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Birth outcomes of second children after community-based home visiting: A research protocol

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Abstract

Birth-related outcomes, such as birth weight, have lifelong impacts on health. Home visiting (HV) is an established approach to improve the health of children and families, parenting practices, and connections to social and health services. Many HV programs target first-time mothers, in part because HV activities related to a first-birth may improve birth outcomes for subsequent children, but few researchers have examined these effects. We will link data from a statewide HV program (Nurturing Families Network [NFN]) to birth certificate data to create comparison groups and measure outcomes in this observational study. Specifically, we will compare birth outcomes for NFN second-children ($n = 3000$) to those for: (a) first-child older siblings whose birth/gestation led to NFN enrollment ($n = 3000$); (b) second children of families who were screened as eligible for NFN, but not offered the program due to home visitor availability and other logistical reasons ($n = 650$); and (c) non-NFN second children in a propensity-score-matched group created using the likelihood of enrollment in NFN based on maternal health, demographics, and neighborhood characteristics ($n = 6000$). The outcomes we will examine are birth spacing, prenatal care received, cesarean section rate, gestational age, and birth weight in second-children. We will also examine the associations between program attendance (i.e., missed visits, dropout) and birth outcomes, that will generate evidence that may be used in programmatic decisions regarding continued funding and/or modification of NFN, prioritization of specific retention efforts, and targeting of first-time mothers. Use of this evidence should improve outcomes for future NFN families and may inform similar programs.

Keywords

birth intervals; birth weight; home visiting; pregnancy outcome

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

1 | INTRODUCTION

Home visiting (HV) is an evidence-based approach shown to improve the health of children and families, parenting practices, and connections to social and health services (Health Resources and Services Administration, 2016). First-time high-risk mothers are often targeted for HV programs, in part because subsequent children are hypothesized to benefit from the parenting and other skills learned through participation in the program with a first child (Olds et al., 1999). Birth outcomes of second children may possibly also improve due to HV care provided in the second preconception and prenatal periods (Figure 1). Few studies, however, have focused on outcomes for second children. In this research study, funded by an Academic Research Enhancement Award (R15) from the National Institute of Nursing Research, we aim to generate evidence on whether a statewide home visiting program offers long-term benefits by improving outcomes for second children born to home-visited mothers. To our knowledge, we are the first team to examine second-child birth weight and gestational age in a natural field setting of home visiting and the first to examine second-child cesarean section rate and prenatal care initiation in any setting.

Established through the Affordable Care Act of 2010 and recently reauthorized through 2022, the Maternal, Infant, and Early Childhood Home Visiting program represents a substantial federal investment in early home visiting in the United States (“Bipartisan Budget Act of 2018,” 2018). Eighteen home visiting models qualify for federal funds through the Maternal, Infant, and Early Childhood Home Visiting program, and qualification requires evidence of improved outcomes including child and maternal health, child development, positive parenting practices, and linkages to social and health services (Administration on Children & Families, 2016a). Many programs target first-time mothers because of the anticipated influence on both first and later children. Increased understanding of this potential benefit has significant implications for home visiting policy.

2 | BACKGROUND

2.1 | Birth outcomes and lifelong health

Healthy People 2020 goals describe the need to improve birth-related outcomes, especially among ethnic or racial minority populations. These goals include reducing the rate of cesarean sections for low-risk births, reducing the incidence of preterm births and low birth weight, decreasing pregnancies occurring less than 18 months after the birth of the previous child, and increasing adequate prenatal care (U.S. Department of Health and Human Services, Office Of Disease Prevention And Health Promotion, 2016; U.S. Department Of Health And Human Services, Office of Disease Prevention and Health Promotion, 2016). Birth outcomes are not only an indication of the quality of the prenatal environment, but also have life-long implications for the parent and child.

