Randomized Controlled Trial of a Universal Postnatal Nurse Home Visiting Program: Impact on Maternal Wellbeing, 18 months after Childbirth

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I. INTRODUCTION

Background

Though home visiting (HV) programs date back to the 1960s, they gained national attention during the late 1980s and early 1990s when the U.S. Advisory Board on Child Abuse and Neglect declared child abuse a "national emergency." The Board recommended that the Secretary of Health and Human Services and Congress adopt HV as a strategy for decreasing child maltreatment (Krugman, 1993). HV is now a widespread early intervention for promoting healthy child development, and is used to improve a variety of child, maternal, family, and community outcomes in domains ranging from health to education (Goodman et al., 2011; Johnson, 2009; Knox, Michalopoulos, Lundquist, Snell, & Mello, 2011).

There are approximately 400 HV programs in the U.S. that collectively serve 450,000 families, with at least one program operating in each state (Avellar & Paulsell, 2011; Johnson, 2009). HV program models vary in goals and purpose, target population/ enrollment eligibility criteria, age at enrollment, program intensity and duration, and qualifications of the home visitor. A majority of HV programs last at least one year (Nievar, Van Egeren, & Pollard, 2010) and target at-risk, low socio-economic status families and/ or first-time mothers.

Durham Connects (DC), the program of interest to this paper, is a universal postnatal nurse HV program in Durham County, North Carolina, that seeks to increase child wellbeing by linking parents to a network of community resources based on exhibited type of service need. DC departs from most other home visiting models on a number of defining program characteristics. The program is universal rather than targeted, is brief in duration relative to other models, and focuses on the postnatal period rather than the prenatal period.

Postnatal HV programs offer support to a family during a period of significant transition. The period following childbirth is often associated with a myriad of short- and long-term challenges for mothers, including a high prevalence of fatigue (Declercq, Sakala, Corry, Applebaum, & Risher, 2002), post-partum depression, increased stress, generalized immune suppression (Thung & Norwitz, 2010), and difficulty attainting maternal identity (Mercer, Kay, & Tomlinson, 1986). According to a national survey, one-third of mothers felt that their health concerns were not adequately addressed at their six-week postpartum check-up with a healthcare professional (Cheng, Fowles, & Walker, 2006). Because the first DC home visit takes place prior to the postpartum check-up, the program has the potential to positively impact maternal outcomes, such as mental health and economic stability, during a period that is sometimes classified as a gap in care for mothers (Cheng et al., 2006).

It is well established that poor maternal health and wellbeing have negative spillover effects to children. Poor maternal physical health is associated with physical health problems among children, tantrum behavior, and low levels of parenting self-confidence (Sanderson, Scott, & Gonzalez, 1998 Longitudinal Follow Up, 1991). In addition, postpartum depression, which affects approximately 10-15% of women in the U.S. (Grace, Evindar, & Stewart, 2003), is associated with poor child cognitive development and behavior (Grace et al., 2003; Sinclair & Murray, 1998; Tough, Siever, Benzies, Leew, & Johnston, 2010).[1]

[1] For more information, see meta analysis of 193 studies relating to maternal depression and child psychopathology (Goodman et al., 2011).

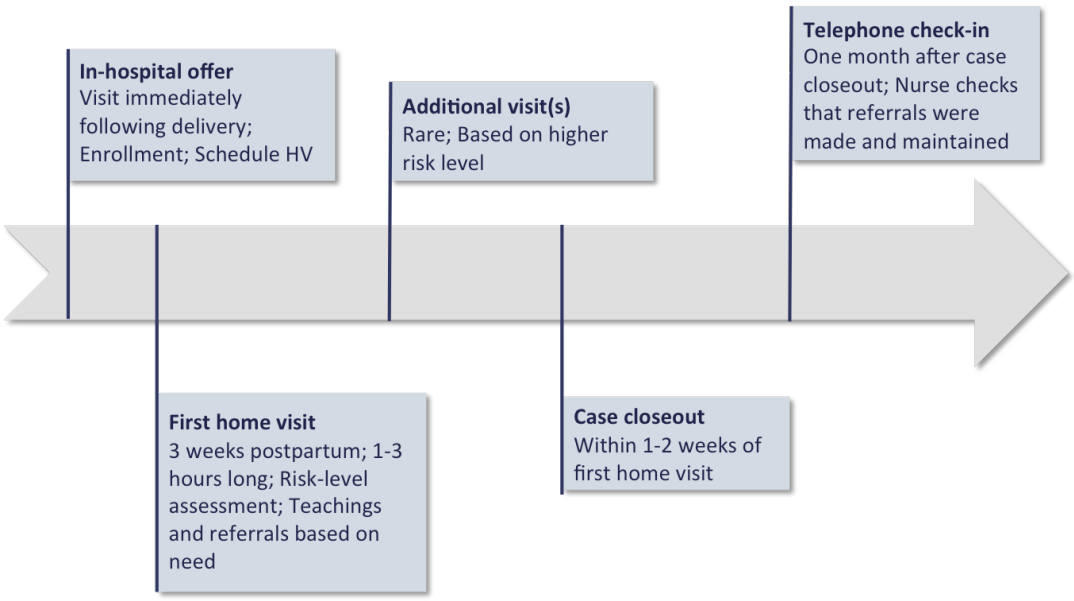
Evaluation of HV Programs

Durham Connects

DC's main goals are to reduce child abuse, to increase appropriate medical care, and to increase connections to community services and agencies that will promote and foster child and family health and wellbeing. Program universality is believed to decrease stigma surrounding program uptake, and to maintain program fidelity and impact (Dodge, Goodman, Murphy, O'Donnell & Sato, 2013; Dodge et al., 2014; Krugman, 1993). A DC staff member first connects with the mother and infant in the hospital upon delivery in order to enroll interested mothers in the program and to schedule a subsequent home visit.

