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Home-Visiting Support for Low-Birth-Weight Preterm Infants: Evaluation Findings from the Following Baby Back Home Intervention

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Evaluation of Following Baby Back Home

Executive Summary

Low birth weight (LBW) preterm infants, particularly extremely LBW infants, are at increased risk for death and long-term health, development, and behavioral morbidity.[1,2] LBW preterm infants present significant and unique challenges to their families due to their medical fragility. Families of low socioeconomic status are particularly challenged by LBW preterm infants, putting them at even greater risk for long-term morbidity. These negative effects may be partially due to lack of provision of required health care and immunizations, and also partially due to the lack of comfort and knowledge in how to parent these fragile infants. The time of transition to home after discharge from Neonatal Intensive Care Unit (NICU) is a time of particular need. These infants and families have great need for special community services and coordination of health care and other services.[10,11] Home visiting programs which target preterm children have been shown to improve some aspects of parent mood and perceptions and parent/child interaction,[3–5] but there has been little evidence that home visiting programs improve the health of LBW preterm infants.[5] It is uncertain whether this is due to the high medical fragility of these infants and the difficulty of influencing health status via the home visiting approach, or if the previously published interventions were not adequate to influence health status.

The Following Baby Back Home (FBBH) program of the University of Arkansas for Medical Sciences' Department of Pediatrics began in 2009 with funding from Arkansas Medicaid to assist and support families as they manage their high-risk LBW preterm infants after discharge from the NICU. In 2012, FBBH received additional support from federal home visiting funds (Maternal, Infant, and Early Childhood Home Visiting, MIECHV) to expand services. FBBH is provided through a home visiting team, which consists of a nurse and a social worker, to assist families in the transition from the NICU in health-related areas like breathing and feeding, for example. The teams work to facilitate appointments to the infant's medical providers, and often assist in obtaining medical appointments. FBBH monitors health issues and works to ensure follow-up appointments to subspecialists when needed. FBBH home visitors monitor the developmental progress of infants and are aggressive to refer children with developmental concerns for evaluation and treatment. Completion of the recommended immunization schedule is also a major component of preventive health care for all children, and FBBH home visiting teams work to ensure our infants receive all required immunizations. Parents of LBW preterm infants, in general, face greater challenges in parenting their children. FBBH teams monitor for these issues, support family needs, and make referrals as needed.

This evaluation addresses two primary research questions:

1. Will the children who are followed in the FBBH program demonstrate improved markers of child health, including lower infant mortality rates and better completion of immunizations?
2. Will children followed in the FBBH program demonstrate improved indicators of linkages and referral by increased use of health care (i.e., more routine and non-routine doctor visits, more pharmacy use, more hospitalizations or fewer

Emergency Department visits) by ages 1, 2, and 3 when compared to a matched group who do not receive the FBBH services?

Because of the high-risk nature of the sample of children referred to FBBH, medically vulnerable LBW preterm infants with Neonatal Intensive Care Unit (NICU) hospitalizations, we conducted a quasi-experimental research design using administrative data in order to examine the outcomes of the children in FBBH to similarly at-risk infants. The research focused on review of state vital records and insurance claims data looking at infant mortality, immunizations, and the frequency of medical visits.

The primary population targeted in this evaluation was medically complex, LBW preterm infants and their families, living in 57 Arkansas counties in Northeast, Northwest, River Valley, Central, South, and Southwest regions of the state. The infants are referred from all Arkansas NICUs and out-of-state NICUs for Arkansas infants living in our program coverage area. Eligible infants are those with an NICU admission or a NICU-like admission identified by a neonatologist, for example a physician in the cardiovascular unit or in the ventilator and tracheostomy unit. The analytic sample for the analyses includes all infants referred to FBBH born between January 1, 2013 and December 31, 2017 who could be located in the Arkansas Birth Certificate Data and All Payer Claims Database (APCD) data set, who had insurance enrollment data for the span of each year of analysis, and for whom an adequate propensity match can be made (N=496).

To reduce selection bias, FBBH infants were matched with children in the control group based on a 1:1 propensity matching[6,7] as follows. First, a logistic regression analysis was performed to estimate the probability of a patient being assigned to FBBH based on the infant's demographics, the mother's demographics and socio-economic conditions, prenatal behaviors, and the infant's medical conditions. These independent variables specifically included the child's gender, the mother's race/ethnicity, the mother's marital status, the rural-urban commuting area code (RUCA), the type of health care coverage, the mother's smoking status during pregnancy, the ZIP code-level median household income, the weight of the child at birth, the Apgar score five minutes after birth, the child's length of the NICU stay, the newborn respiratory disease indicator, history of intraventricular hemorrhage, convulsions, presence of critical congenital heart disease, chromosome abnormality, use of gastrostomy tube, and the Arkansas Perinatal Regionalization Levels of Care[8] of the facility of longest stay (infants may have transferred from one NICU to another). Median household income quartiles were derived from assigning the mother's address a median household income based on the ZIP code in which they resided at the time of delivery. A greedy matching algorithm was then used to match FBBH infants (cases) and non-FBBH infants (controls) based on a 1:1 match of those with identical or near identical model-derived propensity to be in the FBBH group. The SAS procedure proc psmatch[6] was used to perform both the estimation of propensity score and matching. An exact match was made on some key characteristics (gender, NICU length of stay category, type of health care coverage, race/ethnicity, and facility level of longest stay). The incorporation of an exact match led to an improvement of overall balance across covariates. Gestational age and birth weight were obtained from birth certificate data. Clinical conditions were obtained from patient diagnoses from the claims data set. All statistical analyses were performed using SAS/STAT software Version 9.4 of the SAS system

for Windows. SAS and all other SAS Institute Inc. products or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, N.C. These matched analyses were used to examine all of the child health, utilization, and mortality outcomes.

Propensity score matching resulted in a non-FBBH matched control group that was not significantly different from the FBBH infants (see Appendix B). The non-FBBH matched control group infants had significantly higher odds (aOR=7.40 [95% CI=2.56-21.44], $p<.001$) of infant mortality than those managed in the FBBH program. The difference in infant mortality is striking, where 26 infants in the non-FBBH matched control group died, compared to four infants who were enrolled in FBBH. Infants in FBBH were significantly more likely to have more visits in the first year of life when immunizations were provided and to have significantly higher odds of having had at least four immunization visits in the first year, which was used as a proxy for completing the immunization series from birth to 12 months.

When we examine health care use, we find infants in FBBH were significantly more likely to have both routine and non-routine medical appointments from discharge from NICU through their third birthdays than non-FBBH control infants. We also find significantly greater hospital use in the first year of life (post-NICU discharge) of FBBH infants compared to control infants and greater use of the emergency department in the first and second years of life (all use and care deemed non-urgent). We did find more episodes of injuries for FBBH infants compared to the control group by ages 1 and 2. Findings from the Michigan Maternal and Infant Health Program, which is also delivered with nurse/social worker teams, also demonstrated increases in injuries, which was mostly explained by superficial injuries.[9] These analyses did not account for the severity of the injury, but FBBH infants were seen in emergency departments for evaluation and minor emergencies at greater rates than matched control infants. Therefore, like was found in the in the MI-MIHP program, families in FBBH were more likely to seek care for evaluation of less severe issues.

Results suggest that nurse/social worker FBBH home visiting teams positively affect the health of medically fragile LBW preterm infants when measured by mortality and immunizations. While previous literature hypothesized that these home visits would decrease hospitalization and emergency department visits, our results suggest that such a result is not feasible, nor perhaps even desirable, for medically fragile infants particularly in the first years of life. For this sample, the more frequent use of care in the first year of life is beneficial for the longer-term health of medically fragile infants. The results of the FBBH intervention extend the literature of home visiting with LBW preterm infants. Our data expands the current literature by investigating the effects of the program over three years. These findings demonstrate that acute health care use for FBBH infant does decrease as the child ages, while use of routine and non-routine medical visits remains higher. Home visiting (FBBH) appears to be a wise investment as it reduces mortality and optimizes the health and well-being of LBW infants after discharge from the NICU. In summary, these findings support the conclusion that the FBBH program positively impacted the program goals of improved child health and linkages and referrals for health care use.

Background

The benefit of home visiting programs on the mortality, health, and development of at-risk families and their infants and young children has been emphasized by professional organizations such as the American Academy of Pediatrics, the Academic Pediatric Association, and Zero to Three.[10–12] They emphasize that home visiting programs are a mechanism to ensure that at-risk families have social support; linkage to health care and to a variety of public and private services; and ongoing health, developmental, and safety education. Research demonstrates that some of the most effective home visits have been provided by nurses and nurse/social worker pairs[10,13–15], and such nurse home visits have been shown to improve maternal and child mortality as well as aspects of child behavior and learning.[9,14,16,17] Home visiting programs have received increasing national attention as an important form of intervention to assist certain families and their children, as reported by a full supplement in a recent issue of *Pediatrics*.[18]

LBW preterm infants, particularly extremely LBW infants, are at increased risk for death and long-term health, development, and behavioral morbidity.[1,2] Additionally, they present significant and unique financial, physical, and emotional challenges to their families due to their medical fragility and challenges for child care. Families of low socioeconomic status are particularly challenged by extremely LBW infants, and these infants are at even greater risk for long-term morbidity. These negative effects may be partially due to lack of provision of required health care and immunizations, and also partially due to the lack of comfort and knowledge in how to parent these fragile infants. The time of transition to home after discharge from NICU is a time of particular need for such families. These infants and families have a great need for special community services and coordination of health care and other services.[10,11] Home visiting programs that target preterm children have been shown to improve some aspects of parent mood and perceptions and parent-child interaction,[3–5] but there has been little evidence that home visiting programs improve the health of these high-risk children.[5] It is uncertain whether this is due to the high medical fragility of these infants and the difficulty of influencing health status via the home visiting approach, or if the previously published interventions were not adequate to influence health status.