Children born by cesarean section have an increased risk of obesity and immune diseases in adulthood (Cho & Norman, 2013; Li, Zhou, & Liu, 2013). Similarly, preterm birth is associated with increased hospitalizations, increased chronic illness, and poorer general health at ages 3 and 5 years (Boyle et al., 2012). Low birth weight is associated with increased risk of cardiovascular disease, type-2 diabetes, and chronic kidney disease in

adulthood (Barker et al., 1993; Wang et al., 2016; White et al., 2009; Zhang, Kris-Etherton, & Hartman, 2014). Inadequate prenatal care is associated with increased risk of poor birth outcomes (Partridge, Balayla, Holcroft, & Abenhaim, 2012). Finally, close spacing of pregnancies is associated with poorer outcomes for the first child, second child, and mother (Buckles & Munnich, 2012; Conde-Agudelo, Rosas-Bermudez, Castaño, & Norton, 2012; Crowne, Gonsalves, Burrell, McFarlane, & Duggan, 2012; Nerlander, Callaghan, Smith, & Barfield, 2015). Given these long-term health risks, examining the potential for early home visiting to improve birth outcomes for subsequent children, particularly among vulnerable families, is an important area for nursing research.

2.2 | Early home visiting

2.2.1 | The Nurturing Families Network (NFN)—NFN is a voluntary program provided by the state of Connecticut that aims to reduce child maltreatment in families at high risk of child abuse and neglect (Children's Trust Fund, n.d.; ConnPAT, 2014). NFN has served over 12,000 families in Connecticut since 1995, and has adopted the curriculum from Parents as Teachers, a model approved by the Maternal, Infant, and Early Childhood Home Visiting program (Health Resources and Services Administration, 2016). NFN sites are certified affiliates of the Parents as Teachers model, which requires initial and ongoing staff training on model implementation, among other requirements. Goals of the NFN program are to address family needs in four target areas: nurturing parenting, healthy families, parent life outcomes, and school readiness (Children's Trust Fund, 2013). NFN targets first-time mothers and recruits the majority of participants in hospitals after birth, although attempts are made to engage families prenatally whenever possible.

According to the visit data we received, 18.9% of families who received home visits had any prenatal home visits; 4.2% began in the month before the child's birth; 7.0% began visits in the second or third months preceding the child's birth; 5.3% began in either the fourth or fifth month before the child's birth; all others began prior to the fifth month.

Pregnant women and families with children up to 3 months old are eligible. Families are enrolled based on program availability and risk for child maltreatment as assessed by a standardized tool, the Revised Early Identification Screen (Children's Trust Fund, 2013).

NFN home visitors are paraprofessionals with at least a high school diploma who receive home visiting training through NFN. Supervisors of home visitors generally have Master's degrees, often in social work. The frequency of home visits varies based on the family's needs and interest, and visits most often occur every other week. The home visitor provides parenting and child development education, social support, and links to other social and health services; families may stay enrolled in the program until the end of the child's 5th year (Children's Trust Fund, 2013). This approach of supporting families, improving parenting, and making connections to social services and health care is hypothesized to improve outcomes for all members of the family, including subsequent children.

2.3 | Home visiting and vulnerable groups

2.3.1 | Racial disparities—Previous evidence suggests that more vulnerable mothers benefit the most from home visiting (Olds et al., 1999). For instance, racial disparities in birth outcomes may be reduced by home visiting (Christopher & Simpson, 2014; Zhang et al., 2013). Potential mechanisms to explain this are improvements in socioeconomic factors and reductions in stress (Braveman et al., 2015; Strutz et al., 2014). In the case of NFN, home visitors help families develop knowledge of and connections to social services, which may reduce stress by helping parents meet the basic needs of their families, develop better coping strategies, and obtain social support. Furthermore, because Parents as Teachers is an explicitly “two-generation” model, home visitors also directly support mothers’ pursuit of education and employment, which may reduce socioeconomic disadvantage.

2.3.2 | Adolescent mothers—Birth outcomes are more concerning for adolescent mothers than older mothers because there is a greater likelihood for adolescent mothers to give birth to a low birth weight baby, initiate prenatal care late, and be negatively affected by close birth spacing (Child Trends, 2015; Vaughan, Cleary, & Murphy, 2014). Adolescent mothers also face challenges due to their own incomplete development and education (Chico, Gonzalez, Ali, Steiner, & Fleming, 2014). Many are not independent from their own families, who may provide social support, but who may also cause stress (Beers & Hollo, 2009). Finally, adolescent mothers may respond to home visiting differently than older mothers due to different social, economic, and developmental characteristics, but it is unknown whether they will respond more or less favorably.

