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Enhanced Billing Leads to Positive Health Outcomes for Parents and Infants Receiving Medicaid: A Randomized Controlled Trial

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Research Article

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Abstract

Background

This study explored whether increases in spending to support home visiting services could help improve social determinants of health and subsequent health care utilization among families. It represents a rare opportunity to directly evaluate, via a randomized controlled trial, the impact of increased spending on outcomes for pregnant individuals and their infants.

Methods

A total of 59 home visiting agencies participated in the study, with half of the agencies randomized into a treatment group (n=31) and the rest into a control group (n=28). Home visitors in the treatment group agencies could bill for additional services for eligible “high risk” families while those in the control group agencies could only bill for the discharge visit for “high risk” families. Using survey and administrative data, random effects regression models were estimated to evaluate the effects of enhanced billing on the outcomes of interest.

Results

Results indicate that the enhanced billing intervention had positive effects on families’ economic security. Parents in the treatment group had fewer reports of going without essential utilities, more reports of contacting someone about a job if unemployed, and fewer reports of homelessness.

Subgroup analyses indicated that first-time parents and families receiving services from private agencies in the treatment group reported less food insecurity than their counterparts in the control group. First time parents in the treatment group reported more full-time employment, while families receiving services from private agencies reported more part-time employment and fewer experiences of domestic abuse compared to their counterparts in the control group.

The enhanced billing intervention also had significant health care utilization effects across subgroups. Black parents in the treatment group had more home visiting and postpartum visits. First time parents in the treatment group had more home visiting program visits, and families receiving services from private agencies had fewer prenatal visits compared to their counterparts in the control group. No significant intervention effects were detected on infants’ health care utilization.

Conclusions

Overall, study results demonstrate that allocating more funding towards home visiting services leads to better social determinants of health outcomes, especially economic stability, and for some subgroups, increases healthcare utilization.

Trial Registration

ClinicalTrials.gov. Trial Registration Number: NCT07817407. Retrospectively registered on 9/14/2026.

Keywords: Maternal and Infant Health; Social Determinants of Health; Home Visiting; Medicaid; Billing; Health Care Utilization

Declarations:

Human ethics approval and consent to participate. The study design, data collection, and data analysis for this study (HUM00195929) was reviewed by the University of Michigan's Institutional Review Board (IRB) and conducted in accordance with prevailing ethical principles. All survey respondents gave their informed consent prior to their inclusion in the study. The IRB approval contained a waiver of consent for participants in the administrative data. All experiments were performed in accordance with relevant guidelines and regulations (such as the Declaration of Helsinki).

Consent for publication. Not applicable.

Availability of data and materials. The authors are unable to share the data publicly due to the terms of their IRB and data sharing agreement with the state of Michigan.

Competing interests. The authors declare that they have no conflicts of interest (financial or other).

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Authors' contributions. ST conceived the study, oversaw the statistical analyses, and wrote the manuscript. RJ acquired the study funding, conceived the study, and assisted with writing the manuscript. Both authors read and approved the final manuscript.

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Open Science Framework Preregistration. The *Health Moms Healthy Babies Pilot Project* was registered on May 14th, 2021 with OSF. doi: 10.17605/OSF.IO/2BYX4. An amendment related to the analysis of administrative data was added in February 2026.

Among medical providers, researchers, and policy makers there is growing recognition that health outcomes, including maternal-infant health outcomes, are linked to social determinants of health (SDOH) [1,2,3]. SDOH encompass a broad range of non-medical factors relating to people's economic stability, access to and quality of education and health care, neighborhood and the built environment, and social and community context [4]. Their impact can be lifelong and multi-generational as evidenced by a robust body of research [3,5].

Studies have found relationships between adverse maternal and infant health outcomes and community-level social risk factors, such as neighborhood deprivation, residential segregation and rurality [6]. At a population level, U.S. adults and infants living in rural areas have lower life expectancies than their counterparts living in large metro areas [7]. Adults are more likely to experience poor health outcomes (e.g., cancer or diabetes diagnosis, psychological distress) if they are unemployed, have lower levels of education, or live below the poverty line [7,8]. SDOH, primarily by way of the parent, also affect infant health outcomes, and patterns of health inequalities are evident as well. For example, inadequate prenatal care is linked to an increase in infant mortality [9], and Black mothers are more likely to receive insufficient prenatal care and/or prenatal care that is lower quality than their White counterparts [10, 11]. Similarly, infants born to a parent who is experiencing domestic violence are at greater risk for infant mortality in part due to its high correlation with other contributors to infant mortality such as mental health conditions and drug and alcohol use [12, 13]. For these reasons, SDOH have been highlighted as an important nationwide health priority for the upcoming decade by the U.S. Department of Health and Human Services in their recent *Healthy People 2030* report [14].

Investing greater resources in public health and social programs that address SDOH is a potentially promising approach to remediating them. A wide research base demonstrates an association between state and local spending on public health and positive health outcomes, including decreased mortality [15, 16, 17] and decreased rates of health conditions such as obesity, asthma, and heart attacks [18]. These impacts are larger in areas with greater proportions of racial/ethnic minorities [17]. However, these studies all explore the relationship between spending on public health and population-level health outcomes, not SDOH, which may be important precursors to improved outcomes. Further, while several studies rigorously attempt to isolate the causal impact of spending on outcomes, none directly test whether a decision to increase spending on a public health program leads directly to improved outcomes for the families who participate. This paper describes analysis of a recent experiment in the state of Michigan that allowed for a direct causal exploration of the relation between increased spending on a maternal and infant home visiting program and outcomes, including both SDOH and health care utilization.

Background on home visiting programs

Maternal and infant home visiting programs are a widely used, evidence-based approach to addressing maternal and child health and well-being, including SDOH [19]. Home visitors (typically nurses or social workers) visit expectant parents or parents of young children in their home and provide a range of services to address family needs. Home visitors offer families information and support on healthy pregnancy and postpartum behaviors, safe sleep, breastfeeding, parent-child interactions, early learning, and developmental milestones. They also link families with unmet mental, social, economic, or other needs to community resources. Research demonstrates that home visiting can lead to a wide range of positive outcomes, including reductions in child maltreatment, increases in health care usage,

and increases in school readiness [20, 21, 22]. Some studies have also found positive impacts on family economic self-sufficiency including employment, education, and income [23, 24]. Given the strong research base supporting home visiting effectiveness, investing additional resources in home visiting programs could be a promising approach to improving both SDOH and maternal and child health. Moreover, the risk and protective factors experienced during important stages of life, like pregnancy and infancy, can significantly affect biological systems, resulting in diverse disease paths and health outcomes [25]. Stressful events occurring during pregnancy and early infancy are associated with an increased risk of heart disease and other illnesses for both the parent and child, however protective measures including public policies and intervention programs can play a positive role in buffering these adverse effects [5].

Objectives

This study explored whether increases in spending to support home visiting services could help improve SDOH and subsequent health care utilization among families. It represents a rare opportunity to directly evaluate, via a randomized controlled trial, the impact of increased spending on outcomes for pregnant individuals and their infants. The Maternal Infant Health Program (MIHP) is funded by the Michigan Department of Health and Human Services (MDHHS) and provides services for Medicaid-eligible pregnant individuals and infants. As Michigan's largest evidence-based home visiting program, MIHP's services are geared towards reducing maternal and infant mortality and morbidity though the intermediary goals of promoting healthy pregnancies, positive birth outcomes, and healthy infant growth and development. The current study was designed after several years of data collection from MIHP participants and MIHP providers about their satisfaction with program and barriers to receiving or delivering services.

This study investigates whether expanding the services that MIHP provider agencies can bill to MDHHS leads to a reduction in SDOH and better use of health care services by families who demonstrated high levels of need for basic services. It also explores whether there are differential impacts of the program on specific subgroups who are hypothesized to benefit most, including black families, first-time parents, and families receiving services from private agencies. We examined the effects of providing additional resources on parent and infant outcomes using both survey and administrative data. Specifically, the study focuses on the following research questions:

1. What are the impacts of additional resources on SDOH (economic stability, employment, housing, education, neighborhood and built environment, social and community context)?

2. What are the impacts of additional resources on utilization of health care services (prenatal visits, postpartum visits, well-child visits and emergency room visits) for families participating in MIHP?

3. What are the impacts of additional resources on SDOH and utilization of health care services for the following subgroups receiving MIHP services: black families, first time parents, and families receiving services from private agencies (relative to county health departments, FQHCs and hospital systems)?

Method

The *Healthy Moms, Healthy Babies* (HMHB) pilot study ran from June 2021 to December 31, 2023. Over 80 MIHP agencies were invited to join the study, and 59 agencies elected to participate. The 59 MIHP provider agencies were randomly assigned to be in the treatment (enhanced billing) or control group. This study (HUM00195929) was reviewed by the University of Michigan's Institutional Review Board and conducted in accordance with prevailing ethical principles.

Background on Michigan's Maternal Infant Health Program

Michigan's Maternal Infant Health Program (MIHP) provides services to Medicaid eligible pregnant individuals up to 60 days postpartum and infants up to 18 months of age. The statewide program utilizes licensed social workers, registered nurses, and lactation consultants who visit families in their homes to provide support. [26, 27]. The program is administered by approximately 80 independent agencies, who are reimbursed by the state for providing home visiting services. Agencies include county health departments, federally qualified health centers, hospital systems, and private providers.

Upon enrollment in the program, MIHP home visitors fill out a comprehensive assessment of health and social risk factors for each maternal and infant beneficiary. Domains in the assessment include health history, prenatal care, family planning, mental health, social support, substance use, intimate partner violence, and basic needs. The goal of the assessment is to understand the family's current situation and identify risk factors in each domain to develop a care plan that will guide the services the family receives in MIHP.