Description of Intervention

The FBBH program of the UAMS Department of Pediatrics began in 2009 with funding from Arkansas Medicaid to assist and support families as they manage their high-risk LBW preterm infants after discharge from the NICU. The general goals of FBBH are to maximize the health and developmental progress of medically fragile infants, within the constraints of their medical conditions, and to improve the family's skill and confidence in providing a safe, stimulating, nurturing home. As shown in the logic model in Appendix A, we achieve these general goals by:

1. Improving adherence to medical appointments and immunizations,
2. Facilitating coordination of health care,
3. Monitoring children's growth and development,

4. Identifying local resources to meet the needs of the family and infants, including developmental intervention services, and
5. Providing parent education.

Home visiting teams, which include a registered nurse (RN) and licensed social worker, were placed in Northwest, Northeast, and South Arkansas in 2009. A fourth team was added to serve families in North Central Arkansas in 2011. In 2012, FBBH received support from federal home visiting funds (MIECHV) and started additional services in Central and Southwest Arkansas. The nurse/social worker teams assist families in the transition from the NICU in health-related areas like breathing and feeding. The teams work to facilitate appointments to the family's medical providers and often assist in obtaining medical appointments on behalf of the family. The teams monitor health issues and work to ensure follow-up appointments to subspecialists at Arkansas Children's Hospital when needed. As a preterm infant ages, it is common for concerns to arise regarding the child's developmental course. FBBH home visitors monitor the developmental progress of infants and are aggressive to refer children with developmental concerns for evaluation and treatment. Completion of the recommended immunization schedule is a major component of preventive health care for all children. FBBH visiting teams work hard to ensure our infants receive all required immunizations as they age. Parents of LBW preterm infants, in general, face greater challenges in parenting their children, which results in occasional anxiety or depression. FBBH teams monitor for these issues, support the family's needs, and make referrals as needed.

The home visiting team follows a protocol to determine the frequency of home visits. This protocol includes two home visits per month for the first two months after enrollment as close as possible to the transition to home, one home visit per month until age 1, and one home visit every other month until age 3. In addition, the home visiting teams contact the families by telephone on months without a visit. To accomplish the goals of the program, the home visitors provide case management services to identify child and family issues that require assistance, coordination, or referral. The home visitors were trained to monitor growth and weight, conduct family assessments to support family and caregiver education, assist with services coordination (medical appointments and community services for family support), assist with the Parents as Teachers curriculum, and screen for developmental delays using the Ages and Stages Questionnaire-3 (ASQ-3) and Ages and Stages Questionnaire: Social-Emotional (ASQ:SE).

Methods

Evaluation Design and Approach to Analysis

This evaluation addresses two primary research questions:

1. Will the children who are followed in the FBBH program demonstrate improved markers of child health, including lower infant mortality rates and better completion of immunizations?
2. Will children followed in the FBBH program demonstrate improved indicators of linkages and referral by increased use of health care (i.e., more routine and non-routine doctor visits, more pharmacy use, more hospitalizations and fewer Emergency Department visits)

at ages 1, 2, and 3, when compared to a matched group who do not receive the FBBH services?

A cross-sectional prospective quasi-experimental evaluation design, with a matched FBBH/non-FBBH (control) population using propensity scores prior to observing outcomes, is an efficient design given the limitations of treatment randomization. In a well-balanced match, where FBBH and non-FBBH are systematically similar (by demographics, socio-economics, and medical conditions of infants), differences between FBBH and non-FBBH can depict the effectiveness of the FBBH treatment. We included FBBH and non-FBBH matched dyad pairs as a random variable in the generalized linear models, and as such our design is very close to a randomized block experiment. We employed an intent-to-treat design (e.g., FBBH infants may have received no services), which is the most conservative approach to analysis.

To reduce selection bias among the non-FBBH control group, FBBH infants were matched with non-FBBH infants based on a 1:1 propensity score matching algorithm[6,7] using the following approach. First, a logistic regression model was fitted to estimate the probability of a patient being assigned to the FBBH intervention using the infant's demographics, mother's demographics and prenatal behaviors, socioeconomic status, and medical conditions. These independent variables specifically included the child's gender, the mother's race/ethnicity, the mother's marital status, the rural-urban commuting area code (RUCA), the type of health care coverage, the mother's smoking status during pregnancy, the ZIP-code-level median household income, the weight of the child at birth, the Apgar score five minutes after birth, the child's length of stay in the NICU, the newborn respiratory disease indicator, history of intraventricular hemorrhage, convulsions, presence of critical congenital heart disease, chromosome abnormality, use of gastrostomy tube, and the Arkansas Perinatal Regionalization Levels of Care[8] of the facility of longest stay (infants may have transferred from one NICU to another). Median household income quartiles were derived from assigning the mother's address a median household income based on the ZIP code in which they resided at the time of delivery. A greedy matching algorithm was then used to match FBBH infants (treatment) and non-FBBH infants (controls) based on a 1:1 match of those with an identical or near identical model-derived propensity to be in the FBBH group. The SAS procedure proc psmatch[6] was used to perform both estimation of propensity score and matching. An exact match was made on some key characteristics (gender, NICU length of stay category, type of health care coverage, race/ethnicity, and facility level of longest stay). The incorporation of an exact match led to an improvement of overall balance across covariates. Gestational age and birth weight were obtained from birth certificate data. The incorporation of exact match led to an improvement of overall balance across covariates. Clinical conditions were obtained from patient diagnoses from the claims data set. All statistical analyses were performed using SAS/STAT software Version 9.4 of the SAS system for Windows. SAS and all other SAS Institute Inc. products or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, N.C. USA.

Outcomes of interest were modeled using generalized linear models. For counts variables (e.g., hospitalizations or emergency room visits), negative binomial distribution was applied with a log-link function. For binary variables (e.g., mortality), a binomial distribution with a logit link functions was used. Since the duration of each observation window (i.e., within each year) was

fixed, we did not use an offset option in the model statement of proc glimmix. For hospital readmission and length of stay, the proportion was computed conditional on having a hospitalization. Each model included matched case-control dyad as a random variable.

Measures

The evaluation outcomes studied included linkages and referrals to health care as measured by inpatient hospitalizations, 30-day hospital readmissions, length of hospital stay, emergency department visits, wellness visits, non-wellness outpatient visits, and filled pharmacy prescriptions. Child health outcomes included mortality as of December 31, 2018 as the primary outcome. The number of immunization visits in the first year of life were assessed as a proxy for pediatric immunization series completion. In the first 15 months after birth, guidelines recommend that a child receives a minimum of five encounters (not including influenza vaccination) in order to complete the immunization series, with the last round of immunizations administered between 12 and 15 months of age. For this evaluation, we considered immunization coverage to be complete if an infant had a minimum of four immunization encounters in the first year of life. Clinical child health outcomes included episodes of injuries, dehydration, failure to thrive, and nutrition deficiency.

All Payer Claims Database (APCD) description: In 2015, the Arkansas General Assembly established the Arkansas Health Care Transparency Initiative (AHTI) to address the state's data needs to improve health and support research. This initiative mandates entities throughout the state to submit medical, pharmacy, and dental claims from Arkansans. This led to the creation of the Arkansas All-Payer Claims Database (APCD), a large-scale database securely administered by the Arkansas Center for Health Improvement (ACHI) and governed by the Arkansas Insurance Department (AID). The APCD includes claims for all Arkansans starting in 2013, with claims data updated on an annual basis. ACHI and AID keep all records within the APCD confidential and manage and regulate data requests and subscriptions for researchers wishing to use the information. The University of Arkansas for Medical Sciences Arkansas Biosciences Institute (ABI) holds a subscription to the ACPD for approved researchers within UAMS to use. Infants' clinical conditions from the APCD were used for propensity score matching. Outcomes from the APCD include health care use, immunizations, and other clinical child health outcomes.

Birth Certificate Records data: Arkansas Department of Health Vital Statistics provided individual- and address-level birth event data found on an Arkansas birth certificate about the child, mother (if available) and father (if available) from 1989 to 2018. Birth certificate records data are included in the ABI subscription of APCD. Birth certificate data were used for propensity score matching, including gender, race, maternal marital status, smoking, RUCA, and income quartile as well as birth information including 5-minute Apgar score, gestational age, and birth weight.

Death Certificate Records data: Arkansas Department of Health Vital Statistics provided individual- and address-level death event data found on Arkansas death certificates. Death certificate records data are included in the ABI subscription of APCD. This was the data source for infant mortality.

Data linkage description: Within the ABI APCD subscription, ACHI extracted data fields for our analyses. In order to protect any personally identifiable information (PII) within the data, the APCD uses HASH IDs to differentiate individuals. The HASH ID is an anonymous and unique 44-character anonymous and unique identifier that incorporates a person's last name and date of birth. The HASH ID is further combined with gender to improve data linkage accuracy. Individuals within data sources, including the Arkansas Department of Health birth and death certificate records, linked by HASH ID are then linked across different data sources. Birth, death, health care coverage program enrollment, medical, and pharmaceutical claims records are continuously updated. After ACHI uptakes and processes the data, there is a refresh of data for the ABI subscription once a year. For this study, we were able to use administrative claims as well as birth and death certificate records up to December 31, 2018.

Sample Size and Sampling Plan

APCD and Birth Certificate Records files from 2013 to 2018 were used to exclude infants and identify the study population. Enrollees who did not meet each of the following criteria were excluded:

- Not born between January 1, 2013 and December 31, 2017.
- No birth record in the Arkansas Birth Certificate Records.
- Not uniquely identifiable by HASH ID.
- Not found in the APCD eligibility file.
- Did not have a NICU Record.