2.4 | Home visiting attendance

Missed visits and attrition are common problems in home visiting (Holland, Olds, Dozier, & Kitzman, 2018; Ingoldsby et al., 2013; O’Brien et al., 2012). In NFN, just over one-half of families drop out before the end of their first year in the program and between 25 and 30% remain engaged at 2 years (Joslyn, Hughes, & Pidano, 2016). Patterns of missed visits and attrition, or “dosage,” may be associated with outcomes from home visiting and therefore program effectiveness (Holland, Xia, Kitzman, Dozier, & Olds, 2014). There is limited evidence, however, on the associations between home visiting program attendance and birth outcomes for either first or second children.

2.5 | Study aims

The purpose of this study is to examine (1) the associations between home visiting and birth outcomes of a second child, (1.1) whether these associations differ for mothers of different racial/ethnic backgrounds and (1.2) different age groups (adolescent or older); and (2) if variations in home visiting program attendance affect these associations (Figure 2). The specific aims of this study are as follows:

Specific Aim 1: Examine if birth-related outcomes (i.e., birth spacing, receiving prenatal care, cesarean section rate, gestational age, birth weight) are better for second children of NFN families compared to (a) first children of NFN families; (b) second children of families who were eligible for but did not receive NFN home visiting; and (c) a propensity-score

matched sample of second children (defined below in section 3). We will also conduct two sub-analyses to explore the generality of these effects:

- 1.1 Stratify by race to examine if the associations between participation in the program and birth outcomes differ by race.
- 1.2 Stratify by age (<20 vs. 20 years) to examine if the associations between participation in the program and birth outcomes differ for adolescent mothers compared to older mothers.

Specific Aim 2: Examine patterns of program attendance (i.e., duration of engagement, visit attendance) for those enrolled in NFN and the associations between these patterns and birth outcomes for second children. This will involve 3 sub-analyses:

- 2.1 Identify patterns in program attendance using latent class analysis. Patterns may include common times to dropout or periods of decreased home visit attendance.
- 2.2 Examine the extent to which home visit attendance patterns are associated with birth outcomes of second children.
- 2.3 Examine the extent to which home visit attendance patterns moderate associations between birth outcomes of the second child and both racial/ethnic minority and adolescent status of mothers (<20 vs. 20 years).

3 | METHODS

This is a retrospective cohort study utilizing existing data. The exposed cohort consists of mother-child dyads who enrolled in NFN from 2005 to 2015. Birth outcomes for the second children of NFN families will be compared to: (a) older siblings whose birth led to enrollment in NFN; (b) children of families who were screened as eligible for NFN but were not offered the program due to home visitor availability or other logistical reasons; and (c) a propensity-score-matched group of non-NFN children created using the likelihood of enrollment in the program based on maternal health, individual demographics, and neighborhood characteristics. Key study variables are displayed in Table 1.

3.1 | Data sources

In this study, we will link three sources of data according to the identifying information shown in Table 2. Prior to receiving funding, we obtained Institutional Review Board approval from both universities involved, as well as from both state agencies providing data for this project. Data were transferred via a secure file transfer program, and stored on a secure, encrypted server supported by Yale University.

3.1.1 | NFN data—NFN data were provided by the University of Hartford Center for Social Research. This dataset includes mothers who were screened and/or enrolled in NFN from 2005 to 2015. For birth spacing, all NFN mothers whose first child was born at least 27 months prior to the end of 2015 will be included. For other outcomes, all NFN mothers with a second birth will be included. Starting with a full NFN sample of 6,500 and assuming half of the mothers have a second child, we expect a sample size of 3,000 after accounting for losses due to data cleaning/linkage. Of approximately 56,000 families who have been

screened for NFN, we anticipate identifying 650 second children of families eligible for NFN who were not enrolled due to program availability or other reasons outside of the families' control. Only families who consented to participate in research studies at the time of NFN enrollment will be included in analyses.

3.1.2 | Birth certificate data—Birth certificate data from 2005 to 2015 were provided by the Connecticut Department of Public Health. The birth outcomes and covariates are listed in Table 1. The linking variables available from birth certificates are listed in Table 2.