The home visit usually takes place within three weeks following delivery, though it can take place up to 12 weeks postpartum. During the 1-3 hour long home visit, registered nurses (RNs) assess the family based on 12 factors in four domains: healthcare, parenting/childcare, household safety and violence, and parent mental health/ wellbeing. Based on the family's needs, the nurses deliver "tailored teachings" to the mother and provide the family with referrals for medical and community-based resources. Some families, depending on their risk level, receive additional visits. The nurses close out most families' cases within one to two weeks of the first home visit. Figure 1 depicts the complete program model timeline.

Figure 1. Timeline: Durham Connects Intervention



DC Impact. In 2013, a study team conducted an impact evaluation of the DC program using data collected from a randomized controlled trial (RCT) in Durham County. Over an 18-month period (July 1, 2009 - December 1, 2010), all babies born on even birth dates were assigned to the treatment (offer to enroll in DC), and all babies born on odd birth dates were assigned to receive "services as usual."

Six months following delivery of the child, the study team interviewed the mothers to assess the program's impact. Not all study mothers were interviewed; the evaluation team randomly selected a

subsample of the study population using a computer algorithm that randomly chose one baby per birth date across the 18-month enrollment period. The impact evaluation reported that, compared to control families, DC families accessed more community resources and displayed more positive family functioning, child health, and positive parenting behavior six months following childbirth. In addition, DC mothers were less likely to have anxiety relative to control mothers (Dodge, Goodman, Murphy, O'Donnell & Sato, 2013; Dodge et al., 2014).

This study adds to the impact evaluation research of DC by examining maternal outcomes at 18 months following childbirth.

Other HV Models

Several other HV programs have conducted impact evaluations and have found positive effects in the parenting, maternal health, and maternal wellbeing domains. The most frequently cited programs in the literature include Parents as Teachers (PAT), Healthy Families America (HFA), Early Head Start - Home Visiting (EHS-HV), Family Check-Up (FCU) and Nurse-Family Partnership (NFP) (Avellar, Paulsell, Sama-Miller, & Del Grosso, 2013).[2]

Some components of these HV models are similar to DC, while other components are vastly different. Most notably, HFA does not require their direct service staff (home visitors) to be RNs, while all DC home visitors are RNs. NFP is similar to DC in that it only employs registered professional nurses as home visitors, but differs in other components, including target population (first-time, low-income mothers and their children) and visit dosage (long-term). FCU, PAT, and EHS-HV also do not require that their home visitors be RNs, but are similar to DC in other ways. For example, Family Check-Up employs a model of short-term initial visitation followed by linkages and referrals to community resources.

In the maternal wellbeing domain[3], HFA programs reported a more favorable home environment (A. Duggan et al., 2007) and increased training (LeCroy & Krysik, 2011). NFP studies reported increased relationship quality (D. L. Olds et al., 2007; David Olds et al., 2004), increased workforce participation (D. Olds et al., 2002), increased usage of community services (D. L. Olds et al., 1986), reduced public assistance receipt (D. L. Olds et al., 2007; David Olds et al., 1997, 2004), and a safer home environment (L. Olds & Henderson, 1994). For FCU, studies reported a favorable impact in change in AFDC status (Drazen & Haust, 1993). EHS-HV studies showed an increase in family monthly income (Harden et al., 2012).

[2] HomVEE is a comprehensive review of home visiting impact literature, prioritized 35 programs for evidence-based models for review, assessed the quality of 270 HV impact studies, and reported program effectiveness by outcome domain. For each program, the HomVEE report provides information about the program model, implementation guidelines, constructs used to measure effectiveness, and duration of impacts ("Program Model Profiles - Home Visiting Evidence of Effectiveness," n.d.)

[3] See the following studies for findings on parenting and maternal health domains: HFA studies reported reduced alcohol use (LeCroy & Krysik, 2011). For NFP, effects include reduced rates of subsequent pregnancies and births (Kitzman et al., 1997; D. L. Olds et al., 2007; David Olds et al., 1997, 2004), increased intervals between the births (David Olds et al., 1997), increased breastfeeding (Kitzman et al., 1997), less substance use (L. Olds & Henderson, 1994). For FCU, studies show program effects of reduced maternal depressive symptoms (Shaw, Connell, Dishion, Wilson, & Gardner, 2009).

This study fills a gap in the literature by assessing the impact of the short-term, postnatal, universal model (versus more common models characterized by a longer duration and targeted service to first-time and/ or low income mothers) on measures of maternal wellbeing.

Subgroup Impacts

In addition to examining impacts for all mothers, it is also important to examine impacts by subgroup to explore potential heterogeneity in treatment effects. Understanding if the program has a larger effect on a specific group can help direct resources to groups that benefit the most from the program. The most common limitation to discerning heterogeneous treatment impacts is insufficient power to detect a meaningful difference and/or insufficient information collected at baseline (Avellar & Paulsell, 2011).