Approximately 40% of program participants are considered "high risk" based on the outcomes of this risk assessment. Maternal beneficiaries are deemed "high risk" if they indicate any one of the following: no prenatal care, alcohol/substance use during pregnancy, severe depression symptoms (Edinburgh Postnatal Depression Score >=13) [28], feeling unsafe in current relationship, homelessness, or serious nutrition issues (i.e., pica). In addition, infant beneficiaries are deemed "high risk" if the parent indicates any one of the following: preterm birth (<37 weeks gestational age), low birth weight (<2500g), no family doctor visit, infant safety issues (e.g., tobacco/alcohol/substance use in household, unsafe sleep, no car seat), or serious nutrition issues. While some beneficiaries are considered "high risk" because of health-related factors, others fall into the "high risk" category because they are experiencing a challenge related to SDOH.

Home visitors provide interventions, education, and/or referrals related to these risk factors during a series of home visits with the family. In addition to the in-home visits, MIHP provider agencies typically provide care coordination services and help families access additional community resources. However, MIHP provider agencies are typically only reimbursed by Medicaid for the face-to-face time they spend with a client. As a result, many agencies are either unable to provide this enhanced care coordination or provide it at substantial financial loss to their organization.

The Michigan Department of Health and Human Services (MDHHS) wanted to explore how MIHP provider agencies could better address SDOH for the families they serve. With funds from the Governor Whitmer's *Healthy Moms, Healthy* Babies (HMHB) initiative, they piloted a service enhancement program. [29]. The state of Michigan sought to enhance services and provide more resources for addressing families' diverse needs by allowing MIHP providers to bill for case management activities that occur outside the home (e.g., helping connect families with social programs related to food and

domestic violence), additional visits, and additional time spent with families in the home to address SDOH.

Recruitment and Sample Size Determination

We aimed to recruit approximately 50 MIHP providers to participate in the study, half of whom would be assigned to a treatment condition and half to a control condition. MIHP provider agencies were eligible for inclusion if they held an active MIHP certification and if they were not already participating in another ongoing evaluation of the MIHP program.

On average, we assumed (based on existing data at the time) that providers served an average of 245 maternal and infant beneficiaries each year, of whom 40% (n=98) would be considered "high risk" based on responses to the Maternal Risk Identifier (MRI) or Infant Risk Identifier (IRI). We assumed that approximately 75% of this caseload would be seen each month. With an average of 70 families (pregnant individuals and infants) per site per year, we estimated that we would have the power to detect impacts of 0.15 standard deviations on survey outcomes, assuming p=.10 and ICC=0.03.

Randomization and Intervention Description

We successfully recruited 59 agencies to participate. Half of these participating agencies (n=31) were randomized into a treatment group and the other half (n=28) were randomized to a control group by an analyst on the study team using a random number generator. The home visitors in the treatment group agencies had the opportunity to bill for additional services for eligible families who scored as "high risk" on either the Maternal Risk Identifier (MRI) or Infant Risk Identifier (IRI). The additional services included 1) an additional home visit; 2) a complex home visit with additional face-to-face time (30 additional minutes allowed for visits longer than 60 minutes in length); 3) care coordination (including phone calls or other activities to coordinate services that lasted more than 30 minutes); and 4) a discharge visit (billed at a higher rate than a typical visit and designed to develop a plan for transitioning the family out of MIHP services). As part of the evaluation, the discharge visit also included the completion of a brief survey [30].

Control group agencies were only able to bill for the typical services and a discharge visit for families deemed "high risk" on the MRI or IRI [29, 30]. Families served by control group agencies also completed a brief study survey at the discharge visit. Participants were essentially blind to the treatment—they were not told that they were eligible (or not eligible) for additional services, agency staff were simply allowed to bill for the provision of those additional services if and when they provided them.

Sample

As noted, 59 MIHP agencies participated in the study. See Table 1 for the background characteristics (type, size, and location) of the participating MIHP agencies in this study. Approximately 39% of agencies were large serving more than 120 "high risk" participants per year, and 31% served fewer than 45 "high risk" beneficiaries (defined as small). A little over half (56%) of agencies were run by private providers (56%), 31% were run by local health departments. A majority of agencies were located in Michigan's highly populated Southern Lower Peninsula. Note no statistically significant differences between the treatment and control groups on these agency characteristics were detected, thus indicating balance across groups.

The participant sample included "high risk" beneficiaries served by the study agencies. High risk was determined based on participant responses to the Maternal Risk Identifier (MRI) or Infant Risk Identifier (IRI), as described above.

Table 1. Background Characteristics of Participating MIHP Agencies

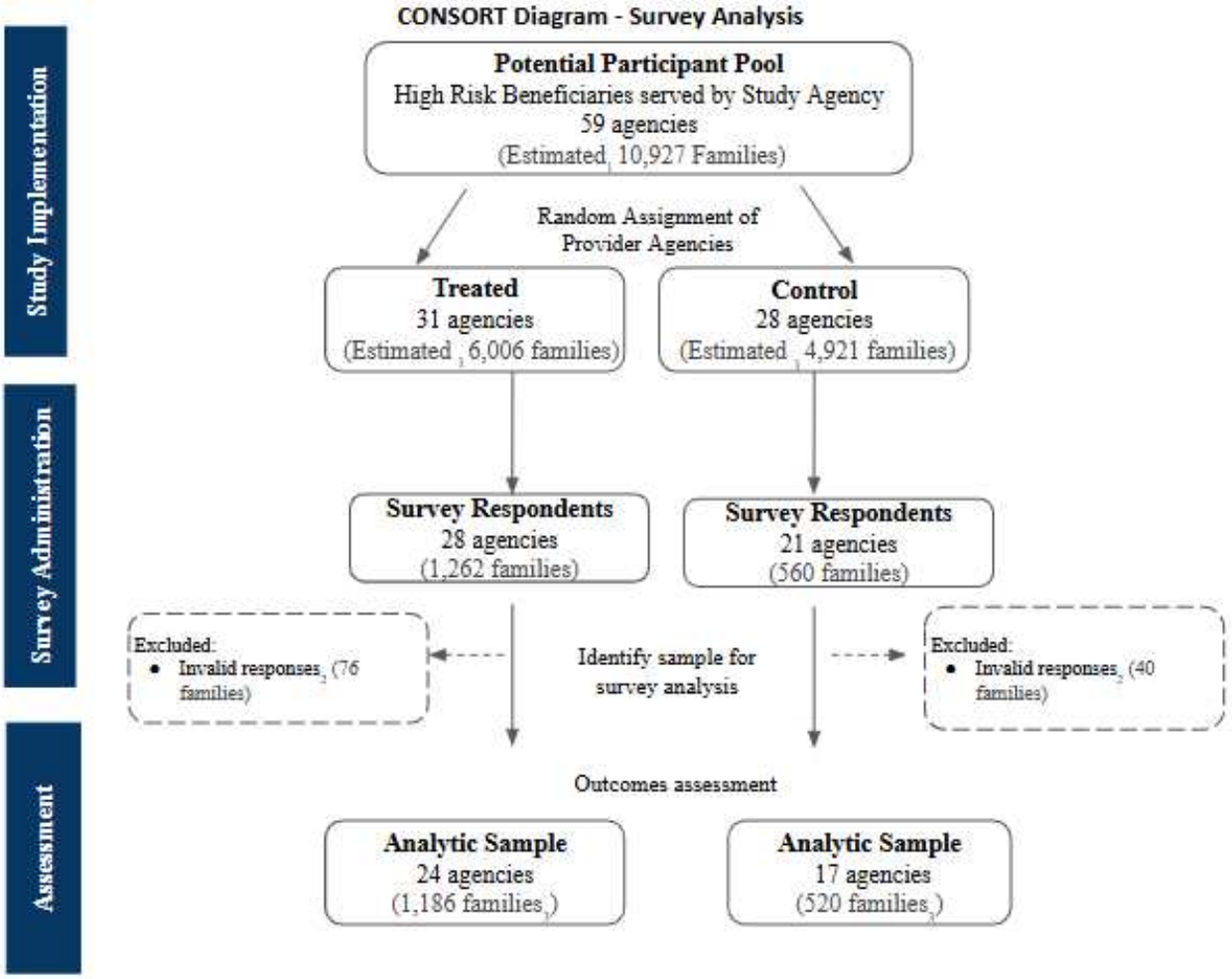
	Total		Control		Treatment		
	%	N	%	N	%	N	*p-value*
Agency Type							
Private Agency	56%	33	64%	18	48%	15	0.31
Health Care Organization Agency	8%	5	7%	2	10%	3	
Local Health Department Agency	31%	18	29%	8	32%	10	
Federally Qualified Health Center	5%	3	0%	0	10%	3	
Agency Size							
Small Agency	31%	18	29%	8	29%	9	0.68
Medium Agency	31%	18	29%	8	32%	10	
Large Agency	39%	23	43%	12	39%	12	
Agency Location							
Nothern Lower Peninsula	14%	8	11%	3	16%	5	0.94
Southern Lower Peninsula	81%	48	82%	23	81%	25	
Upper Peninsula	5%	3	7%	2	3%	1	
TOTAL	100%	59	47%	28	53%	31	

Note. Percentages may not add up to 100% due to rounding. P-value of group differences based on chi-square test.

Survey Sample.

The survey sample is drawn from the "high-risk" MIHP participants who completed a survey (see methods section for details) when they were discharged from the program. A total of 1,706 parent surveys were submitted (representing 24 treatment group agencies and 17 control group agencies). As shown in Figure 1, there was some attrition in the survey sample. Some surveys were considered invalid if the participant completed less than 60% of the survey or if the agency no longer participated in the project. Since the differential response rates between treatment and control families could potentially introduce bias into the results, we also decided to obtain administrative data on health care utilization, which was available for most participants in the trial.