Figure 1: Flow Diagram Depicting the Development of the Analyzable Study Population

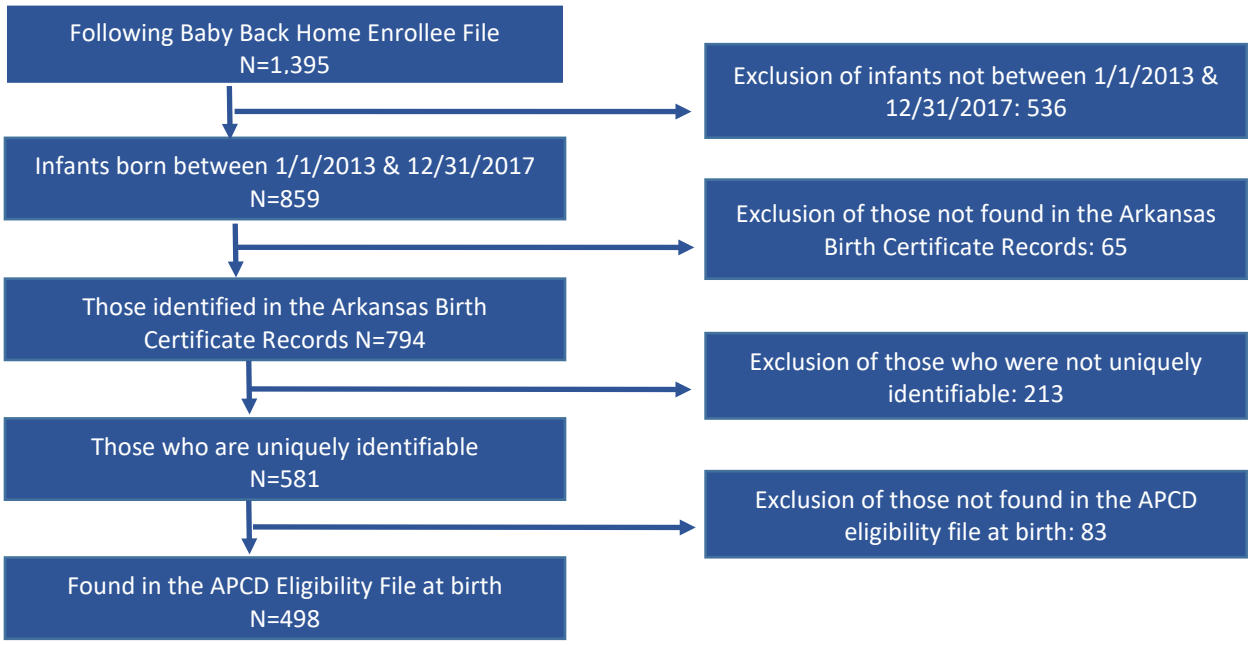

Figure 1 outlines the study population development starting from the total population of infants who enrolled in the FBBH program. For the analyses comparing the FBBH infant mortality rate, we utilized all participants who satisfied the inclusion and exclusion criteria as a candidate for propensity score match. The final mortality sample included 482 participants for whom an adequate propensity score match was made. The pre- and post-propensity score matching characteristics for the infants included in the infant mortality analysis are provided in Table B-1.

Three analytic samples for the health outcome and utilization analyses were created to correspond to age 0-1 Year, 1-2 Year, and 2-3 Year observation windows. Each analytic sample includes all participants who satisfied the inclusion/exclusion criteria in Figure 1 and were followed for at least one year (with observation windows occurring birth to the first birthday, the first birthday to second birthday, and the second birthday to the third birthday), and for whom an adequate propensity match could be made. The eligible pre-match populations for the outcomes examined using data in the APCD for Year 1, Year 2, and Year 3 included N=83,725, N=51,241, and N=40,185 non-FBBH participants and N=473, N=350, and N=252 FBBH participants. Analyses were conducted using an intent-to-treat design; therefore we did not limit our sample based on the duration of the FBBH program. Out of 473, 350, and 252 candidates, a match was made for 418, 310, and 218 FBBH participants in the Year 1, Year 2, and Year 3 observation windows, respectively. Tables B-2, B-3, and B-4 present enrollee characteristics before and after propensity score matching for each age period examined. Characteristics with an absolute standardized difference of 0.10 or higher indicate categorical differences between treatment and control groups. The group assignment and intraventricular hemorrhage in Years 2 and 3 showed a weak association in the matched samples, with the treatment group having a slightly higher rate of intraventricular hemorrhage. In Year 3, RUCA and the group assignment also saw a weak association. However, all these associations were statistically insignificant ($p>0.05$). The variance ratio showed good balance, with most variables within the recommended range of 0.5 to 2.0.[6]

We performed a calculation to determine the power to correctly reject null hypotheses, given sample sizes and minimum effect of differences between FBBH (treatment/intervention) and non-FBBH populations (control) to conclude success of the intervention. We chose to determine power on the least prevalent but most important outcome, mortality. We used the 2017 Arkansas infant mortality rate from CDC Wonder[19] for preterm (<37 weeks gestational age) and low birth weight (<2500 grams) children as the reference proportion. We used the assumption of the control group being four times as likely to die as the control group, which is a conservative estimate taken from the 2018 FBBH evaluation report, to obtain the expected effect size. We used SAS proc power to perform the calculation. The power to detect the effect described above with the probability of a Type I error set at alpha=0.05, given the sample of 482 in each matched group was 0.97. Similarly, for a more prevalent outcome, the power to detect an effect of 0.2 in the number of emergency departments visit was 0.86.

Results

Evaluation Question 1 – Child Health

Infant Mortality Rate: We compared the mortality rate of FBBH enrollees with matched control. The adjusted odds ratio was computed using the FBBH recipients as the referent group. As shown in Table 1, infants in the control group had significantly greater odds of infant mortality than FBBH infants.

Table 1. Infant Mortality

		PS Matched (N=964)			
		Control (N=482) N (percent)	FBBH Treatment (N=482) N (percent)	Adjusted odds ratio (CI)	p-value
Death by Dec 31st 2018	Yes	26	4	7.40 (2.56-21.44)	**< 0.01**
	No	456	479		
Note: Reference = FBBH Treatment; Model adjustment was made by log (Dec31st2018 - child birthday); CI=Confidence Interval					

We conducted an additional sensitivity analysis for this outcome as the primary outcome for child health. As shown in Table B-1, after propensity matching, there remained a significant association between income quartile and treatment group status in which the matched control condition was overrepresented in the higher income quartiles. We further increased the precision of the income quartile match by performing exact match and reduced the sample to 444 infants in FBBH and non-FBBH matched controls in order to obtain the additional non-significance for income. In this analysis, the significant association between infant mortality and treatment status was still observed (aOR=4.47 [95% CI=1.48-13.50], $p<.001$; see Appendix C).

Immunization Completion: The APCD does not contain records of vaccines administered to children during an immunization visit. We used the count of immunization visits seen in medical claims (including wellness visits with immunization codes) as a proxy of completion of immunization series in the first year of lives. Findings shown in Table 1 suggest FBBH infants received significantly more medical visits in which immunizations (excluding influenza) were received than the control group. FBBH infants were also more likely than the non-FBBH matched control to have received immunizations in at least four medical visits.

Additional Child Health Outcomes: The APCD includes diagnostic codes, which permitted the exploration of additional child health variables. From discharge from NICU through age 1, infants in FBBH were more likely to have episodes of injuries and dehydration than the non-FBBH matched comparison. From age 1 to age 2, infants and toddlers in FBBH had more episodes of injury than the non-FBBH matched comparison. From age 2 to age 3, there were no differences in these outcomes by intervention. Results are in Tables D-1, D-2, and D-3.

Evaluation Question 2 – Health Care Utilization

Health Care Utilization: The health care utilization from the day after the last day of NICU stay to age 1 are shown in Table 2. Infants in FBBH had significantly more use of the health care system than the non-FBBH matched control group. This includes hospitalizations (and the length of stay), emergency department visits (and significantly more visits for non-urgent care), wellness visits, non-wellness visits, and pharmacy claims.

Table 2. Following Baby Back Home Treatment and Control Group Health Care Utilization and Outcome Measures Differences - Year 1

Measure	Treatment (N=418)	Control (N=418)	IRR/ aOR	95% CI	P- Value*
Year 1 Health care Utilization					
Mean (StdErr) inpatient visits	0.59 (0.08)	0.25 (0.04)	2.68	**1.82-3.95**	**< 0.001**
Proportion (StdErr) with all-cause 30-day readmission per 100 inpatient stays	0.05 (0.01)	0.05 (0.02)	0.94	0.23-3.83	0.927
Mean (StdErr) length of stay in days for all hospitalizations	13.44 (2.94)	8.77 (1.70)	1.53	**1.07-2.20**	**0.021**
Rate (StdErr) of emergency department visits per year	1.65 (0.12)	0.96 (0.08)	1.81	**1.46-2.23**	**< 0.001**
Rate (StdErr) of non-urgent** evaluation and management of minor emergency department visits per year	0.92 (0.07)	0.49 (0.05)	1.92	**1.51-2.44**	**< 0.001**
Rate (StdErr) of wellness visit per year	13.46 (0.53)	8.78 (0.65)	1.59	**1.37-1.85**	**< 0.001**
Rate (StdErr) of outpatient non-wellness visits per year	1.86 (0.40)	1.01 (0.23)	1.81	**1.23-2.65**	**0.003**
Rate (StdErr) of filled pharmacy prescriptions per year	10.64 (0.53)	8.60 (0.42)	1.24	**1.08-1.43**	**0.002**
Year 1 Child Health: Immunizations					
Mean (StdErr) of immunization visits	3.74 (0.09)	2.53 (0.11)	1.49	**1.35-1.65**	**<0.001**
Proportion (StdErr) with ≥ 4 immunization visits	0.61 (0.02)	0.39 (0.02)	2.37	**1.80-3.14**	**<0.001**

Notes: *Continuous variable P value based on t-test for continuous variables and chi-square for categorical variables. **CPT code: 99281–99283 (ED visit for the E/M of a patient [Levels 1-3]) were used.
Abbreviations: IRR = Incidence rate ratio; aOR = Adjusted odds ratio; StdErr = Standardized error; PS = Propensity score; CI=Confidence Interval.

