contraceptive Initiation and Short Interpregnancy Intervals

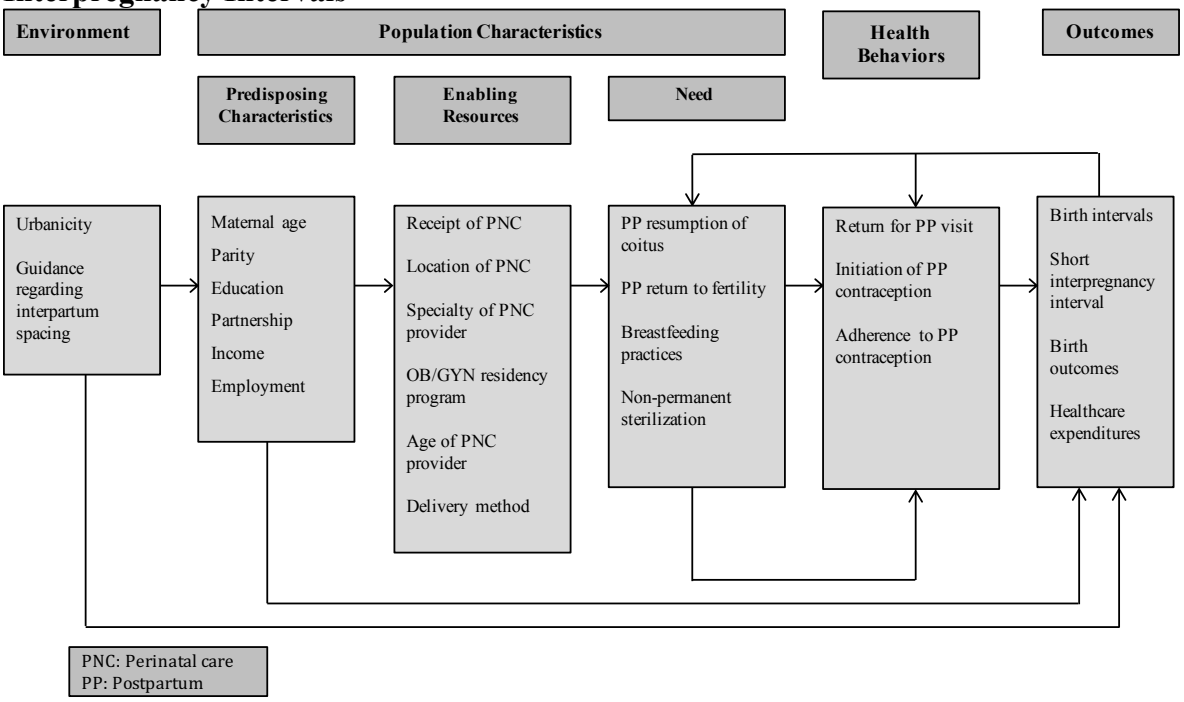
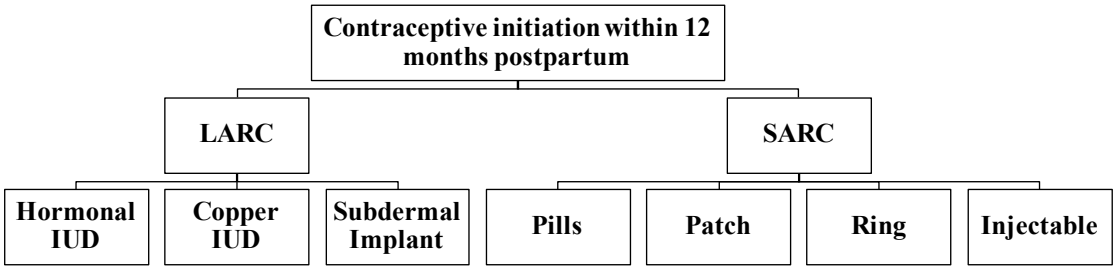


Figure 2.2 Nested multinomial model structure



CHAPTER 3: THE EFFECT OF MATERNITY CARE PROVIDER SPECIALTY, RESIDENCY AFFILIATION AND PATIENT RURALITY ON POSTPARTUM CONTRACEPTIVE INITIATION PATTERNS

Overview

Objective: To determine if provider and healthcare setting characteristics effect the timing and type of postpartum contraception initiation.

Methods: Using administrative claims from a large, private insurance company, we assessed how provider specialty, provider association with an obstetrics and gynecology residency program and living in a rural area affected the time to and method of postpartum contraceptive initiation. The sample included 14,426 women with a live birth who were continuously insured for 60 months after their first delivery claim. We used both a two-stage residual inclusion model and inverse probability of treatment weighted logistic regression to determine the probability a woman would begin a contraceptive over time and whether she would use long-acting versus short-acting reversible contraceptives.

Results: Approximately 65% of women in this sample initiated a contraceptive within 12 months postpartum and 29% initiating a long-acting reversible method. Among women in the sample, receiving care from a residency affiliated provider did not increase the probability of initiating contraceptives or a long-acting reversible method within 12 months postpartum ($p>05$). Additionally, we found no significant association between provider type at delivery and contraceptive timing. Living in a rural area also had no significant effect on postpartum contraceptive practices. However, receiving maternity care from a Family Medicine provider

increased utilization of long-acting reversible contraceptives within 12 months postpartum by 13.6% and 25.3% in the 2SRI and IPTW models, respectively ($p<.05$), as compared with receiving care from an obstetrician/gynecologist.

Conclusions: Provider specialty or affiliation with an OB/GYN residency program did not effect a woman's time to contraceptive initiation; however, Family Medicine providers were linked to higher rates of LARC initiation as compared with OB/GYN specialists. These findings suggest that while OB/GYN providers may have the most formal training in contraception, the continuity of care a woman receives from a primary care provider before, during and after her pregnancy may play an important role in selecting a highly-effective contraceptive.

Key words: contraception, postpartum care, postpartum contraception, birth spacing, long-acting reversible contraceptive

Introduction/Background

Modern contraceptives have led to a dramatic reduction in unintended pregnancies, teen birth rates, and poor infant outcomes since their introduction (1). Despite highly effective contraceptive interventions, half of all births in the United States are unintended and almost half of these are unwanted (2). Postpartum contraceptive initiation is a critical component of family planning and promoting healthy birth spacing. However, in a recent study in California among women with contraceptive coverage, only 41% of women had a contraceptive claim within 90 days postpartum (3). Short birth intervals are associated with numerous poor outcomes for both women and infants (4) including eclampsia (10,11), anemia (12–14), uterine rupture (15–17), third trimester bleeding (12), premature membrane rupture (10,18), puerperal endometriosis

(12,18), placental previa (19), maternal death (12,20,21), low birthweight, preterm birth (18,20–27), small for gestational age (18,22,24,26,27), intrauterine growth restriction (28), stunting (29–33), underweight, low height for age, low weight for height (30,33–37), miscarriage (20,38), fetal death (21,38–40), and neonatal, infant and early childhood mortality (20,21,33,38–40). Given these findings, the American Congress of Obstetricians and Gynecologists recommends women in the United States have an interpregnancy period of no less than 18 months citing increased risks of preterm birth, low birth weight and small-for-gestational age (44).

However, it is estimated that half of all women leave labor and delivery without any plan for postpartum contraception (46). Early postpartum contraceptive initiation is key to long-term contraceptive use and prevention of unintended pregnancy (38). The Centers for Disease Control and Prevention have established recommendations indicating that intrauterine contraceptives, subdermal implants, progestin only pills, and injectable contraceptives are recommended in the postpartum period as the advantages and benefits of initiating the method outweigh the risk for both breastfeeding and non-breastfeeding women (exceptions in the event of puerperal sepsis).

Use of less effective contraceptives during the postpartum period are associated with increased risk of unintended short interpregnancy interval (48). Short-acting reversible methods include all types of oral pills, hormonal patch, hormonal vaginal ring and injectable contraceptives and are considered among the lesser effective hormonal methods; the typical use failure rate for the injectable is 6% and 9% for the pill, patch, and vaginal ring.(61) Long-acting reversible methods include both the hormonal and copper intrauterine devices (IUDs) as well as the subdermal implant and have efficacy rates of greater than 99%.(61) Existing literature and current medical recommendations support women using the more effect LARCs in the early postpartum period (1,64,83).

Women who receive perinatal care in rural areas of the United States lack comparable reproductive health services as compared to urban women; factors such as poverty, geographic isolation, insufficient numbers of appropriately trained providers, lack of transportation and lower rates of insurance are all thought to be contributors. Rural women are less likely to receive prenatal and postpartum care (71). Women in rural communities are also more likely to face the inability to acquire prescription contraceptives if local pharmacists refuse to dispense due to their own moral objections (72,73). Women in rural areas are less likely to rely upon any reversible contraceptive methods yet more likely to rely on permanent sterilization as compared with women in metropolitan areas (74,75). This may be related to challenges women in rural areas face in reliably accessing highly-effective reversible contraceptives.

Much of the existing research on postpartum contraceptive initiation has focused only on maternal characteristics such as age, race, education attainment, religious affiliation, previous pregnancy, previous abortion and insurance status (2,50,63–65) . Thus far, evidence suggests younger providers, female providers and providers with training in obstetrics and gynecology are most likely to be knowledgeable about updated contraceptive practice and more likely to provide long-acting methods (66–68). Small, qualitative studies have also found that many family medicine practitioners are not adequately trained in family planning; there are currently multiple national initiatives underway to improve family medicine practitioners' knowledge and skills related to all contraceptives with an emphasis on long-acting methods (69,70). Patient-provider miscommunication about contraceptive effectiveness is believed to be strongly associated with misuse, discontinuation and subsequent unintended pregnancies (67).

This study aims to estimate the potential effects of provider specialty, provider affiliation with an OB/GYN residency site and living in a rural community on both the timing to and

method of postpartum contraception. Given the existing literature, we hypothesized that women who received maternity care from an OB/GYN provider or a provider affiliated with an OB/GYN residency program would be more likely to initiate postpartum contraceptives within 3 and 6 months as compared with women receiving care from other provider types. We hypothesized women who lived in rural areas would be less likely to use any contraceptive within 12 months postpartum. Finally, we hypothesized women who received maternity care from an OB/GYN provider or a provider affiliated with an OB/GYN residency program would be more likely to initiate a long-acting reversible contraceptive as compared with with women who received care from other provider types. We hypothesized women who lived in rural areas would be less likely to initiate a long-acting reversible contraceptive.

Methods

Data

This study used administrative claims data (professional, facility, and pharmaceutical) from a large, private insurance company in North Carolina. The professional and facility claims data included information on diagnoses, procedures completed, provider and facility characteristics. Provider information included name, specialty, National Provider Identifier (NPI), organization/practice name, and address of practice location. We recorded provider specialty based upon the specialty classification associated with the NPI. The pharmaceutical claims file included information on the name and type of drug, dosage, refill status, pharmacy identifier, and Drug Enforcement Agency (DEA) provider number. In addition, a membership file included a unique member identification number, date of birth, ZIP code of residence, and insurance coverage information. Additional data were included to offer a more complete profile

of women, their communities and their service providers. Due to the limited demographic indicators available within the membership data, zip code level characteristics such as race/ethnicity proportions, median income, and educational attainment were added from the 2010-2014 American Community Survey. Additionally, urbanicity was determined by Rural Urban Commuting Area codes for a subscriber's residential zip code (82). RUCA codes are often divided into four groups: urban, large rural, small rural, and isolated rural. For analytic purposes, we collapsed these categories into binary urban and rural designations.

This study used the Multi-Level Clinical Classification Software (CCS) for ICD-9-CM to standardize classification of both diagnoses and procedures (84). The CCS aggregates codes into useful groups for analysis such as combining all variations of a caesarian delivery (caesarian-twins, caesarian without complications, caesarian with hemorrhage, etc.) into a single category labeled "Caesarian delivery".

Key Measures and Definitions

The key measures for this study included time to contraceptive, type of contraceptive, provider specialty and OB/GYN residency site affiliation. Time to contraceptive was measured as the number of days after a live birth until the first indication of a contraceptive in claims. Contraceptive type is defined as non-use, short-acting reversible contraceptive (pills, patch, ring, injectable), long-acting reversible contraceptive (intrauterine device or subdermal implant), or permanent (tubal ligation or occlusion). In this study, we classified specialty into the five most common groups: OB/GYN, family medicine, certified nurse midwife, pediatrics and other/multispecialty practice. The insurance provider uses a global billing code for maternity services; the global billing code is used to reimburse a provider for most maternity related

services rendered. Global billing allows us to observe in claims which provider or practice provider prenatal, labor and delivery, and postpartum care to women. For our analysis, we used the provider associated with prenatal care maternity services as the designated provider for that pregnancy event. A woman's provider type was recorded based upon the provider who received payment for maternity care services (prenatal and postpartum care always, sometimes delivery care). We also denoted physicians as affiliated with an OB/GYN residency site if they practiced at a facility associated with one of Graduate Medical Education accredited residency programs in Obstetrics and Gynecology. Finally, we used ZIP code demographic indicators as controls in our model including the percent of a ZIP code population identifying with the major racial groups, Hispanic ethnicity, and women over 25 years of age without a high school diploma or equivalent degree. Table 3.1 below provides additional definitions and explanations for how we developed our key measures.

Sample

Our sample included female insurance members between the ages of 10-60 during the study period of January 2008-September 2014 with at least one live birth during the study period. We required women to have at least 60 months of continuous insurance coverage with a gap no greater than 3 months after their first live birth in the study period. Finally, we included only those women with complete zip code information to merge the necessary social and demographic characteristics of her residential zip code. The final analytic file represented 14,226 unique women and 19,848 live births. Figure 3.1 shows the sample design.

