

The Impact of Intensive Nurse Home Visiting on Pregnancy and Postpartum Mental Health for Low-Income First-Time Mothers [‡]

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Abstract

Perinatal depression affects a quarter of low-income women, and Black mothers experience lower rates of screening and treatment. We evaluate the impact of the Nurse Family Partnership (NFP) on mental health outcomes using a large-scale RCT. NFP had no statistically significant impacts on mental health diagnoses and treatment for the full sample. However, White treatment mothers were more likely to receive medication, and Black treatment mothers less likely, relative to their respective control groups. While Black mothers were more likely to present with depressive symptoms at baseline, they had lower diagnosis, screening, and referral rates by NFP.

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1 Introduction

Depression during pregnancy or the postpartum period affects many women - 17% of mothers experience antenatal depression and 13% of mothers experience postpartum depression (Dagher et al., 2021). Maternal depression rates are higher among disadvantaged groups; postpartum depression affects approximately one in four low-income women (Kozhimannil and Kim, 2014) and Black women (Getahun et al., 2023). Maternal depression can have potentially severe consequences for the mother and infant. Maternal depression left untreated can increase the risk of suicide, substance abuse, and missed prenatal or postnatal health care appointments for the mother and for the child increases the risk of adverse health outcomes (Casey et al., 2004; Perry, 2008), child development issues (Deave et al., 2008), and child behavioural problems (Frank and Meara, 2009). Moreover, the consequences of maternal depression are increasingly recognised by policymakers (Kim, 2024) as potential drivers of racial and economic inequalities in maternal and infant health (Kennedy-Moulton et al., 2022; Case et al., 2002).

Many low-income parents experiencing depression never receive a diagnosis. The U.S. Preventive Services Task Force (USPSTF) recommends screening for depression for all adults, including pregnant and postpartum women, as well as having systems in place such that individuals can receive sufficient follow-up and treatment if needed (O'Connor et al., 2019). Specifically for mothers, the USPSTF recommends counseling intervention for mothers who are at increased risk of perinatal depression (United States Preventive Services Task Force, 2019). Even when perinatal depression is identified during pregnancy or postpartum, many who are diagnosed never receive any treatment (Huang et al., 2007). Further, racial disparities exist. Black women are less likely to be screened relative to White women (Sidebottom et al., 2021), have lower health care utilisation (Song et al., 2004), and are less likely to receive treatment (Kozhimannil et al., 2011).

Policymakers have invested in interventions targeting low-income mothers to try to address health inequalities. Pregnancy and early childhood interventions, in particular, have been shown to have positive effects on health, education, and earnings throughout the life course (e.g. Conti et al. (2016); Campbell et al. (2014)). This paper explores the effects of one such intervention: intensive nurse home visiting. We look at the impact of intensive nurse

home visiting on perinatal mental health outcomes for a low-income, Medicaid eligible population. Intensive home visiting programmes are designed to develop a long-term relationship between a home visitor and a pregnant person during the transition to parenthood. They have the potential to reduce anxiety and stress in the perinatal period by providing mothers with support, advice, and reassurance. Intensive nurse home visiting programmes may also increase the identification and treatment of depression and anxiety during pregnancy and postpartum. For example, these programmes often feature regular mental health screens. Furthermore, home visiting programmes often seek to support new mothers with challenges that are closely linked with maternal mental health, including substance abuse and conflict between partners.

Evidence on the impacts of intensive nurse home visiting on diagnosis, treatment, and occurrence of mental health conditions is somewhat mixed. There is some evidence that nurse home visiting can have a positive effect on reducing depressive symptoms and use of psycholeptics ([Sandner et al., 2018](#); [Michalopoulos et al., 2019](#)), but most studies have found no significant effects of nurse home visiting on maternal depression outcomes ([Jacobs et al., 2015](#); [Olds et al., 2004b](#)). Similarly, the existing literature on the impacts of home visiting on substance use and domestic violence is inconclusive. Few U.S. trials of NFP have found any treatment effects on substance use and domestic abuse ([Olds et al., 2019, 2004a,b](#)). Canadian and Dutch trials of NFP found reductions in prenatal smoking ([Mejdoubi et al., 2014](#); [Catherine et al., 2020](#)), and physical assault rates ([Mejdoubi et al., 2013](#)). Little is known about how intensive nurse home visiting programmes address racial inequities in mental health, and the programmes have not historically been designed to serve this aim.