The utilization and health outcomes from age 1 to age 2 are shown in Table 3. As was observed before age 1, infants in FBBH had significantly more use of the health care system than the non-FBBH matched control group. Infants in FBBH had significantly more emergency department visits (including significantly more visits for non-urgent care), wellness visits, and non-wellness visits than the matched control group. Unlike as was demonstrated in the Year 1 observation window, there were not significant differences between the groups for hospitalizations or pharmacy claims.

Table 3. Following Baby Back Home Treatment and Control Group Health Care Utilization Differences - Year 2

Outcomes	Treatment (N=310)	Control (N=310)	IRR/ aOR	95% CI	P Value
Year 2 Health care Utilization					
Mean (StdErr) inpatient visits	0.35 (0.07)	0.27 (0.06)	1.31	0.70-2.48	0.400
Proportion (StdErr) with all-cause 30-day readmission per 100 inpatient stays	0.06 (0.02)	0.11 (0.04)	0.52	0.10-2.71	0.431
Mean (StdErr) length of stay in days for all hospitalizations	10.62 (2.99)	15.08 (6.50)	0.79	0.43-1.45	0.441
Rate (StdErr) of emergency department visits per year	1.44 (0.12)	0.99 (0.11)	1.49	**1.15-1.93**	**0.003**
Rate (StdErr) of non-urgent** evaluation and management of minor emergency department visits per year	0.75 (0.07)	0.50 (0.06)	1.55	**1.15-2.09**	**0.004**
Rate (StdErr) of wellness visit per year	18.35 (1.63)	11.12 (1.34)	1.78	**1.40-2.26**	**<0.001**
Rate (StdErr) of outpatient non-wellness visits per year	3.03 (0.92)	0.80 (0.20)	3.80	**2.42-5.95**	**<0.001**
Rate (StdErr) of filled pharmacy prescriptions per year	13.47 (0.97)	11.80 (0.92)	1.15	0.95-1.40	0.149

Notes: *Continuous variable P value based on t-test for continuous variables and chi-square for categorical variables. **CPT code: 99281–99283 (ED visit for the E/M of a patient [Levels 1-3]) were used.
Abbreviations: IRR = Incidence rate ratio; aOR = Adjusted odds ratio; StdErr = Standardized error; PS = Propensity score; CI=Confidence Interval.

The utilization and health outcomes from age 2 to age 3 are shown in Table 4. Similar to observation before age 2, infants in FBBH had significantly more use of the health care system than the non-FBBH matched control group. Infants in FBBH had significantly more wellness visits and non-wellness visits than the matched control group. Unlike earlier observation, there were not significant differences between the groups for hospitalizations, emergency department visits, or pharmacy claims.

Table 4. Following Baby Back Home Treatment and Control Group Health Care Utilization Differences - Year 3

Outcomes	Treatment (N=218)	Control (N=218)	IRR/ aOR	95% CI	P Value
Year 3 Health care Utilization					
Mean (StdErr) inpatient visits	0.11 (0.04)	0.09 (0.02)	1.27	0.57-2.83	0.553
Proportion (StdErr) with all-cause 30-day readmission per 100 inpatient stays	0.03 (0.03)	0.00 (0.00)	*	*	*
Mean (StdErr) length of stay in days for all hospitalizations	5.34 (1.45)	4.82 (0.61)	1.11	0.64-1.91	0.704

Outcomes	Treatment (N=218)	Control (N=218)	IRR/ aOR	95% CI	P Value
Rate (StdErr) of emergency department visits per year	0.89 (0.10)	0.68 (0.08)	1.30	0.95-1.78	0.103
Rate (StdErr) of non-urgent** evaluation and management of minor emergency department visits per year	0.45 (0.06)	0.41 (0.05)	1.09	0.75-1.58	0.648
Rate (StdErr) of wellness visit per year	18.16 (2.12)	11.68 (1.64)	1.73	**1.29-2.32**	**< 0.001**
Rate (StdErr) of outpatient non-wellness visits per year	3.82 (1.50)	1.27 (0.37)	3.00	**1.63-5.55**	**< 0.001**
Rate (StdErr) of filled pharmacy prescriptions per year	9.86 (0.84)	11.46 (1.07)	0.86	0.68-1.09	0.211

Notes: *Continuous variable P value based on t-test for continuous variables and chi-square for categorical variables. **CPT code: 99281–99283 (ED visit for the E/M of a patient [Levels 1-3]) were used.
Abbreviations: IRR = Incidence rate ratio; aOR = Adjusted odds ratio; StdErr = Standardized error; PS = Propensity score; CI=Confidence Interval.

Discussion

The FBBH intervention had a robust significant impact on child health and health care use. The non-FBBH matched control group infants had significantly higher odds (aOR=7.40 [95% CI=2.56-21.44], p<.001) of infant mortality than those managed in the FBBH program. The difference in infant mortality is striking: 26 infants in the non-FBBH matched control group died compared to four infants who were enrolled in FBBH. Infants in FBBH also had significantly more visits in the first year of life where immunizations were provided and to have significantly higher odds of having had at least four immunization visits in the first year. These two variables, infant mortality rate and immunizations, are two major metrics which reflect the health and wellbeing of children.

When we examine health care use, we find infants in FBBH were significantly more likely to have routine and non-routine medical appointments from discharge from NICU through their third birthdays than non-FBBH control infants. We also find significantly greater hospital use in the first year of life and greater use of the emergency department, for all care and non-urgent care, in the first and second years of life of FBBH infants compared to control infants. We did find more episodes of injuries for FBBH infants compared to the control group at ages 1 and 2. Findings from the Michigan Maternal and Infant Health Program, which is also delivered with nurse/social worker teams, also demonstrated increases in injuries, which was mostly explained by superficial injuries.[9] These analyses did not account for the severity of the injury, but FBBH infants were seen in emergency departments for evaluation and minor emergencies at greater rates than matched control infants. Therefore, families in FBBH were more likely to seek care for evaluation of less severe issues.

Goals of FBBH are to work with parents to educate and support them as they care for their medically fragile infants, to assure that they receive the medical care necessary to maintain the

health of their infants, and to facilitate compliance with their medical regimens. The education and support provided by FBBH resulted in the families using medical care more frequently. It is probable that this clinical care contributed to the lower mortality rate of the FBBH infants. Indeed, infants in FBBH interacted with every type of health care provider examined earlier in their development. As infants aged, acute health care interactions (hospitalizations and emergency department visits) became more comparable to those in the matched control families. However, even between the ages of 2 and 3, infants who participated in FBBH were using significantly more routine well-child and specialized care than infants in the non-FBBH matched control group.

Results suggest that nurse/social worker FBBH home visiting teams positively affect the health of medically fragile LBW preterm infants when measured by mortality and immunizations. While previous literature hypothesized that these home visits would decrease hospitalization and emergency department visits, our results suggest that such a result is not feasible, or perhaps even desirable, for medically fragile infants particularly in the first years of life. For this sample, the more frequent use of care in the first year is beneficial for the longer-term health of medically fragile infants. The results of the FBBH intervention extend the literature of home visiting with LBW preterm infants. These findings demonstrate that acute health care use for FBBH infant does decrease as the child ages, while use of routine and non-routine medical visits remains higher. Much effort is spent to keep infants alive in the NICU. It is a wise investment to continue support of home visiting (FBBH), which reduces mortality and optimizes the health and well-being of infants after NICU discharge. In summary, these findings support the conclusion that the FBBH program positively impacted the program goals of improved child health and linkages and referrals for health care use.