While the literature on subgroup impacts of HV programs is relatively scarce, there are a few studies that report differences in treatment effects. For example, studies examining the impact of NFP reported that effects were most positive for women that were "highest-risk" (young, unmarried, and poor) (D. L. Olds et al., 1986). In particular, these women were more likely to show increased employment and fewer subsequent births. Other studies show that HV is especially effective for psychologically vulnerable women (DuMont et al., 2008; David Olds et al., 2004), which can include women who have a history of abuse. I did not come across studies that showed a statistically significant difference in treatment effects based on race/ ethnicity. However, the literature suggests that race/ ethnicity may moderate program impacts (Krieger, 1999; Sue, Capodilupo, & Holder, 2008).

Objectives

This paper seeks to answer two questions: (1) *18 months following the birth of a child, do mothers who participated in Durham Connects show improved wellbeing, relative to controls?* (2) *Does the impact vary across maternal subgroups?*

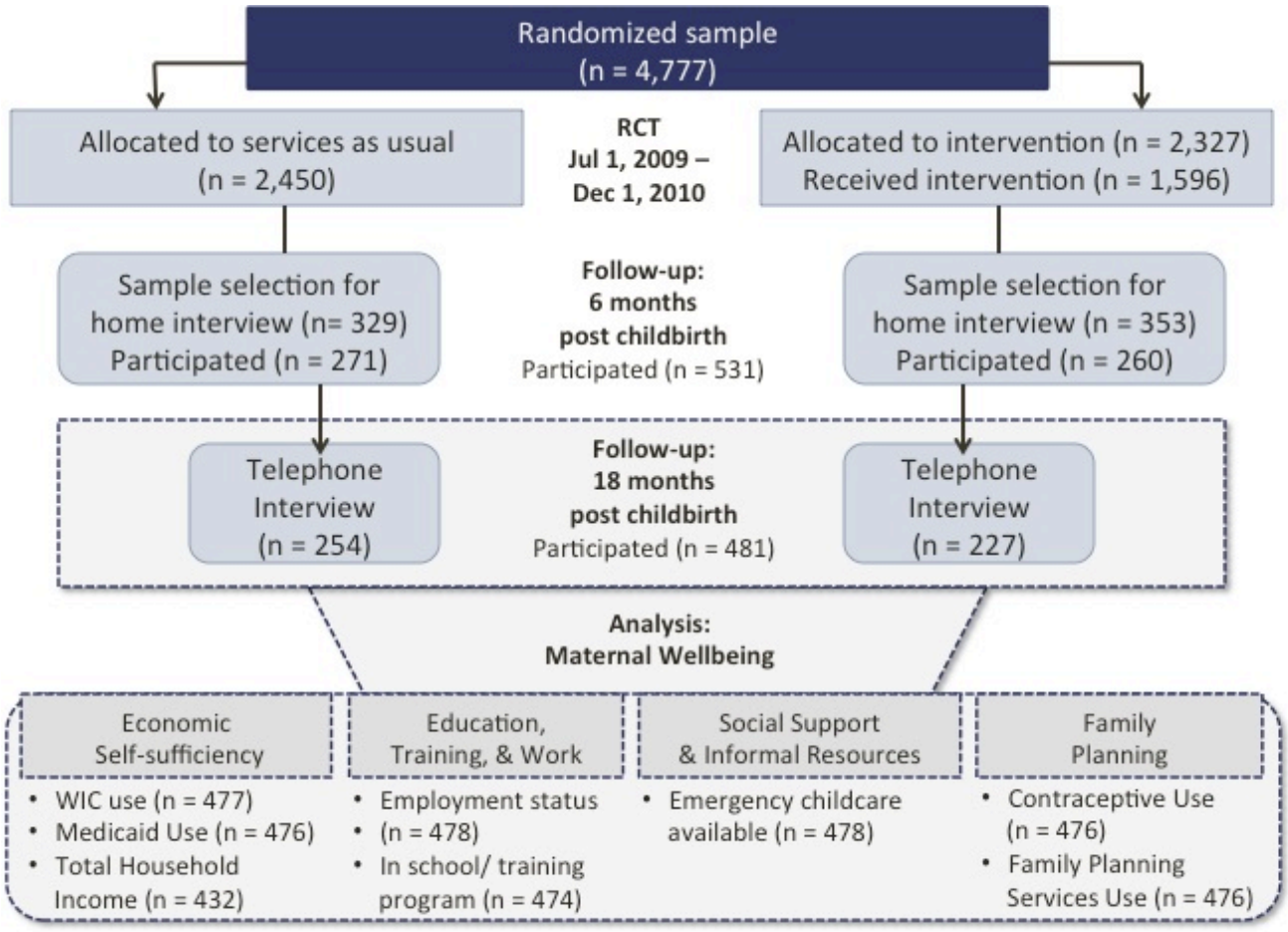
The DC program design can impact maternal wellbeing in two potential ways: (1) through nurse-delivered teachings, and (2) through referrals for medical and/ or community resources. During the RCT period, nurses reported that of the tailored teachings they delivered, teachings on maternal wellbeing were among the most common. It is possible that because of either or both of these teachings and DC-initiated linkages, women could experience improved wellbeing.

Although DC is universal, and therefore targeted to all women, the program could impact certain subgroups of women more than others. The literature suggests that there might be larger effect sizes for younger mothers, Medicaid/ no insurance mothers, and/or African-American mothers, due to these groups' higher "risk factors" relative to older mothers, and White mothers. Understanding impact variation would be useful for DC should the program consider targeting resources toward a specific subgroup in the future.