For people with mental health conditions, there may be challenges in implementing intensive home visiting programmes as designed. Mothers suffering from depression and anxiety may struggle to engage with these intensive programmes and have been found to exit home visiting programmes if they lack access to outside mental health services ([Molina et al., 2020](#)). The programmes cannot be implemented without nurses having consistent and prolonged access to mothers in their homes ([Duggan et al., 2018](#)). A survey of NFP nurses also reveals that nurses report lacking confidence in evaluating mothers' mental health and meeting their needs ([Beeber et al., 2022](#)).

In this paper, we evaluate the effects of an intensive nurse home visiting programme on maternal mental health diagnoses and treatment, and substance use and domestic violence, leveraging a large-scale randomised controlled trial of the Nurse-Family Partnership (NFP) in South Carolina that enrolled between 2016 and 2020, and followed outcomes through 2022. We look at outcomes during pregnancy and up to sixty days postpartum using multiple linked datasets (including administrative records): survey data collected from mothers at baseline, NFP programme data, vital records data, Medicaid claims and hospital discharge data, and South Carolina Department of Mental Health data. We find that NFP has no statistically significant impact on mental health diagnoses and treatment, nor on substance use or experiences of violence. However, heterogeneity analysis reveals differences in the impact of the programme on depression medication by race. Non-Hispanic Black mothers assigned to NFP were less likely to receive medication than their counterparts in the control group, by 3 percentage points (95% confidence interval: -5.02, -0.36). In contrast, non-Hispanic White mothers assigned to NFP were more likely to receive medication than control mothers, by 4 percentage points (95% confidence interval: 0.17, 8.53). These effects are on top of existing racial differences - 24% of non-Hispanic Black control mothers had a mental health diagnosis, in comparison to 43% of non-Hispanic White control mothers. 21% of White control mothers had some medication for mental health, relative to 10% of Black control mothers. We explore potential drivers of this finding with descriptive analyses of baseline characteristics, NFP visits, and mental health screening and referrals across Black and White mothers. Baseline prevalence of mental health conditions cannot explain our findings as our sample of Black mothers were more likely to present with depressive symptoms at intake (21% vs. 17%). While Black mothers had fewer NFP visits than White mothers, consistent with the prior literature (O'Brien et al., 2012), differences in engagement with the programme are small and unlikely to fully explain the disparate treatment effects. Screening and referrals may play a role; Black mothers participating in NFP were less likely to be screened at recommended intervals and referred to mental health services by NFP nurses.

The paper proceeds as follows. Section 2 provides background on the Nurse Family Partnership. We discuss methods in Section 3, then present our empirical results in Section 4. Section 5 provides a discussion and concludes.

2 Nurse-Family Partnership

NFP is an established home-visiting programme for low-income, first-time mothers and their families. The original trials evaluating NFP took place between the 1970s and 1990s (Olds, 2006), with families enrolled in these trials being followed across many decades (Eckenrode et al., 2017; Conti et al., 2024; Olds et al., 2019). Evidence from these early trials motivated the scale-up of NFP to forty US states and eight countries with millions of dollars in U.S. federal funding through the Maternal, Infant, and Early Childhood Home Visiting (MIECHV) programme.

As part of the NFP programme, registered nurses visit families in their homes every other week during pregnancy and every month for up to two years following birth. Visits last between sixty to ninety minutes, and take place weekly for the first four weeks after enrolment and then fortnightly until the birth. This totals up to 40 home visits - up to 15 visits during the prenatal period, up to 8 visits in the postpartum period through to 60 days post delivery, and up to 9 visits in the remaining period until the child is 24 months. The visit cadence can be adjusted depending on mothers' needs, and families can choose to exit the programme anytime. NFP nurses use methods such as motivational interviewing, goal-setting, and educational tools to provide the most value to the mothers they see. The nurses routinely assess physical and mental health, and can make referrals to health and social services. Mothers could view nurses as a substitute for some forms of routine healthcare, although previous results from the trial have indicated limited differences in routine prenatal or postpartum care across treatment and control groups (Gourevitch et al. (2023); Rokicki et al. (2024)). Nurses are mandated reporters of child abuse and neglect. The NFP nurses tailor their visits and visit content to the clients' needs and preferences, while also building in specific programme requirements. For example, nurses must screen mothers for depression and anxiety at pre-specified intervals (36 weeks pregnant, 1-8 weeks postpartum, 4-6 months postpartum, and 12 months postpartum) and follow protocols for referral and care coordination for mothers who screen positive. Screening is also recommended at intake, or within the first few visits. Additional screening is encouraged, as needed. The recommended screening tools are the Patient Health Questionnaire-9 (PHQ-9) for depression, and the Generalised Anxiety Disorder (GAD-7) form for anxiety. The results of these screens are recorded