Figure 1. CONSORT Diagram for Survey Analysis



Note 1. The numbers are estimated based on administrative records.
Note 2. Considered as invalid if the survey progress is less than 60% or if the agency no longer participated in the project as of October 2023
Note 3. The number of sample available for the analysis varies by outcome. See Table 4 for the maximum number of observations in the analytic sample.

Of the participants in the survey sample at baseline (See Table 2), approximately 47% identified as White, 29% identified as Black, 12% identified as multiracial, 5% identified as Hispanic and the remaining 7% identified as another race or ethnicity or declined to provide their racial background. Lastly, about 36% of the survey sample indicated this was their first pregnancy. No statistically significant differences between the treatment and control groups on these covariates were detected, thus indicating balance across groups.

Table 2. Descriptives of Covariates Pre-Imputation in the Survey Data

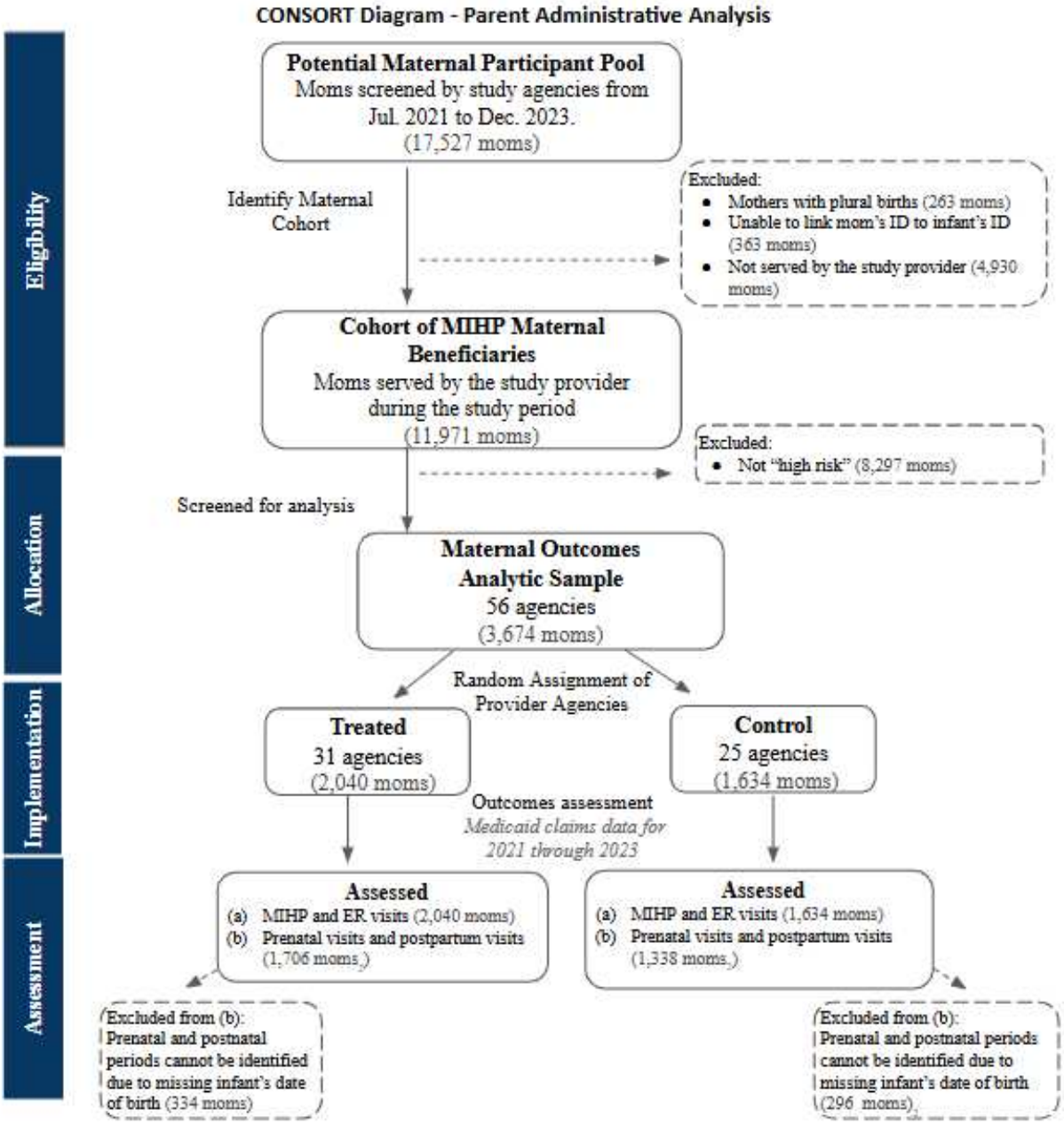
	Total			Control Group		Treatment Group		
	%	N	% Missing	%	N	%	N	*p-value*
Parent race: Black	29.46%	1636	4.10%	18.31%	497	36.32%	1139	0.89
Parent race: Hispanic	5.32%	1636	4.10%	2.82%	497	9.11%	1139	0.33
Parent race: White	46.64%	1636	4.10%	60.97%	497	36.73%	1139	0.90
Parent race: Multiracial	12.04%	1636	4.10%	13.48%	497	9.73%	1139	0.41
Parent race: Other	6.54%	1636	4.10%	4.43%	497	8.12%	1139	0.77
First Pregnancy	36.39%	1624	4.81%	36.36%	495	36.40%	1129	0.87

Note. P-value of group differences based on regressions. **p<0.10, **p<0.05, ***p<0.01*

Administrative Sample.

The administrative parent sample is drawn from the set of maternal MIHP beneficiaries that had been screened by a study agency during the study period (n=11,971). As shown in Figure 2, parents who did not score as "high risk" on the MRI were excluded from our analyses (n=8,297). In total, we had 3,674 unique parents (representing 31 treatment group agencies and 25 control group agencies) in our sample. Some parents were excluded from the analysis due to challenges with identifying pre- and post-natal periods due to missing data in the administrative records.

Figure 2. CONSORT Diagram for Administrative Parent Analysis



Note 1. Moms were included in the sample if they scored as "high risk" on the Maternal Risk Identifier (MRI).
Note 2. Analyses with imputed outcomes are provided in the Appendix.

Of the parents in the administrative sample at baseline (See Table 3), approximately 48% of the administrative sample identified as White, 41% identified as Black, 9% identified as Hispanic, and 2% identified as another race/ethnicity. About 49% of the sample indicated this was their first pregnancy, the mean age of the parent at screening was 27 years old, 18% of the sample was married, and 6% of the sample scored as a "high-risk" pregnancy based on the MRI. The treatment group in the administrative parent sample had a higher percentage of Hispanic parents than the control group (12% vs. 5%, $p = 0.02$).

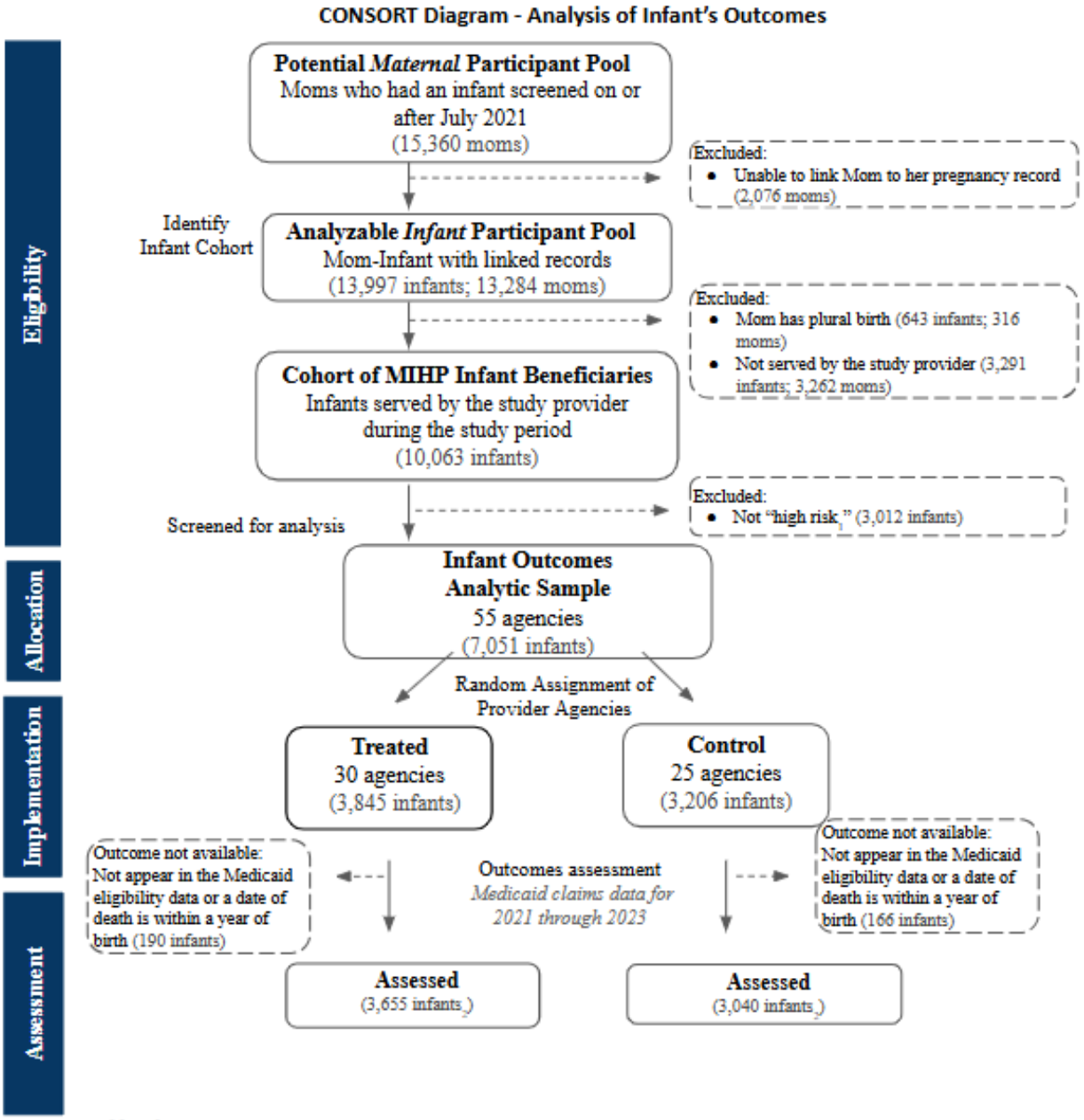
Table 3. Descriptives of Covariates Pre-Imputation in the Administrative Data