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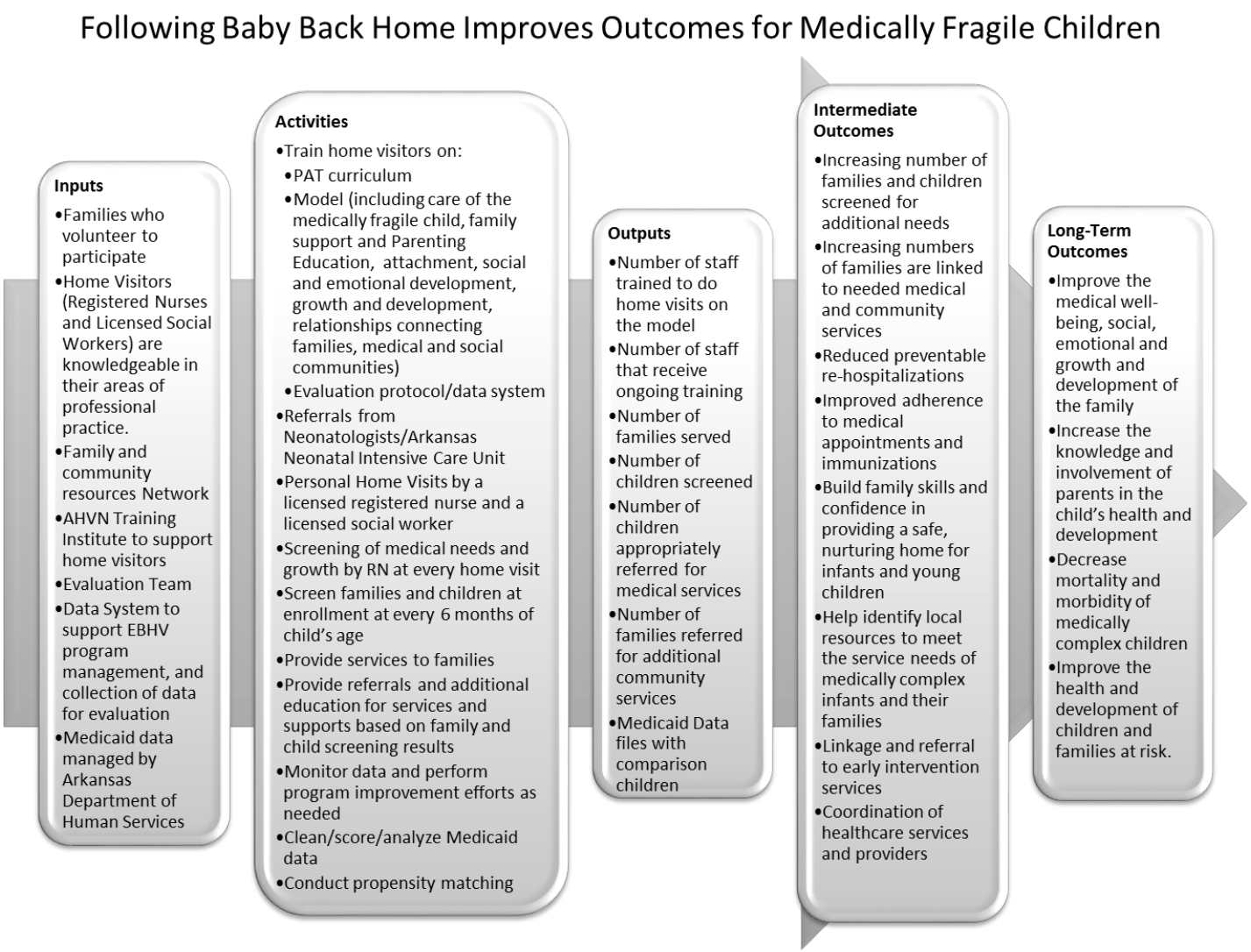
Appendix A. Logic Model for the FBBH Evaluation



Appendix B. Characteristics of Samples Pre- and Post-Propensity Score Matching

Table B-1. Following Baby Back Home Treatment and Control Groups Background Characteristics, Pre- and Post-Propensity Score Matching - Mortality

		Unmatched (N=113,162)			Propensity Score Matched (N=964)				
		Treatment (N=496)	Control (N=112,666)		Treatment (N=482)	Control (N=482)			
Continuous variables	**Unit**	**Mean (SE)**	**Mean (SE)**	**P value***	**Mean (SE)**	**Mean (SE)**	**Std Diff**	**Var Ratio**	**P Value***
Apgar score 5 minutes after birth	Score	6.6 (0.3)	8.6 (0.0)	**<0.001**	6.6 (0.3)	6.4 (0.3)	0.04	0.97	0.630
Weight at birth	Grams	1760.7 (39.8)	3234.9 (1.7)	**<0.001**	1759.5 (40.4)	1839.3 (42.8)	-0.11	0.89	0.175
Estimated gestational age at birth	Weeks	31.4 (0.2)	38.4 (0.0)	**<0.001**	31.3 (0.2)	31.6 (0.2)	-0.09	1.04	0.283
Categorical variables	**Category**	**N (%)**	**N (%)**	**P value***	**N (%)**	**N (%)**	**Std Diff**	**Var Ratio**	**P Value***
Gender	Male	277 (55.9)	57,693 (51.2)	**0.039**	269 (55.8)	269 (55.8)	0.00	1.00	1.000
	Female	219 (44.2)	54,973 (48.8))		213 (44.2)	213 (44.2)			
Race	White	267 (53.8)	73,221 (65.0)	**<0.001**	266 (55.2)	266 (55.2)	0.00		1.000
	Black	171 (34.5)	24,138 (21.4)		168 (34.9)	168 (34.9)			
	Hispanic	29 (5.9)	10,745 (9.5)		27 (5.6)	27 (5.6)			
	Others	29 (5.9)	4,562 (4.1)		21 (4.4)	21 (4.4)			
Mother marital indicator	Yes	139 (28.0)	41,620 (36.9)	**<0.001**	135 (28.0)	130 (27.0)	0.03		0.867
	No	264 (53.2)	48,598 (43.1)		255 (52.9)	254 (52.7)			
	Unknown	93 (18.8)	22,448 (19.9)		92 (19.1)	98 (20.3)			
Income quartiles[1]	First	126 (25.4)	28,589 (25.4)	**0.008**	123 (25.5)	117 (24.3)	0.22		**0.024**
	Second	151 (30.4)	27,337 (24.3)		149 (30.9)	112 (23.2)			
	Third	112 (22.6)	28,152 (25.0)		105 (21.8)	128 (26.6)			
	Fourth	107 (21.6)	28,588 (25.4)		105 (21.8)	125 (25.9)			
NICU length of stay	< 5 days	17 (3.4)	96,837 (86.0)	**<0.001**	16 (3.3)	16 (3.3)	0.00		1.000
	5-< 10 days	19 (3.8)	8,528 (7.6)		19 (3.9)	19 (3.9)			
	10 -< 21 days	50 (10.1)	3,708 (3.3)		49 (10.2)	49 (10.2)			
	21 -< 47 days	151 (30.4)	2,231 (2.0)		150 (31.1)	150 (31.1)			
	47 =< 94 days	151 (30.4)	932 (0.8)		143 (29.7)	143 (29.7)			
	> 94 days	108 (21.8)	430 (0.4)		105 (21.8)	105 (21.8)			

		Unmatched (N=113,162)			Propensity Score Matched (N=964)				
		Treatment (N=496)	**Control (N=112,666)**		**Treatment (N=482)**	**Control (N=482)**			
RUCA	Urban	254 (51.2)	62,590 (55.6)	0.224	243 (50.4)	272 (56.4)	0.13		0.226
	Large rural	125 (25.2)	25,496 (22.6)		124 (25.7)	112 (23.2)			
	Small rural	77 (15.5)	16,925 (15.0)		77(16.0)	71 (14.7)			
	Isolated	40 (8.1)	7,655 (6.8)		38 (7.9)	27 (5.6)			
Type of insurance used in NICU	Medicaid	459 (92.5)	96,562 (85.7)	**<0.001**	448 (93.0)	448 (93.0)	0.00	1.00	1.000
	Private	37 (7.5)	16,104 (14.3)		34 (7.1)	34 (7.1)			
Mother smoked during pregnancy	Yes	87 (17.5)	18,178 (16.1)	0.537	86 (17.8)	79 (16.4)	0.03		0.811
	No	301 (60.7)	71,015 (63.0)		289 (60.0)	291 (60.4)			
	Unknown	108 (21.8)	23,473 (20.8)		107 (22.2)	112 (23.2)			
Chromosome abnormality	Yes	19 (3.8)	299(0.3)	**<0.001**	17 (3.5)	11 (2.3)	-0.09	1.53	0.250
	No	477 (96.2)	112,367 (99.7)		465 (96.5)	471 (97.7)			
Intraventricular hemorrhage	Yes	31 (6.3)	155 (0.1)	**<0.001**	31 (6.4)	32 (6.6)	0.01	0.97	0.896
	No	465 (93.8)	112,511 (99.9)		451 (93.6)	450 (93.4)			
Respiratory disease	Yes	427 (86.1)	9,043 (8.0)	**<0.001**	414 (85.9)	404(83.8)	-0.07	0.89	0.369
	No	69 (13.9)	103,623 (92.0)		68 (14.1)	78 (16.2)			
Congenital heart disease	Yes	16 (3.2)	285 (0.3)	**<0.001**	16 (3.3)	19 (3.9)	0.05	0.85	0.606
	No	480 (96.8)	112,381 (99.8)		466 (96.7)	463 (96.1)			
Convulsion	Yes	19 (3.8)	373 (0.3)	**<0.001**	18 (3.7)	20 (4.2)	0.03	0.90	0.741
	No	477 (96.2)	112,293 (99.7)		464 (96.3)	462 (95.9)			
Gastrostomy tube	Yes	14 (2.8)	125 (0.1)	**<0.001**	13 (2.7)	9 (1.9)	-0.07	1.43	0.388
	No	482 (97.2)	112,541 (99.9)		469 (97.3)	473 (98.1)			
Facility level of longest stay	4	126 (25.4)	1,910(1.7)	**<0.001**	125 (25.9)	125 (25.9)	0.00		1.000
	3b	277 (55.9)	22,051 (19.6)		270 (56.0)	270 (56.0)			
	3a	62 (12.5)	22,689 (20.1)		56 (11.6)	56 (11.6)			
	other	31 (6.3)	66,016 (58.6)		31 (6.4)	31 (6.4)			

Notes: *Continuous variable P value based on t-test for continuous variables and chi-square for categorical variables. [1]Income quartiles compiled from median household income based on ZIP code of mother's residential address at time of delivery.