Analysis

Time to Contraceptive

Two-stage residual inclusion (2SRI) model

For our analysis, we used live births as the unit of analysis. After each live birth, we calculate the amount of time until a woman initiates contraception. Within our dataset, there were 5,587 repeat births indicating multiple observations for some women. As described further below, we adjusted the standard errors of our models to account for repeated measures. We constructed an instrumental variable (IV) to address the selection bias inherent in women's choice of clinical practices and provider. Numerous factors influence a woman's decision to receive care in a particular facility including proximity, relationship to practice, type of provider, degree of pregnancy risk, and other unobserved factors (85). As this study hypothesized that clinical providers and the practices in which they work are causally linked to postpartum contraceptive initiation, we address the unobserved factors related to selecting a provider associated with an OB/GYN residency program. We used the distance from the centroid of the residence zip code to the nearest OB/GYN residency site as an instrument for the selection of a healthcare provider at residency center in accordance with previous literature (86–88). Figure 3.2 shows the proposed instrumental pathway. We tested this instrument's strength using a Wald test and found it to be strong with an F-stat of 29.56 at $p<.00001$.

Using this instrument, we used a two stage residual inclusion (2SRI) model to determine first if a woman initiated any contraceptive method within 3,6, and 12 months postpartum. The first stage addresses selection bias of clinic choice in a linear probability model using distance as an instrument and controlling for all other exogenous covariates. The second stage uses a logit

model, the exogenous covariates, the endogenous variable (receiving care from a provider associated with an OB/GYN residency program) and the residuals from the first stage to estimate probability of contraceptive initiation at 3, 6 and 12 months postpartum. We then repeated the same first stage model among women who initiated a non-permanent method and predicted the probability of selecting a long-acting method within 12 months in the second stage. We then tested the instrument via the exclusion test. In doing so, we run the second stage of the model again with the instrument included (distance to nearest residency program); the instrument should not be significantly associated with the dependent variable. The model passed the exclusion test indicating the distance to a residency program only effected the dependent variable through the defined pathway we hypothesized. We then proceeded with confidence that our model met the proper criteria for an effective 2SRI model.

For each outcome model, we bootstrapped the clustered standard errors by unique women 500 times over both stages. This and other 2SRI models yield estimates that should be interpreted within a Local Average Treatment Effect (LATE) context.

Inverse probability of treatment weights (IPTW) model

In a secondary analysis, we used inverse probability of treatment weights (IPTWs) to estimate causal effects under the assumption of no unmeasured confounding. IPTWs are used to create similar distributions of measured covariates between treatment and control groups (89,90); for our study controls are those women who did not receive care from an OB/GYN residency affiliated provider and the intervention group are those who did. For the IPTW model, we regressed treatment (receipt of care by OB/GYN residency provider) on the observed covariates believed to be associated with postpartum contraceptive initiation. From this model, we then

generated propensity scores and inverse weighted them based upon treatment assignment. We applied the weights and measured the balance of baseline risk factors; the weights achieve balance when the observed baseline risk factors have a standardized difference of less than 10% between the treatment and control group. Table 3.4 shows the variables included as well as the weighted and unweighted covariate means and standardized differences. We then applied these weights to logistic regression models measuring contraceptive initiation at 3, 6 and 12 months postpartum and predicted the average marginal effects using clustered standard errors to account for repeated measures on women over time. This and other IPTW models yield estimates that should be interpreted within an Average Treatment Effect (ATE) context.

Method of contraceptive

Two-stage residual inclusion multinomial model

After establishing causal models associated with timing to postpartum contraception, we developed models to test how our key independent variables (provider specialty, provider affiliation with an OB/GYN residency program, and rural residence) effected the method of contraception a woman began in the postpartum period. We hypothesized based upon the existing literature that women receiving care from OB/GYN providers and those providers affiliated with OB/GYN residency programs would have higher uptake of LARCs. We constructed a 2SRI multinomial model predicting the probability of initiation within 12 months by method types short-acting reversible method, long-acting reversible method, and permanent; the referent category was non-use of a contraceptive within 12 months postpartum. The model failed the Independence of Irrelevant Alternatives test under all method type exclusions and therefore was not considered appropriate for interpretation.

Inverse probability of treatment weights (IPTW) model

To answer our question of the effect on the type of method initiated given the multinomial model failure, we then constructed a binary model predicted SARC or LARC among women who initiated a non-permanent contraceptive within 12 months and predicted the average marginal effects using clustered standard errors by unique woman.

Results

The age at time of first delivery ranged from 14 to 53 with a mean of 31.8 years old. The sample was predominantly concentrated in urban areas (88%). Of those in the sample, nearly 60% were the insurance subscriber while 39% were spouses and 1.8% were children of the subscriber. Approximately 89% of people in the sample were enrolled in a group health plan (Table 3.2).

Of the live births in the sample, 66% were delivered vaginally and 34% were delivered via a caesarian section (Table 3.3). The total number of live births per woman ranged from one to five during the study period with the mean relative parity of 1.3 births per woman. Ten percent of women received care from a provider affiliated with an OB/GYN residency program. Approximately 83% of births were attended to by an OB/GYN, 1.5% by a Family Medicine Provider, 1.0% by a Pediatrician, and .14% by a Certified Nurse Midwife (CNM). Additionally, 14.7% of deliveries were attended to by a provider associated with a "Multispecialty Practice"; from these births we could not assess provider specialty (see Table 3.1 for further details).

Following a live birth, 33.9% of the time a woman did not initiate any form of observable contraceptive observable within 24 months of delivery (n=7,447); this is referred to as "non-use" in the tables and figures. Among women who initiated a contraceptive method, 61% used a

SARC, 28.7% used a LARC and 10.3% received permanent sterilization (Table 3.5). The most common methods initiated were oral contraceptive pills (57.3%), hormonal IUD (24.5%) and permanent sterilization (10.3%). The average time to contraceptive initiation following a vaginal, forceps or vacuum delivery was 170 days versus 275 days for women with a caesarian delivery. Time to initiation varied by method type with intrauterine devices, both copper and hormonal, being initiated at 150 and 162 days, respectively. In comparison, initiation of oral contraceptive pills occurred at an average of 180 days postpartum and subdermal implant at 185 days. The ring was the latest non-permanent method initiated at 312 days postpartum (Table 3.6).

Contraceptive Initiation Timing Models

2SRI Logistic Regression Model (Table 3.7)

The two-stage residual inclusion model presents result through a local average treatment effect (LATE) interpretation. This interpretation emphasizes that the measured effects is only among those observations for whom the instrument altered the outcome. As such, all results for the 2SRI models must be considered with the caveat that the effect reported is among women for whom distance affected contraceptive initiation. In the two-stage residual inclusion models estimating the probability of contraceptive initiation at 3, 6 and 12 months postpartum, among women for whom distance affected their utilization of receiving care from a residency affiliated provider, receiving care from a residency affiliated provider was associated with a 7.1 and 6.0 percentage point decrease in contraceptive initiation at 3 and 6 months postpartum ($p<.05$); there was no significant difference in contraceptive initiation within 12 months based upon the provider type. Women who had a caesarian delivery were significantly less likely to initiate a contraceptive at all time points, decreasing the predicted probability by 4.8, 4.6 and 4.0

percentage points at 3, 6 and 12 months postpartum, respectively ($p<.001$). There was a small positive association between increasing maternal age and increased probability of contraceptive initiation at all time points ($p<.05$). There was no significant effect of living in a rural area on timing of contraceptive initiation.

IPTW Logistic Regression Model (Table 3.7)

In the model estimating initiation patterns weighted by inverse probability of treatment weights, receiving maternity care from a provider associated with an OB/GYN residency program had no significant effect on contraceptive initiation within 3, 6 or 12 months postpartum. There was no significant effect on initiation patterns among women whose provider's specialty was Family Medicine or Pediatrics as compared with women who were attended to by an OB/GYN. Women who had a caesarian delivery were significantly less likely to initiate any contraceptive at 6 and 12 months, reducing the predicted probability by 3.6 and 2.3 percentage points, respectively ($p<.05$). Women who lived in a rural area were significantly more likely to initiate a contraceptive method within 6 and 12 months by 6.9 and 3.5 percentage points, respectively ($p<.05$).

Contraceptive Method Models

2SRI Multinomial Logistic Regression Model (Table 3.8)

The results of the two-stage multinomial logistic regression estimating the effect the key independent variables on initiating a certain type of contraceptive are displayed in Table 3.8 for illustrative purposes only; the model did not pass any variation of the test of Independence of Irrelevant Alternatives and should not be considered reliable (test results not shown).

2SRI Logistic Regression Model (Table 3.9)

Our final model tested how our key independent variables affected a woman's choice to use a LARC within 12 months given that she began any non-permanent method. There was no significant association between receiving care from a provider associated with an OB/GYN residency site and the probability of initiating a long-acting reversible contraceptive versus a short-acting reversible contraceptive within 12 months postpartum. However, when compared with women who received care from an OB/GYN, those who received care from a Family Medicine provider were 13.6 percentage points more likely to initiate a long-acting contraceptive within 12 months postpartum ($p<.05$). There was no significant association between receiving care from a Pediatrician and LARC initiation at 12 months postpartum. As compared to women who had a vaginal delivery, women who had a caesarian delivery were 2.8 percentage points less likely to begin using a LARC by 12 months postpartum ($p<.01$). There was a positive association between maternal age and LARC initiation ($p<.001$) as well as an inverse relationship between a woman's relative parity and LARC initiation ($p<.001$). There was no significant effect associated with living in a rural area.

IPTW Logistic Regression Model (Table 3.9)

In the IPTW model predicting a woman's likelihood of initiating a long-acting method given she began a non-permanent method within 12 months postpartum, there was no association between receiving care from a provider associated with an OB/GYN residency program. There was a large, significant effect on LARC initiation among women and girls who received care from a Family Medicine provider; women and girls who received delivery care from a Family

Medicine provider were 25.3 percentage points more likely to use a LARC within 12 months postpartum as compared to women who received care from and OB/GYN ($p<.05$). There was no significant difference between Pediatrician providers and OB/GYN providers. There was no significant difference in LARC initiation based upon having a caesarian delivery, maternal age or living in a rural area.

Discussion

This study found through two different estimation methods that receiving care from a residency affiliated provider did not increase a woman's probability of initiating contraceptives nor increase her probability of initiating a long-acting reversible method within 12 months postpartum ($p<.05$). In the 2SRI models, we actually found that for women for whom distance to residency affected their use of residency affiliated providers, residency affiliation actually decreased the probability of initiating any contraceptive within 3 or 6 months. There are several considerations to take into account when interpreting this finding. First, women who receive care from a teaching practice (residency affiliated) may have different maternal risk factors that are not observed within the data. For example, women at highest risk for complications may anticipate problems and chose to receive care from a provider associated with a more comprehensive neonatal intensive care unit (NICU); in the state studied, all level 4 NICUs (the most comprehensive/highest care level) were affiliated with a residency program.

Additionally, residency programs have providers with the most advanced training in terms of those teaching the skills of the field as well as the most novice of providers. From our data, we could not observe which residency affiliated providers were in training and those that were teaching. This may account for some of the negative effect as some providers may have

been at the very beginning of their careers and still learning how to most effectively meet the needs of women in the postpartum period.

However, we did find that women who received care from a Family Medicine provider had increased LARC utilization in the postpartum period. These findings suggest that while OB/GYN providers typically have the most formal contraceptive training, there may be an added benefit to postpartum contraceptive initiation of receiving maternity care from a primary care provider. This could be indicative of the effects of an established relationship between primary care providers and women before, during, and after pregnancy. Additionally, while our study did not assess this, there may be additional points of contact between women and family medicine maternity care providers should their infants receive care from them as well; this would potentially increase opportunities to discuss postpartum contraceptive initiation at infant wellness visits such as when obtaining vaccinations or doing well-baby visits. In fact, according to Bright Futures, the American Academy of Pediatrics Guidelines for Health Supervision of Infants, Children and Adolescents, providers are recommended to discuss postpartum care and birth control with women at the one-month well-baby visit (91).

We also find higher contraceptive initiation patterns among women in rural areas as compared with women in urban areas. This finding was also unexpected given the body of literature suggesting women in rural areas have less access to contraceptives(71,72,75). This may suggest that the unmet need for contraceptives in rural areas is diminishing or indicative of women in rural areas exerting more effort to prevent additional pregnancies. This may be associated with the significant strain of poverty, underemployment, and lower educational attainment opportunities in rural areas as described above; preventing additional pregnancies may be related to efforts to conserve limited resources within families.

Limitations

This research has several limitations to consider. In the absence of a randomized control trial assigning women to residency affiliated providers, we implemented two methodologies used to address potentially endogenous variables: an instrumental variable and inverse probability of treatment weights. Though they vary in their results, both adjust for unobserved differences in participants at baseline. We accept that these models are useful in determining causation, however, there may be unobserved factors influencing outcomes that our models could not address. Additionally, inverse-probability of treatment weights have an additional limitation in that they can only weigh based upon observable characteristics in the data which may lead to greater unobserved variable bias.