in the programme’s database, along with any referrals made. Nurses can make referrals for mental health services by calling a community provider and requesting services, or can support mothers in connecting to providers themselves. Screening provided by NFP nurses that suggests depression or anxiety is not considered a clinical diagnosis of depression, and is not a substitute for a complete mental health assessment and clinical judgement. In addition, NFP nurses are not gatekeepers of mental health diagnosis and treatment. Mothers can directly seek out diagnosis and treatment from healthcare providers. With regards to substance use, nurses attempt to identify mothers who are currently smoking, drinking alcohol, and/or using illicit substances given the risks that these behaviours pose for infant health, and encourage cessation of such activities. Nurses can also provide resources for cessation, such as information on hotlines, and refer mothers to healthcare providers. In addition, nurses have a unique opportunity to identify cases of intimate partner violence given that visits typically occur in the home and nurses’ ability to build a relationship with mothers throughout pregnancy and postpartum. Nurses should complete a clinical intimate partner violence (IPV) assessment during pregnancy, between the 5th and 7th visit. If the mother is diagnosed with IPV at this first assessment, or if the mother is engaging with a new partner, or re-engaging with a former abusive partner, their nurse should complete the assessment again at the 12 weeks postpartum visit. Nurses should repeat the assessment 13 to 18 months post birth. At any point, nurses can delay this assessment to ensure the mother’s privacy and safety. If nurses identify a mother as being at risk, they can refer the mother to healthcare providers and locally available services. These services are likely to differ substantially across NFP sites, resulting in varying support for mothers experiencing domestic violence.

The South Carolina NFP trial was delivered through the South Carolina Department of Health and Human Services (SCDHHS) with initial funding via a Medicaid 1915(b) waiver and philanthropists. The programme was financed through a Pay for Success model, so that later funding was delivered by SCDHHS if evaluation of the trial found impact estimates that exceeded pre-specified thresholds. ¹ NFP was well-established in South Carolina, as it had operated in the state since 2009. This means that referral pathways

¹More detail on the Pay for Success model can be found in the study protocol ([McConnell et al., 2020](#)).

were already embedded prior to the trial. The trial was implemented by nine agencies, each serving their own catchment area, within the state. Both rural and urban areas were covered by the programme during the trial. Prior to the RCT, NFP served 500 to 600 mothers annually in South Carolina. The trial increased this number to 1200 mothers annually, with a respective increase in staffing.

Prior work from the South Carolina trial found that NFP had no significant effects on birth or neonatal outcomes (McConnell et al., 2022), prenatal care (Gourevitch et al., 2023), postpartum care (Rokicki et al., 2024) or birth spacing and the take-up of contraception (Steenland et al., 2024). Child health and social service utilisation outcomes are being explored in other forthcoming manuscripts.

3 Methods

3.1 Study design

We conducted an individually randomised clinical trial of NFP in South Carolina (Baicker et al., 2021). Trained NFP staff members ran trial enrolment. Potential study participants were identified by the South Carolina Department of Health and Human Services based on the Medicaid eligibility database. Others were recommended via referring partners (e.g. local health care providers, schools, WIC agencies), or by a family member or friend. Individuals could also self-refer. Following referral, eligibility had to be determined. Individuals were eligible if they were currently pregnant (with gestation period of less than 28 weeks), had no previous live births, were income-eligible for Medicaid during pregnancy, were at least 15 years old, lived in the NFP catchment area, were not incarcerated or living in a lockdown facility, and had sufficient language fluency to benefit from the programme. Study participants then completed a baseline survey. Following this, study participants were randomised into the treatment group, with access to the NFP programme, or the control group. Two-thirds of mothers were randomised to the treatment group, and a third to the control group. The control group had access to regular care available in South Carolina, including community and medical services. Mothers in the control group may have received services during pregnancy that mirror some of what NFP offers. For example, the Healthy Families America, Healthy Steps