3.1.3 | American community survey—The American Community Survey is a publicly available dataset from the U.S. Census Bureau (United State Census Bureau, 2016). The online geographic information system ArcGIS and the University of Connecticut's Map and Geographic Information Center were used to extract information on neighborhood characteristics. Neighborhood disadvantage is most often measured by an aggregate of indicators at the census-tract level (Ford & Browning, 2011; Handley, Rogosch, Guild, & Cicchetti, 2015; Shoff & Yang, 2012). We will follow the established approach of combining these indicators using loadings determined through factor analysis (Ford & Browning, 2011; Handley et al., 2015). The initial list of indicators includes the percentages of residents living in the same household for five or more years, owner-occupied homes, female-headed households, adults who are unemployed, households in poverty, and households on public assistance (Ford & Browning, 2011; Handley et al., 2015; Shoff & Yang, 2012).

4 | DATA ANALYSIS

After obtaining and cleaning the individual datasets, we will link them into an analysis dataset and perform propensity score matching to create the comparison groups. In subsequent analyses, we will utilize regression and survival analyses to examine second birth outcomes, and latent class analysis to identify program attendance patterns and examine associated outcomes. We will use multiple imputation for covariates with greater than 5% missing data if we can assume that these data are missing at random.

4.1 | Creating comparison groups

We are utilizing three strategies for creating comparison groups to minimize the impact of any inaccuracies in assumptions required by each approach. Figure 3 illustrates the linkage and comparison group creation plan. We started with linking datasets, and then will create the comparison groups from the linked analysis dataset.

4.1.1 | Comparison group A: First children ($n = 3,000$)—For second birth outcomes, we will use the first child as a matched comparison. This will control for a wide range of maternal and genetic characteristics, and should reduce the effect of the father's genetic characteristics to the extent that first and second children have the same father. The father is listed on the birth certificate for only 48% of NFN children, however, so we will not have enough information to investigate the effects of having different biological fathers.

4.1.2 | Comparison group B: Screened at-risk group ($n = 650$)—For all outcomes, we will compare NFN families to families who were screened as eligible for

NFN, but who were not offered the program. The primary reason a family would not be offered the program, if they were eligible, is if they lived in an area where the program was not available or was currently filled to capacity. If the reason they did not enroll was independent of their own characteristics, they should represent a population with very similar demographics and risk-levels as the enrolled families. This group will have the smallest sample size.

4.1.3 | Comparison group C: Matched group ($n = 6,000$)—The initial pool for the third comparison group will include all families with a birth in the time period for which we have data, excluding those enrolled in NFN. We will utilize propensity score matching to create a comparison group of mother-child dyads that is as similar to the NFN group as possible. Propensity score matching is a method for reducing bias when treatment and comparison groups are not randomly assigned (Guo & Fraser, 2010). For matching, we will use neighborhood disadvantage and the following variables from birth certificates: month and year of birth, maternal age, whether the mother was born in the United States, whether the mother was employed, mother's education, site of prenatal care (private/clinic), health insurance (public/private), father's name listed (as a proxy for the father's involvement), and maternal race/ethnicity. Variables that could be influenced by enrollment in NFN (e.g., maternal smoking, maternal drinking) will not be included in the matching procedure. We will use two comparison families for each NFN family to increase statistical power while maximizing the similarities between matched families.

4.2 | Covariates and exclusions

Maternal diabetes, obtained from birth certificate records, will be included as a covariate in models predicting mode of birth, gestational age, and birth weight because diabetes may impact these outcomes. For analyses that include comparison to groups B and C, we will control for the same variable measured for the first birth (i.e., for birth weight of the second child, we will control for birth weight of the first child). This approach will control for many maternal characteristics, and prior birth characteristics are important covariates when examining birth outcomes (Ball, Pereira, Jacoby, de Klerk, & Stanley, 2014). The child's sex will be included as a control variable because it impacts birth outcomes (Blencowe et al., 2012). Interaction terms between home visiting attendance and the child's sex will be included to test for sex differences. For birth outcomes other than birth spacing, we will exclude twins, other multiple births, and severe congenital anomalies.

4.3 | Specific Aim 1

The purpose of the first aim is to determine whether birth outcomes are improved for second children of NFN families as compared to children in the three comparison groups described above.