Unobserved variables believed to affect provider selection include preexisting relationship with a provider, provider availability, proximity to services and risk level of a pregnancy. These factors are not included within the data and may lead to unobservable differences in the sample across provider types. Additionally, provider specialty type was denoted by the NPI used to bill for services rendered; this number could represent a single provider or a clinical practice. Some of the potential effect of provider specialty may be altered by how a practice bills for services (per individual provider or per the entire practice). For example, a Family Practice group consisting of five physicians may all bill the insurer under a practice level NPI restricting our ability to identify the specific provider seen by a woman during her pregnancy and postpartum period. While the practice is detonated as Family Medicine, they may have a Pediatrician on staff whose specialty will be recorded as Family Medicine. This may alter the specialty specific effects.

There are also limitations to how we were able to measure contraceptive utilization. Our data only included information on contraceptives that were billed to the insurance company; contraceptives paid for out-of-pocket are not included in analysis. Condoms, natural family and partner vasectomy are also not available within the dataset. For this study we did not focus on the duration of contraceptive use or method switching but rather the timing and type of the first method used in the postpartum period.

Finally, our sample of women was narrow to women with at least 60 months of stable insurance coverage following a live birth. While this helps ensure that insurance coverage was not a factor in method initiation and selection, this limits generalizability of our study to other populations with potentially shorter insured periods such as those with Medicaid or new participants in the Affordable Care Act insurance exchanges.

Conclusion

While we hypothesized OB/GYN providers and providers associated with an OB/GYN residency program would increase the probability of a woman initiating contraceptives within 12 months and use LARC more often than other providers, our findings did not support this. While no provider type showed statistically different time to initiation patterns from OB/GYN providers, women who received care from Family Medicine providers were significantly more likely to initiate a LARC within 12 months postpartum. This finding may suggest that women who receive their maternity care from a primary care provider have greater access and support for contraceptive services in the postpartum period.

Tables and Figures

Table 3.1 Key Measures and Definitions

Contraceptive Use	
Contraceptive initiation	The first postpartum medical or pharmaceutical claim associated with beginning contraceptives; e.g. CPT code 58300- Insertion of an intrauterine device or prescription filled for oral contraceptive method
Time to contraceptive initiation	The number of day from live birth to contraceptive initiation claim
Contraceptive non-use	No recoded claim for any contraceptive method within 24 months of delivery
Short-acting reversible contraception	Includes hormonal pills, patch, vaginal ring and injectable
Long-acting reversible contraceptive	Includes both the hormonal and copper intrauterine devices as well as the subdermal implant
Permanent sterilization	Includes both tubal ligation and exclusion
Contraceptive type	Mutually exclusive categories of non-use, SARC, LARC, permanent
Provider Characteristics	
Provider Specialty Designation	The specialty code of the provider who received the payment for the maternity care; this always included prenatal and postpartum services and may have included delivery
Provider Specialty	For this study, we categorized providers into the five largest groups: Obstetricians and Gynecologists, Family Medicine, Certified Nurse Midwives (CNM), Pediatrics and Multispecialty Practice. During analysis, we did not interpret the findings associated with women seen by CNMs due to a very small sample. Additionally, Multispecialty Practice designation did not provide sufficient information for comparison with our referent group, OB/GYNs; it remained in the model as a covariate however could not be meaningfully interpreted given the lack of detailed information.
Residency Affiliation	Using the Accreditation Council for Graduate Medical Education directory, we identified those hospitals and practices associated with an OB/GYN residency training program. We allocated all providers at that site as "affiliated" to an OB/GYN residency program, regardless of specialty.
Distance to nearest OB/GYN residency program	The distance (miles) from a woman's ZIP code centroid to the nearest accredited OB/GYN residency program; for multi-clinic practices, the central hospital was used as the end point
Demographic Characteristics	
Maternal age	A woman's age on the day of delivery (years)
Rural	Residential zip code with RUCA classification of large rural, small rural or isolated rural
Relative parity	The number of live births a woman has within the data time frame
White %	The percent of a zip code identifying as White per Census estimates
Black %	The percent of a zip code identifying as Black per Census estimates
Native American/American Indian %	The percent of a zip code identifying as Native American/American Indian per Census estimates

Asian %	The percent of a zip code identifying as Asian per Census estimates
Native Hawaiian/Pacific Islander %	The percent of a zip code identifying as Native Hawaiian/Pacific Islander per Census estimates
Hispanic %	The percent of a zip code identifying as Hispanic per Census estimates; includes ALL races
Females over 25 without high school degree/GED %	The percent of women in a zip code over age 25 without a high school diploma or GED equivalency per Census estimates

Table 3.2 Attributes of women in sample

	n	%
Unique women in sample	14,226	-
Number of discrete live births	19,848	-
Age at time of event (mean)	31.81	-
Insurance Membership Classification		
Insured Member		
Child	362	1.82
Spouse	7,780	39.2
Subscriber	11,704	58.97
Other	2	0.01
Geographic Attributes of ZIP Code		
Urban	18,010	87.98
Large rural	1,503	7.34
Small rural	519	2.54
Isolated rural	438	2.14

Table 3.3 Attributes of live births in sample

	n	%
Relative Parity Number		
First live birth	15,743	73.81
Second live birth	4,980	23.35
Third live birth	569	2.67
Fourth or higher	38	0.17
Average relative parity	1.3	-
Delivery Type		
Vaginal delivery	13,030	65.65
Caesarian delivery	6,818	34.35
Provider Type at Delivery		
OB/GYN	16,399	82.6
Family Medicine	291	1.47
CNM	27	0.14
Pediatrics	207	1.04
Other*	2,924	14.7
**85% of Other denoted as "Multispecialty Practice"*		
Residency Affiliation		
OB/GYN Residency Site	2,106	10.6
Delivery Facility Type		
Hospital	19,143	99.3
Birthing Center	120	0.62
Emergency Room	13	0.07

Table 3.4 Standardized differences in means of IPTW covariates

	Unweighted Mean	Weighted Mean	Standardized Difference
Location of Delivery			
Hospital	0.9899	0.9993	0.1992
Birthing Center	0.0061		
Emergency Room	0.0040	0.0007	0.3164
County of Residence Number	56.8878	58.1095	9.8750
Provider Type at Delivery			
OB/GYN	0.8171	0.8374	3.5486
Family Medicine	0.0143	0.0087	0.2235
CNM	0.0013		
Pediatrics	0.0097	0.0094	0.8897
Other Specialty	0.1576	0.1446	3.4529
Insurance Membership Classification			
Child	0.0181	0.0179	1.8473
Spouse	0.3935	0.3925	5.1390
Subscriber	0.5882	0.5893	4.6019
Other	0.0001	0.0003	0.0758
Age on Delivery	31.8900	31.7367	2.0069
Relative parity	1.4244	1.3450	2.1469
White %	73.2311	73.1471	1.5010
Black %	18.1975	18.2962	5.8002
Native American/American Indian %	0.8704	0.8890	9.0207
Asian %	2.5897	2.5680	6.5454
Native Hawaiian/Pacific Islander %	0.0447	0.0438	9.2136
Hispanic (all races) %	8.3343	8.3192	7.2828
Women over 25 with no HS degree/GED %	7.0008	7.0620	5.1971
Rural	0.1198	0.1206	1.4663

Table 3.5 Method of postpartum contraceptive initiated

	n	%		
Non-use	7,447	34.91	*Among Contraceptive Users Only*	
Pills	7,968	37.36	57.39	SARC: 61%
Injectable	169	0.79	1.22	
Ring	330	1.55	2.38	
Implant	231	1.08	1.66	LARC: 28.7%
Hormonal	3,404	15.96	24.52	
Copper	349	1.64	2.51	
Permanent Sterilization	1,432	6.71	10.31	Permanent: 10.3%

Table 3.6 Contraceptive initiation patterns

	n	%
Time to First Contraceptive after live birth		
Within 3 months	9,047	81.32
4-6 months	1,225	11.01
7-9 months	497	4.47
10-12 months	356	3.2
Average days to initiation, by delivery type		
Vaginal Delivery	169.81	
Caesarian Delivery	275.18	
Average days to initiation, by method		
Pills	180.02	
Injectable	214.65	
Implant	184.78	
Ring	312.34	
Hormonal IUD	162.38	
Copper IUD	149.68	
Permanent sterilization	529.03	

Table 3.7 Average marginal effect of initiating contraceptive within 3, 6 and 12 months postpartum

n=11558

	2SRI			IPTW		
	3 mos.	6 mos.	12 mos.	3 mos.	6 mos.	12 mos.
Residency affiliation (ref: non-residency affiliation)	-0.0708* [-0.130,-0.0118]	-0.0597** [-0.101,-0.0185]	-0.025 [-0.0574,0.00737]	-0.0134 [-0.0508,0.0241]	-0.00216 [-0.0315,0.0272]	0.00505 [-0.0151,0.0252]
Family Medicine (ref: OB/GYN)	-0.0317 [-0.125,0.0611]	-0.0202 [-0.105,0.0649]	-0.0065 [-0.0650,0.0520]	0.0303 [-0.106,0.166]	-0.0222 [-0.129,0.0850]	-0.00359 [-0.0872,0.0800]
Pediatrics (ref: OB/GYN)	0.0557 [-0.0106,0.122]	0.00989 [-0.0520,0.0718]	0.0228 [-0.0144,0.0600]	0.0541 [-0.0336,0.142]	-0.00652 [-0.0736,0.0606]	0.0278 [-0.0311,0.0867]
Other specialties (ref: OB/GYN)	0.0262* [0.00218,0.0502]	0.0116 [-0.00835,0.0315]	-0.000234 [-0.0144,0.0140]	0.0343 [-0.00464,0.0733]	0.00904 [-0.0199,0.0380]	-0.00154 [-0.0213,0.0182]
Rural community (ref: urban community)	0.00932 [-0.0160,0.0346]	0.00628 [-0.0136,0.0262]	0.00117 [-0.0141,0.0164]	0.0645 [-0.00960,0.139]	0.0681** [0.0249,0.111]	0.0348* [0.00572,0.0638]
Age on delivery	0.0254*** [0.0105,0.0403]	0.0158* [0.00376,0.0278]	0.00972* [0.000454,0.0190]	0.0317 [-0.000915,0.0644]	0.00497 [-0.0216,0.0315]	0.00503 [-0.0112,0.0213]
Relative parity	0.0193** [0.00654,0.0321]	0.0105 [-0.000551,0.0216]	0.00585 [-0.00279,0.0145]	-0.00589 [-0.0346,0.0228]	0.00743 [-0.0142,0.0290]	0.00624 [-0.00821,0.0207]
Caesarian section (ref: vaginal delivery)	-0.0477*** [-0.0660,-0.0294]	-0.0458*** [-0.0600,-0.0317]	-0.0397*** [-0.0512,-0.0282]	-0.0242 [-0.0606,0.0121]	-0.0363* [-0.0654,-0.00718]	-0.0227* [-0.0436,-0.00187]
Residual	0.0622 [-0.00464,0.129]	0.0655** [0.0191,0.112]	0.0314 [-0.00552,0.0684]			

[95% confidence intervals in brackets]
* p<0.05, ** p<0.01, *** p<0.001

Table 3.8 Average marginal effect of initiating type of contraceptive (multinomial); base outcome non-use

	SARC	LARC	Permanent
Residency affiliation (ref: non-residency affiliation)	-0.0307 [-1.140,1.078]	0.312 [-0.903,1.526]	0.0697 [-3.614,3.753]
Family Medicine (ref: OB/GYN)	-0.725** [-1.251,-0.198]	-0.35 [-0.780,0.0803]	-0.788 [-2.393,0.817]
Pediatrics (ref: OB/GYN)	-0.294 [-0.835,0.248]	-0.103 [-0.679,0.472]	-0.421 [-2.248,1.405]
Other specialties (ref: OB/GYN)	0.109 [-0.196,0.413]	0.0297 [-0.250,0.310]	1.598*** [0.701,2.495]
Age on delivery	0.0722 [-0.00459,0.149]	-0.0987* [-0.180,-0.0172]	0.264* [0.0629,0.464]
Relative parity	-0.374*** [-0.432,-0.316]	-0.166*** [-0.233,-0.0979]	0.582*** [0.427,0.736]
Rural community (ref: urban community)	0.051 [-0.107,0.209]	0.139 [-0.0375,0.316]	0.0339 [-0.440,0.508]
Caesarian section (ref: vaginal delivery)	-0.033 [-0.111,0.0452]	-0.204*** [-0.294,-0.115]	0.597*** [0.384,0.811]
First stage residual	-0.052 [-1.223,1.119]	-0.438 [-1.723,0.848]	-1.106 [-4.941,2.729]

[95% confidence intervals in brackets]
* p<0.05, ** p<0.01, *** p<0.001

Table 3.9 Average marginal effect of initiating a LARC given initiation of any non-permanent method within 12 months postpartum

n=10297

	2SRI	IPTW
Residency affiliation (ref: non-residency affiliation)	0.0414 [-0.0218,0.105]	0.00577 [-0.0504,0.0619]
Family Medicine (ref: OB/GYN)	0.136* [0.0121,0.261]	0.253** [0.101,0.405]
Pediatrics (ref: OB/GYN)	0.0431 [-0.0495,0.136]	0.071 [-0.0231,0.165]
Other specialties (ref: OB/GYN)	-0.0134 [-0.0428,0.0159]	-0.0179 [-0.0691,0.0333]
Age on delivery	-0.0363*** [-0.0541,-0.0185]	-0.000155 [-0.000786,0.000476]
Relative parity	0.0482*** [0.0343,0.0621]	0.0398** [0.0120,0.0676]
Rural community (ref: urban community)	-0.000154 [-0.0320,0.0317]	0.0959 [-0.0287,0.221]
Caesarian section (ref: vaginal delivery)	-0.0275** [-0.0479,-0.00718]	-0.0195 [-0.0711,0.0320]
Residual	-0.0625 [-0.139,0.0142]	