II. METHODS

This study evaluates the impact of DC based on the subsample of families that stemmed from data collected during the DC RCT (July 1, 2009 - December 1, 2010). The RCT treatment and control groups were randomly assigned by date of birth; babies born on even birth dates were assigned the intervention (n = 2,327), and babies born on odd birth dates were assigned to the "services as usual," or control group (n = 2,450). The RCT utilized electronic discharge hospital records in Durham County to ensure that the population was fully identified and randomized for the 18-month period. See Figure 2 for a flow diagram of the RCT's randomization and follow-up analyses.

Figure 2. Flow Diagram: Randomization and Follow-up Analyses



Dependent Variables at Age 18 Months

Outcome measures were taken from data collected through interviews when the child was 18 months old. Research assistants delivered the telephone interview to the same subsample of study mothers that

were selected for the follow-up study when the child was 6 months old.[4] The data includes 497 observations. The instrument is available at http://sites.duke/edu/psid/interviews.

I organized the key outcomes of interest into four maternal wellbeing subdomains that the program could potentially impact: economic self-sufficiency; work, education, and training; social support; family planning.

Economic self-sufficiency subdomain. In the telephone interview, mothers were asked to report their resource use for WIC (Woman, Infant, and Children) and Medicaid (for respondent) in the past 12 months. The responses were coded as 0 (no) or 1 (yes, used in the past 12 months). The mothers were also asked to report their total household income for their family (from last year; all sources of income). The responses were originally coded as categorical variables (1: Less than $10,000 through 10: $150,000+). I recoded for analysis by creating a quasi-continuous variable (by taking the midpoint of each bin). I also created an indicator variable for poverty (less than $20,000 reported total household income at 18 months) to assess if families moved over the poverty threshold.

Work, education, and training subdomain. Mothers reported their current employment status and if they were currently enrolled in school, a job training program, or a vocational training program. These variables are binary and were coded as 0 (no) or 1 (yes). I created a new variable from the raw survey data that combined enrolled in school, job training, or vocational training to indicate that the mother was currently enrolled in schooling or training a program.

Social support subdomain. In the interview, research assistants asked the mother if she had anyone who could help take care of the child overnight or for a full day, in the case of an emergency. The response was coded 0 (no) or 1 (yes).

Family planning subdomain. Mothers reported if they were currently using any form of birth control. They were also asked to report whether they had utilized family planning services in the past 12 months. Responses were coded 0 (no) or 1 (yes).

Statistical Analysis

I conducted an intent-to-treat analysis using Stata version 12.1 software. I used ordinary least squares regression models to estimate the impact of randomly assigned treatment to the DC intervention. For main effects models, I included Medicaid/ no insurance status (at time of hospital discharge; 0 = no, 1 = yes), birth complications (0 = no, 1 = yes), young mother (25 years old or younger; 0 = no, 1 = yes), marital status (married at time of birth; 0 = no, 1 = yes), and minority race/ ethnicity (Black, Hispanic, and Other) as covariates. Medicaid/ no insurance status also serves as a proxy for socio-economic status.

I conducted subgroup analyses for each outcome in order to test for heterogeneous treatment impacts. I created a variable for each subgroup that interacted treatment with the subgroup of interest. I defined subgroups using baseline demographic information collected during the sample selection process for the DC RCT (Dodge & Goodman, 2012). Subgroups of interest include African-American mothers (as compared to White mothers), mothers on Medicaid or without insurance at time of hospital discharge (as compared to those that were insured not on Medicaid), mothers that were not married at time of delivery (as compared to mothers that were married), and young mothers (as compared to older mothers; "young"

[4] The interviewers utilized a 44-page survey instrument to guide the 1-2 hour interview in the family home.

defined as 25 years old and younger). Because there were significantly more married mothers in the treatment group than in the intervention group (discussed in section III), I used married mothers as the subgroup of interest in my analysis. See Table 1 for subgroup descriptive statistics.

I replaced 11 missing values for age by imputing the mean age from the sample. I then included an indicator variable for imputed age in my regressions for main effects and dropped these cases in subsequent analyses to ensure that the imputed values were not impacting the estimates.

III. RESULTS

Implementation

Of the 682 families that were selected randomly for the six-month follow-up interview, 549 families participated. Eighteen families were subsequently dropped due to administrative record error (after accounting for these families the n = 531). Of the 531 families surveyed in the six-month follow-up interview (intervention families: n = 260; control families: n = 271), 481 families participated in the 18-month follow-up telephone interview (intervention families: n = 227; control families: n = 254).

Thirteen percent of the 481 families had birth complications (n = 63); 64 percent of the 481 families were on Medicaid or did not have insurance (n = 305); 28 percent were White (n = 137), 40 percent were Black (n = 191), 10 percent were Hispanic (n = 46), and 22 percent were Other (n = 107); 24 percent were young moms (25 and younger; n = 116); 45 percent were married at birth (n = 219). The average maternal age was 30.

Balance checks. I ran chi-squared tests for categorical variables and t-tests for continuous variables to ensure independence between assignment to intervention and preintervention characteristics. Table 1 shows two important pieces of information. First, the association between intervention assignment and being married at time of the child's birth was not independent ($P = 0.08$). Second, while the number of people in the treatment and control groups were not equal for the other preintervention characteristics, the differences were not statistically significant.