	Total				Control Group			Treatment Group			
	Mean/%	**SD**	**N**	**% Missing**	**Mean/%**	**SD**	**N**	**Mean/%**	**SD**	**N**	***p-value***
Parental Beneficiaries											
Parent race: Black	40.88%		3674	7.73%	40.96%		1634	40.82%		2040	0.92
Parent race: Hispanic	9.09%		3674	7.73%	5.27%		1634	12.11%		2040	0.02**
Parent race: White	47.61%		3674	7.73%	50.77%		1634	45.11%		2040	0.40
Parent race: Other	2.42%		3674	7.73%	3.00%		1634	1.96%		2040	0.22
First Pregnancy	48.53%		3674	17.39%	47.27%		1634	49.53%		2040	0.29
Parent age at screening	26.73	5.76	3674	5.44%	26.77	5.77	1634	26.71	5.75	2040	0.79
Married	17.87%		3674	45.48%	19.32%		1634	16.60%		2040	0.17
Pregnancy Health MRI High Risk Indicator	5.74%		3674	0.00%	3.79%		1634	7.30%		2040	0.61
Infant Beneficiaries											
Infant Race: Black	41.89%		5787	17.93%	43.49%		2610	40.57%		3177	0.60
Infant Race: Hispanic	10.07%		5787	17.93%	5.29%		2610	14.01%		3177	0.02**
Infant Race: White	45.84%		5787	17.93%	48.81%		2610	43.41%		3177	0.60
Infant Race: Other	2.19%		5787	17.93%	2.41%		2610	2.01%		3177	0.31
First Pregnancy	48.42%		7030	0.30%	46.23%		3199	50.25%		3831	0.07*
Parent age at screening	27.66	5.93	7051	0.00%	27.91	5.93	3206	27.46	5.92	3845	0.42
Married	25.59%		7051	0.00%	30.07%		3206	21.85%		3845	0.40
Pregnancy Health MRI High Risk Indicator	2.34%		3674	47.89%	0.66%		1823	4.00%		1851	0.05*

Note. P-value of group differences based on regressions clustered at the agency level. *p<0.10, **p<0.05, ***p<0.01

The administrative infant sample is based on all mothers who had an infant screened on or after July 1, 2021. Since the MIHP agency name was not included with the infant screener data received by the team, infants were linked to their MIHP provider using Medicaid claims data, which were filed by an MIHP provider for an infant intake. These claims were used to create an infant beneficiary- MIHP provider crosswalk. A maternal-infant crosswalk was also created to link all infant screeners to the correct infant beneficiary. An infant was considered to be the infant beneficiary attached to the infant screener if born to the mother whose beneficiary ID is connected to the infant screener and if the screener was completed between 30 days before or 480 days after the infant's birth date. Infants born as part of a plural birth were excluded from our sample. As shown in Figure 3, we identified 10,063 infants who had been screened and served by a study provider during our study period. Infants were excluded from the study if they did not score as "high risk" on the IRI. In total, we had 7,051 unique infants (representing 30 treatment group agencies and 25 control group agencies) in our sample. Infants were dropped from the study if they did not appear in the Medicaid eligibility data or a date of death was within a year of birth.

Figure 3. CONSORT Diagram for Administrative Infant Analysis



Note 1. Infants were included in the sample if they scored as "high risk" on the Infant Risk Identifier (MRI).
Note 2. Analyses with imputed outcomes are provided in the Appendix.

Of the administrative infant sample at baseline (see Table 3), approximately 46% of the infants identified as White, 42% identified as Black, 10% identified as Hispanic, and 2% identified as another race/ethnicity. About 48% of the sample was a first pregnancy, the mean age of the parent at screening was 28 years old, 26% of the sample was married, and 2% of the sample was born to a parent who scored as a "high-risk" pregnancy based on the MRI. In comparison to the control group, the treatment group in the administrative infant sample had a higher percentage of Hispanic infants than the control

group (14% vs. 5%, p = 0.02), first pregnancies (50% vs. 46%, p =0.07), and "high risk" pregnancies (4% vs. >1%. p = 0.05). (See Table 3).

Setting

All services were provided in the participants' homes or an agreed upon meeting location.

Data Sources and Measures

We used several sources of survey and administrative data to assess the outcomes of the HMHB pilot project. See Tables 4 and 5 for descriptives of the outcomes of interest from the survey and administrative data.

Table 4. Descriptives of Imputed Outcome Variables from the Survey Data (N=1706)

	Total			Control Group		Treatment Group		
	%	N	% Missing	%	N	%	N	*p-value*
Economic Stability								
Financial Insecurity	9.38%	1610	5.63%	11.36%	493	8.50%	1117	0.04**
Food Insecurity	12.87%	1616	5.28%	16.19%	494	11.41%	1122	0.16
Employment								
Employed Full-Time	23.03%	1611	5.57%	21.57%	496	23.68%	1115	0.77
Employed Part-Time	15.83%	1611	5.57%	17.34%	496	15.16%	1115	0.41
Unemployed & Contacted Someone about a Job	32.53%	249	5.63%	23.88%	67	35.71%	182	0.10
Unemployed & Applied to a Job Posting	47.39%	249	5.63%	44.78%	67	48.35%	182	0.92
Unemployed & Had a Job Interview	20.88%	249	5.63%	20.90%	67	20.88%	182	1.00
Housing								
Housing Satisfaction	19.72%	1592	6.68%	20.29%	483	19.48%	1109	0.79
Experiencing Homelessness (self-report)	4.75%	1601	6.15%	4.75%	484	4.74%	1117	1.00
Experiencing Homelessness (McKinney–Vento definition)	14.71%	1536	9.96%	16.23%	462	14.06%	1074	0.46
Education Access								
Enrolled in school	10.87%	1619	5.10%	10.57%	492	11.00%	1127	0.83
Neighborhood and Built Environment								
Access to Reliable Transportation	85.12%	1626	4.69%	86.90%	496	84.34%	1130	0.99
Social and Community Context								
Experiencing Domestic Abuse	8.66%	1594	6.57%	9.73%	483	8.19%	1111	0.39
Exhibit Symptoms of Depression	10.31%	1504	11.84%	10.31%	456	10.31%	1048	0.61
Exhibit Symptoms of Anxiety	16.71%	1490	12.66%	18.86%	456	15.76%	1034	0.16

Note. P-value of group differences based on regressions. **p<0.10, **p<0.05, ***p<0.01*

Table 5. Descriptives of Imputed Outcome Variables from the Administrative Data

	Total				Control Group			Treatment Group			
	Mean/%	SD	N	% Missing	Mean/%	SD	N	Mean/%	SD	N	*p-value*
Parent Outcomes (N=3674)											
Total MIHP visits	5.67	3.59	3674	0.00%	5.49	3.24	1634	5.81	3.85	2040	0.60
Total ER visits - parent	1.99	2.05	3674	0.00%	2.09	2.08	1634	1.91	2.02	2040	0.56
Total prenatal visits	0.40	0.55	3674	17.15%	0.39	0.55	1634	0.41	0.55	2040	0.47
Ever had a postpartum visit	85.91%		3674	17.15%	85.65%		1634	86.11%		2040	0.97
Infant Outcomes (N=7051)											
Total ER visits - infant	0.62	1.05	7051	5.05%	0.59	1.05	3206	0.64	1.06	3845	0.26
Total Well Child Visits	8.01	4.82	7051	5.05%	8.10	5.02	3206	7.94	4.64	3845	0.77

Note. P-value of group differences based on regressions clustered at the agency level. **p<0.10, **p<0.05, ***p<0.01*

Survey Measures.

YPL developed a survey to measure outcomes related to SDOH and MIHP services. This survey, which was administered to control and treatment group parents during their discharge visit, collected information on the family's background characteristics, social determinants of health, and experiences with the MIHP home visitor.

Economic Stability. Parents were asked about their economic stability across two questions, and two variables were created:

Financial Insecurity. Parents reported on their financial insecurity by answering the question "*In the past 30 days, have you gone without… (check all that apply) water; gas, oil or electricity; phone or internet; none of the above.*" A dichotomous variable was created to represent utility insecurity where a response of "none of the above" was as assigned a value of 0=not experiencing utility insecurity, and any other response was assigned as 1=experiencing utility insecurity. If no item was selected, the variable is set to missing.

Food Insecurity. Parents reported on their food insecurity by responding to the yes/no question, "*In the past 30 days, did you or other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?*" (1=yes; 0=no). If no item was selected, the variable is set to missing.

***Employment*.** Parents reported on their employment status by responding to two questions. In response to the question, "*Do you work outside the home (including telework or remote work)?*", parents had the option of selecting one of the following responses: "*Yes, employed full-time*", "*Yes, employed part-time*", "*I'm on leave or vacation*", "*I am temporarily laid off*", "*I am not employed but looking for work*", "*I am not employed and not looking for work*", "*I am retired*", or "*I am disabled and unable to work*". Unemployed parents were asked the question: "*If not employed and looking for work, please check all that apply. In the past 30 days, have you…looked at job postings; contacted someone about a job (an employment agency, employer, friend); applied to a job posting; had a job interview; posted a resume online or posted/updated information on a career networking website; other (please specify*), none of the above." Five variables were created:

Employed Full-Time: A dichotomous variable, equal to 1 if respondent indicated "Yes, employed full-time" and 0 otherwise. If no item was selected, the variable is set to missing.