[95% confidence intervals in brackets]
* p<0.05, ** p<0.01, *** p<0.001

Figure 3.1 Sample Design

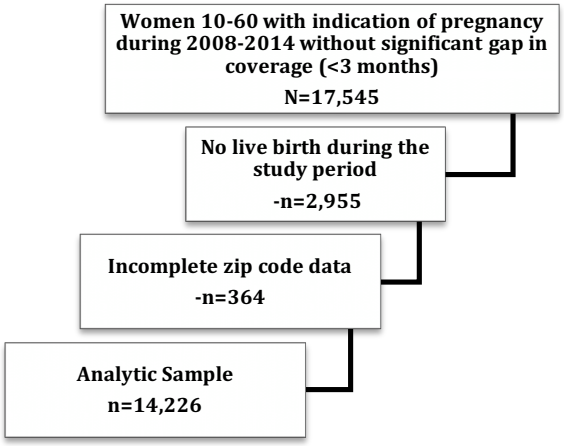
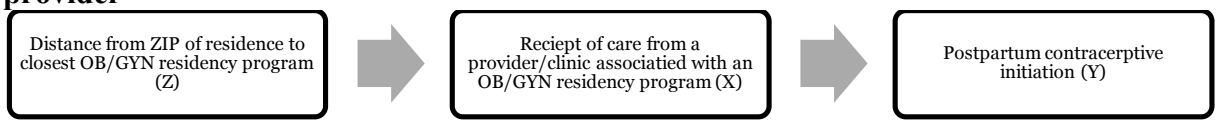


Figure 3.2 Instrumental Variable for Receiving Care from an OB/GYN residency affiliated provider



CHAPTER 4: THE EFFECT OF MATERNITY CARE PROVIDER SPECIALTY, RESIDENCY AFFILIATION, PATIENT RURALITY AND POSTPARTUM CONTRACEPTIVE METHOD ON SHORT INTERPREGNANCY INTERVALS

Overview

Objective: To determine if healthcare provider characteristics, such as specialty and residency affiliation, and type of postpartum contraceptive used are associated with short interpregnancy intervals among women with multiple births during the study period.

Methods: We used administrative claims from a large, private insurer merged with ZIP code-level sociodemographic data from the Census. Our sample included only women with at least two live births during the study period. We used a two-stage residual inclusion model to determine how provider specialty, provider association with an obstetrics and gynecology residency program and the type of postpartum contraceptive initiated affected the probability of having a short interpregnancy interval. A short interpregnancy interval was defined as a subsequent live birth within 27 months of a previous live birth.

Results: There were 4,298 women in the sample who had at least two live births during the study period. Among women with subsequent live births, nearly 40% occurred within 27 months of a previous delivery. The mean interpregnancy interval was 33.1 months but varied by postpartum contraceptive choice (unadjusted means of 27.9 months for non-use, 35.2 months for short-acting reversible contraceptives and 41.5 months for long-acting reversible contraceptives). Compared to women who did not use an observable contraceptive, there was no significant effect on having a short interpregnancy interval among women who used a short-acting reversible method within

12 months postpartum. Women who initiated a long-acting reversible method within 12 months postpartum were 54.2 percentage points less likely to have a repeat birth within 27 months as compared with women who used a short-acting reversible contraceptive ($p<.01$).

Conclusions: Among women with continuous insurance coverage during the postpartum period, short interpregnancy intervals were common at nearly 40% of all live births. Controlling for provider specialty and residency affiliation, the facility where she received care, and the demographics of the area in which she lives, the strongest predictor of whether she will have a short birth interval is the type of contraceptive she uses in the postpartum period. These findings support expanding LARC utilization in the postpartum period to prevent short interpregnancy intervals.

Key Words: interpregnancy intervals, interpregnancy spacing, postpartum contraception, long-acting reversible contraception

Introduction/Background

Despite the evidence of associated poor health outcomes, short interpregnancy intervals – births spaced less than 27 months apart - are common in the United States. In 2015, analysis of the National Survey of Family Growth and birth records determined that among the second or higher order pregnancies, 35% occurred within 18 months of a previous pregnancy(92). Short interpregnancy intervals are associated with poor outcomes for women and infants including eclampsia (10,11), anemia (12–14), uterine rupture (15–17), third trimester bleeding (12), premature membrane rupture (10,18), puerperal endometriosis (12,18), placental previa (19), and maternal death (12,20,21), low birthweight, preterm birth (18,20–27), small for gestational age (18,22,24,26,27), intrauterine growth restriction (28), stunting (29–33), underweight, low

height for age, low weight for height (30,33–37), miscarriage (20,38), fetal death (21,38–40), and neonatal, infant and early childhood mortality (20,21,33,38–40). Preterm birth, low birthweight and small-for-gestational age are all associated with both poor proximal and long-term birth outcomes for infants including physiological malformations, respiratory problems, sensory deficits, cognitive development delays and death (41,42).

Given these findings and the high prevalence of short interpregnancy intervals, the American Congress of Obstetricians and Gynecologists recommends women in the United States have an interpregnancy period no less than 18 months citing increased risks of preterm birth, low birth weight and small-for-gestational age (44). The Centers for Disease Control and Prevention identified the reduction of short interpregnancy birth intervals as a priority area by proposing a national reduction of 10% as a Healthy People 2020 objective (5). Much of the existing research describes the attributes of women with short interpregnancy intervals, focusing on insurance status and maternal factors such as age, race and ethnicity. This study will expand the literature by integrating attributes of the providers and healthcare settings as well as postpartum contraceptive initiation patterns as potential factors in predicting short interpregnancy intervals.

In our study, we will focus on women who had at least two live births during the study period. We will test how contraceptive use practices, as well as provider characteristics, affect the probability of having a short interpregnancy interval to the next live birth. Our previous findings showed that maternity care provider affiliation with an OB/GYN residency program did not increase a woman's probability of initiating postpartum contraceptives nor did it affect her initiation of a long-acting reversible method. However, we did observe that women who received maternity services from family medicine providers were 13.6 percentage points more likely to use a long-acting reversible contraceptive as compared with women who received care

from an OB/GYN. In this study, we will test whether a woman's maternity care provider specialty, affiliation to an OB/GYN residency program or the type of non-permanent contraceptive used (long-acting reversible verses short-acting reversible) affects whether or not a woman will have a short interpregnancy interval to her next live birth.

We hypothesize that women who received maternity care from an OB/GYN provider or a provider affiliated with an OB/GYN residency program will be less likely to have a short interpregnancy interval. We also hypothesize that among women who initiated a non-permanent contraceptive method within 12 months of delivery, women who initiated a long-acting reversible method will be less likely to have a short interpregnancy interval as compared with women who initiated a short-acting reversible method.

Methods

Data

This study used professional, facility and pharmaceutical administrative claims from a large, private insurer in North Carolina. The professional and facility claims contained information on diagnoses and procedures as well as information on providers such as their name, specialty, place of business, and National Provider Identifier (NPI). Provider specialty was denoted as the primary specialty associated with a provider's NPI. Table 4.1 defines the provider specialty groups used in analysis that primarily included Obstetricians/Gynecologists and Family Medicine providers. Our data comes from an insurance company that uses global billing for maternity care services. The global billing codes allowed us to observe in claims the provider or practice who provided prenatal, labor and delivery and postpartum services. For this analysis, we

used the provider associated with the prenatal services as the designated provider for the pregnancy.

The pharmaceutical claims provided the name of the drug filled, dosage and refill status. In addition to claims, we also used a membership file that provided information on the insured person including date of birth, ZIP code of residence, employment status and insurance coverage information. Due to the limited individual level characteristics included in the membership file, we also used ZIP code level demographics from the 2010-2014 5-Year Census' American Community Survey such as race/ethnicity proportion, poverty indicators and educational information. Finally, we determined each ZIP code's rurality status using the Rural Urban Commuting Area (RUCA) codes (82).The RUCA classifications include four groups: urban, large rural, small rural and isolated rural. For analysis, we collapsed all non-urban categories into a single rural indicator due to small sample sizes in the individual rural categories.

To systematically classify the claims into meaningful diagnoses and procedure groups, we used the Multi-Level Clinical Classification Software (CCS) for ICD-9-CM developed by the Healthcare Cost and Utilization Project at the Agency for Healthcare Research and Quality(84).

Key Measures and Definitions

Among the key measures integral to this study were interpregnancy interval, short interpregnancy interval, and contraceptive type used in the postpartum period. For this study, the interpregnancy interval is defined as the time in months from a live birth to the next live birth. A short interpregnancy interval is defined as an interpregnancy interval less than 27 months. We restricted our analysis to live birth-live birth intervals for several reasons. First, our dependent variable- short interpregnancy interval- is dependent upon a reliable indicator of time. In the

absence of date of conception data, we relied on the terminal point of a pregnancy to measure estimate conception. As spontaneous abortions, induced abortions, and fetal deaths can occur at many points during gestational development, we would introduce up to 20 weeks of measurement error by including non-live births in the sample. Secondly, much of the existing, nationally represented research on interpregnancy intervals has used live birth-live birth estimates as it is recorded on the birth record. While the National Survey of Family Growth (NSFG) includes estimates for non-live birth terminal events, recent publications comparing NSFG and birth record data have focused exclusive on live birth intervals. Finally, we know our sample included women who did not have insurance coverage for induced abortions but do not know what proportion of the total this group represents. For such reason, we used the most conservative measure, live birth to live birth, to estimate interpregnancy interval spacing.

Contraceptive type is defined as non-use (no evidence of prescription contraceptives), short-acting reversible contraceptive (pills, patch, ring, injectable), long-acting reversible contraceptive (intrauterine device or subdermal implant), or permanent (tubal ligation or occlusion). In this study, we primarily focus on the differences between the short-acting reversible and long-acting reversible methods. We also used provider specialty and affiliation with an OB/GYN residency program throughout our analysis. The provider associated with the birth interval was the one for whom the global maternity payment was made for the first birth in the interpregnancy interval pair; this provider was responsible for prenatal and postpartum care and sometimes delivery. In this study, we classified specialty into the five most common groups: OB/GYN, family medicine, certified nurse midwife, pediatrics and other/multispecialty practice. We also denoted physicians as affiliated with an OB/GYN residency site if they practiced at a facility associated with one of Graduate Medical Education accredited residency programs in

Obstetrics and Gynecology. Finally, we used ZIP code demographic indicators as controls in our model including the percent of a ZIP code population identifying with the major racial groups, Hispanic ethnicity, and women over 25 years of age without a high school diploma or equivalent degree. Table 4.1 below provides additional definitions and explanations for how we developed our key measures.

Sample

Our sample included women between the ages of 10-60 with at least two live births during the study period of January 2008-September 2014. All women in the sample retained insurance coverage for at least 60 months following their first live birth with no more than 3 months of lapsed coverage. We removed births from our sample if there was not at least 36 month follow up period to protect against time censoring. As 12% of women have more than two live births during the study period, we will use adjusted standard errors due to multiple observations per woman. The final analytic sample included 4,298 unique women and 4,793 interpregnancy intervals. The unit of analysis for estimation models is the interpregnancy interval between two live births.

Analysis

We modeled the probability of a woman having two live births within 27 months of one another using causal techniques to control for the effects of previous provider type and affiliation with an OB/GYN residency program as well as the type of postpartum contraceptive used. We anticipated that both receiving care from a residency provider and the method of contraception used in the previous postpartum period are endogenous to our outcome. As such, we constructed

a two-stage residual inclusion (2SRI) model to address potentially endogenous variables and measure the causal pathway on the probability of having a short interpregnancy interval.

To address the endogeneity of both previous provider residency affiliation as well as previous postpartum contraceptive method, we constructed two first-stage models. Numerous factors influence a woman's decision to receive care in a particular facility including proximity, existing relationship with the practice, type of provider, degree of pregnancy risk, and other unobserved factors (85). First, we use an instrumental variable (IV) in a linear probability model to address the endogeneity and unobserved variation of women's decision to receive maternity care from a provider associated with an OB/GYN residency program. Following prior work, we used the distance (in miles) from the centroid of a woman's residential zip code to the address of the closest residency program as an instrument for her choice to receive residency-affiliated care(86–88). Figure 4.1 shows the proposed instrumental pathway. We tested the strength of the instrument using a Wald test which yielding an F-statistic of 25.96 with $p<.01$ indicating a strong instrument.

We then constructed a multinomial logit model addressing the endogeneity of the method of contraceptive used in the postpartum period after the first live birth. The dependent variable included non-use (women with no observable contraceptive claim within 12 months of delivery), short-acting reversible contraceptive use and long-acting reversible contraceptive use. To do so, we constructed an instrument for a woman's initiation of a long-acting reversible contraceptive or short-acting contraceptive based upon her previous providers prescribing preference; the instrumental pathway is shown in Figure 4.2. This instrumental variable approach has previously been successful when applied to similar other areas such as prescribing preferences of Cox-2 inhibitors (93). We calculated a provider's prescribing preference as the number of long-acting

reversible contraceptives prescribed divided by all non-permanent contraceptives prescribed by providers within the sample. For example, if Provider A had ten women in the sample and three began a LARC and seven begin a SARC in the postpartum period, that provider's LARC prescribing preference is 3/10 or .33. We excluded providers who only had one contraceptive claim within the data. The mean LARC prescribing preference for the sample was 4.6% with a minimum of zero and a maximum of 100%. We tested the strength of the instrument based on prescribing preference using a Wald test. For the SARC dependent variable, the F-statistic was 10.38 ($p<.01$) while it was 32.22 ($p<.001$) for the LARC dependent variable indicating a strong instrument in both branches of the model.