and Parents as Teachers programmes. Most of these programmes enrol after pregnancy, and operate at a much smaller scale than NFP during the study period. Further, mothers enrolled in Medicaid have access to two postpartum home visits up to six weeks after delivery. These home visits includes a medical assessment of the mother and infant, an assessment of barriers to health, counselling on postpartum recovery, family planning, information on the needs of a newborn, and assistance with establishing a primary source of care for the mother and infant. Only 11% of control group participants received at least one of these visits, while 6% of NFP intervention participants received at least one of these visits (Rokicki et al., 2024). All participants were given a list of available community resources for first time, low-income mothers. Most home visits took place in the client’s home, but there were disruptions caused by the COVID-19 pandemic. South Carolina restricted public gatherings on March 23rd 2020, and following this date, 93% of home visits were via telehealth. 88% of mothers concluded their pregnancy prior to the start of the COVID-19 pandemic, and 84% of mothers concluded their 60 day postpartum period prior to the start of the pandemic. The nurses spoke English or Spanish, and translation services were available for mothers who spoke another language. The nurses in our trial had a mean caseload of 14.35 mothers per month, and a median monthly caseload of 12.72 mothers. More details on the trial are available in the published study protocol (McConnell et al., 2020).

3.2 Data

We combine several rich administrative datasets to evaluate the effects of NFP on maternal mental health, substance use, and domestic violence. First, we use data from a baseline survey that collected information on participants’ demographic and health information, such as age, race and ethnicity, body mass index, education, receipt of social service programmes, substance use, and mental health symptoms and treatment history. Next, we use NFP programme data. This includes information on visits conducted by the nurses, mental health screening, and referrals to mental health and substance use providers. Third, we use vital records data to identify live births and fetal deaths and for linkage to other datasets. Fourth, we use Medicaid claims and hospital discharge data, including pharmacy records, to observe diagnoses of depression, anxiety, substance use, and domestic violence. We also see receipt

of treatment (medication or therapy). Finally, we use data from the South Carolina Department of Mental Health to observe therapy visits. We cannot observe any healthcare use outside of Medicaid and the South Carolina Department of Mental Health. Participants are matched to administrative data via a probabilistic match based on name, race, Social Security number, birth date, and Medicaid ID in collaboration with South Carolina’s data repository.

3.3 Sample

The sample is made up of study participants with a live birth in the vital records data within 120 days of the expected delivery date reported on the baseline survey. We call these “index births”. Supplemental Appendix Table 1 provides more detail. We include all mothers in our index birth sample, regardless of whether they match to all of the relevant data sources. As a robustness check, we repeat the programme analysis on a sample of mothers who have at least one day of Medicaid coverage in the postpartum period and on a sample of mothers who have continuous Medicaid coverage up to 60 days postpartum.

There are no statistically significant differences in baseline characteristics between the treatment and control groups (Table 1). The sample is racially diverse: 55% of mothers self-identified as Black, 35% as White, and 10% as Hispanic. 18% of the sample are teenagers between the ages of 15 and 17, and just over half (54%) are 19 to 24 years old. Considering highest level of education, a little less than 60% of the sample have at most a high school diploma. Nearly 20% of the sample report depressive symptoms at baseline, and 66% report high levels of stress. 14% of mothers report receiving mental health treatment in the past year. Half of mothers (51%) drank alcohol in the 3 months prior to their pregnancy, and a quarter (26%) of mothers smoked cigarettes in the same time period. 66% of the sample received at least one social service programme such as Temporary Assistance for Needy Families or the Supplemental Nutrition Assistance Programme.

As we do subgroup analyses by race, we also check if there are statistically significant differences in baseline characteristics across the treatment and control arms for non-Hispanic White and Black mothers separately. Supplemental Appendix Table 7 show that there is balance across the arms for these two subgroups.