Employed Part-Time: A dichotomous variable, equal to 1 if respondent indicated "Yes, employed part-time" and 0 otherwise. If no item was selected, the variable is set to missing.

Unemployed & Contacted Someone about a Job: For those who indicated they were not employed but looking for work, a dichotomous variable, equal to 1 if respondent indicated "Yes, contacted someone about a job" and 0 if respondent indicated "No". If no item was selected, the variable is set to missing.

Unemployed & Applied to a Job Posting: For those who indicated they were not employed but looking for work, a dichotomous variable, equal to 1 if respondent indicated "Yes, Applied to a Job Posting" and 0 if respondent indicated "No". If no item was selected, the variable is set to missing.

Unemployed & Had a Job Interview: A dichotomous variable, equal to 1 if respondent indicated "Yes" and 0 otherwise. If no item was selected, the variable is set to missing.

Housing. Parents were asked about their housing situation across three questions, and three variables were created:

Housing Satisfaction. A dichotomous variable was created, equal to 1 if respondent indicated "Yes" in response to the question "*Do you currently have any concerns or worries about your housing situation*" and 0 if respondent indicated "No". If no item was selected, the variable is set to missing.

Experiencing Homelessness (self-report). A dichotomous variable was created, equal to 1 if respondent indicated "Yes" in response to the question "*Are you homeless"* and 0 if respondent indicated "No". If no item was selected, the variable is set to missing.

Experiencing Homelessness (McKinney-Vento definition). A dichotomous variable was created to represent the McKinney-Vento measure of homelessness using parents' response to the question, "*In the past 30 days, have you lived… (check all that apply) in a home that you/your family rents (apartment, house, trailer, etc.); in a home that you/ your family owns; at someone else's home; at a hotel/motel; at a shelter; in a car, van, or other vehicle; outside (for example, in a tent); where I live changes frequently; other (please specify).*" Any response except y "*In a home that you/your family rents (apartment, house, trailer, etc.)*" or "*In a home that you/your family owns*", was calculated as 1 = experiencing homelessness according to the McKinney-Vento measure. A selection of either "*In a home that you/your family rents (apartment, house, trailer, etc.)*" or "*In a home that you/your family owns*", was calculated as 0 = not experiencing homelessness according to the McKinney-Vento measure. If no item was selected, the variable is set to missing.

Education Access. Parents reported on their access to education by responding to one question, "*Are you currently enrolled in school?*".

Enrolled in School. A dichotomous variable was created, equal to 1 if respondent answered "Yes" and 0 if "No". If no item was selected, the variable is set to missing.

Neighborhood and Built Environment. Families reported on their neighborhood environment by responding to one question, "*Do you have access to reliable transportation?*".

Reliable Transportation. A dichotomous variable was created, equal to 1 if respondent answered "Yes" and 0 if "No". If no item was selected, the variable is set to missing.

Social and Community Context. Parents reported on their relationships and social support across several items, and three variables were created:

Experiencing Domestic Abuse. Parents reported on their experience with domestic abuse in response to the question: "*In the past 30 days, has your partner or someone else in your life…(check all that apply), called you names, humiliated you, or made you feel that you don't count; kept you from seeing or talking to your family, friends, or other people?; forced you to have sexual activities; hit, kicked, slapped or otherwise physically hurt you; none of the above.*" A dichotomous variable was created, equal to 1 if respondent selected any response that did not include "*none of the above*" and 0if respondent selected "none of the above". If no item was selected, the variable is set to missing.

Symptoms of Depression. Parents answered questions from the Patient Health Questionnaire-2 (PHQ-2) [31], which is a pre-screener for having a depressive disorder. Parents responded to two items: "*In the past 2 weeks, how often have you been bothered by the following problems: little interest or pleasure in doing things; feeling down, depressed, or hopeless?*" on a 4-point scale (*0-Not at all, 1-Several days, 2-More than half the days, 3-Nearly every day*). A dichotomous

variable was created, equal to 1 if the parent scored a total of three or more points, which is the recommended cutoff for further diagnostic evaluation, and 0 if the parent scored less than three points. If no items were selected, the variable is set to missing.

Symptoms of Anxiety. Parents answered questions from the Generalized Anxiety Disorder-2 (GAD-2) [32], which is a pre-screener for having a generalized anxiety disorder. Parents responded to two items: "*In the past 2 weeks, how often have you been bothered by the following problems: feeling nervous, anxious or on edge; not being able to stop or control worrying?*" on a 4-point scale (*0-Not at all, 1-Several days, 2-More than half the days, 3-Nearly every day*). A dichotomous variable was created, equal to 1 if the parent scored a total of three or more points, which is the recommended cutoff for further diagnostic evaluation, and 0 if the parent scored less than three points. If no items were selected, the variable is set to missing.

Administrative Data and Outcome Measures.

The administrative data for this study came from multiple sources including Michigan's Medicaid claims data from the study period, January 2021 to December 2023, the Vital Records for Medicaid births from 2009 through 2023, and MIHP agency-reported data collected by MDHHS and the study team prior to study randomization. Due to some extreme and unlikely values, outliers in the administrative data were top coded to the 95th percentile. The following variables were explored:

Total MIHP Visits Parent had with Provider. A variable was created to represent the total number of MIHP visits a parent had with their provider using the Medicaid claims procedural codes: "96167","96168","H1000","H2000", "S9442", "S9443", "S9444", "T1023", "99402", "99600", "T2022", "96154", "H1004", "H1001", "99600", and "T2022". Claims that only had a transportation-related procedural code were not counted as a distinct MIHP visit. The variable was set to 0 if no claims were found.

Total ER Visits Parent. A variable was created to represent the total number of unique ER visits a parent had during the study period after their MIHP screening date using only revenue codes: "0455", "0456", "0457", and "0458". The variable was set to 0 if no claims were found. The operationalization of this variable mimics prior literature on ER utilization by pregnant persons on Medicaid [33].

Total Prenatal Visits. A variable was created to represent the total number of prenatal visits the parent had after their MIHP screening based on distinct claims to Medicaid with a prenatal diagnostic code ("Z34", "Z35", "Z36"), procedural code ("59400","59510","59610","59618","59425","59426"), and service date before the infant's date of birth. The variable was set to 0 if no claims were found.

Ever Had a Postpartum Visit. A dichotomous variable was created to represent whether the parent ever had a postpartum visit claim after their MIHP screening, equal to 1 if there was a claim using diagnosis code ("Z39"), procedural codes ("59400", "59510", "59610", "59618", "59430", "99394", "99395", "99396", "99397", "96161", "99202", "99203", "99204", "99205", "99211", "99212"), and service date after the infant's data of birth. The variable was set to 0 if no claims were found.

Total ER Visits Infant. A variable was created to represent the total number of unique ER visits an infant had during the study period using only revenue codes: "0455", "0456", "0457", and "0458". The variable was set to 0 if no claims were found. The operationalization of this variable mimics prior literature on ER utilization by pregnant persons on Medicaid [33].

Total Well Child Visits. A variable was created to represent the total number of unique well child visits a child had during the study period using diagnosis codes (“Z00110”, “Z00111”, “Z00121”, “Z00129”) and procedure codes ("99391","99461","99432","99394","99395","99393","99393","99382", "99383", "99384", “99385”, “99391”, “99202”. “99203”, “99204”, “99205” “99206”, “99207”, “99208”, “99209”,"99210","99211","99212","99213","99214","99215"). The variable was set to 0 if no claims were found. Any infant who did not appear in the Medicaid eligibility file or who had a date of death within a year of birth had all values related to well-child visits set to missing.

Covariate Measures.

The following variables were used as covariates and/or to explore heterogeneity in outcomes:

Parents’ Race/Ethnicity. In the survey analyses, parents’ race/ethnicity background was based on parents’ self-report in the survey (Black, Hispanic, White, Multiracial, Other). In the administrative analyses, parents’ race/ethnicity in the parent outcomes models and children’s race/ethnicity in the child outcomes models were drawn from Michigan’s Medicaid Claims data (Black, Hispanic, White, Other). Dichotomous 0/1 variables were created to represent each race/ethnicity group.

First Pregnancy. In the survey analyses, first pregnancy was based on parent response to the yes/no question, “*Is this your first pregnancy?*” (1=yes, 0=no). In the administrative analyses, a dichotomous variable representing first pregnancy was drawn from the Vital Records where 1=first birth in Michigan since 2009 and 0=not first birth in Michigan since 2009.

Parent Age. In the administrative analyses, parents’ date of birth was drawn from the Vital Records and converted to parents’ age at the time of infant’s birth.

Marital Status. In the administrative analyses, a dichotomous variable was created based on the MIHP Screener data collected from each MIHP agency (1=married, 0=single, divorced, or widowed).

“High-risk” Pregnancy. In the administrative analyses, the MIHP Maternal Risk Identifier (MRI) score in the MIHP agency-reported data was used to indicate a “high-risk” pregnancy (1=high-risk, 0=not high-risk).

Agency Factors. Information on agency size and type were drawn from MIHP agency-reported data. Dichotomous 0/1 variables were created to represent agency size (small, medium, large); and agency type (private, health care organization, local health department, federally qualified health center).

***Treatment*.** A dichotomous variable was created to indicate if the parent received services from an agency in the study’s treatment group, equal to 1 for treatment and 0 for control group.