We calculated an indicator of whether or not a woman had a second live birth within 27 months of previous delivery. Within administrative claims, it is difficult to measure the time point of conception given the significant variation in when women first realize they are pregnant and when are seen for their first prenatal care visit. As such, we selected the terminal point in the pregnancy, the live birth, to determine healthy birth intervals. To do so, we measured the days from previous delivery to current delivery. To allow for slight variations in gestational age at birth, we counted backwards using a 37-week gestational period; this allowed for deliveries that occurred prior to 40 weeks' gestation but were conceived after 18 months postpartum to be considered as having a healthy interpregnancy interval. We will hereafter describe short interpregnancy intervals as those with less than 27 months between deliveries. Figure 4.3 shows the timeline of events and measurement points.

In the second stage of the model, we used a logistic regression model of the dependent variable indicating a short interpregnancy interval. For the 2SRI model, we included key covariates such as previous provider type and type of delivery, control variables for a woman's

ZIP code demographics (such as racial and ethnic group mix and high school educational attainment) as well as both the endogenous variables from the first stage (previous provider associated with a residency program and type of contraceptive used in previous postpartum period) and the residuals from both stage one models. We used bootstrapped clustered errors by unique women to adjust for women who had multiple interpregnancy intervals within the dataset.

Sensitivity Analysis

In sensitivity analyses, we tested if there was a potential interaction between provider specialty type and the type of contraceptive a woman used and an interaction between the time at which a woman initiated postpartum contraceptives and the type of contraceptive she used. We also conducted sensitivity analysis using a 26- month interpregnancy interval threshold to allow for up to four weeks of prematurity.

Results

The age at first delivery ranged from 16 to 55 with a mean of 32.4 years old; the median age was 32.3. The sample was predominantly concentrated in urban areas (89.2%) following by large rural (7.1%), small rural (1.8%) and isolated rural (1.99%) per RUCA classification of residential zip code. For analytic purposes, we grouped all non-urban areas together as rural. Among the subsequent births (the unit of analysis), approximately 88.8% were a woman's second observed live birth during the study period, 10.5% the third, and < 1% the fourth or higher; this indicates 88.8% of women only contributed one interpregnancy interval to the sample. The average relative parity at time of first live birth in the interval pair was 2.12. Of subsequent live births in the sample, 64.6% were delivered vaginally after a previous vaginal

delivery and 2.3% were delivered vaginally after previous caesarian. Among those delivered via caesarian, 26.1% were repeat caesarians while 6.99% were following a previous vaginal delivery (Table 4.3).

Of the second births in the interval pair, 81.4% were attended to by an OB/GYN, 1.8% by a Family Medicine Provider, 1.5% by a Pediatrician, and .13% by a Certified Nurse Midwife (CNM). Additionally, 15.2% of deliveries were attended to by a provider associated with a "Multispecialty Practice"; multispecialty practice could denote a variety of provider specialties. For further explanation of the multispecialty practice variable, see the data sections of Chapter 3. These trends were very similar to the women's previous provider specialty (Table 4.4).

The mean interpregnancy interval was 994 days (33.1 months) and the media was 904 days (30.1 months). The mean interpregnancy interval varied by the type of contraceptive method first used by women. Among women who did not use an observable contraceptive within 12 months of delivery, the mean interpregnancy interval was 837 days or approximately 27.9 months (Table 4.5). The mean interpregnancy spacing for women with evidence of using a short-acting reversible contraceptive was 1057 days (35.2 months), while the mean interpregnancy spacing for women with evidence of using a long-acting reversible contraceptive method was 1244 days (41.5 months). Figure 4.3 shows the distribution of births occurring at various postpartum time points by the type of contraceptive used. Of all the subsequent births in the data, 39.7% occurred within 27 months of a previous live birth (Table 4.5). Among births to women who did not use any observable form of contraception within 12 months of delivery, 55.9% of all subsequent births occurred within 27 months postpartum.

Table 4.6 shows the results of the first stage models. Table 4.7 shows the results of the two-stage residual inclusion model estimating the probability of having a short interpregnancy

interval. The results in Table 4.7 are to be interpreted via the local average treatment effect (LATE) context; this interpretation yields results that represent only those observations which were affected by the instrumental variables. For Table 4.7, results should be interpreted within the context that these findings are representative of women for whom distance affected provider selection and provider's prescribing preference affected choice of postpartum contraceptive method.

A woman's maternity providers' affiliation to a residency program and specialty for the first live birth of the interpregnancy interval pair did not have a significant effect on having a second live birth within 27 months. As hypothesized, there were significant differences in interpregnancy intervals by the method of contraceptive used during the previous postpartum period. The mean predicted probability of having a second live birth within 27 months of a previous live birth was estimated as 39% across all women in the sample. As compared to women who did not use an observable contraceptive method, there was no effect of using a short-acting reversible method within 12 months postpartum on having a repeat live birth within 27 months after controlling for selection bias inherent to use. However, women who initiated a long-acting reversible method within 12 months postpartum were 54.2 percentage points less likely to have a repeat live birth within 27 months ($p<.05$) than women who used a short-acting reversible method. Additionally, there was no significant effect of living in a rural area or having a caesarian delivery at last birth and having a short interpregnancy interval. As is seen in Table 4.7 as age increased by one year, the probability of an interpregnancy interval of less than 27 months decreased by eight percentage points ($p<001$).

In our sensitivity testing, the interactions between provider specialty type and the type of contraceptive a woman used did not have significant coefficients. None of the interaction terms had a significant coefficient (data not shown). In the model with a shortened interpregnancy interval of 26 months allowing for up to 4 weeks of prematurity, results were not meaningfully different (data not shown).

Discussion

After selecting a sample of women with continuous private insurance coverage and controlling for maternal age and relative parity, delivery characteristics and the demographics of a woman's residential zip code, there was a large statistically and clinically significant association between a woman's postpartum contraceptive method and short interpregnancy intervals. The type of provider she saw for her initial pregnancy (OB/GYN, Family Medicine, Pediatrics or Other Specialty) and the provider's affiliation with an OB/GYN residency program had no significant effect on her interpregnancy intervals. This suggests that current messaging to women about the importance of healthy interpregnancy intervals may be lacking across all specialty types.

This research also confirmed that contraceptive initiation within 12 months of delivery reduces the risk of short interpregnancy intervals. These findings support expanded utilization of LARCs in the postpartum period for women hoping to have another pregnancy while safely delaying until the recommended time of conception. Future research in this area should explore additional factors such as desired family size and contraceptive history not observable in claims. There is opportunity for mixed methods that could intersect claims data with both patient and provider interviews regarding the challenges and barriers to LARC initiation. One known area of

improving LARC access is ensuring that women have access to providers trained in the insertion of intrauterine devices or implants; our data did not include any indicators regarding a provider's ability to insert LARCs. An area of opportunity for the insurance provider is to determine what proportion of its current maternity care providers do not have this training and consider funding expanded training opportunities for in-network providers. Additionally, the insurer could also provide a comprehensive list of providers and facilities with currently trained staff to support service referrals for women wishing to initiate a LARC.

One of the more interesting findings is that among our sample of women with stable, continuous insurance coverage, the probability of short interpregnancy intervals was higher than observed in previous national estimates(94). While this sample contains only women with private insurance coverage, and therefore cannot be extrapolated to represent national estimates, our findings offer new insights into the potential relationship between insurance coverage and interpregnancy intervals. Previous literature has suggested that one potential reason for short interpregnancy intervals is that women may have inconsistent insurance following a birth (due to limited coverage via Medicaid coverage for pregnant women or gaps in coverage caused by women leaving the workforce)(94–97). Our estimates for short interpregnancy intervals among women with consistent insurance coverage, are slightly higher than the most recent national statistics. First, the women in our sample are older than the general population of women giving birth as well as more likely to be employed; this may suggest women in our sample may have delayed childbearing for educational and professional opportunities. As pregnancy related risks increase with maternal age, our sample of women may be balancing the risks of short interpregnancy intervals with those associated with advanced maternal age to achieve ideal

family size. Future research could explore the risk trade-offs and outcomes from women who may face opposing recommendations.

Given that all women in the sample had some access to clinical services as well as contraceptives, we could also hypothesize that the perceived risk of poor birth outcomes caused by short interpregnancy intervals may not be high enough to deter women from short birth intervals. These findings suggest further research on the messaging women receive in the prenatal and postpartum period on healthy interpregnancy spacing. It may be particularly relevant to study how provider's counseling and recommendations for healthy interpregnancy intervals differ by age as women must balance the risks of short interpregnancy intervals with the risks advanced maternal age.

Limitations

This study has several limitations to consider. In the absence of a randomized control trial, we used instrumental variables to address the known endogeneity of provider and contraceptive method selection. While these instruments are useful, there may be other unobservable differences across women in the sample that are likely associated with provider selection, contraceptive initiation, and interpregnancy intervals that our models could not address.

As our data source was administrative claims, we can only measure those services that reimbursed by the insurance company. Our analysis was not able to account for the use of condoms, natural family planning or partner vasectomy as a method of contraception thereby likely over-estimating the number of women classified as not using any contraceptive method and potentially biasing our estimates. If the true risk of a short interpregnancy interval is

actually higher for women not using any method (masked by some of our non-use sample actually using an unobservable method), our model under-estimates the effect of SARCs and LARCs on reducing short interpregnancy intervals. Additionally, we did not have access to many individual level demographic characteristics and therefore relied on attributes of zip codes, which may not be representative of individual members' characteristics. While these indicators are useful control variables, interpreting these population level attributes as though they represent the individuals is an ecological fallacy and will bias the interpretation of the models. As such, our models included these covariates but did not directly interpret any of the coefficients or effects associated with them.

Because we are unable to precisely estimate the date of conception, we used claims associated with labor and delivery in order to estimate the time from birth until the next pregnancy. Given the heterogeneity of when women realize they are pregnant and how quickly they enter prenatal care, we used the labor and delivery claim as the referent point. While we relaxed the healthy gestational age to include any delivery greater than 36 weeks, we may have overestimated short interpregnancy intervals among women who had preterm births at earlier gestations as the maternal claims did not include an indicator for birth outcomes such as gestational age or NICU admission. Future analysis on interpregnancy intervals could integrate the infant claims and therefore better estimate gestational age. Additionally, we did not include spontaneous abortions, fetal deaths, or induced abortions in our analysis thereby underestimating postpartum pregnancies.

Finally, the requirement of 60 months of continuous private insurance coverage may limit the generalizability of our study to other populations such as women using Medicaid or those who have recently enrolled in insurance programs via the Affordable Care Act marketplaces.

Conclusions

Among women with consistent insurance coverage during the postpartum period, short interpregnancy intervals were common, exceeding previous national estimates. Controlling for characteristics associated with her provider, the facility where she received care, and the demographics of the area in which she lives, the strongest predictor of whether a woman would have a short birth interval is the type of contraceptive she uses in the postpartum period. Women using a long-acting method versus a short-acting method were significantly less likely to have a short interpregnancy interval to their next birth. Given the mounting evidence supporting the use of long-acting reversible contraceptives in the postpartum period and the current recommendations from the American Congress of Obstetricians and Gynecologists (45), these findings demonstrate that postpartum contraceptives are a critical component to preventing short birth intervals and that continued emphasis should be placed on the value of long-acting methods.

Tables and Figures

Table 4.1 Key Measures and Definitions

Interpregnancy Intervals	
Interpregnancy interval	The time (months) between two live births
Short interpregnancy interval	An interpregnancy interval of <27 months
Contraceptive Use	
Contraceptive initiation	The first postpartum medical or pharmaceutical claim associated with beginning contraceptives; e.g. CPT code 58300- Insertion of an intrauterine device or prescription filled for oral contraceptive method
Contraceptive non-use	No recoded claim for any contraceptive method within 24 months of delivery
Short-acting reversible contraception	Includes hormonal pills, patch, vaginal ring and injectable
Long-acting reversible contraceptive	Includes both the hormonal and copper intrauterine devices as well as the subdermal implant
Permanent sterilization	Includes both tubal ligation and occlusion
Contraceptive type	Mutually exclusive categories of non-use, SARC, LARC, permanent
Provider Characteristics	
Provider Specialty Designation	The specialty code of the provider who received the payment for the maternity care
Provider Specialty	For this study, we categorized providers into the five largest groups: Obstetricians and Gynecologists, Family Medicine, Certified Nurse Midwives (CNM), Pediatrics and Multispecialty Practice. During analysis, we did not interpret the findings associated with women seen by CNMs due to a very small sample. Additionally, Multispecialty Practice designation did not provide sufficient information for comparison with our referent group, OB/GYNs; it remained in the model as a covariate however could not be meaningfully interpreted given the lack of detailed information.
Residency Affiliation	Using the Accreditation Council for Graduate Medical Education directory, we identified those hospitals and practices associated with an OB/GYN residency training program. We allocated all providers at that site as "affiliated" to an OB/GYN residency program, regardless of specialty.
Distance to nearest OB/GYN residency program	The distance (miles) from a woman's ZIP code centroid to the nearest accredited OB/GYN residency program; for multi-clinic practices, the central hospital was used as the end point
Provider's LARC prescribing preference	Among all non-permanent contraceptive prescriptions attributed to a provider, the proportion that are for a long-acting reversible contraceptive
Demographic Characteristics	
Maternal age	A woman's age on the day of delivery (years)
Group health plan	Binary indictor of whether a woman was enrolled in a group based insurance plan or individual plan