Table 1. Balance table

Variables	Treatment	Control	Difference
	Mean	Mean	P-val
Age (%)			
- 15-18	18.21	17.53	0.56
- 19-24	54.81	54.98	0.91
- 25-34	24.16	25.47	0.31
- 35+	2.82	2.02	0.09
Race/ethnicity (%)			
- Hispanic	5.52	6.25	0.32
- Non-Hispanic Black	55.04	55.62	0.71
- Non-Hispanic White	34.89	34.39	0.73
- Non-Hispanic Other	4.55	3.75	0.21
BMI (%)			
- <18.5	5.73	5.34	0.58
- 18.5-24.9	37.18	39.52	0.12
- 25-29.9	22.22	21.66	0.66
- >30.0	34.87	33.48	0.34
Highest education level (%)			
- < HS	22.62	21.70	0.47
- HS	36.00	34.27	0.23
- < BA	33.89	36.05	0.13
- BA+	7.47	7.97	0.53
Mental health/substance use (%)			
- Depressive symptoms	19.27	18.70	0.63
- High stress	66.06	66.01	0.97
- MH treatment	13.79	13.54	0.81
- Alcohol use	50.72	51.32	0.69
- Cigarette use	25.05	27.03	0.14
Other health indicators (%)			
- ED use	51.11	52.26	0.44
- Fair/poor health	12.79	11.04	0.08
Family planning indicators (%)			
- FP/birth control access	55.88	55.42	0.76
- Desire for children	67.62	67.73	0.94
Pregnancy indicators at baseline (%)			
- Gestational age	1486.77	1452.05	0.07
- Started prenatal care (%)	85.08	84.04	0.34
Socioeconomic indicators (%)			
- Used social services	65.46	66.81	0.35
- Worked for pay	52.94	52.63	0.83
- Lived with parents	43.30	44.34	0.49
- Housing insecure	16.50	17.51	0.37
Observations	3295	1637	4932

Notes: Survey data collected after enrolment and before randomisation between 2016 and 2020. “Non-Hispanic Other” is Asian, Indigenous, Native Hawaiian/Pacific Islander and more than two races. BMI is body mass index. ‘<HS’ is less than a high school diploma. “HS” is a high school diploma or equivalent. “<BA” is some college, less than a bachelor’s degree. “BA+” is a bachelor’s degree or higher. “Depressive symptoms” is a Patient Health Questionnaire 2 score of ≥ 3 . “High stress” is a Perceived Stress Scale 4 score of ≥ 4 . “MH treatment” is receipt of mental health treatment in the last year. “Alcohol use” is reported alcohol use in the 3 months before pregnancy. “Cigarette use” is reported cigarette use in the 3 months before pregnancy. “ED use” is use of the emergency department in the 6 months before enrolment. “Fair/poor health” is self-reported health as fair or poor. “FP/birth control access” is whether the mother has access to family planning or birth control. “Desire for children” is self-reported desire for children in the future. “Gestational age” is at enrolment in weeks. “Started prenatal care” is receipt of at least one prenatal visit before enrolment. “Used social services” is use of programmes such as TANF; SNAP; SSI; WIC; and unemployment benefits. “Housing insecure” is whether the mother moved at least twice in the previous 12 months.

3.4 Outcomes

In order to analyse the effects of NFP on perinatal mental health, we look at outcomes relating to diagnosis and treatment of mental health conditions in the perinatal period. We also examine mental health adjacent outcomes on substance use and maternal experience of violence. We focus on outcomes that were pre-registered in the clinical trials registry, and set out in the trial protocol and pre-analysis plan (McConnell et al., 2020, 2021). These pre-specified outcomes include: any outpatient diagnosis of depression, anxiety or stress-reaction; any medication; any psychotherapy visit; any inpatient or emergency department visit with a diagnosis for depression, anxiety, or stress-reaction; the number of inpatient or emergency department visits with a diagnosis for depression, anxiety, or stress reaction; whether the mother received a second prescription or therapy visit within 120 days of their first; any substance use (neonatal abstinence disorder, opioids, tobacco, alcohol, sedative, cocaine, amphetamines, cannabis), and any maternal experience of violence or homicide. A composite outcome captures any depression, anxiety, or stress-reaction diagnosis; any psychotherapy visit; or any medication. Any medication is defined as a filled prescription for antidepressants or anxiolytics. ICD-10 diagnosis, therapeutic class codes, and Current Procedure Terminology (CPT) codes used to define these outcomes can be found in Supplemental Appendix Tables 2, 3, 4, 5, 6. The diagnosis outcome is intended to capture detection of mental health conditions. The variables including prescriptions and therapy measure mental health treatment for mothers. The inpatient or emergency department visit outcome represents an outcome the programme might hope to avoid, as these hospital visits could indicate inadequate outpatient treatment of perinatal depression. All outcomes are examined throughout the pregnancy period and up to sixty days postpartum, as this is when many women lost Medicaid coverage in South Carolina during the trial (prior to the onset of the COVID-19 pandemic). The variables measuring inpatient and emergency department visits with a diagnosis for depression or anxiety exclude inpatient claims for labour and delivery, as diagnoses at delivery may arise from depression screening at delivery or represent coding as a comorbidity or secondary diagnosis. These analytical choices were pre-specified in a pre-analysis plan (McConnell et al., 2021).