Analytic Approach

To evaluate the effects of enhanced billing on parents’ SDOH and utilization of health care services, we estimated random effects regression models using the *xtreg, re* command in Stata 19 to account for the non-random residual distribution. We ran two main sets of analyses. The first set focused on the outcomes drawn from the survey data in which we controlled for parent’s race/ethnicity, first pregnancy, and agency size and type. In the second set we focused on the outcomes drawn from the administrative data in which we controlled for the same covariates as the first set of analyses plus parent age, high-risk pregnancy, and marital status. Since the intervention was targeted at parents who

scored as "high-risk" on the MRI, analyses were restricted to only the sample of parents and infants with "high-risk" MRI/IRI scores. We estimated the following random-effects regression model:

$$Y_{ij} = \alpha + \beta Treatment_j + \gamma COV_{ij} + \mu_j + \varepsilon_{ij}$$

where:

Y_{ij} = outcome for an individual *i* in agency *j*;

$Treatment_j$ is an indicator variable equal to 1 if the agency is in the treatment group and 0 otherwise;

COV_{ij} = vector of individual and agency covariates;

γ = vector of coefficients on the covariates;

β = estimated association between treatment and outcome;

μ_j = error term for individual *i*; and

ε_{ij} = random error term for individual *i* in agency *j*.

Subgroup Analyses.

For both sets of analyses, we ran separate regressions on the following subgroups of interest: Black, first-time parent, and independent agency. We selected these subgroups for several reasons. One of the goals of the HMHB initiative was to increase equity and reduce disparities in racial outcomes. Infant and maternal mortality among Black families is very high in Michigan. Since MIHP is meant to address the needs of the most vulnerable families in Michigan, we were particularly interested in seeing if this expanded billing intervention was helpful for Black families. We also wanted to investigate the effects of the intervention on first time parents because they make up a large proportion of MIHP participants [34]. Finally, we focused on the effects of the intervention on private agencies because compared to the other types of MIHP agencies, they often have the most difficulty making ends meet. MIHP agencies that are a part of health service or county health departments can cross-subsidize their resources in many ways whereas private agencies do not have this flexibility. As such, we wanted to see if the enhanced billing intervention had a particularly positive effect on private agencies.

All eligible participants with valid outcome data who were served by study agencies during the study period were included in the analyses.

Imputation

The amount of data missing on covariate and predictor variables was low (4-13%) in the survey data (see Tables 2 and 4) and moderate (0.3% to 48%) in the administrative data (see Tables 3 and 5). To address the missing data, we followed best practices for RCTs and only imputed missing predictors and covariate data [35, 36]. In the survey analyses, we used mean imputation to impute parent's first pregnancy and dummy imputed parents' race/ethnicity. In the administrative analyses, we used chained multiple imputations to impute missing data. In both sets of analyses, we included dichotomous variables in the model to indicate imputed variables. Finally, as a sensitivity analysis of our imputation

method, we imputed missing data on the outcome variables as well and results were similar (see Tables A1-A5 in the Appendix).

Results

Baseline Equivalence

The means, standard deviations, range, and percentage missing of the outcome variables in the survey and administrative data analyses are presented in Tables 4 and 5, respectively. In the survey data, a higher percentage of families indicated experiencing financial insecurity in the control group compared to the treatment group (11% vs. 9%, p = 0.04). No statistically significant differences between the treatment and control groups were detected in the administrative outcomes, thus indicating balance across groups.

Social Determinants of Health

Results from the analyses on the survey outcomes indicate that the enhanced billing intervention had positive effects on a variety of social determinants of health related to families' economic stability. In the full sample (see Table 6), parents in the treatment group had fewer reports of going without essential utilities (b=-0.07, se=0.03, p=0.01), more instances of contacting someone about a job if unemployed (b=0.15, se=0.07, p=0.03), and fewer instances of reported experiences of homelessness based on the McKinney-Vento measure (-0.05, se=0.02, p=0.04). No significant treatment effects were evident in any of the SDOH outcomes related to education, neighborhood and built environment, or social and community context.

Table 6. Survey Outcomes Adjusted for Covariates (N=1706)

	Control Group Mean from Unconditional Model	Treatment Coefficient from Conditional Model	St. Error on Treatment from Conditional Model	P-value of Treatment from Conditional Model	Observations
Economic Stability					
Financial Insecurity	0.16	-0.07	0.03	0.01***	1610
Food Insecurity	0.17	-0.05	0.03	0.16	1616
Employment					
Employed Full-Time	0.22	0.00	0.03	0.89	1611
Employed Part-Time	0.17	-0.01	0.03	0.71	1611
Unemployed & Contacted Someone about a Job	0.24	0.15	0.07	0.03**	249
Unemployed & Applied to a Job Posting	0.46	-0.01	0.09	0.89	249
Unemployed & Had a Job Interview	0.21	0.02	0.07	0.77	249
Housing					
Housing Satisfaction	0.20	-0.03	0.03	0.33	1592
Experiencing Homelessness (self-report)	0.05	-0.01	0.01	0.44	1601
Experiencing Homelessness (McKinney–Vento definition)	0.16	-0.05	0.02	0.04**	1536
Education Access					
Enrolled in School	0.11	0.00	0.02	0.99	1619
Neighborhood and Built Environment					
Access to Reliable Transportation	0.85	0.00	0.02	0.90	1626
Social and Community Context					
Experiencing Domestic Abuse	0.11	-0.02	0.03	0.37	1594
Exhibit Symptoms of Depression	0.11	0.01	0.01	0.72	1504
Exhibit Symptoms of Anxiety	0.19	-0.01	0.02	0.53	1490

*Note. Models based on imputed covariates. Covariate estimates not shown. *p<0.10, ** p<0.05, *** p<0.01*

In the subsample analyses (see Tables 7, 8, 9), Black families (b=-0.13, se=0.05, p=0.01), first-time parents (b=-0.09, se=0.04, p=0.01), and families receiving services from private agencies (b=-0.07, se=0.04, p=0.05) in the treatment group all had fewer reports of going without essential utilities compared to their counterparts in the control group. In addition, first-time parents (b=-0.11, se=0.04, p=0.01) and parents receiving services from private agencies (b=-0.09, se=0.05, p=0.05) in the treatment group reported less food insecurity compared to their counterparts in the control group. First-time parents in the treatment group also reported more full-time employment (b=0.09, se=0.03, p=0.01) than first-time parents in the control group. Families receiving services from private agencies reported more part-time employment (b=0.05, se=0.03, p=0.05) and fewer experiences of domestic abuse (b=-0.05, se=0.02, p=0.02) compared to their counterparts in the control group.

Table 7. Black, Non-Hispanic Subgroup Survey Outcomes Adjusted for Covariates (N=482)

	Control Group Mean from Unconditional Model	Treatment Coefficient from Conditional Model	St. Error on Treatment from Conditional Model	P-value of Treatment from Conditional Model	Observations
Subgroup: Black, Non-Hispanic Families					
Economic Stability					
Financial Insecurity	0.24	-0.13	0.05	0.01**	474
Food Insecurity	0.24	-0.05	0.07	0.46	475
Employment					
Employed Full-time	0.26	0.00	0.05	0.98	470
Employed Part-time	0.15	0.00	0.06	0.96	470
Unemployed & Contacted Someone about a Job	0.25	0.08	0.12	0.52	106
Unemployed & Applied to a Job Posting	0.53	-0.15	0.11	0.19	106
Unemployed & Had a Job Interview	0.30	-0.12	0.12	0.31	106
Housing					
Housing Satisfaction	0.26	0.05	0.04	0.26	468
Experiencing Homelessness (self-report)	0.05	0.01	0.03	0.70	471
Experiencing Homelessness (McKinney–Vento definition)	0.22	-0.06	0.04	0.20	445
Education Access					
Enrolled in school	0.08	0.05	0.04	0.25	475
Neighborhood and Built Environment					
Access to Reliable Transportation	0.72	0.04	0.05	0.47	477
Social and Community Context					
Experiencing Domestic Abuse	0.08	0.01	0.03	0.84	469
Exhibit Symptoms of Depression	0.10	0.04	0.05	0.43	420
Exhibit Symptoms of Anxiety	0.14	-0.02	0.04	0.64	419

*Note. Models based on imputed covariates. Covariate estimates not shown. *p<0.1, **p<0.05, ***p<0.01*

Table 8. First Time Parent Subgroup Survey Outcomes Adjusted for Covariates (N=591)

	Control Group Mean from Unconditional Model	Treatment Coefficient from Conditional Model	St. Error on Treatment from Conditional Model	P-value of Treatment from Conditional Model	Observations
Subgroup: First Time Parent					
Economic Stability					
Financial Insecurity	0.17	-0.09	0.04	0.01***	579
Food Insecurity	0.23	-0.11	0.04	0.01**	582
Employment					
Employed Full-time	0.17	0.09	0.03	0.01***	580
Employed Part-time	0.23	-0.08	0.05	0.11	580
Unemployed & Contacted Someone about a Job	0.16	0.13	0.13	0.30	91
Unemployed & Applied to a Job Posting	0.43	0.00	0.15	0.98	91
Unemployed & Had a Job Interview	0.27	-0.08	0.14	0.56	91
Housing					
Housing Satisfaction	0.13	0.01	0.03	0.68	571
Experiencing Homelessness (self-report)	0.05	0.00	0.02	0.84	576
Experiencing Homelessness (McKinney–Vento definition)	0.15	0.00	0.04	0.96	553
Education Access					
Enrolled in school	0.15	-0.01	0.05	0.87	588
Neighborhood and Built Environment					
Access to Reliable Transportation	0.83	0.03	0.04	0.35	589
Social and Community Context					
Experiencing Domestic Abuse	0.11	-0.01	0.03	0.66	571
Exhibit Symptoms of Depression	0.11	-0.02	0.04	0.70	552
Exhibit Symptoms of Anxiety	0.21	-0.05	0.05	0.35	548