Rural	Residential zip code with RUCA classification of large rural, small rural or isolated rural
Relative parity	The number of live births a woman has within the data time frame
White %	The percent of a zip code identifying as White per Census estimates
Black %	The percent of a zip code identifying as Black per Census estimates
Native American/American Indian %	The percent of a zip code identifying as Native American/American Indian per Census estimates
Asian %	The percent of a zip code identifying as Asian per Census estimates
Native Hawaiian/Pacific Islander %	The percent of a zip code identifying as Native Hawaiian/Pacific Islander per Census estimates
Hispanic %	The percent of a zip code identifying as Hispanic per Census estimates; includes ALL races
Females over 25 without high school degree/GED %	The percent of women in a zip code over age 25 without a high school diploma or GED equivalency per Census estimates

Table 4.2 Attributes of women in sample

	n	%
Unique women in sample	4298	-
Number of discrete interpregnancy intervals	4793	-
Age at time of event (mean)	32.4	-
Insurance Membership Classification		
Subscriber	2,593	54.1
Spouse	2,130	44.44
Child	70	1.46
Geographic Attributes of ZIP Code		
Urban	4,275	89.19
Large rural	338	7.05
Small rural	85	1.77
Isolated rural	95	1.98

Table 4.3 Attributes of live births in sample

	n	%
Relative Parity Number		
Second live birth	4,254	88.75
Third live birth	504	10.52
Fourth or higher	34	0.73
Average relative parity	2.12	
Delivery Type		
Vaginal delivery after vaginal delivery	3,118	64.6
Vaginal delivery after caesarian	112	2.32
Caesarian delivery after vaginal	337	6.98
Caesarian delivery after caesarian	1,259	26.1

Table 4.4 Provider, Residency and Facility Characteristics of Births

	Subsequent (2nd) Pregnancy		Previous (1st) Pregnancy	
	n	%	n	%
Provider Specialty				
OB/GYN	3,903	81.43	3,973	82.89
Family Medicine	85	1.77	74	1.54
CNM	6	0.13	7	0.15
Pediatrics	73	1.52	48	1
Other specialty	726	15.15	691	14.42
Residency Affiliation				
OB/GYN Residency Site	518	10.81	515	10.74
Delivery Facility Type				
Hospital	4,600	99.03	4,589	99.2
Birthing Center	41	0.88	35	0.76
Emergency Room	4	0.09	2	0.04

Table 4.5 Interpregnancy Interval Characteristics

	n	%
<12 months	95	1.98
<18 months	451	9.42
<24 months	930	19.42
<30 months	946	19.75
<36 months	721	15.05
<42 months	523	10.92
<54 months	714	14.91
<60 months	179	3.74
5 years +	231	4.82
Mean time to next delivery	944 days (33.1 months)	
Mean time to next delivery by previous method of contraceptive		
	n	mean
Non-use	1735	837 days (27.9 months)
SARC	2282	1057 days (35.2 months)
LARC	586	1244 day (41.5 months)
Short interpregnancy intervals by previous method of contraception		
	n	%
Non-use	970	55.91
SARC	738	32.34
LARC	100	17.06

Table 4.6 First stage models

First Stage Models (n=4587)	Model 1: Pr(Residency Program)	Model 2: Pr(Contraceptive Type)	
	Coefficient	Coefficient on SARC Choice	Coefficient on LARC Choice
Distance to closest residency	-0.00232*** [-0.00321,-0.00143]	-	-
LARC provider prescribing preference	-	-0.0748** [-0.123,-0.0269]	0.211*** [0.138,0.284]
Family Medicine (ref: OB/GYN)	0.205*** [0.129,0.281]	-1.355*** [-1.981,-0.729]	-1.007* [-1.820,-0.193]
Certified Nurse Midwife	-0.00587 [-0.0253,0.0136]	-0.771 [-2.582,1.040]	-0.351 [-2.634,1.932]
Pediatrics (ref: OB/GYN)	0.381*** [0.333,0.429]	-0.449 [-1.102,0.205]	-0.656 [-1.747,0.434]
Other specialties (ref: OB/GYN)	0.254*** [0.234,0.273]	0.237* [0.0405,0.434]	0.0327 [-0.258,0.323]
Age on delivery	0.00721 [-0.0000234,0.0144]	0.374*** [0.211,0.538]	0.139 [-0.0884,0.366]
Relative parity	-0.00632* [-0.0120,-0.000662]	-0.651*** [-0.820,-0.482]	-0.623*** [-0.900,-0.346]
Rural community (ref: urban community)	-0.00278 [-0.0311,0.0256]	-0.0703 [-0.296,0.155]	0.0609 [-0.258,0.380]
White %	-0.00392 [-0.00797,0.000125]	0.0157 [-0.0492,0.0806]	-0.0326 [-0.124,0.0588]
Black %	-0.00366 [-0.00771,0.000386]	0.013 [-0.0527,0.0788]	-0.0288 [-0.121,0.0637]
Native American/American Indian %	-0.00392 [-0.00807,0.000238]	0.0154 [-0.0541,0.0848]	-0.0369 [-0.134,0.0606]
Asian %	-0.000731 [-0.00526,0.00380]	0.00511 [-0.0653,0.0756]	-0.0572 [-0.158,0.0441]
Native Hawaiian/Pacific Islander %	-0.0118 [-0.0424,0.0188]	0.391 [-0.159,0.941]	0.24 [-0.510,0.989]
Hispanic %	-0.00118 [-0.00269,0.000330]	-0.0213* [-0.0397,-0.00292]	-0.0355* [-0.0632,-0.00782]
Females over 25 without high school degree/GED %	-0.00133 [-0.00296,0.000300]	0.0320** [0.0123,0.0516]	0.0443** [0.0165,0.0721]
constant	0.438* [0.0214,0.854]	-5.367 [-12.24,1.506]	1.463 [-8.181,11.11]

Table 4.7 Second stage model

	Coefficient	Average Marginal Effect
SARC (ref: non-use)	-1.765 [-4.905,1.376]	-0.387 [-0.920,0.146]
LARC (ref: non-use)	-2.845 [-6.373,0.683]	-0.542* [-1.071,-0.0132]
Residency affiliation (ref: non-residency affiliation)	0.0032 [-0.292,0.298]	0.000681 [-0.0629,0.0642]
Family Medicine (ref: OB/GYN)	-0.447 [-1.473,0.580]	-0.0908 [-0.303,0.122]
Certified Nurse Midwife	0.251 [-1.717,2.220]	0.0545 [-0.322,0.431]
Pediatrics (ref: OB/GYN)	-0.45 [-1.209,0.309]	-0.0914 [-0.244,0.0612]
Other specialties (ref: OB/GYN)	-0.0259 [-0.243,0.191]	-0.0055 [-0.0556,0.0446]
Rural community (ref: urban community)	-0.00289 [-0.212,0.206]	-0.000616 [-0.0474,0.0462]
Age on delivery	-0.387** [-0.670,-0.105]	-0.0825* [-0.146,-0.0185]
Relative parity	0.343 [-0.149,0.834]	0.073 [-0.0479,0.194]
Caesarian section (ref: vaginal delivery)	0.0813 [-0.125,0.288]	0.0173 [-0.0308,0.0655]
White %	-0.0647* [-0.128,-0.00174]	-0.0138 [-0.0295,0.00197]
Black %	-0.0640* [-0.128,-0.000225]	-0.0136 [-0.0296,0.00233]
Native American/American Indian %	-0.0707* [-0.137,-0.00387]	-0.015 [-0.0318,0.00168]
Asian %	-0.0772* [-0.147,-0.00753]	-0.0164 [-0.0338,0.000969]
Native Hawaiian/Pacific Islander %	-0.549 [-1.105,0.00656]	-0.117 [-0.260,0.0258]
Hispanic %	-0.00694 [-0.0304,0.0165]	-0.00148 [-0.00721,0.00425]
Females over 25 without high school degree/GED %	-0.0206 [-0.0466,0.00527]	-0.00439 [-0.0110,0.00218]
Residual: Residency Affiliation	-0.0261 [-0.345,0.292]	-0.00555 [-0.0748,0.0637]
Residual: SARC Use	0.799 [-2.340,3.939]	0.17 [-0.575,0.916]
Residual: LARC Use	0.957 [-2.571,4.486]	0.204 [-0.665,1.072]
constant	14.22*** [7.368,21.08]	

[95% confidence intervals in brackets]
* p<0.05, ** p<0.01, *** p<0.001

Figure 4.1 Instrumental Variable for Receiving Care from an OB/GYN residency affiliated provider

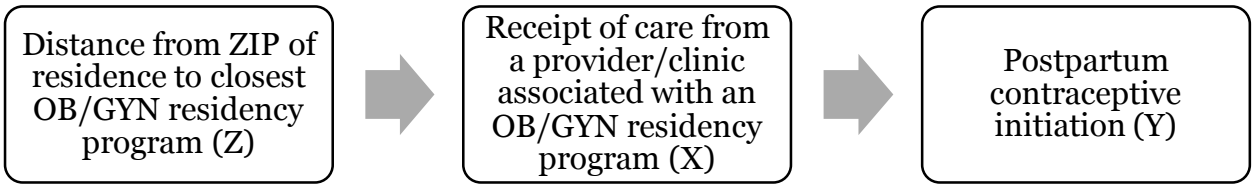


Figure 4.2 Instrumental Variable for Contraceptive Choice in Postpartum Period

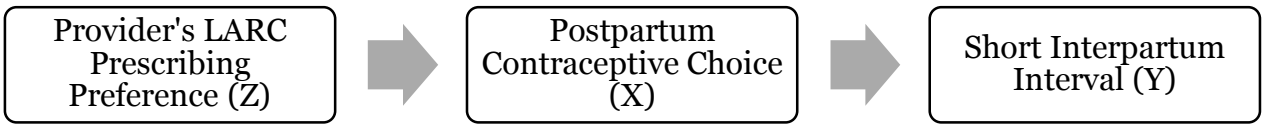
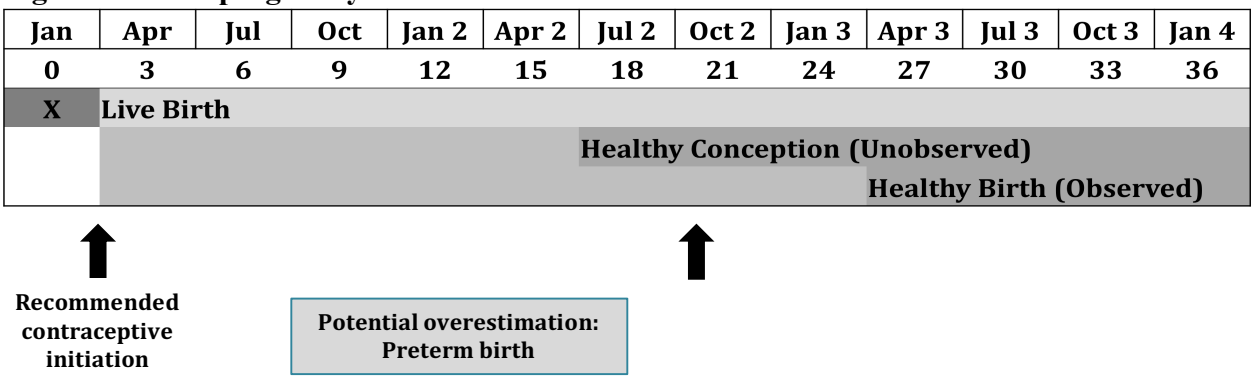


Figure 4.3 Interpregnancy interval timeline



CHAPTER 5: DISCUSSION

Findings

Our study has several notable findings that enhance the scientific literature on postpartum contraceptive initiation patterns and interpregnancy intervals. We found that receiving maternity care from a provider associated with an obstetrics and gynecology residency site did not increase a woman's probability of initiating a postpartum contraceptive. We also found that women who received care from a residency affiliated provider were not more likely to use a long-acting reversible contraceptive during the postpartum period. While these findings are contrary to our initial hypotheses, there are several potential reasons for these results. Providers at residency sites represent not only experienced providers teaching new physicians but also those physicians in early training; new providers may not have sufficient experience with postpartum contraceptive counseling and services to advise women on the importance of preventing short interpregnancy intervals.

In addition to the provider variation, despite having a sample of women with consistent private insurance, there may be unobserved differences between women who receive care from a residency affiliated provider and those who do not. For example, in many communities, large teaching hospitals act as safety-net institutions and may have a riskier patient pool as compared with other providers. Additionally, residency affiliated providers may be more likely to practice within institutions that have more specialty services for high risk pregnancies. For example, women with previous poor birth outcomes or chronic conditions that may make pregnancy

dangerous are likely more apt to receive services at facilities with enhanced NICU services or maternal and fetal medicine providers; these providers are more likely to be associated with teaching/residency sites. These characteristics were not available in our data yet may influence a woman's postpartum contraceptive behaviors as well as interpregnancy spacing may our estimates.

Our findings also showed that the specialty of a woman's maternity care provider did not affect the timing to postpartum contraceptive initiation or the probability of having a short interpregnancy intervals. The only significant relationship between provider specialty and our key outcomes was between family medicine providers and long-acting reversible contraceptive initiation. While these findings do not support our initial hypothesis that women who receive care from obstetricians and gynecologist would have higher postpartum contraceptive utilization, higher LARC utilization and fewer short interpregnancy intervals, they still offer additional insights into how service delivery systems may or may not affect our key outcomes of interest.