Table 1. Descriptive Statistics: Preintervention Characteristics for Selected Evaluation Subsample Groups: Durham County, NC; Jul 1, 2009 - Dec 31, 2010

	Intervention (n = 227)			Control (n=254)			Difference[1]
Variable	Mean	SD	N	Mean	SD	N	*P*
Birth complications	11%	0.31	25	15%	0.36	38	0.22
Medicaid/ no insurance	60%	0.49	135	67%	0.47	170	0.13
Maternal age (mean)	30.2	6.18		30.0	6.07		0.13
Young mothers[2]	24%	0.43	56	24%	0.43	63	0.96
Married mothers	50%	0.50	113	41%	0.49	106	0.08
Maternal ethnicity							
White, non-Hispanic	25%	0.43	77	33%	0.47	66	0.14
Black, non-Hispanic	42%	0.49	87	37%	0.48	110	0.34
Hispanic	10%	0.30	22	9%	0.29	26	0.93
Other	23%	0.42	49	21%	0.41	60	0.58

[1] Chi-squared tests were used for categorical variables; t-tests were used for continuous variables.
[2] Young mothers = 25 years old and younger.

Attrition analysis. Attrition from the six-month subsample to the 18-month subsample was higher in the intervention group (6.6 percent of the control group attrited (n = 18); 12.3 percent of the treatment group attrited (n = 33)). A chi-squared test of independence between Treatment and attrition showed that attrition differed systematically by Treatment status ($P = 0.02$). Given this finding, it was important to understand if attrition was predicted various indicators of risk, including Medicaid/ no insurance status, being a young mother, having birth complications, and being of a minority status.

I ran logit regressions to test if attrition was predicted by each risk indicators. I then interacted each risk indicator with treatment status to test if the combination of treatment status and the risk indicator significantly predicted attrition. The interaction terms did not show any statistically significant differential attrition in the treatment group by risk indicator. However, the results of the study are still limited by the baseline differences in a key moderator variable (marital status), and by the differential attrition in the treatment group.

Impact Evaluation

Main Effects

Descriptive statistics for intervention and control groups are displayed in Table 2 and organized by maternal wellbeing subdomain. Table 3 shows the effect of treatment on each outcome, controlling for several preintervention characteristics (see Appendix A for regression tables that also include coefficients on each covariate, organized by subdomain).

Table 2. Descriptive Statistics: Maternal Wellbeing Outcomes, 18 Months after Childbirth

	Intervention			Control			Difference
Variable	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	***P***
Economic Self-sufficiency							
WIC use	0.52	0.50	226	0.57	0.50	254	0.29
Medicaid use	0.22	0.41	225	0.34	0.47	254	0.00
Total household income	44,599	43,405	212	40,740	42,556	223	0.35
Work, Education, & Training							
Employment status	0.55	0.50	227	0.65	0.48	254	0.03
In school or training program	0.17	0.38	225	0.21	0.41	252	0.31
Social Support							
Emergency childcare available	0.93	0.25	227	0.94	0.24	254	0.75
Family Planning							
Contraceptive use	0.55	0.50	226	0.64	0.48	253	0.04
Family planning services use	0.10	0.30	225	0.09	0.29	254	0.90

Note. These mean outcomes do not include control variables.

Table 3 illustrates three key findings. First, intervention mothers reported less public assistance use than control mothers. Those randomly assigned to the DC intervention were eight percent less likely to report using Medicaid within the past 12 months compared to the control group ($P = 0.01$). Second, intervention mothers reported 10 percentage points less workforce participation ($P = 0.02$), and were also less likely to be enrolled in school or a training program. Finally, mothers randomly assigned to DC were 9 percentage points less likely to report contraceptive use than the control group ($P = 0.06$). The other outcomes are consistent in the negative direction, though they are not statistically significant and the effect sizes are relatively small.

Table 3. Main Effects: OLS Regression Testing Impact of Random Assignment to Durham Connects on Maternal Wellbeing

	Model							
Variable	(1) WIC Use	(2) Medicaid Use	(3) Household Income	(4) Employment Status	(5) In School/ Training	(6) Emergency childcare	(7) Contraceptive Use	(8) Family Planning
Treatment	0.00	-0.08**	-1,580	-0.11**	-0.03	-0.01	-0.09*	0.01
	(0.04)	(0.03)	(2,754)	(0.04)	(0.03)	(0.02)	(0.05)	(0.03)
Observations	477	476	432	478	474	478	476	476
R-squared	0.39	0.45	0.58	0.05	0.12	0.01	0.02	0.08

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note. All modes include marital status at time of birth, Medicaid/ no insurance status at time of birth, birth risk, maternal age at time of birth, and minority race/ ethnicity status (Black, Hispanic, and Other) as covariates.

Subgroup Analyses

In addition to conducting analysis for main effects, I used OLS regression to test for potential heterogeneity in treatment impacts on subgroups that might have benefited more from the intervention. These subgroups include young moms (25 and younger); African-American moms; Medicaid/ uninsured moms (at time of hospital discharge); Married moms (at time of child's birth).

Table 4 displays interaction term coefficients for every maternal wellbeing outcome, for all four sets of subgroups. The p-value on the interaction term coefficient shows whether the treatment effect difference between the subgroup of interest and the comparison group is statistically significant.