Abbreviations: RUCA = Rural-urban commuting area code; NICU = Neonatal Intensive Care Unit; SE = Standard error; PS = Propensity score; Std Diff = Standardized Difference; Var = Variance

Table B-2. Following Baby Back Home Treatment and Control Groups Background Characteristics, Pre- and Post-Propensity Score Matching - Year 1

		Unmatched (N=84,198)			Propensity Score Matched (N=836)				
		FBBH (N=473)	Control (N=83,725)		FBBH (N=418)	Control (N=418)			
Continuous variables	**Unit**	**Mean (SE)**	**Mean (SE)**	**P value***	**Mean (SE)**	**Mean (SE)**	**Std Diff**	**Var Ratio**	**P value***
Apgar score 5 minutes after birth	Score	6.7 (0.3)	8.6 (< 0.1)	**<0.001**	6.4 (0.2)	6.8 (0.4)	0.07	0.39	0.400
Weight at birth	Grams	1,760 (40.9)	3,231 (1.9)	**<0.001**	1,714 (42.5)	1,729 (43.5)	-0.02	0.95	0.816
Estimated gestational age at birth	Weeks	31.3 (0.2)	38.4 (< 0.1)	**<0.001**	31.0 (0.2)	31.1 (0.2)	-0.02	0.99	0.813
Categorical variables	**Category**	**N (%)**	**N (%)**	**P Value***	**N (%)**	**N (%)**	**Std Diff**	**Var Ratio**	**P Value***
Gender	Male	265 (56.0)	42,714 (51.0)	**0.030**	239 (57.2)	239 (57.2)	0.00	1.00	1.000
	Female	208 (44.0)	41,011 (49.0)		179 (42.8)	179 (42.8)			
Race	White	247 (52.2)	51,568 (61.6)	**<0.001**	229 (54.8)	229 (54.8)	0.00		1.000
	Black	168 (35.5)	19,670 (23.5)		157 (37.6)	157 (37.6)			
	Hispanic	29 (6.1)	9,029 (10.8)		17 (4.1)	17 (4.1)			
	Others	29 (6.1)	3,458 (4.1)		15 (3.6)	15 (3.6)			
Mother marital indicator	Yes	126 (26.6)	27,016 (32.3)	**0.001**	106 (25.4)	113 (27.0)	0.05		0.841
	No	258 (54.6)	38,705 (46.2)		232 (55.5)	229 (54.8)			
	Unknown	89 (18.8)	18,004 (21.5)		80 (19.1)	76 (18.2)			
Income quartiles[1]	First	123 (26.0)	22,300 (26.6)	**0.026**	110 (26.3)	106 (25.4)	0.05		0.923
	Second	144 (30.4)	20,577 (24.6)		129 (30.9)	128 (30.6)			
	Third	108 (22.8)	21,401 (25.8)		92 (22.0)	89 (21.3)			
	Fourth	98 (20.7)	19,447 (23.2)		87 (20.8)	95 (22.7)			
NICU length of stay	< 5 days	16 (3.4)	72,653 (86.3)	**<0.001**	14 (3.4)	14 (3.4)	0.00		1.000
	5-< 10 days	18 (3.8)	6,170 (7.3)		17 (4.1)	17 (4.1)			
	10 -< 21 days	45 (9.5)	2,804 (3.3)		40 (9.6)	40 (9.6)			
	21 -< 47 days	145 (30.5)	1,643 (2.0)		138 (33.0)	138 (33.0)			
	47 =< 94 days	147 (31.0)	643 (0.8)		127 (30.4)	127 (30.4)			
	> 94 days	104 (21.9)	245 (0.3)		82 (19.6)	82 (19.6)			
RUCA	Urban	238 (50.3)	46,097 (55.1)	0.146	208 (49.8)	205 (49.0)	0.04		0.962

		Unmatched (N=84,198)			Propensity Score Matched (N=836)				
		FBBH (N=473)	**Control (N=83,725)**		**FBBH (N=418)**	**Control (N=418)**			
	Large rural	121 (25.6)	18,873 (22.5)		113 (27.0)	111 (26.6)			
	Small rural	74 (15.6)	12,933 (15.5)		66 (15.8)	67 (16.0)			
	Isolated	40 (8.5)	5,822 (6.9)		31 (7.4)	35 (8.4)			
Type of insurance used in NICU	Medicaid	446 (94.3)	79,453 (94.9)	0.551	401 (95.9)	401 (95.9)	0.00	1.00	1.000
	Private	27 (5.7)	4,272 (5.1)		17 (4.1)	17 (4.1)			
Mother smoked during pregnancy	Yes	288 (61.3)	13,650 (16.3)	0.735	75 (17.9)	66 (15.8)	0.08		0.510
	No	102 (21.6)	18,780 (22.4)		251 (60.1)	267 (63.9)			
	Unknown	83 (17.6)	51,295 (61.3)		92 (22.0)	85 (20.3)			
Chromosome abnormality	Yes	19 (4.0)	184 (0.2)	**<0.001**	8 (2.0)	3 (0.7)	-0.08	2.63	0.130
	No	454 (96.0)	83,541 (99.8)		410 (98.1)	415 (99.3)			
Intraventricular hemorrhage	Yes	31 (6.5)	85 (0.1)	**<0.001**	29 (6.9)	24 (5.7)	-0.06	1.19	0.478
	No	442 (93.5)	83,640 (99.9)		389 (93.1)	394 (94.3)			
Respiratory disease	Yes	408 (86.3)	6,383 (7.6)	**<0.001**	363(86.8)	362 (86.6)	-0.03	0.95	0.919
	No	65 (13.7)	77,342 (92.4)		55 (13.2)	56 (13.4)			
Congenital heart disease	Yes	16 (3.4)	161 (0.2)	**<0.001**	15 (3.6)	8 (2.0)	-0.13	2.36	0.139
	No	479 (96.6)	83,564 (99.8)		403 (96.4)	410 (98.1)			
Convulsion	Yes	18 (3.8)	235 (0.3)	**<0.001**	14 (3.4)	10 (2.4)	-0.11	1.84	0.410
	No	455 (96.2)	83,490 (99.7)		404 (96.7)	408 (97.6)			
Gastrostomy tube	Yes	14 (3.0)	94 (0.1)	**<0.001**	10 (2.4)	10 (2.4)	0.00	1.00	1.000
	No	459 (97.0)	83,631 (99.9)		408 (97.6)	408 (97.6)			
Facility level of longest stay	4	125 (26.4)	1,318 (1.6)	**<0.001**	98 (23.4)	98 (23.4)	0.00		1.000
	3b	262 (55.4)	16,333 (19.5)		248 (59.3)	248 (59.3)			
	3a	57 (12.1)	16,741 (20.0)		45 (10.8)	45 (10.8)			
	other	29 (6.1)	49,333 (58.9)		27 (6.5)	27 (6.5)			

Notes: *Continuous variable P value based on t-test for continuous variables and chi-square for categorical variables. [1]Income quartiles compiled from median household income based on ZIP code of mother's residential address at time of delivery.

Abbreviations: RUCA = Rural-urban commuting area code; NICU = Neonatal Intensive Care Unit; SE = Standard error; PS = Propensity score; Std Diff = Standardized Difference; Var = Variance

Table B-3. Following Baby Back Home Treatment and Control Groups Background Characteristics, Pre- and Post-Propensity Score Matching - Year 2

		Unmatched (N=51,591)			Propensity Score Matched (N=620)				
		FBBH (N=310)	Control (N=51,241)		FBBH (N=310)	Control (N=310)			
Continuous variables	**Unit**	**Mean (SE)**	**Mean (SE)**	**P Value***	**Mean (SE)**	**Mean (SE)**	**Std Diff**	**Var Ratio**	**P Value***
Apgar score 5 minutes after birth	Score	6.5 (0.3)	8.6 (0.0)	**<0.001**	6.2 (0.1)	6.7 (0.5)	-0.09	0.09	0.352
Weight at birth	Grams	1,758 (48.1)	3,219 (2.5)	**<0.001**	1,730 (51.0)	1,746 (50.8)	-0.01	0.99	0.824
Estimated gestational age at birth	Weeks	31.3 (0.3)	38.4 (0.0)	**<0.001**	31.2 (0.3)	31.2 (0.3)	-0.02	1.01	0.924
Categorical variables	**Category**	**N (%)**	**N (%)**	**P Value***	**N (%)**	**N (%)**	**Std Diff**	**Var Ratio**	**P Value***
Gender	Male	197 (56.3)	26,312 (51.4)	0.066	177 (57.1)	177 (57.1)	0.00	1.00	1.000
	Female	153 (43.7)	24,929 (48.7)		133 (43.0)	133 (43.0)			
Race	White	181 (51.7)	31,179 (60.1)	**<0.001**	166 (53.6)	166 (53.6)	0.00		1.000
	Black	127 (36.3)	12,318 (24.0)		122 (39.4)	122 (39.4)			
	Hispanic	25 (7.1)	5,714 (11.2)		13 (4.2)	13 (4.2)			
	Others	17 (4.9)	2,030 (4.0)		9 (2.9)	9 (2.9)			
Mother marital indicator	Yes	82 (23.4)	15,064 (29.4)	0.007	68 (21.9)	68 (21.9)	0.03		0.981
	No	181 (51.7)	22,354 (43.6)		166 (53.6)	164 (52.9)			
	Unknown	87 (24.9)	13,823 (27.0)		76 (24.5)	78 (25.2)			
Income quartiles[1]	First	94 (26.9)	14,125 (27.6)	0.163	87 (28.1)	79 (25.5)	0.09		0.731
	Second	105 (30.0)	12,760 (25.0)		94 (30.3)	94 (30.3)			
	Third	79 (22.6)	12,903 (25.18)		67 (21.6)	78 (25.2)			
	Fourth	72 (20.6)	11,453 (22.4)		62 (20.0)	59 (19.0)			
NICU length of stay	< 5 days	12 (3.4)	44,018 (86.0)	**<0.001**	10 (3.2)	10 (3.2)	0.00		1.000
	5-< 10 days	13 (3.7)	3,584 (7.0)		12 (3.9)	12 (3.9)			
	10 -< 21 days	32 (9.1)	1,742 (3.4)		31 (10.0)	31 (10.0)			
	21 -< 47 days	111 (32.0)	1,090 (2.1)		104 (33.6)	104 (33.6)			
	47 =< 94 days	103 (29.4)	525 (1.0)		86 (27.7)	86 (27.7)			
	> 94 days	78 (22.4)	282 (0.6)		61 (20.2)	61 (20.2)			
RUCA	Urban	182 (52.0)	27,766 (54.2)	0.668	157 (50.7)	162 (52.3)	0.05		0.966