*Note. Models based on imputed covariates. Covariate estimates not shown. *p<0.1, **p<0.05, ***p<0.01*

Table 9. Private Agency Subgroup Survey Outcomes Adjusted for Covariates (N=556)

	Control Group Mean from Unconditional Model	Treatment Coefficient from Conditional Model	St. Error on Treatment from Conditional Model	P-value of Treatment from Conditional Model	Observations
Subgroup: Private Agency					
Economic Stability					
Financial Insecurity	0.20	-0.07	0.04	0.05*	556
Food Insecurity	0.20	-0.09	0.05	0.05*	556
Employment					
Employed Full-time	0.24	-0.05	0.05	0.36	556
Employed Part-time	0.12	0.05	0.03	0.05**	556
Unemployed & Contacted Someone about a Job	0.29	0.02	0.07	0.74	145
Unemployed & Applied to a Job Posting	0.48	-0.08	0.08	0.30	145
Unemployed & Had a Job Interview	0.27	-0.05	0.07	0.45	145
Housing					
Housing Satisfaction	0.23	-0.02	0.04	0.51	556
Experiencing Homelessness (self-report)	0.07	-0.02	0.02	0.22	556
Experiencing Homelessness (McKinney–Vento definition)	0.19	-0.06	0.04	0.17	556
Education Access					
Enrolled in school	0.11	0.02	0.04	0.67	556
Neighborhood and Built Environment					
Access to Reliable Transportation	0.83	0.03	0.04	0.51	556
Social and Community Context					
Experiencing Domestic Abuse	0.11	-0.05	0.02	0.02**	556
Exhibit Symptoms of Depression	0.12	0.00	0.02	0.80	556
Exhibit Symptoms of Anxiety	0.21	-0.03	0.03	0.26	556

*Note. Models based on imputed covariates. Covariate estimates not shown. *p<0.1, **p<0.05, ***p<0.01*

Administrative Data

Results from the analyses on the administrative data (see Table 10) with the full sample indicated that the intervention had no significant effect on any of the parent or infant health care utilization outcomes. There were, however, significant treatment effects on parent outcomes across subsamples.

Table 10. Parent and Infant Administrative Outcomes Adjusted for Covariates

	Control Group Mean from Unconditional Model	Treatment Coefficient from Conditional Model	Standard Error of Treatment from Conditional Model	P-value of Treatment from Conditional Model	Observations
Parent (N=3674)					
Full Sample					
Total MIHP Visits	5.23	0.51	0.53	0.33	3674
Total ER Visits - parent	2.08	-0.07	0.11	0.52	3674
Total Prenatal Visits	0.37	-0.01	0.04	0.69	3044
Ever had a postpartum visit	0.86	0.00	0.01	0.79	3044
Subgroup: Black, Non-Hispanic					
Total MIHP Visits	4.80	1.25	0.64	0.05*	1386
Total ER Visits - parent	2.54	-0.18	0.20	0.37	1386
Total Prenatal Visits	0.30	0.02	0.05	0.63	1200
Ever had a postpartum visit	0.79	0.04	0.02	0.02**	1200
Subgroup: First Time Parent					
Total MIHP Visits	5.14	0.92	0.53	0.09*	1473
Total ER Visits - parent	1.92	0.03	0.15	0.86	1473
Total Prenatal Visits	0.34	0.06	0.05	0.23	1473
Ever had a postpartum visit	0.88	-0.01	0.02	0.83	1473
Subgroup: Private Agency					
Total MIHP Visits	5.41	0.77	0.79	0.33	1604
Total ER Visits - parent	2.10	0.15	0.12	0.19	1604
Total Prenatal Visits	0.34	-0.06	0.03	0.09*	1316
Ever had a postpartum visit	0.84	0.02	0.02	0.36	1316
Infant (N=6695)					
Full Sample					
Total ER Visits - infant	0.54	0.03	0.03	0.29	6695
Total well child visits	7.81	-0.01	0.24	0.96	6695
Subgroup: Black, Non-Hispanic					
Total ER Visits - infant	0.63	-0.02	0.06	0.75	2264
Total well child visits	6.81	-0.14	0.35	0.69	2264
Subgroup: First Time Parent					
Total ER Visits - infant	0.55	0.06	0.04	0.12	3230
Total well child visits	8.22	-0.13	0.26	0.60	3230
Subgroup: Private Agency					
Total ER Visits - infant	0.52	0.01	0.04	0.73	3205
Total well child visits	7.74	-0.02	0.21	0.94	3205

*Note. Models based on imputed covariates. Covariate estimates not shown. *p<0.10, **p<0.05, ***p<0.01*

Subsample analyses with Black families indicate that Black parents in the treatment group had more MIHP visits (b=1.25, se=0.64, p=0.05) and were more likely to have a postpartum visit (b=0.04, se=0.02, p=0.02) compared to Black parents in the control group. Subsample analyses of first-time parents indicated that those in the treatment group had more MIHP visits (b=0.92, se=0.53, p=0.09) than first-time parents in the control group, and subsample analyses of families receiving services from

private agencies indicated that parents had fewer prenatal visits (b=-0.06, se=0.03, p=0.09) compared to parents receiving services from other agency types. No significant treatment effects on ER visits or well child visits were detected for infants in any of the subsample analyses.

Discussion

This study used survey and administrative data to answer two research questions about the impact of additional resources on MIHP participants' social determinants of health and utilization of health services.

Regarding the first research question, study results indicate that the enhanced billing intervention had a positive impact on MIHP families' economic security. MIHP families in the enhanced billing group had fewer reports of going without utilities, more reports of contacting someone about a job if unemployed, and fewer reports of homelessness. The intervention, however, did not have an impact on any other SDOH measures (i.e., education, neighborhood and built environment, and social and community context) nor did it lead to an increase in healthcare utilization among families. It may be that intervention impacts were detected on only economic SDOHs because access to services like a foodbank can provide immediate relief to financial insecurity whereas services focused on other SDOH outcomes (e.g., changes in education) take more time to show impact. Consistent with this idea, research using longitudinal data has found that social expenditures led to stronger and better health outcomes when examined over a longer period [37]. Future research should investigate the impact of the additional resources on these outcomes longitudinally to understand how the intervention affected families' SDOH and healthcare utilization over time. Reasons that the intervention did not lead to more healthcare utilization for everyone may be related to access barriers that were not accounted for in the present study. Families on Medicaid have reported experiencing a variety of barriers to accessing healthcare services such as logistical and administrative constraints, limited provider availability, and discrimination [38, 39].

The enhanced billing intervention was particularly impactful for the families receiving MIHP services from the examined subgroups (Black, first-time parent, service from private agency). It led to both positive outcomes across several SDOH categories and changes to healthcare utilization. Echoing the results from the full sample, the enhanced billing intervention led to greater financial stability for all three subgroups. Although the intervention did not have any impact on the SDOH measures of education or neighborhood and built environment for families in any of the subgroups, it had an impact on families' social and community context. Specifically, the enhanced billing intervention led to fewer reports of domestic abuse among families receiving services from private agencies. A potential explanation for this finding is that private MIHP agencies with more funding may be better equipped to reduce domestic abuse because they are able to offer longer or more frequent home visits which may allow home visitors to recognize warning signs and build trust. Lending credence to this hypothesis is that the additional claims bills most frequently submitted by the agencies in this study's treatment group were for extended visit time (complex home visit) and care coordination [30].

With respect to healthcare utilization among the subgroups examined in this study, results indicate that the enhanced billing intervention had the strongest impact on Black families. Black parents in the treatment group had more MIHP visits with their provider and were more likely to have a postpartum visit. In analyses reported separately, researchers also found that Black families were more likely to rate their relationship quality with their home visitor as excellent [40] and to report high

satisfaction with the home visiting program meeting their needs [30]. Similarly, first time parents in the treatment group had more MIHP visits with their provider compared to their control group counterparts. These patterns indicate that the additional funding given to MIHP agencies was effective in helping agencies to provide additional support to families with more complex needs and who face broader challenges. Surprisingly, additional funding led to less healthcare utilization, specifically fewer prenatal visits, among families receiving services from private agencies. It is possible that these families in the intervention group felt that their questions and concerns were addressed by the home visitor within the additional time and visits afforded to them by the enhanced billing intervention and thus they did not want to spend additional time and effort to attend a separate prenatal visit. Another potential reason for fewer prenatal visits is that part of the study took place during the global COVID-19 pandemic, which may have deterred families from leaving the house for prenatal care. Families who received services from private agencies may have hesitated to leave the house for prenatal visits during the pandemic because private agencies are typically not affiliated with a hospital system or health department, typically have the fewest resources of all the agency types, and thus, may be less equipped to handle pandemic precautions.

Overall, the results from this study demonstrate that allocating more funding towards home visiting services leads to better SDOH outcomes, especially economic stability, and for some subgroups, increases healthcare utilization. This study corroborates research showing that increased spending on social services leads to better health outcomes [18, 41, 42]. Similar trends are evident among longitudinal studies of OECD countries that find that when spending on social services was higher than health spending, population-level health outcomes were better [18], and associated with improvements in quality of life [42]. Although the enhanced billing intervention did not lead to more healthcare utilization across all groups, it did lead to two vulnerable subgroups (Black families and first-time parents) receiving more support. Taken together, the results from this study highlight the importance of providing adequate funding to social services to support the health of vulnerable populations.

Study Limitations

This study should be considered in light of its limitations. One, the number of measures was uneven across SDOH categories. This study had several measures of economic security, but only one measure of other categories such as education access and quality, and neighborhood and built environment. It may be intervention impacts would have been detected if there were more measures of these SDOH categories. Two, study outcomes were measured soon after the intervention. Given prior research indicating that the impact of social spending on health outcomes may take time to appear, including measures of key outcomes at a later time may help detect intervention impacts. Three, the SDOH outcomes were based on families' self-report in a survey, which may have biased results. The study results could be strengthened by including non-self-reported measures of SDOH outcomes as well. Finally, it is possible that differential attrition between the treatment and control groups may have biased results as well.