Our findings also present new evidence to the field as our sample was drawn from a population of women with continuous, private insurance coverage. Much of the previous literature on interpregnancy spacing and short interpregnancy intervals has focused on women with Medicaid and hypothesized insurance discontinuity was a considerable factor in the high incidence of short interpregnancy intervals. Our findings show comparable, and even slightly higher, rates of short interpregnancy intervals. While this cannot dispel the hypothesis that insurance status is potentially protective against short interpregnancy intervals, it does suggest that the relationship may be more complex than simply having any insurance coverage. As research continues on this important topic, it will be important to consider the implications of the Affordable Care Act and increased access to insurance coverage for women via either Medicaid

expansion of the subsidized marketplaces. The demographics of uninsured, publicly insured, and privately insured women will continue to shift in the coming years and lend themselves to more comprehensive research on what personal characteristics are protective against short interpregnancy intervals beyond simply having insurance.

Policy Implications

These findings have several potential policy implications for insurers, both private and public. As private insurance companies and Medicaid move towards bundled maternity care services with global billing codes, there is increased potential to implement quality improvement initiatives into routine care. With bundled maternity services, providers receive an agreed upon amount for all routine prenatal, labor and delivery, and postpartum care; reimbursement rates differ by delivery type with caesarian sections being reimbursed at a higher value due to increased costs. Included within the bundled maternity care is the expectation that providers are adhering to a standard of care in the postpartum visit which requires postpartum contraceptive counseling. However, as the reimbursed amount is previously agreed upon, there may not be additional incentives for providers to fully document all services rendered. For example, providers may see no added benefit of recording postpartum contraceptive counseling as it will not affect the reimbursement. The insurer could implement a strategic quality improvement effort that requires providers to certify via a billing modifier code that return to fertility and contraceptives have been discussed with women, among other important services included within the bundled payment mechanism.

In addition to ensuring this postpartum service is being provided, the insurer could explore additional targeted interventions for women in the late prenatal and early postpartum

period to initiate contraceptives. Women receiving maternity services are a particularly engaged consumers of health services; by the end of pregnancy many women are interacting with providers nearly weekly. Insurers could work with providers and clinical practices to strategically communicate the importance of postpartum contraceptive with women during their final prenatal care visits. This could include the use of new media in clinics, revising contraceptive counseling practices or using reminder cards. Reminder cards (cards mailed directly to patients' homes to prompt a patient to schedule an important health service) have been used successfully to remind patients to return for dental cleaning, breast exams, colonoscopies and pap smears. Practices or the insurer themselves could implement a similar tactic with women in the postpartum period indicating that a woman will soon return to fertility and that it is an appropriate time to consider contraceptive options. Considering two of the primary reasons women stated they did not initiate postpartum contraceptives earlier in the postpartum period was not believing they could become pregnant or forgetting given the demands of a new infant(9), this may be a potential low-cost intervention that may not substantially burden providers.

Finally, long-acting reversible contraceptives require specialty training for providers. Many of the trainings are proprietary to the manufacturers of the contraceptive devices and can be costly to clinical practices. Given the financial burden of unintended pregnancies on insurance companies, they may consider providing additional, no-cost training to providers interested in providing LARCs to their patients. This may increase the proportion of members relying on LARCs in the postpartum period and thereby reduce the incidence of short interpregnancy intervals. Additionally, the insurer could also put in place penalties for practices that provide in-network maternity services without any clinical staff trained in LARC insertions or removals.

Limitations

These studies had several limitations to consider when interpreting the findings. First and foremost, this study was designed to retrospectively use administrative claims data. In the absence of a randomized control trial, we used several techniques to adjust for potential selection bias and endogeneity in our models. Both two-stage residual inclusion and inverse probability of treatment weights are useful to address biases caused by unobserved variants however have their limitations. There may be additional unobserved biases associated with selecting a provider affiliated with a residency program and the method of postpartum contraceptive initiated that are not accounted for in our models.

Provider attributes were an important component of this study, namely provider specialty. The available claims used the NPI used to bill for services rendered; this number could represent a single provider or an entire clinical practice. This may effect how some provider specialties were measured and lead to the large number of women seen by "multispecialty providers". Additionally, the inclusion of both individuals and practices in the provider identification variable may have also affected how the prescribing preference instrument used in Chapter 3 functioned.

This study also focused on the contraceptive a woman first initiated in the postpartum period. We did not measure adherence or method switching, both of which would affect a woman's protection against unintended pregnancy. Additionally, our analysis was limited only to those methods which were observed from reimbursement. Women who were using condoms, natural family planning or partner vasectomy to prevent unintended pregnancy are denoted as non-users in our analysis. This unobserved variant leads our estimates to be negatively biased

and underestimate the effect of long and short-acting reversible contraceptives on short interpregnancy intervals.

Measuring pregnancy related outcomes in claims data is challenging. Claims does not provide an estimated date of conception thereby requiring us to use alternative time points to measure the timing of pregnancy. Given the heterogeneity of when women realize they are pregnant as well as when they receive their first prenatal care visit, we relied on the terminal point in pregnancy as the timing measure and counted backwards to conception. While this method is the more stable option, it relies on estimated gestational age. While we relaxed the healthy gestational age to include any delivery greater than 36 weeks, we may have overestimated short interpregnancy intervals among women who had preterm births at earlier gestations as the maternal claims did not include an indicator for birth outcomes such as gestational age or NICU admission. Due to the challenges of measuring date of conception in claims data, we limited our study to only live births. This lead to underreporting of pregnancies as we did not take into account those ending in spontaneous abortion, induced abortion or fetal death.

Claims data offers limited social and demographics information on members. To control for some heterogeneity across women in the sample, we used population level characteristics from a woman's ZIP code of residency. These characteristics may not reflect the actual members and therefore bias our estimates.

Finally, the requirement on 60 months of continuous private insurance coverage, may limit the generalizability of our study to other populations.

Areas for Future Research

While this project has enhanced the body of literature on postpartum contraceptive initiation patterns and interpregnancy intervals, there are still significant opportunities for future research. One potential area of opportunity is to further document and assess how women receive information on the importance of postpartum contraceptives and healthy interpregnancy intervals. This lends itself to a mixed methods approach which could combine insurance claims, medical charts and surveys with both women and their providers. While there is some literature on the barriers providers face when discussing contraceptives, this study could expand and ask not only about the challenges of patient counseling but also those factors that a health system could modify such as the provision of additional training, tools for proper reimbursement as well as stock issues. For women, additional qualitative information could study how women decide on when to begin postpartum contraception as well as assess their perceived risks associated with short interpregnancy intervals. Subpopulation analysis could further measure how women of make interpregnancy interval decisions while balancing the risks of short interpregnancy intervals with the those of advanced maternal age.

Additionally, future studies could study how women initiate, adhere, and discontinue contraceptives in the postpartum period. While this study exclusively looked at the method and timing of a woman's first postpartum contraceptive method, future studies could examine what factors lead to increased adherence of SARCs as well as what motivates women to switch methods in the postpartum period. This study could also investigate what dictates when women discontinue contraceptives in an effort to become pregnant again.

This study also builds a foundation for studies to test how short interpregnancy intervals affect pregnancy and birth outcomes among privately insured women. Future studies could

match the maternal insurance claims with those of infants and young children to determine how interpregnancy intervals are linked to outcomes such as pregnancy loss, infant birthweight, and gestational age at delivery. Finally, currently there is not literature on the economic implications impact of short interpregnancy intervals for insurance payers. Future analysis could build off this study and integrate infant health claims to understand the potential effects of postpartum contraceptive initiation on unintended pregnancies, preterm and low birthweight infants, and NICU admissions.

REFERENCES

1. Trussell J, Henry N, Hassan F, Prezioso A, Law A, Filonenko A. Burden of unintended pregnancy in the United States: potential savings with increased use of long-acting reversible contraception. Contraception. 2013 Feb;87(2):154–61.

2. Finer LB, Zolna MR. Unintended pregnancy in the United States: incidence and disparities, 2006. Contraception. 2011 Nov;84(5):478–85.

3. Thiel de Bocanegra H, Chang R, Menz M, Howell M, Darney P. Postpartum Contraception in Publicly-Funded Programs and Interpregnancy Intervals: Obstet Gynecol. 2013 Aug;122(2, PART 1):296–303.

4. Conde-Agudelo A, Rosas-Bermudez A, Castaño F, Norton MH. Effects of Birth Spacing on Maternal, Perinatal, Infant, and Child Health: A Systematic Review of Causal Mechanisms. Stud Fam Plann. 2012 Jun 1;43(2):93–114.

5. Healthy People 2020 [Internet]. The Centers for Disease Control and Prevention; Available from: https://www.healthypeople.gov/node/4461/data_details

6. Centers for Disease Control and Prevention. 2003 Revisions of the U.S. Standard Certificates of Live Birth and Death and the Fetal Death Report [Internet]. 2012 Jul. Available from: http://www.cdc.gov/nchs/nvss/vital_certificate_revisions.htm

7. North Carolina Center for Health Statistics. 2013 Live Birth Data [Internet]. 2015. Available from: http://www.schs.state.nc.us/schs/data/births/bd.cfm

8. Centers for Disease Control and Prevention. PRAMS [Internet]. 2011. Available from: ww.cdc.gov/prams

9. Centers for Disease Control and Prevention. PRAMStat [Internet]. Pregnancy Risk Assessment Monitoring System (PRAMS). 2015 [cited 2015 Apr 2]. Available from: http://www.cdc.gov/prams/pramstat/index.html

10. Razzaque A, Da Vanzo J, Rahman M, Gausia K, Hale L, Khan MA, et al. Pregnancy spacing and maternal morbidity in Matlab, Bangladesh. Int J Gynecol Obstet. 2005 Apr;89, Supplement 1:S41–9.

11. Trogstad LI, Eskild A, Magnus P, Samuelsen SO, Nesheim B-I. Changing paternity and time since last pregnancy; the impact on pre-eclampsia risk. A study of 547 238 women with and without previous pre-eclampsia. Int J Epidemiol. 2001 Dec 1;30(6):1317–22.

12. Conde-Agudelo A, Belizán JM. Maternal morbidity and mortality associated with interpregnancy interval: cross sectional study. BMJ. 2000 Nov 18;321(7271):1255–9.

13. King JC. The Risk of Maternal Nutritional Depletion and Poor Outcomes Increases in Early or Closely Spaced Pregnancies. J Nutr. 2003 May 1;133(5):1732S – 1736S.

14. Md D, To L. Socio-demographic determinants of anaemia in pregnancy at primary care level: a study in urban and rural Oyo State, Nigeria. Afr J Med Med Sci. 2004 Sep;33(3):213–7.

15. Bujold E, Mehta SH, Bujold C, Gauthier RJ. Interdelivery interval and uterine rupture. Am J Obstet Gynecol. 2002 Nov;187(5):1199–202.

16. Esposito MA, Menihan CA, Malee MP. Association of interpregnancy interval with uterine scar failure in labor: A case-control study. Am J Obstet Gynecol. 2000 Nov;183(5):1180–3.

17. Shipp TD, Zelop CM, Repke JT, Cohen A, Lieberman E. Interdelivery interval and risk of symptomatic uterine rupture. Obstet Gynecol. 2001 Feb;97(2):175–7.

18. Rousso D, Panidis D, Gkoutzioulis F, Kourtis A, Mavromatidis G, Kalahanis I. Effect of the interval between pregnancies on the health of mother and child. Eur J Obstet Gynecol Reprod Biol. 2002 Oct 10;105(1):4–6.

19. Getahun D, Oyelese Y, Salihu HM, Ananth CV. Previous Cesarean Delivery and Risks of Placenta Previa and Placental Abruption: Obstet Gynecol. 2006 Apr;107(4):771–8.

20. Davanzo J, Hale L, Razzaque A, Rahman M. The effects of pregnancy spacing on infant and child mortality in Matlab, Bangladesh: How they vary by the type of pregnancy outcome that began the interval. Popul Stud. 2008 Jul 1;62(2):131–54.

21. Conde-Agudelo A, Rosas-Bermúdez A, Kafury-Goeta AC. Birth spacing and risk of adverse perinatal outcomes: a meta-analysis. Jama. 2006;295(15):1809–23.

22. Conde-Agudelo A, Rosas-Bermúdez A, Kafury-Goeta A. Birth spacing and risk of adverse perinatal outcomes: A meta-analysis. JAMA. 2006 Apr 19;295(15):1809–23.

23. DeFranco EA, Stamilio DM, Boslaugh SE, Gross GA, Muglia LJ. A short interpregnancy interval is a risk factor for preterm birth and its recurrence. Am J Obstet Gynecol. 2007 Sep;197(3):264.e1–264.e6.

24. Khoshnood B, Lee K, Wall S, Hsieh H, Mittendorf R. Short Interpregnancy Intervals and the Risk of Adverse Birth Outcomes among Five Racial/Ethnic Groups in the United States. Am J Epidemiol. 1998 Oct 15;148(8):798–805.

25. Miller JE. Birth Intervals and Perinatal Health: An Investigation of Three Hypotheses. Fam Plann Perspect. 1991 Mar 1;23(2):62–70.

26. Zhu B-P, Haines KM, Le T, McGrath-Miller K, Boulton ML. Effect of the interval between pregnancies on perinatal outcomes among white and black women. Am J Obstet Gynecol. 2001 Dec;185(6):1403–10.

27. Zhu B-P, Rolfs RT, Nangle BE, Horan JM. Effect of the Interval between Pregnancies on Perinatal Outcomes. N Engl J Med. 1999 Feb 25;340(8):589–94.