Using healthcare claims, discharge data and prescription fills is an imper-

fect way to assess prevalence of depression and anxiety in the study population. Receiving a depression diagnosis by a Medicaid provider is a function of the patient's presence at the facility, the information revealed to a doctor by the patient, and the doctor's propensity to diagnose to that patient. Further, seeing an increase in depression diagnoses could represent either an increase in the prevalence, or an increase in the identification of depression in a population. Participation in NFP could reduce depressive symptoms through easing stress and anxiety via interactions with NFP nurses, or it could increase the detection of perinatal depression if the NFP nurses helped mothers recognise their symptoms and encouraged them to seek care and treatment from a mental health provider. The former would lead to a reduction in depression diagnoses, and the latter, an increase. Moreover, medication use is observed for mothers who filled a prescription (although we cannot confirm whether the medication was taken as prescribed). We are not able to observe mothers who received a prescription but did not fill it. Finally, we cannot observe treatment that is not billed to Medicaid. Therefore, the outcomes we explore can be thought of as indicating health care utilisation relating to mental health rather than indicators of mental health status.

In order to understand the context of routine depression, substance use, and domestic violence screening within the Medicaid programme in South Carolina, we also conduct descriptive analysis on exploratory outcomes. These exploratory outcomes include mental health screening and referrals captured within Medicaid claims, and indicators of programme implementation related to what happened during NFP visits. We look at perinatal mental health screening through routine health care delivery in the Medicaid programme. We observe screening for mental health, alcohol and substance use, smoking patterns, and domestic violence using the Screening, Brief Intervention and Referral to Treatment (SBIRT). Clinicians are encouraged to deliver SBIRT to all pregnant mothers on Medicaid, as early as possible. The first component of the SBIRT is screening, where a doctor asks a set of questions to assess the risks to the mother and infant. This takes five to ten minutes to complete. If needed, a brief intervention is then conducted. This is a short counseling session to highlight potential issues and motivate the mother to acknowledge any problems. The brief intervention can last between five to thirty minutes. Then, there is referral to treatment. As per SBIRT guidelines, if an individ-

ual screens positive for any risk factors, providers should make a referral and ideally secure an appointment before the individual leaves. Patients can be referred to the Department for Mental Health, Department of Alcohol and Other Drug Abuse Services, Quitline (for tobacco cessation), a domestic violence hot line, or a private provider ([South Carolina Department of Health and Human Services, 2010](#)). Providers can bill for the screening once per fiscal year, and the brief intervention twice per fiscal year. We also observe specific depression screening in Medicaid claims. NFP recommends using a standardised depression screening tool for postpartum women - the Edinburgh Postnatal Depression Scale (EPDS). The EPDS is a screening questionnaire that aims to identify mothers with symptoms of depression and anxiety in the perinatal period. The EPDS is not a diagnostic tool; mothers with scores indicating depressive symptoms should receive follow-up care. Mothers complete the questionnaire themselves, answering ten questions about their emotional experiences over the past week. The American College of Obstetricians and Gynecologists (ACOG) recommends that all women are screened for perinatal mental health conditions, at the following cadence: at the first obstetric visit to assess mental health before pregnancy, at 24 to 28 weeks of gestation to assess mental health during pregnancy, and at the comprehensive postpartum visit to identify onset in early postpartum ([The American College of Obstetricians and Gynecologists, 2024](#)). Screenings can take place during prenatal care appointments. Providers can also bill for a depression screening at well-child visits under South Carolina’s Medicaid policy (twice per date of service) ([South Carolina Department of Health and Human Services, 2024](#)). Infants should receive a well-child visit 3-5 days, one month, and two months after birth.

In addition to screening in routine and emergency health care utilisation, mothers in the treatment group could also be screened and referred for services by NFP nurses. We look at the prevalence of depression screening, mental health referrals, and substance use referrals by NFP nurses across the pregnancy and postpartum period in the treatment arm. We examine outcomes in the prenatal period, from birth to sixty days postpartum, and a combination of these two periods.

Finally, in order to understand patterns of differential treatment impacts on study outcomes across race, we look at screening and referral within the

Medicaid programme and screening accordance to timing guidelines by nurses implementing NFP, by race. For the study period we focus on, NFP guidance advised screening at intake, at 36 weeks pregnant, and 1-8 weeks after birth.