4.3.1 | Analysis plan—After the comparison groups are created and data linkage is completed (Figure 3), a series of regression analyses will be conducted. As each of the continuous outcomes also has a clinical cutoff (e.g., gestational age under 37 weeks is preterm), we will examine these both as continuous measures (to maximize the information available) and as dichotomies (below vs. above the clinical cutoff). Because birth weight has

a nonlinear relationship with better health (i.e., both low and high birth weight are associated with health problems), rather than modeling birth weight as a continuous measure we will examine it using two dichotomous outcomes in two separate logistic analyses: low birth weight (<2500 g) and very low birth weight (<1500 g), compared to normal birth weight (2500–4500 g). We will not examine high birth weight as we expect this group to be too small to detect meaningful results. Additionally, low birth weight is a known health risk in our population and reduction of low birth weight is a specific Healthy People 2020 goal (U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion, 2016a; U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion, 2016b).

For all continuous outcomes, we will estimate linear regression models. We will use logistic regression for dichotomous outcomes including close birth spacing (<27 months between births, to approximate 18 months from previous birth to next conception/pregnancy plus 9 months gestation), low birth weight, very low birth weight, preterm (<37 weeks gestation), and mode of birth. For ordered categories (i.e., trimester that prenatal care began and adequacy of prenatal care), we will use ordered logistic regression. For time between births, we will use survival analysis. Finally, for birth spacing we will also conduct sensitivity analyses utilizing various cutoffs, ranging from 18 to 36 months between births.

4.3.2 | Aim 1.1: Differences by race and ethnicity—First, we will test for differences in birth outcomes by race, to determine if previously reported disparities are replicated in our sample. Regardless of whether disparities are found, we will continue to the next step, to determine if the program has different effects by race/ethnicity by adding race/ethnicity to the models in Aim 1 as potential moderators of the effect of NFN on birth outcomes. If there are disparities, our findings will indicate whether the program ameliorates racial disparities in birth outcomes. For example, if enrollment in NFN has a stronger positive impact on birth outcomes for racial/ethnic minorities than for non-Hispanic whites, racial disparities will be decreased. If not, our findings will indicate whether the program has different effects across racial and ethnic groups, which could inform programmatic adjustments to achieve “precision home visiting.”

4.3.3 | Aim 1.2: Adolescent mothers—Because engagement in NFN during adolescence is hypothesized to enhance the effect of the program, we will examine whether the association between NFN and birth outcomes is different for adolescent mothers using the models described above (Aim 1). We define this group as mothers who were less than 20 years old at their first child’s birth.

4.4 | Specific Aim 2

The purpose of the second aim is to examine aspects of program engagement (including duration of engagement and patterns of visit attendance) in NFN and their associations with birth outcomes. Although other indicators, such as program satisfaction or goal attainment, may also affect outcomes, these are only measured in families who stay engaged in the program and thus their use would lead to biased results. Program engagement and

attendance, however, are known for all families who were ever enrolled in home visiting during the study time frame.

4.4.1 | Aim 2.1: Program attendance patterns—Repeated measures latent class analysis will be used to identify patterns of home visit attendance (Holland, Olds, Dozier, & Kitzman, 2018; Holland et al., 2014). The number of visits attended per month will be used to cluster families who enrolled in NFN into common patterns of program attendance based on when they attended or missed visits and when they dropped out. Although families may not follow any one pattern perfectly, their likelihood of following each pattern will be estimated. Based on previous program attendance pattern research and our available sample size, we anticipate identifying 3 to 5 patterns (Holland, Olds et al., 2018; Holland et al., 2014). As this previous work was conducted with a different program model, the Nurse Family Partnership, we cannot assume the same patterns will emerge, and thus we will conduct new analyses to identify patterns specific to the NFN program. Examples of possible patterns are illustrated in Figure 4.

4.4.2 | Aim 2.2: Associations between program attendance patterns and birth outcomes of second children—After program attendance patterns are identified, we will test associations between these patterns and birth outcomes of subsequent children. Using chi-square tests, analysis of variance, and regression models, we will compare the outcomes of participants who followed each pattern, controlling for individual and neighborhood risk factors.

4.4.3 | Aim 2.3: Differences by racial/ethnic minority and adolescent status of mothers—We will examine the extent to which maternal race/ethnicity is associated with program attendance using two strategies. First, for each outcome that exhibited racial disparities in Specific Aim 1.1, we will test for racial disparities within each program attendance group identified in Specific Aim 2.1. We will also test whether the number of visits attended moderates the effect of race/ethnicity on outcomes in each regression model that exhibited racial disparities (i.e., add the number of visits attended, along with an interaction term between the number of visits attended and race). We will follow the same strategy for exploring differences in outcomes by adolescent status (Specific Aim 1.2).