The key takeaway from Table 4 is that the intervention appears to have more of an impact on younger mothers than on older mothers, in three outcome areas: reported WIC use, reported Medicaid use, and reported employment. Younger mothers that received the treatment were 24 percentage points more likely to report being employed than older mothers who received the treatment ($P = 0.02$). Younger mothers were also significantly less likely to report WIC use (15 percentage points; $P = 0.10$) and Medicaid use (18 percentage points; $P = 0.04$), compared to older mothers. These findings suggest that Durham Connects could be especially beneficial for younger mothers.

Table 4. OLS Regression Testing Differential Impact of Random Assignment to Durham Connects on Maternal Wellbeing, by Subgroup

	Model							
Variable	(1) WIC Use	(2) Medicaid Use	(3) Household Income	(4) Employment Status	(5) In School/ Training	(6) Emergency Childcare	(7) Contraceptive Use	(8) Family Planning
Subgroup A. Black vs. White[1]								
Treatment	0.01	0.01	661	-0.15**	-0.02	-0.02	-0.06	0.00
	(0.04)	(0.03)	(4,262)	(0.06)	(0.04)	(0.03)	(0.06)	(0.04)
Black	0.09	0.42***	-4,154	0.06	0.19***	0.04	-0.01	-0.10**
	(0.06)	(0.05)	(3,725)	(0.06)	(0.06)	(0.03)	(0.07)	(0.04)
Treatment × Black	-0.02	-0.21***	-5,577	0.11	-0.01	0.03	-0.07	0.03
	(0.08)	(0.07)	(5,190)	(0.09)	(0.08)	(0.04)	(0.09)	(0.05)
Subgroup B. Married vs. Unmarried[2]								
Treatment	-0.02	-0.13**	314	-0.04	0.01	-0.02	-0.07	0.03
	(0.05)	(0.05)	(2,367)	(0.06)	(0.05)	(0.03)	(0.06)	(0.04)
Married	-0.19***	-0.19***	25,556***	-0.01	0.07	0.02	0.01	0.01
	(0.07)	(0.05)	(5,246)	(0.07)	(0.06)	(0.03)	(0.07)	(0.05)
Treatment × Married	0.04	0.12*	-3,875	-0.15	-0.07	0.02	-0.04	-0.05
	(0.07)	(0.06)	(5,652)	(0.09)	(0.07)	(0.04)	(0.09)	(0.05)
Subgroup C. Medicaid/ no ins. vs. Ins.[3]								
Treatment	0.03	-0.01	-3,379	-0.20***	-0.06	-0.01	-0.09	-0.02
	(0.05)	(0.03)	(5,580)	(0.07)	(0.05)	(0.03)	(0.08)	(0.03)
Medicaid/ no insurance	0.38***	0.39***	-35,906***	-0.30***	0.02	-0.00	0.02	0.04
	(0.07)	(0.05)	(5,966)	(0.07)	(0.06)	(0.03)	(0.08)	(0.04)
Treatment × Medicaid/ no ins.	-0.04	-0.10*	2,965	0.15	0.05	0.00	0.00	0.05
	(0.07)	(0.05)	(6,228)	(0.0895)	(0.07)	(0.04)	(0.09)	(0.05)
Subgroup D. Young Mom vs. Older Mom[4]								
Treatment	0.04	-0.03	-1,704	-0.16***	-0.04	-0.01	-0.08	0.03
	(0.04)	(0.03)	(3,466)	(0.05)	(0.04)	(0.03)	(0.05)	(0.03)
Young Mom	0.10	0.18***	-5,670*	-0.13*	0.17**	0.02	-0.06	0.01
	(0.06)	(0.06)	(3,075)	(0.08)	(0.07)	(0.04)	(0.08)	(0.05)
Treatment × Young Mom	-0.15*	-0.18**	544.8	0.24**	0.06	0.01	-0.03	-0.07
	(0.09)	(0.09)	(4,700)	(0.11)	(0.10)	(0.05)	(0.11)	(0.06)

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[1] Model covariates: marital status at time of birth, Medicaid/ no insurance status at time of birth, birth risk, and maternal age at time of birth.

[2] Model covariates: Medicaid/ no insurance status at time of birth, birth risk, maternal age at time of birth, and minority race/ ethnicity status (Black, Hispanic, and Other).

[3] Model covariates: marital status at time of birth, birth risk, maternal age at time of birth, and minority race/ ethnicity status (Black, Hispanic, and Other).

[4] Model covariates: marital status at time of birth, Medicaid/ no insurance status at time of birth, birth risk, and minority race/ ethnicity status (Black, Hispanic, and Other).

IV. DISCUSSION

Impact Evaluation

Main Effects

The results of this study suggest that 18 months following childbirth, DC does not significantly impact most measures of mothers' overall wellbeing. However, the study does show interesting findings for three outcome measures: Medicaid use, employment status, and contraceptive use. While the program aims to increase referrals and linkages with community and medical services (including social programs like Medicaid), mothers rolling off of Medicaid could suggest increased family and parental stability in the treatment group. The significant difference in reported Medicaid use is a potentially promising finding for the DC program.

The lower employment and lower contraceptive use findings (compared to the control group) present a curious twist to the results. A possible explanation for these findings could be that DC made mothers feel more secure, self-sufficient, and economically stable, which could translate into feeling ready to have another child. Attempting to have another child, or being pregnant, could explain the lower contraceptive use amongst treatment mothers compared to the control group. The targeted teachings and medical and community linkages could have made mothers more confident in their ability to parent and engage in healthy personal and family functioning.