3.5 Empirical approach

We use ordinary least squares linear regression models to compare outcomes for participants in the treatment and control group using two-sided hypothesis tests. We estimate raw comparisons in unadjusted models, and then control for pre-specified covariates in adjusted models (McConnell et al., 2021). Covariates include indicators for the implementing NFP agency, age groups, race and ethnicity, gestational age at time of study enrolment, relationship with father of the child, education, employment, receipt of social services, housing stability, health status, psychological state, access and utilisation of health care, alcohol and smoking use, stress, pregnancy risk factors, and family planning metrics. We also use the dummy-variable adjustment approach to account for missing baseline covariates, as described in the pre-analysis plan (McConnell et al., 2021; Puma et al., 2009).

To evaluate the effects of NFP on maternal mental health, we use an intent to treat (ITT) framework which estimates the average impact of NFP comparing outcomes for all index births assigned to treatment and all index births assigned to control. All mothers who were randomised to receive NFP were in the treatment group. Our primary specification relies on an ITT framework, rather than a treatment on the treated (TOT) framework. This is because the policy relevant analysis seeks to understand the impact of the opportunity to access the NFP programme, with the understanding that many families in a realistic implementation setting may choose not to participate in the full programme activities. We see almost total take-up of at least one NFP visit (Table 2), and beyond this there is variation in the level of participation in the programme that we would expect to be a feature of any realistic implementation.

We conduct subgroup analyses for non-Hispanic Black mothers, non-Hispanic White mothers, and a pre-specified vulnerable subgroup. The vulnerable subgroup is defined as participants who were at least one of the following: younger than 19 years at baseline, without a high school degree, or who experienced mental health challenges. Mothers with mental health challenges were identified

by either receiving a score of three or higher on the Patient Health Questionnaire 2, or reporting receipt of mental health treatment in the year prior to enrolment. These indicators of vulnerability put the mother at risk of developing postnatal depression (Biaggi et al., 2016; Goyal et al., 2010; Kingston et al., 2012). Additionally, this subgroup mimics subgroups in which the original NFP trials found greater impacts. We also conduct subgroup analyses by race since prior work shows racial differences in treatment for perinatal depression (Kozhimannil et al., 2011).

4 Results

4.1 Descriptive analysis of programme implementation

Table 2 shows descriptive statistics on participation in the South Carolina NFP trial across the prenatal period and up to 60 days postpartum. 98% of mothers received at least one nurse visit in the prenatal period, and this figure is 76% in the the postpartum period. Telehealth visits were less common - around a quarter of mothers received at least one telehealth visit. Visits lasted about an hour, and in-person visits were over double the length of telehealth visits. The mean number of visits in the prenatal period was 9.34, and 3.64 in the postpartum period up to 60 days after birth.

Table 2. Participation in NFP

	Prenatal %/Num.	60 days postpartum %/Num.
Programme encounters		
Received at least one visit	98.27	75.51
Received at least one in-person visit	98.24	66.43
Received at least one telehealth visit	28.01	25.25
Received visits to within 14 days of delivery	78.26	70.83
Number of visits	9.34	3.64
Number of in-person visits	8.29	2.89
Number of telehealth visits	1.05	0.75
Visit duration		
Avg. duration of visits	66.82	62.97
Avg. duration of in-person visits	70.46	70.10
Avg. duration of telehealth visits	28.16	28.91

Notes: N=3,295. Data only available for participants who matched to programme data. “Duration” variables available for participants with at least one in-person visit. “Number” and “Duration” variables are means. “Received” variables are percentages. “Duration” variables are in minutes.

4.2 Descriptive analysis of mental health screening and referral

Table 3 Panel A shows depression screening in the NFP programme. Nearly all (99%) mothers in the treatment group received a depression screening at some point from the start of their pregnancy up to sixty days postpartum. Among mothers in the treatment group, 16% were ever referred to treatment, with the majority of referrals occurring in the prenatal period. A small proportion of NFP mothers received a referral for substance use, 4%, with the majority of these referrals occurring in the prenatal period when there is heightened concern for the health of the infant from maternal substance use. Table 3 Panel B shows screening by the Medicaid programme for the full sample. The rate of depression screening by Medicaid providers is much lower than in the NFP programme. There is almost no depression screening by Medicaid providers during pregnancy. After birth, 24% of mothers receive a depression screening. This figure is low given the guidance to screen in the postpartum period ([The American College of Obstetricians and Gynecologists, 2024](#)), and the fact that providers can bill depression screens for mothers during well-child visits. Providers are using the SBIRT screen in the prenatal period. 30% of mothers received a prenatal SBIRT screening. 8% of mothers receive an SBIRT referral. After delivery, the use of SBIRT screens falls close to zero.