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Appendix

Table A1. Imputed Survey Outcomes Adjusted for Covariates (N=1706)

	Control Group Mean from Unconditional Model	Treatment Coefficient from Conditional Model	St. Error on Treatment from Conditional Model	P-value of Treatment from Conditional Model	Observations
Economic Stability					
Financial Insecurity	0.15	-0.03	0.02	0.12	1706
Food Insecurity	0.17	-0.05	0.03	0.07*	1706
Employment					
Employed Full-Time	0.22	0.01	0.03	0.72	1706
Employed Part-Time	0.17	-0.01	0.03	0.78	1706
Unemployed & Contacted Someone about a Job	0.24	0.09	0.05	0.06*	345
Unemployed & Applied to a Job Posting	0.45	0.00	0.06	0.98	345
Unemployed & Had a Job Interview	0.21	0.01	0.05	0.85	345
Housing					
Housing Satisfaction	0.20	-0.02	0.02	0.38	1706
Experiencing Homelessness (self-report)	0.05	-0.01	0.01	0.43	1706
Experiencing Homelessness (McKinney–Vento definition)	0.16	-0.04	0.02	0.04**	1706
Education Access					
Enrolled in School	0.11	0.00	0.02	1.00	1706
Neighborhood and Built Environment					
Access to Reliable Transportation	0.85	-0.01	0.02	0.77	1706
Social and Community Context					
Experiencing Domestic Abuse	0.10	-0.02	0.01	0.11	1706
Exhibit Symptoms of Depression	0.10	0.00	0.01	0.87	1706
Exhibit Symptoms of Anxiety	0.19	-0.01	0.02	0.45	1706

*Note. Models based on imputed covariates and outcomes. Covariate estimates not shown. *p<0.10, ** p<0.05, *** p<0.01*

Table A2. Black, Non-Hispanic Subgroup Imputed Survey Outcomes Adjusted for Covariates (N=482)

	Control Group Mean from Unconditional Model	Treatment Coefficient from Conditional Model	St. Error on Treatment from Conditional Model	P-value of Treatment from Conditional Model	Observations
Subgroup: Black, Non-Hispanic Families					
Economic Stability					
Financial Insecurity	0.24	-0.13	0.05	0.01***	482
Food Insecurity	0.24	-0.06	0.07	0.41	482
Employment					
Employed Full-time	0.26	0.00	0.05	0.98	482
Employed Part-time	0.15	0.00	0.06	0.99	482
Unemployed & Contacted Someone about a Job	0.25	0.08	0.11	0.48	119
Unemployed & Applied to a Job Posting	0.52	-0.15	0.11	0.16	119
Unemployed & Had a Job Interview	0.29	-0.11	0.10	0.24	119
Housing					
Housing Satisfaction	0.26	0.05	0.04	0.28	482
Experiencing Homelessness (self-report)	0.05	0.01	0.03	0.64	482
Experiencing Homelessness (McKinney–Vento definition)	0.21	-0.05	0.04	0.24	482
Education Access					
Enrolled in school	0.08	0.05	0.04	0.28	482
Neighborhood and Built Environment					
Access to Reliable Transportation	0.72	0.04	0.05	0.48	482
Social and Community Context					
Experiencing Domestic Abuse	0.08	0.00	0.02	0.89	482
Exhibit Symptoms of Depression	0.10	0.03	0.04	0.44	482
Exhibit Symptoms of Anxiety	0.15	-0.02	0.03	0.50	482

*Note. Models based on imputed covariates and outcomes. Covariate estimates not shown. *p<0.1, **p<0.05, ***p<0.01*

Table A3. First Time Parent Subgroup Imputed Survey Outcomes Adjusted for Covariates (N=591)

	Control Group Mean from Unconditional Model	Treatment Coefficient from Conditional Model	St. Error on Treatment from Conditional Model	P-value of Treatment from Conditional Model	Observations
Subgroup: First Time Parent					
Economic Stability					
Financial Insecurity	0.17	-0.09	0.04	0.01***	591
Food Insecurity	0.23	-0.11	0.04	0.01**	591
Employment					
Employed Full-time	0.17	0.08	0.03	0.01***	591
Employed Part-time	0.23	-0.08	0.05	0.11	591
Unemployed & Contacted Someone about a Job	0.17	0.11	0.12	0.34	103
Unemployed & Applied to a Job Posting	0.44	0.02	0.14	0.89	103
Unemployed & Had a Job Interview	0.27	-0.07	0.13	0.60	103
Housing					
Housing Satisfaction	0.13	0.01	0.03	0.64	591
Experiencing Homelessness (self-report)	0.05	0.00	0.01	0.82	591
Experiencing Homelessness (McKinney–Vento definition)	0.15	0.00	0.04	0.97	591
Education Access					
Enrolled in school	0.15	-0.01	0.05	0.85	591
Neighborhood and Built Environment					
Access to Reliable Transportation	0.83	0.04	0.04	0.35	591
Social and Community Context					
Experiencing Domestic Abuse	0.10	-0.01	0.03	0.70	591
Exhibit Symptoms of Depression	0.11	-0.02	0.04	0.64	591
Exhibit Symptoms of Anxiety	0.21	-0.05	0.05	0.35	591

*Note. Models based on imputed covariates and outcomes. Covariate estimates not shown. *p<0.1, **p<0.05, ***p<0.01*

Table A4. Private Agency Subgroup Imputed Survey Outcomes Adjusted for Covariates (N=556)

	Control Group Mean from Unconditional Model	Treatment Coefficient from Conditional Model	St. Error on Treatment from Conditional Model	P-value of Treatment from Conditional Model	Observations
Subgroup: Private Agency					
Economic Stability					
Financial Insecurity	0.20	-0.08	0.04	0.05*	518
Food Insecurity	0.20	-0.10	0.05	0.06*	519
Employment					
Employed Full-time	0.24	-0.05	0.05	0.36	512
Employed Part-time	0.12	0.05	0.03	0.04**	512
Unemployed & Contacted Someone about a Job	0.30	0.03	0.12	0.80	100
Unemployed & Applied to a Job Posting	0.49	-0.13	0.10	0.19	100
Unemployed & Had a Job Interview	0.28	-0.07	0.09	0.43	100
Housing					
Housing Satisfaction	0.23	-0.03	0.04	0.49	505
Experiencing Homelessness (self-report)	0.07	-0.02	0.02	0.21	510
Experiencing Homelessness (McKinney–Vento definition)	0.20	-0.07	0.05	0.17	467
Education Access					
Enrolled in school	0.11	0.02	0.05	0.66	517
Neighborhood and Built Environment					
Access to Reliable Transportation	0.82	0.03	0.04	0.44	519
Social and Community Context					
Experiencing Domestic Abuse	0.15	-0.05	0.02	0.03**	505
Exhibit Symptoms of Depression	0.12	-0.01	0.02	0.74	463
Exhibit Symptoms of Anxiety	0.21	-0.04	0.04	0.36	460

*Note. Models based on imputed covariates and outcomes. Covariate estimates not shown. *p<0.1, **p<0.05, ***p<0.01*

Table A5. Parent and Infant Imputed Adminstrative Outcomes Adjusted for Covariates

	Control Group Mean from Unconditional Model	Treatment Coefficient from Conditional Model	St. Error on Treatment from Conditional Model	P-value of Treatment from Conditional Model	Observations
Parent (N=3674)					
Full Sample					
Total MIHP Visits	5.23	0.52	0.53	0.33	3674
Total ER Visits - parent	2.08	-0.07	0.11	0.51	3674
Total Prenatal Visits	0.37	-0.01	0.03	0.75	3674
Ever had a postpartum visit	0.86	0.01	0.01	0.66	3674
Subgroup: Black, Non-Hispanic					
Total MIHP Visits	4.80	1.26	0.64	0.05**	1386
Total ER Visits - parent	2.54	-0.18	0.20	0.39	1386
Total Prenatal Visits	0.30	0.03	0.05	0.58	1386
Ever had a postpartum visit	0.79	0.04	0.02	0.02**	1386
Subgroup: First Time Parent					
Total MIHP Visits	5.14	0.92	0.53	0.08*	1473
Total ER Visits - parent	1.92	0.03	0.15	0.86	1473
Total Prenatal Visits	0.34	0.06	0.05	0.24	1473
Ever had a postpartum visit	0.88	0.00	0.02	0.91	1473
Subgroup: Private Agency					
Total MIHP Visits	5.41	0.80	0.78	0.31	1604
Total ER Visits - parent	2.10	0.15	0.12	0.21	1604
Total Prenatal Visits	0.34	-0.04	0.03	0.21	1604
Ever had a postpartum visit	0.84	0.02	0.02	0.39	1604
Infant (N=7051)					
Full Sample					
Total ER Visits - infant	0.51	0.03	0.03	0.35	7051
Total Well Child Visits	7.75	0.02	0.22	0.93	7051
Subgroup: Black, Non-Hispanic					
Total ER Visits - infant	0.59	-0.04	0.06	0.55	2424
Total Well Child Visits	6.72	-0.11	0.31	0.73	2424
Subgroup: First Time Parent					
Total ER Visits - infant	0.54	0.04	0.04	0.26	3404
Total Well Child Visits	8.16	-0.11	0.23	0.63	3404
Subgroup: Private Agency					
Total ER Visits - infant	0.49	0.02	0.04	0.58	3380
Total Well Child Visits	7.68	0.01	0.20	0.97	3380

*Note. Models based on imputed covariates and outcomes. Covariate estimates not shown. *p<0.10, **p<0.05, ***p<0.01*