28. Ferraz EM, Gray RH, Flemming P, Maia T. Interpregnancy interval and low birth weight: findings from a case-control study. Am J Epidemiol. 1988;128(5):1111–6.

29. Aerts D, Drachler M de L, Giugliani ERJ. Determinants of growth retardation in Southern Brazil. Cad Saúde Pública. 2004;20(5):1182–90.

30. Boerma JT, Bicego GT. Preceding birth intervals and child survival: searching for pathways of influence. Stud Fam Plann. 1992;243–56.

31. Clark CA. Demographic and socioeconomic correlates of infant growth in Guatemala. 1981;

32. Ricci JA, Becker S. Risk factors for wasting and stunting among children in Metro Cebu, Philippines. Am J Clin Nutr. 1996;63(6):966–75.

33. Rutstein SO. Effects of preceding birth intervals on neonatal, infant and under-five years mortality and nutritional status in developing countries: evidence from the demographic and health surveys. Int J Gynecol Obstet. 2005 Apr;89, Supplement 1:S7–24.

34. Huttly SR, Victora CG, Barros FC, Vaughan JP. Birth spacing and child health in urban Brazilian children. Pediatrics. 1992;89(6):1049–54.

35. Mozumder AKA, KHUDA B-E, KANE TT, Levin A, Ahmed S. The effect of birth interval on malnutrition in Bangladeshi infants and young children. J Biosoc Sci. 2000;32(03):289–300.

36. Sekiyama M, Ohtsuka R. Significant effects of birth-related biological factors on pre-adolescent nutritional status among rural Sundanese in West Java, Indonesia. J Biosoc Sci. 2005;37(04):413–26.

37. Thuita FM, Mwadime RKN, Wang'ombe JK. Child nutritional status and maternal factors in an urban slum in Nairobi, Kenya. East Afr Med J. 2005;82(4).

38. Ruelas-Orozco G, Guzman J, Malacara JM. [Perinatal mortality risk factors in a case-control study]. Bol Med Hosp Infant Mex. 1985;42(3):153–8.

39. Bartlett AV, Bocaletti MP de. Intraparturn and neonatal mortality in a traditional indigenous community in rural Guatemala. Acta Paediatr. 1991;80(3):288–96.

40. Wang PD, Lin RS. Perinatal mortality in Taiwan. Public Health. 1999;113(1):27–33.

41. Eichenwald EC, Stark AR. Management and Outcomes of Very Low Birth Weight. N Engl J Med. 2008 Apr 17;358(16):1700–11.

42. CDC - Preterm Birth-Prematurity - Maternal Infant Health - Reproductive Health [Internet]. [cited 2015 Apr 21]. Available from: http://www.cdc.gov/reproductivehealth/MaternalInfantHealth/PretermBirth.htm

43. WHO | Report of a technical consultation on birth spacing [Internet]. WHO. [cited 2014 Nov 4]. Available from: http://www.who.int/maternal_child_adolescent/documents/birth_spacing05/en/

44. The American Academy of Pediatrics and The American Congress of Obstetricians and Gynecologists. Guidelines for pernatal care. 7th ed. Washington, DC: The American Academy of Pediatrics and The American Congress of Obstetricians and Gynecologists; 2012.

45. Practice AC on O. Guidelines for Perinatal Care. AAP Books. 2012;

46. Glasier AF, Logan J, McGlew TJ. Who gives advice about postpartum contraception? Contraception. 1996 Apr;53(4):217–20.

47. Gemmill A, Lindberg LD. Short Interpregnancy Intervals in the United States: Obstet Gynecol. 2013 Jul;122(1):64–71.

48. Bennett IM, Culhane JF, McCollum KF, Elo IT. Unintended short interpregnancy interval and low education status: Any role for depression and contraceptive use? Am J Obstet Gynecol. 2006 Mar;194(3):749–54.

49. Cubbin C, Braveman PA, Marchi KS, Chavez GF, Santelli JS, Gilbert BJC. Socioeconomic and Racial/Ethnic Disparities in Unintended Pregnancy Among Postpartum Women in California. Matern Child Health J. 2002 Dec 1;6(4):237–46.

50. Glazer AB, Wolf A, Gorby N. Postpartum contraception: needs vs. reality. Contraception. 2011 Mar;83(3):238–41.

51. Update to CDC's U.S. Medical Eligibility Criteria for Contraceptive Use, 2010: Revised Recommendations for the Use of Contraceptive Methods During the Postpartum Period [Internet]. The Centers for Disease Control and Prevention; 2011 Jul. (Morbidity and Mortality Weekly Report). Report No.: 60(26);878-883. Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6026a3.htm

52. DePiñeres T, Blumenthal PD, Diener-West M. Postpartum contraception: the New Mexico Pregnancy Risk Assessment Monitoring System. Contraception. 2005 Dec;72(6):422–5.

53. Zite N, Wuellner S, Gilliam M. Failure to Obtain Desired Postpartum Sterilization: Risk and Predictors: Obstet Gynecol. 2005 Apr;105(4):794–9.

54. Speroff L, Mishell Jr. DR. The postpartum visit: it's time for a change in order to optimally initiate contraception. Contraception. 2008 Aug;78(2):90–8.

55. Frost JJ, Darroch JE, Remez L. Improving contraceptive use in the United States. Issues Brief (Alan Guttmacher Inst). 2007;(1):1–8.

56. Peterson HB, Curtis KM. Long-Acting Methods of Contraception. N Engl J Med. 2005 Nov 17;353(20):2169–75.

57. Peipert JF, Zhao Q, Allsworth JE, Petrosky E, Madden T, Eisenberg D, et al. Continuation and Satisfaction of Reversible Contraception. Obstet Gynecol. 2011 May;117(5):1105–13.

58. Espey E, Ogburn T. Long-Acting Reversible Contraceptives: Intrauterine Devices and the Contraceptive Implant. Obstet Gynecol. 2011 Mar;117(3):705–19.

59. American Congress of Obsetricians and Gynecologists. Adolescents and long-acting reversible contraception: Implants and intrauterine devices. [Internet]. [cited 2014 Dec 2]. Report No.: Committee Opinion No. 539. Available from: http://www.acog.org/Resources-And-Publications/Committee-Opinions/Committee-on-Adolescent-Health-Care/Adolescents-and-Long-Acting-Reversible-Contraception

60. Stevens-Simon C, Kelly L, Kulick R. A village would be nice but …: It takes a long-acting contraceptive to prevent repeat adolescent pregnancies. Am J Prev Med. 2001 Jul;21(1):60–5.

61. Hatcher RA, Trussell J. Contraceptive Technology, (pp 293-294). New York: Ardent Media. Inc; 2011.

62. Trussell J, Lalla AM, Doan QV, Reyes E, Pinto L, Gricar J. Cost effectiveness of contraceptives in the United States. Contraception. 2009 Jan;79(1):5–14.

63. Cheng D, Schwarz EB, Douglas E, Horon I. Unintended pregnancy and associated maternal preconception, prenatal and postpartum behaviors. Contraception. 2009 Mar;79(3):194–8.

64. Baldwin MK, Edelman AB. The Effect of Long-Acting Reversible Contraception on Short interpregnancy interval in Adolescents: A Review. J Adolesc Health. 2013 Apr;52(4, Supplement):S47–53.

65. Rigsby DC, Macones GA, Driscoll DA. Risk Factors for Short interpregnancy interval Among Adolescent Mothers: A Review of the Literature. J Pediatr Adolesc Gynecol. 1998 Aug;11(3):115–26.

66. Dehlendorf C, Levy K, Ruskin R, Steinauer J. Health care providers' knowledge about contraceptive evidence: a barrier to quality family planning care? Contraception. 2010 Apr;81(4):292–8.

67. Isaacs JN, Creinin MD. Miscommunication between healthcare providers and patients may result in unplanned pregnancies☆. Contraception. 2003 Nov;68(5):373–6.

68. Simonson K, Gerard N, Pomerantz T, Mullersman K, Landy U. Improving access and training for LARC: evaluation of the Ryan LARC program. Contraception. 2014 Sep 1;90(3):323–4.

69. Nothnagle M, Prine L, Goodman S. Benefits of comprehensive reproductive health education in family medicine residency. Fam Med-Kans CITY-. 2008;40(3):204.

70. Schreiber CA, Harwood BJ, Switzer GE, Creinin MD, Reeves MF, Ness RB. Training and attitudes about contraceptive management across primary care specialties: a survey of graduating residents. Contraception. 2006 Jun;73(6):618–22.

71. Bennett T. Reproductive health care in the rural United States. JAMA. 2002;287(1):112–112.

72. Teliska H. Obstacles to Access: How Pharmacist Refusal Clauses Undermine the Basic Health Care Needs of Rural and Low-Income Women. Berkeley J Gend Law Justice. 2005;20:229.

73. Shacter HE, Gee RE, Long JA. Variation in availability of emergency contraception in pharmacies. Contraception. 2007 Mar;75(3):214–7.

74. Jones J, Mosher W, Daniels K. Current contraceptive use in the United States, 2006–2010, and changes in patterns of use since 1995. Natl Health Stat Rep. 2012;60:1–25.

75. Hartlage SA, Breaux C, Gehlert S, Fogg L. Rural and urban midwestern United States contraception practices☆. Contraception. 2001 Jun;63(6):319–23.

76. Contraceptive Coverage in the Health Care Law: Frequently Asked Questions [Internet]. National Women's Law Center. 2012 [cited 2015 Mar 11]. Available from: http://www.nwlc.org/resource/contraceptive-coverage-health-care-law-frequently-asked-questions

77. Andersen R. A behavioral model of families' use of health services. Res Ser. 1968;(25).

78. Andersen RM. Revisiting the Behavioral Model and Access to Medical Care: Does it Matter? J Health Soc Behav. 1995 Mar 1;36(1):1–10.

79. Jackson E, Glasier A. Return of Ovulation and Menses in Postpartum Nonlactating Women: A Systematic Review. Obstet Gynecol March 2011. 2011;117(3):657–62.

80. Fabic MS, Choi Y. Assessing the Quality of Data Regarding Use of the Lactational Amenorrhea Method. Stud Fam Plann. 2013 Jun 1;44(2):205–21.

81. Group TECW, Baird DT, Evers JLH, Gemzell-Danielsson K, Glasier A, Killick SR, et al. Family planning 2011: better use of existing methods, new strategies and more informed choices for female contraception. Hum Reprod Update. 2012 Jun 13;dms021.

82. Cromartie J. USDA Economic Research Service - Rural-Urban Commuting Area Codes [Internet]. [cited 2016 Feb 23]. Available from: http://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx

83. Stevens-Simon C, Kelly L, Kulick R. A village would be nice but …: It takes a long-acting contraceptive to prevent repeat adolescent pregnancies. Am J Prev Med. 2001 Jul;21(1):60–5.

84. Healthcare Cost and Utilization Project (HCUP). Clinical Classifications Software (CCS) for ICD-9-CM [Internet]. Agenecy for Healthcare Research and Quality; 2016 Mar. Available from: https://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp

85. Zuckerman M, Navizedeh N, Feldman J, McCalla S, Minkoff H. Determinants of Women's Choice of Obstetrician/Gynecologist. J Womens Health Gend Based Med. 2002 Mar 1;11(2):175–80.

86. Brekke KR, Gravelle H, Siciliani L, Straume OR. Patient choice, mobility and competition among health care providers. In: Health Care Provision and Patient Mobility. Springer; 2014. p. 1–26.

87. Hibbard JH, Peters E. Supporting informed consumer health care decisions: data presentation approaches that facilitate the use of information in choice. Annu Rev Public Health. 2003;24(1):413–33.

88. McClellan M, McNeil BJ, Newhouse JP. Does more intensive treatment of acute myocardial infarction in the elderly reduce mortality?: analysis using instrumental variables. Jama. 1994;272(11):859–66.

89. Hernán MA, Robins JM. Estimating causal effects from epidemiological data. J Epidemiol Community Health. 2006;60(7):578–86.

90. Hirano K, Imbens GW, Ridder G. Efficient Estimation of Average Treatment Effects Using the Estimated Propensity Score. Econometrica. 2003;71(4):1161–89.

91. Hagan JF, Shaw JS, Duncan P, eds. Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents. Third Edition. Elk Grove Village, IL: American Academy of Pediatrics;

92. Copen C, Thoma M, Kirmeyer S. Interpregnancy Intervals in the United States: Data From the Birth Certificate and the National Survey of Family Growth [Internet]. US Department of Health and Human Services; 2015 Apr. (National Vital Statistics Reports). Report No.: Volume 64, Number 3. Available from: http://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_03.pdf

93. Brookhart MA, Wang P, Solomon DH, Schneeweiss S. Evaluating short-term drug effects using a physician-specific prescribing preference as an instrumental variable. Epidemiol Camb Mass. 2006 May;17(3):268–75.

94. Thiel de Bocanegra H, Chang R, Howell M, Darney P. Interpregnancy intervals: impact of postpartum contraceptive effectiveness and coverage. Am J Obstet Gynecol. 2014 Apr;210(4):311.e1–311.e8.

95. Glazer AB, Wolf A, Gorby N. Postpartum contraception: needs vs. reality. Contraception. 2011 Mar;83(3):238–41.

96. Cheng D, Schwarz EB, Douglas E, Horon I. Unintended pregnancy and associated maternal preconception, prenatal and postpartum behaviors. Contraception. 2009 Mar;79(3):194–8.

97. Moniz MH, Dalton VK, Davis MM, Forman J, Iott B, Landgraf J, et al. Characterization of Medicaid policy for immediate postpartum contraception. Contraception. 2015 Dec 1;92(6):523–31.