		Unmatched (N=51,591)			Propensity Score Matched (N=620)				
		FBBH (N=310)	Control (N=51,241)		FBBH (N=310)	Control (N=310)			
	Large rural	86 (24.6)	11,621 (22.7)		80 (25.8)	80 (25.8)			
	Small rural	53 (15.1)	8,166 (15.9)		49 (15.8)	45 (14.5)			
	Isolated	29 (8.3)	3,688 (7.2)		24 (7.7)	23 (7.4)			
Type of insurance used in NICU	Medicaid	329 (94.0)	48,671 (95.0)	0.400	295 (95.2)	295 (95.2)	0.00	1.00	1.000
	Private	21 (6.0)	2,570 (5.0)		15 (4.8)	15 (4.8)			
Mother smoked during pregnancy	Yes	54 (15.4)	7,713 (15.1)	0.890	48 (15.5)	45 (14.5)	0.03		0.929
	No	203 (58.0)	29,332 (57.2)		180 (58.1)	184 (59.3)			
	Unknown	93 (26.6)	14,196 (27.7)		82 (26.5)	81 (26.1)			
Chromosome abnormality	Yes	15 (4.3)	166 (0.3)	**<0.001**	5 (1.6)	7 (2.3)	0.04	0.72	0.560
	No	335 (95.7)	51,075 (99.7)		305 (98.4)	303 (97.7)			
Intraventricular hemorrhage	Yes	27 (7.7)	79 (0.2)	**<0.001**	24 (7.7)	15 (4.8)	-0.15	1.55	0.137
	No	323 (92.3)	51,162 (99.8)		286 (92.3)	295 (95.2)			
Respiratory disease	Yes	301 (86.0)	4,490 (8.8)	**<0.001**	267 (86.1)	268 (86.5)	0.01	1.02	0.907
	No	49 (14.0)	46,751 (91.2)		43 (13.9)	42 (13.6)			
Congenital heart disease	Yes	12 (3.4)	132 (0.3)	**<0.001**	10 (3.2)	10 (3.2)	0.00	1.00	1.000
	No	338 (96.6)	51,109 (99.7)		300 (96.8)	300 (96.8)			
Convulsion	Yes	12 (3.4)	167 (0.3)	**<0.001**	10 (3.2)	10 (3.2)	0.00	1.00	1.000
	No	338 (96.6)	51,074 (99.7)		300 (96.8)	300 (96.8)			
Gastrostomy tube	Yes	3 (0.9)	15 (0.0)	**<0.001**	1 (0.3)	0 (0.0)	-0.05		0.317
	No	347 (99.1)	51,226 (100.0)		309 (99.7)	310 (100.0)			
Facility level of longest stay	4	91 (26.0)	1,013 (1.98)	**<0.001**	74 (23.9)	74 (23.9)	0.00		1.000
	3b	199 (56.9)	10,002 (19.5)		187 (60.3)	187 (60.3)			
	3a	36 (10.3)	9,699 (18.9)		28 (9.0)	28 (9.0)			
	other	24 (6.9)	30,527 (59.6)		21 (6.8)	21 (6.8)			

Notes: *Continuous variable P value based on t-test for continuous variables and chi-square for categorical variables. [1] Income quartiles compiled from median household income based on ZIP code of mother's residential address at time of delivery.

Abbreviations: FBBH = FBBH Treatment; RUCA = Rural-urban commuting area code; NICU = Neonatal Intensive Care Unit; SE = Standard error; PS = Propensity score; Std Diff = Standardized Difference; Var = Variance

Table B-4. Following Baby Back Home Treatment and Control Groups Background Characteristics, Pre- and Post-Propensity Score Matching - Year 3

		Unmatched (N=40,437)			PS Matched (N=436)				
		FBBH (N=252)	Control (N=40,185)		FBBH (N=218)	Control (N=218)			
Continuous variables	**Unit**	**Mean (SE)**	**Mean (SE)**	**P Value***	**Mean (SE)**	**Mean (SE)**	**Std Diff**	**Var Ratio**	**P Value***
Apgar score 5 minutes after birth	Score	7.1 (0.5)	8.7 (0.0)	**<0.001**	7.1 (0.6)	7.0 (0.6)	0.01	0.98	0.934
Weight at birth	Grams	1,648 (52.8)	3,213(2.8)	**<0.001**	1,611 (54.8)	1,624 (55.1)	-0.02	0.99	0.862
Estimated gestational age at birth	Weeks	31.0 (0.29)	38.4 (0.0)	**<0.001**	30.7 (0.3)	30.8 (0.3)	-0.03	1.02	0.814
Categorical variables	**Category**	**N (%)**	**N (%)**	**P Value***	**N (%)**	**N (%)**	**Std Diff**	**Var Ratio**	**P Value***
Gender	Male	136 (54.0)	20,702 (51.5)	0.438	122 (56.0)	122 (56.0)	0.00	1.00	1.000
	Female	116 (46.0)	19,483 (48.5)		96 (44.0)	96 (44.0)			
Race	White	130 (51.6)	24,317 (60.5)	**<0.001**	116 (53.2)	116 (53.2)	0.00		1.000
	Black	96 (38.1)	10,152 (25.3)		88 (40.4)	88 (40.4)			
	Hispanic	17 (6.8)	4,259 (10.6)		11 (5.1)	11 (5.1)			
	Others	9 (3.6)	1,457 (3.6)		3 (1.4)	3 (1.4)			
Mother marital indicator	Yes	54 (21.4)	11,301 (28.1)	**0.041**	45 (20.6)	41 (18.8)	0.06		0.829
	No	126 (50)	17,502 (43.6)		113 (51.8)	119 (54.6)			
	Unknown	72 (28.6)	11,382 (28.3)		60 (27.5)	58 (26.6)			
Income quartiles[1]	First	70 (27.8)	11,429 (28.4)	**0.047**	64 (29.4)	60 (27.5)	0.08		0.933
	Second	81 (32.1)	10,061 (25.0)		66 (30.3)	66 (30.3)			
	Third	50 (19.8)	10,069 (25.1)		40 (18.4)	45 (20.6)			
	Fourth	51 (20.2)	8,626 (21.5)		48 (22.0)	47 (22)			
NICU length of stay	< 5 days	6 (2.4)	34,679 (86.3)	**<0.001**	5 (2.3)	5 (2.3)	0.00		1.000
	5-< 10 days	7 (2.8)	2,746 (6.8)		6 (2.8)	6 (2.8)			
	10 -< 21 days	25 (9.9)	1,353 (3.4)		22 (10.1)	22 (10.1)			
	21 -< 47 days	80 (31.8)	821 (2.04)		74 (33.9)	74 (33.9)			
	47 =< 94 days	74 (29.4)	391 (1.0)		65 (29.8)	65 (29.8)			

		Unmatched (N=40,437)			PS Matched (N=436)				
		FBBH (N=252)	**Control (N=40,185)**		**FBBH (N=218)**	**Control (N=218)**			
	> 94 days	60 (23.8)	195 (0.5)		46 (21.1)	46 (21.1)			
RUCA	Urban	129 (51.2)	21,749 (54.1)	0.791	109 (50.0)	121 (55.5)	0.12		0.574
	Large rural	60 (23.8)	9,058 (22.5)		55 (25.2)	49 (22.5)			
	Small rural	42 (16.7)	6,469 (16.1)		40 (18.4)	32 (14.7)			
	Isolated	21 (8.3)	2,909 (7.2)		14(6.4)	16 (7.3)			
Type of insurance used in NICU	Medicaid	235 (93.3)	38,072 (94.7)	0.292	208 (95.4)	208 (95.4)	0.00	1.00	1.000
	Private	17 (6.8)	2,113 (5.3)		10 (4.6)	10 (4.6)			
Mother smoked during pregnancy	Yes	28 (11.1)	5,901 (14.7)	0.270	27 (12.4)	25 (11.5)	0.02		0.918
	No	150 (59.5)	22,716 (56.5)		130 (59.6)	134 (61.5)			
	Unknown	74 (29.4)	11,568 (28.8)		61 (28.0)	59 (27.1)			
Chromosome abnormality	Yes	7 (2.8)	130 (0.3)	**<0.001**	6 (2.8)	7 (3.2)	0.04	0.86	0.778
	No	245 (97.2)	40,055 (99.7)		212 (97.3)	211 (96.8)			
Intraventricular hemorrhage	Yes	21 (8.3)	59 (0.2)	**<0.001**	18 (8.3)	10 (4.6)	-0.19	1.73	0.118
	No	231 (91.7)	40,126 (99.9)		200 (91.7)	208 (95.4)			
Respiratory disease	Yes	219 (86.9)	3,565 (8.9)	**<0.001**	194 (89.0)	196 (89.9)	0.03	1.08	0.755
	No	33 (13.1)	36,620 (91.1)		24 (11.0)	22 (10.1)			
Congenital heart disease	Yes	7 (2.8)	106 (0.3)	**<0.001**	4 (1.8)	2 (0.9)	-0.08	1.98	0.411
	No	245 (97.2)	40,079 (99.7)		214 (98.2)	216 (99.1)			
Convulsion	Yes	10 (4.0)	132 (0.3)	**<0.001**	7 (3.2)	7 (3.2)	0.00	1.00	1.000
	No	242 (96.0)	40,053 (99.7)		211 (96.8)	211 (96.8)			
Gastrostomy tube	Yes	0.0 (0.0)	6 (0.0)	0.846	0.0 (0.0)	0.0 (0.0)	0.00	0.00	1.000
	No	252 (100.0)	40,179 (100.0)		218 (100.0)	218 (100.0)			
Facility level of longest stay	4	66 (26.2)	774 (1.9)	**<0.001**	51 (23.4)	51 (23.4)	0.00		1.000
	3b	144 (57.1)	7,644 (19.0)		135 (61.9)	135 (61.9)			
	3a	26 (10.3)	7,297 (18.2)		18 (8.3)	18 (8.3)			
	other	16 (6.4)	24,470 (60.9)		14 (6.4)	14 (6.4)			

Notes: *Continuous variable P value based on t-test for continuous variables and chi-square for categorical variables. [1] Income quartiles compiled from median household income based on ZIP code of mother's residential address at time of delivery.