The DC study team could revise parts of their instrument to measure constructs that could adequately test this theory. For example, asking mothers if they are currently pregnant, or trying to get pregnant, could be a useful construct in determining why mothers had less contraceptive use than control moms. Although the replication RCT will be sampling a different population of mothers, it would still be important for future analyses to collect this type of information.

Subgroups

The results of the subgroup analyses should be interpreted with caution; the small number of observations in each set of subgroups limits the power to detect significant differential effects. The subgroup analyses showed that compared to White mothers, Black mothers were more likely to report that they did not use Medicaid services (in the past 12 months). Interestingly, the same Medicaid finding holds for married mothers (compared to unmarried mothers), younger mothers (compared to older mothers), and mothers that were on Medicaid or were uninsured during time of birth (compared to mothers that were insured/ not on Medicaid). Medicaid use in the past 12 months, however, might be a weak construct for the purpose of this study, as many mothers receive Medicaid for pregnancy and birth. WIC use likely serves as a more accurate proxy for reliance on social programs.

The findings in the young mother subgroup suggest that DC differentially impacts younger mothers (compared to older mothers). This finding aligns with the literature surrounding heterogenous treatment impacts and greater impacts for "at-risk" mothers. Younger mothers often have fewer resources, are less connected, and may have a harder time attaining employment. The DC program could have connected many of these women with referrals that led to increased personal and economic stability. In future research, it would be interesting to run descriptive statistics on where these women were referred to, and if these referrals "stuck."

Limitations

While this study has a number of strengths, there are several key limitations, including concerns of selection bias, attrition, construct validity, and generalizability.

Attrition

The interpretation of these results is significantly limited by the finding that subsample attrition from the 6-month follow-up to the 18-month follow-up systematically varied by treatment status. Although the attrition analysis did not show evidence that particular risk characteristics (e.g. Medicaid status; young mother) were driving attrition in the treatment group, it is not possible to rule out selection bias. Fortunately, the DC impact evaluation team was able to locate some of the attriters in an effort to capture their responses in the next wave of follow-up. However, the differential attrition still limits the interpretation of this study's results.

Construct Validity

The impact evaluation was not necessarily designed to specifically test for maternal wellbeing outcomes at 18 months following childbirth. Improving child health and wellbeing was the primary impetus for the DC program; therefore, a majority of the questions on the 6- and 18-month follow up survey instruments are catered towards understanding DC's impact in child-specific domains.

However, because the teachings and linkages are directly delivered to the child's mother, and maternal health and wellbeing is an established moderator of child health and wellbeing, it is important for the DC program to assess their instruments' ability to measure potential maternal improvements. Of particular note, questions concerning maternal mental and physical health that were included in the 6-month interview were omitted from the 18-month interview due to time and resource constraints. See Table B1 in Appendix B for a comparison of data availability between the 6-month and 18-month survey instruments in the maternal health and maternal wellbeing domains.

The DC impact evaluation team has already revised the 4-month survey they will use in their upcoming replication RCT. The new survey includes many of the same maternal mental health and wellbeing questions from the first RCT's 6-month survey instrument—a revision that directly aligns with the recommendations outlined here. Retaining the same types of maternal health and wellbeing questions in later follow-up interview (e.g. 18 months following childbirth, etc.) survey instruments could benefit impact evaluation efforts in two ways: (1) it could significantly improve the ability to detect meaningful treatment effects in the maternal domain space, and (2) it could allow researchers the ability to examine change in maternal health and wellbeing over time. Understanding if potential impacts on mothers hold over the years (or wane with time) is important information for DC, especially as the program solicits funding.

Generalizability

In addition to the two key limitations described above, there are two additional issues surrounding generalizability of the study results.

Generalizability to current DC structure. The DC program has substantially revised their human capital model, including overhauling their RN staff, changing their hiring protocols, and altering their training processes. These changes could have altered treatment delivery to an extent that the results of this study would not be applicable to the current DC operating model.

External generalizability. DC is specific to Durham County, North Carolina, and the results of this study are not generalizable to other areas of the country, or to other HV programs.

Conclusions

Capturing the impact of DC on mothers' wellbeing (and overall health) is a critical component of evaluating the complete effectiveness of the DC program. In future research and analytical strategy planning efforts, the impact evaluation team should consider ways to strengthen their ability to capture these benefits, including (1) mapping a logic model for how specific program mechanisms could impact specific maternal outcomes, (2) adding and/ or revising questions that measure maternal health and wellbeing, and (2) including the same questions on maternal health and wellbeing in follow-up surveys in order to detect potential change over time.

The upcoming replication RCT provides an opportunity to implement some of these recommendations. This is an important time for DC, especially as the program plans to scale-up and replicate their model in other areas. This strategic effort will require sustained modes of funding. Strengthening the evaluation of maternal wellbeing could reveal additional benefits of DC that this study was unable to capture due to the limitations described above. Uncovering these benefits will only bolster DC's case for funding.