4.5 | Power estimation

To test statistical power, we focused on birth spacing because it has been the most frequently studied of the outcomes we are examining. Using comparison group B, our smallest group, we will be able to detect a 2% difference between NFN families and comparison group families in the proportion of mothers with close birth spacing, assuming 29% base rate (Thoma, Copen, & Kirmeyer, 2016), 80% power, 95% confidence, and two comparison group families per NFN family. This is within the 1–7% range of differences previously reported (Administration on Children & Families, 2016b). Based on preliminary analyses of low-birth-weight rates and effect sizes seen in a trial of the Nurse Family Partnership, another home visiting program for vulnerable first-time mothers, we estimate that we will have sufficient power to detect any substantively meaningful difference in low birth weight rates for all comparison groups (Holland, Groth, Smith, Meng, & Kitzman 2018).

5 | LIMITATIONS

This study is limited by the use of a retrospective, observational design. We attempt to overcome this limitation by our use of three different control groups, including one determined through propensity-score matching. There is a risk that this approach may result in different conclusions from each of the three comparison groups, which may present a challenge in drawing overall conclusions. If findings from the three comparison groups agree, however, our confidence in the findings will be strong. If the differences in significance are due to insufficient power in the smaller comparison groups, but the direction and effect sizes are similar, we will use the largest group to draw our conclusions. To address other scenarios, we may need to perform additional analyses to understand what led to the inconsistent conclusions.

Additionally, although the program model examined here is used nationally, there may be differences in how Parents As Teachers is delivered within NFN (e.g., home visitor hiring and training, evening and weekend availability, participant recruitment) that limit the generalizability of these findings. The results of this study also cannot be generalized to other home visiting models, particularly those that use home visitors with different professional backgrounds, such as registered nurses. Future research should replicate our study in different settings and with different models to test the external validity of our findings.

6 | DISCUSSION

We have obtained the data required and have completed data cleaning. The birth certificate data were largely complete, with less than 2% missing on variables relevant to analyses. As of August 2018, the datasets have been linked, and the comparison groups have been created (Figure 5). We plan to complete initial outcome analyses within 6 months, with additional analyses to be completed through the following year.

The Academic Research Enhancement Award (Parent R15) that supports this research study is a mechanism offered through the National Institutes of Health; it is intended to support small-scale research projects proposed by faculty members of eligible institutions, to expose students to research projects, and to strengthen the research environment of the applicant institution (National Institutes of Health, 2018). Through this funding mechanism, the students are exposed to statistical methods more advanced than often encountered in nursing research, including latent class analysis and propensity score matching. Participation in this project serves to enhance the students' understanding of these methods and also to show them how such methods and administrative datasets can be used to answer important clinical questions.

Because the R15 mechanism encourages inclusion of students as research assistants, we have created a relatively large team including two faculty members (Principal Investigator and Co-Investigator), one Doctor of Philosophy in Nursing student, two Master of Public Health students, and two Master of Science in Nursing students. In addition, we have hired two undergraduates to work over the summer break in the academic calendar. Although this

interdisciplinary approach is a strength of our project, it also comes with a number of challenges. For example, coordinating across a number of research assistants, several of whom are new to this type of work, has been an early challenge. To address this, we have regular team meetings to ensure that everyone is aware of what is being worked on, and we are experimenting with various methods for organization and communication, such as a spreadsheet on the shared server where team members can indicate what they are currently working on. Another barrier to communication is that the group is made up of students from different programs and with different schedules. Although one benefit of participating in this project is the flexibility of working time, we have scheduled some blocks of time for everyone to work together to improve communication and connections across the team.

NFN is run by the Connecticut Office of Early Childhood, but evaluators at the Center for Social Research (CSR) at the University of Hartford have collected and managed program data since 1996. We therefore included CSR as a subcontractor in this grant to facilitate our work with these data. We have regular phone calls and periodic in-person meetings to ensure that we understand the data and are able to access the most accurate versions. CSR will remain an important partner in the interpretation phase of the project due to their long-term experience with the program.