Abbreviations: FBBH = FBBH Treatment; RUCA = Rural-urban commuting area code; NICU = Neonatal Intensive Care Unit; SE = Standard error; PS = Propensity score; Std Diff = Standardized Difference; Var = Variance

Appendix C. Infant Mortality Sensitivity Analysis

Table C-1. Infant Mortality Sensitivity Analysis with Exact Match on Income

		PS Matched (N=888)			
		Control (N=444)	FBBH Treatment (N=444)		
		N (percent)	N (percent)	Adjusted odds ratio (CI)	P-Value
Death by Dec 31st 2018	Yes	16	4	4.47 (1.48-13.50)	**< 0.01**
	No	428	440		
Note: Reference = FBBH Treatment; Model adjustment was made by log(Dec31st2018 - child birthday); CI=Confidence Interval					

Appendix D. Health care Utilization and Child Outcomes by Child Age

Table D-1. Following Baby Back Home Treatment and Control Group Health Care Utilization and Child Health Measures Differences - Year 1

Measure	Treatment (N=418)	Control (N=418)	IRR/aOR	95% CI	P- Value*
Year 1 Health care Utilization					
Mean (StdErr) inpatient visits	0.59 (0.08)	0.25 (0.04)	2.68	**1.82-3.95**	**< 0.001**
Proportion (StdErr) with all-cause 30-day readmission per 100 inpatient stays	0.05 (0.01)	0.05 (0.02)	0.94	0.23-3.83	0.927
Mean (StdErr) length of stay in days for all hospitalizations	13.44 (2.94)	8.77 (1.7)	1.53	**1.07-2.20**	**0.021**
Rate (StdErr) of emergency department visits per year	1.65 (0.12)	0.96 (0.08)	1.81	**1.46-2.23**	**< 0.001**
Rate (StdErr) of non-urgent** evaluation and management of minor emergency department visits per year	0.92 (0.07)	0.49 (0.05)	1.92	**1.51-2.44**	**< 0.001**
Rate (StdErr) of wellness visit per year	13.46 (0.53)	8.78 (0.65)	1.59	**1.37-1.85**	**< 0.001**
Rate (StdErr) of outpatient non-wellness visits per year	1.86 (0.40)	1.01 (0.23)	1.81	**1.23-2.65**	**0.003**
Rate (StdErr) of filled pharmacy prescriptions per year	10.64 (0.53)	8.60 (0.42)	1.24	**1.08-1.43**	**0.002**
Year 1 Child Immunizations and Health Outcomes					
Mean (StdErr) of immunization visits	3.74 (0.09)	2.53 (0.11)	1.49	**1.35-1.65**	**<0.001**
Proportion (StdErr) with ≥ 4 immunization visits	0.61 (0.02)	0.39 (0.02)	2.37	**1.80-3.14**	**<0.001**
Mean (StdErr) episodes of injuries per year	0.12 (0.02)	0.06 (0.01)	2.00	**1.22-3.28**	**0.006**
Proportion (StdErr) of children with at least one episode of dehydration	0.10 (0.01)	0.06 (0.01)	1.82	**1.07-3.11**	**0.028**
Proportion (StdErr) of children with at least one episode of failure to thrive	0.05 (0.01)	0.03 (0.01)	1.79	0.87-3.69	0.115
Proportion (StdErr) of children with at least one episode of nutrition deficiency	0.04 (0.01)	0.01 (0.01)	2.56	0.98-6.66	0.055

Notes: *Continuous variable P value based on t-test for continuous variables and chi-square for categorical variables. **CPT code: 99281–99283 (ED visit for the E/M of a patient [Levels 1-3]) were used.
Abbreviations: IRR = Incidence rate ratio; aOR = Adjusted odds ratio; StdErr = Standardized error; PS = Propensity score; CI=Confidence Interval.

Table D-2. Following Baby Back Home Treatment and Control Group Health Care Utilization and Child Health Differences - Year 2

Outcomes	Treatment (N=310)	Control (N=310)	IRR/aOR	95% CI	P Value*
Year 2 Health care Utilization					
Mean (StdErr) inpatient visits	0.35 (0.07)	0.27 (0.06)	1.31	0.70-2.48	0.400
Proportion (StdErr) with all-cause 30-day readmission per 100 inpatient stays	0.06 (0.02)	0.11 (0.04)	0.52	0.10-2.71	0.431
Mean (StdErr) length of stay in days for all hospitalizations	10.62 (2.99)	15.08 (6.50)	0.79	0.43-1.45	0.441
Rate (StdErr) of emergency department visits per year	1.44 (0.12)	0.99 (0.11)	1.49	**1.15-1.93**	**0.003**
Rate (StdErr) of non-urgent** evaluation and management of minor emergency department visits per year	0.75 (0.07)	0.50 (0.06)	1.55	**1.15-2.09**	**0.004**
Rate (StdErr) of wellness visit per year	18.35 (1.63)	11.12 (1.34)	1.78	**1.40-2.26**	**<0.001**
Rate (StdErr) of outpatient non-wellness visits per year	3.03 (0.92)	0.80 (0.20)	3.80	**2.42-5.95**	**<0.001**
Rate (StdErr) of filled pharmacy prescriptions per year	13.47 (0.97)	11.80 (0.92)	1.15	0.95-1.40	0.149
Year 2 Health Outcomes					
Mean (StdErr) episodes of injuries per year	0.25 (0.03)	0.13 (0.02)	1.92	**1.31-2.82**	**<0.001**
Proportion (StdErr) of children with at least one episode of dehydration	0.07 (0.01)	0.06 (0.01)	1.17	0.62-2.22	0.627
Proportion (StdErr) of children with at least one episode of failure to thrive	0.02 (0.01)	0.01 (0.01)	1.51	0.42-5.41	0.527
Proportion (StdErr) of children with at least one episode of nutrition deficiency	0.02 (0.01)	0.02 (0.01)	1.00	0.35-2.89	1.000

Notes: *Continuous variable P value based on t-test for continuous variables and chi-square for categorical variables. **CPT code: 99281–99283 (ED visit for the E/M of a patient [Levels 1-3]) were used.

Abbreviations: IRR = Incidence rate ratio; aOR = Adjusted odds ratio; StdErr = Standardized error; PS = Propensity score; CI=Confidence Interval.

Table D-3. Following Baby Back Home Treatment and Control Group Health Care Utilization and Child Health Differences - Year 3

Outcomes	Treatment (N=218)	Control (N=218)	IRR/aOR	95% CI	P Value*
Year 3 Health Care Utilization					
Mean (StdErr) inpatient visits	0.11 (0.04)	0.09 (0.02)	1.27	0.57-2.83	0.553
Proportion (StdErr) with all-cause 30-day readmission per 100 inpatient stays	0.03 (0.03)	0.00 (0.00)	*	*	*
Mean (StdErr) length of stay in days for all hospitalizations	5.34 (1.45)	4.82 (0.61)	1.11	0.64-1.91	0.704
Rate (StdErr) of emergency department visits per year	0.89 (0.10)	0.68 (0.08)	1.30	0.95-1.78	0.103
Rate (StdErr) of non-urgent** evaluation and management of minor emergency department visits per year	0.45 (0.06)	0.41 (0.05)	1.09	0.75-1.58	0.648
Rate (StdErr) of wellness visit per year	18.16 (2.12)	11.68 (1.64)	1.73	**1.29-2.32**	**< 0.001**
Rate (StdErr) of outpatient non-wellness visits per year	3.82 (1.50)	1.27 (0.37)	3.00	**1.63-5.55**	**< 0.001**
Rate (StdErr) of filled pharmacy prescriptions per year	9.86 (0.84)	11.46 (1.07)	0.86	0.68-1.09	0.211
Year 3 Health Outcomes					
Mean (StdErr) episodes of injuries per year	0.19 (0.03)	0.16 (0.03)	1.23	0.76-2.02	0.397
Proportion (StdErr) of children with at least one episode of dehydration	0.04 (0.01)	0.02 (0.01)	1.83	0.60-5.58	0.285
Proportion (StdErr) of children with at least one episode of failure to thrive	<0.01 (<0.01)	0.00 (0.00)	*	*	*
Proportion (StdErr) of children with at least one episode of nutrition deficiency	0.01 (<0.01)	<0.01 (<0.01)	1.51	0.25-9.12	0.655

Notes: *Continuous variable P value based on t-test for continuous variables and chi-square for categorical variables. **CPT code: 99281–99283 (ED visit for the E/M of a patient [Levels 1-3]) were used.

Abbreviations: IRR = Incidence rate ratio; aOR = Adjusted odds ratio; StdErr = Standardized error; PS = Propensity score; CI=Confidence Interval.

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