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APPENDICES

Appendix A. Main Effects Regression Tables, by Subdomain

Table A1. Main Effects: OLS Regression Testing Impact of Random Assignment to Durham Connects, Economic Self-sufficiency Subdomain

	Model					
	(1)	(2)	(3)	(4)	(5)	(6)
Variable	WIC Use		Medicaid Use		Household Income	
Treatment	-0.05	0.00	-0.12***	-0.08**	3,859	-1,580
	(0.05)	(0.04)	(0.04)	(0.03)	(4,124)	(2,754)
Married		-0.18***		-0.14***		23,749***
		(0.06)		(0.04)		(4,242)
Medicaid/ no ins.		0.36***		0.34***		-34,416***
		(0.06)		(0.05)		(4,959)
Birth complications		-0.03		0.12**		-408.3
		(0.06)		(0.05)		(3,757)
Young mother		0.04		0.10**		-5,409**
		(0.05)		(0.05)		(2,441)
Black		0.23***		0.13**		-18,651***
		(0.06)		(0.05)		(4,771)
Hispanic		0.15*		-0.32***		-23,440***
		(0.09)		(0.07)		(5,474)
Other		0.24***		-0.29***		-17,584***
		(0.06)		(0.05)		(5,743)
Constant	0.57***	0.24***	0.34***	0.17***	40,740***	67,299***
	(0.03)	(0.07)	(0.03)	(0.05)	(2,850)	(5,152)
Observations	480	477	479	476	435	432
R-squared	0.00	0.39	0.02	0.45	0.00	0.58

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A2. Main Effects: OLS Regression Testing Impact of Random Assignment to Durham Connects, Workforce Participation, Education, & Training Subdomain

	Model			
	(1)	(2)	(3)	(4)
Variable	Employment Status		In School/ Training	
Treatment	-0.10**	-0.11**	-0.04	-0.03
	(0.04)	(0.04)	(0.04)	(0.03)
Married		-0.07		0.04
		(0.06)		(0.05)
Medicaid/ no ins.		-0.23***		0.05
		(0.06)		(0.05)
Birth complications		-0.02		0.01
		(0.07)		(0.05)
Young mother		-0.02		0.19***
		(0.06)		(0.05)
Black		0.12*		0.19***
		(0.06)		(0.05)
Hispanic		-0.01		0.01
		(0.09)		(0.07)
Other		0.03		0.01
		(0.07)		(0.05)
Constant	0.65***	0.78***	0.21***	0.03
	(0.03)	(0.07)	-0.0257	(0.05)
Observations	481	478	477	474
R-squared	0.01	0.05	0.002	0.12

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A3. Main Effects: OLS Regression Testing Impact of Random Assignment to Durham Connects, Social Support Subdomain

	Model	
	(1)	(2)
Variable	Emergency childcare	
Treatment	-0.01	-0.01
	(0.02)	(0.02)
Married		0.03
		(0.03)
Medicaid/ no ins.		-0.01
		(0.02)
Birth complications		-0.01
		(0.03)
Young mother		0.02
		(0.03)
Black		0.03
		(0.03)
Hispanic		-0.04
		(0.05)
Other		-0.03
		(0.04)
Constant	0.94***	0.93***
	(0.01)	(0.03)
Observations	481	478
R-squared	0	0.01

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A4. Main Effects: OLS Regression Testing Impact of Random Assignment to Durham Connects, Family Planning Subdomain

	Model			
	(1)	(2)	(3)	(4)
Variable	Contraceptive Use		Family Planning Services Use	
Treatment	-0.09**	-0.09*	0.01	0.01
	(0.04)	(0.05)	(0.03)	(0.03)
Married		-0.01		-0.01
		(0.06)		(0.04)
Medicaid/ no ins.		0.02		0.06**
		(0.06)		(0.03)
Birth complications		-0.08		-0.05
		(0.07)		(0.03)
Young mother		-0.08		-0.03
		(0.06)		(0.04)
Black		-0.04		0.01
		(0.07)		(0.03)
Hispanic		-0.08		0.13**
		(0.10)		(0.06)
Other		0.04		0.15***
		(0.07)		(0.04)
Constant	0.64***	0.67***	0.09***	0.02
	(0.03)	(0.08)	(0.02)	(0.05)
Observations	479	476	479	476
R-squared	0.01	0.02	0	0.08

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix B. Key Constructs and Data Availability for Maternal Wellbeing & Health Domains

Table B1. Comparison of DC Data Availability: 6- and 18-month Survey Instruments

Domain	Key constructs[1]	Data availability 6 mos.	Data availability 18 mos.
Maternal Wellbeing			
Safety and violence	Overall home environment quality	✗	✗
	Marital relationship conflict score	✗	✗
Relationship functioning	Relationship between caregivers	✓	✗
	Length of relationship	✓	✓
Economic self-sufficiency	Total household income	✗	✓
	Maternal Income	✗	✗
	Paternal income	✗	✗
	Job training program enrollment	✗	✓
	Reduced public assistance receipt	✗	✓
	Material support from father	✓	✗
Education	Level of education completed	✓	✓
	Enrolled in education program	✗	✓
Social support		✓	✗
Workforce participation	Maternal employment status	✓	✓
	Maternal number of hours spent at work/ wk	✗	✓
Maternal Health			
Mental health	Clinical depression	✓	✗
	Clinical anxiety	✓	✗
	Substance use	✓	✗
Physical health	Health care utilization	✗	✗
	Health insurance	✓	✓
	Postpartum check-up	✓	-
	Medical home/ PCP connection	✓	✓
Domestic violence		✓	✗
Reproductive health	Contraceptive use (birth control)	✓	✓
	Pregnancy spacing (unplanned)	✗	✗
	Birth spacing	✓	✓
Overall health	Self-reported health rating	✓	✓

[1] Key constructs were taken from literature review section of author's masters project prospectus. Not an exhaustive list.