An additional challenge for this work has been coordinating with state agencies to obtain data. Committee approvals, modifications, and additions of study personnel, and annual re-approvals require additional time and effort when four Institutional Review Boards are involved. Although personnel at the agencies have been cooperative, there have been some delays due to competing priorities. In addition, our last year of birth certificate data (2015) only became available in March 2018.

We also were required to agree to several constraints due to the size and sensitive nature of these data. First, we were required to strip all identifying information after 6 months. This meant that all data linking needed to be completed within that time frame. The second constraint, which is stricter than many projects face, is that we were required to thoroughly destroy all backups of the dataset containing those identifiers. Software to overwrite files to make data recovery impossible are readily available, but some systems used to share data across teams make it more difficult to ensure that all backups that are overwritten. To satisfy these constraints, we can only use these data on a secure server (which we have available to our research team), and not on individual desktop computers nor on any cloud storage system, even those that are compliant with the Health Insurance Portability and Accountability Act. Careful coordination with our information technology support group was required to determine the most appropriate strategies for storage and deletion.

7 | CONCLUSION

Previous researchers have examined pregnancy spacing after home visiting, but few studies have considered other outcomes related to subsequent children (Administration on Children & Families, 2016b; Olds et al., 2007, 2004). To our knowledge, few other researchers have examined subsequent child birth outcomes in non-research, community program sites (Goyal et al., 2017; Rubin et al., 2011), and none have looked at the full range of outcomes

we are examining. The large sample provided by a statewide program, as well as the availability of administrative data to examine birth outcomes for later children, provides an opportunity to detect even small improvements that may not be detected in smaller clinical trials. This innovative approach of linking data sets to create rigorous comparison groups also provides a model for investigating complex research questions when randomized clinical trials are either not ethical or not feasible.

These findings will broaden our understanding of the lasting impacts of home visiting on families, either supporting the focus on first-time mothers or suggesting that the benefits of this program are limited to the child for whom enrollment was initiated. These findings may also be used to support continued and extended funding for home visiting and to suggest what improvements may be necessary. Second-child birth outcomes are not a stated goal of the program, so negative findings should not be construed as evidence of an ineffective program. Understanding the impact of patterns of program attendance on later outcomes will also help the program prioritize specific retention efforts. Finally, our results will build evidence regarding the potential for home visiting to reduce racial health disparities, and of the potential for enhanced benefits of home visiting for adolescent mothers, issues that are of particular practical and policy importance. As few home visiting researchers have utilized administrative data to examine home visiting outside of research settings, this approach is critical to understanding whether programs remain effective once they are implemented in the community.

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FIGURE 1.

Possible relationship between home visiting and birth outcomes for second children. The outcomes included in the current study are outlined in boxes with double lines

FIGURE 2.
Proposed relationships examined in the study

FIGURE 3.

Plan for data linkage and creating comparison groups

FIGURE 4.

Possible visit attendance patterns over time. The five lines indicate potential patterns of missed visits (attending fewer than 100% of the recommended number) or attrition (dropping out early). For instance, the dash-dot line represents a pattern of many missed visits and very early attrition (no visits after the child is about one month old; “Early Attrition”) and the top solid line shows near-perfect attendance for 24 months (“Consistent Attendance”). These potential patterns are based on our previous work (Holland, Olds et al., 2018)

FIGURE 5.
Overview of research approach

TABLE 1

Key variables to be examined

Dependent	Independent	Covariates	Moderating
Birth spacing	Aim 1: Nurturing Families Network program enrollment	Mode of first birth (cesarean/vaginal)	Aim 1.1: Race/ ethnicity
Mode of second birth (cesarean/vaginal)		Gestational age of first child	Aim 1.2: Was the mother an adolescent at the first birth?
Gestational age of second child		Birth weight of first child	Aim 2: Program Engagement
Birth weight of second child		Low birth weight status of first child	
Prenatal care prior to second birth		Prenatal care prior to first birth	
		Diabetes	
		Child sex	

TABLE 2
Variables used to link nurturing families network, birth certificate and American community survey datasets

Nurturing Families Network	Birth certificate: Program-enrolled birth	Birth certificate: Subsequent births	American Community Survey
Mother's date of birth	Mother's date of birth	Mother's date of birth	
Child's date of birth	Child's date of birth		
Child's sex	Child's sex		
Town of residence	Town of residence		
	Mother's name	Mother's name	
	Census tract	Census tract	Census tract