Table 3. Prevalence of mental health screening and referral

	Prenatal	60 days pp
Panel A: NFP		
Any depression screening	97.32 (16.14)	84.02 (36.65)
Any referral for mental health	12.18 (32.71)	6.86 (25.27)
Any referral for substance use	3.57 (18.55)	0.51 (7.15)
Any referral for domestic violence	1.20 (10.90)	0.30 (5.47)
Panel B: Medicaid		
Any depression screening	0.53 (7.24)	23.95 (42.68)
Any SBIRT screening	29.89 (45.78)	0.28 (5.32)
Any depression or SBIRT screening	30.37 (45.99)	24.15 (42.80)
Any SBIRT referral	7.91 (26.99)	0.12 (3.49)

Notes: N=2,509 for “Panel A: NFP - Prenatal” sample. N=2,315 for “Panel A: NFP - 60 days pp” sample. N=4,932 for “Panel B: Medicaid - Prenatal/60 days pp” sample. “Panel A: NFP” denotes screening and referral conducted by NFP nurses to mothers in the treatment group. “Panel B: Medicaid” denotes screenings and referrals that are observed in Medicaid claims data, for both treatment and control mothers. For all variables the values represent percentages. “Prenatal” denotes that the screening or referral took place during the prenatal period. For “Prenatal”, Panel A statistics are calculated for the sample of mothers who had NFP visits until birth. “60 days pp” denotes that the screening or referral took place after delivery, up to 60 days postpartum. For “60 days pp”, Panel A statistics are calculated for the sample of mothers who had NFP visits until 60 days postpartum. “NFP - Any referral for domestic violence” is whether the mother received a referral for maternal experience of violence or homicide. “Medicaid - Any depression screening” is whether the mother received a depression screen (Edinburgh Postnatal Depression Scale) during any well-child visit. “Medicaid - Any SBIRT screening” is whether the mother received the “Screening, Brief Intervention, and Referral to Treatment” screen. “Medicaid - Any SBIRT referral” is whether the mother was referred to a specialist from an SBIRT screen. Standard errors in parentheses.

4.3 Analysis of main programme effects

When we look at the pre-registered study outcomes, we find that the NFP programme had no statistically significant effect on mental health diagnoses, nor on treatment in the form of medication or therapy. We also find no significant difference in substance use or experiences of maternal violence detected in a healthcare encounters. Table 4 shows the NFP programme effects on our outcomes for all index birth mothers. Supplemental Appendix Table 8 shows the q-values calculated using the [Benjamini and Hochberg \(1995\)](#) procedure.

We find heterogenous NFP programme effects by race; Table 5 shows NFP programme effects for the sub-samples of non-Hispanic White and non-Hispanic Black index birth mothers. Non-Hispanic White mothers randomly assigned to NFP were 4% (95% confidence interval: 0.17, 8.53) more likely to receive mental health medication treatment than those randomly assigned to the control group. In contrast, non-Hispanic Black mothers were 3% (95% confidence interval: -5.02, -0.36) less likely to receive medication if they were in the NFP treatment group rather than the control group. Both of these effects are statistically significant, and the difference between the adjusted treatment

effects for non-Hispanic White and Black mothers is also statistically significant. These opposing programme effects are in addition to the large gap in diagnosis and receipt of treatment for non-Hispanic Black and White mothers. For non-Hispanic White control group mothers, 43% received an outpatient mental health diagnosis. This figure is 24% for non-Hispanic Black control group mothers. Interestingly, we do not see heterogeneous treatment effects on diagnoses. Further, 21% of non-Hispanic White control group mothers received any medication, in comparison to 10% of non-Hispanic Black control group mothers. These racial disparities in rates of medication use are similar to those documented in other studies; [Huybrechts et al. \(2013\)](#) found that 3.5% of Black mothers use antidepressants during pregnancy versus 14.4% of White mothers. There is also a racial difference in therapy use: 6% of non-Hispanic White control group mothers received some therapy, relative to 4% of non-Hispanic Black control group mothers. In addition, non-Hispanic White mothers were more likely to have follow up treatment. We find no significant effects of NFP on maternal mental health for the vulnerable subgroup (Supplemental Appendix Table 9). Sensitivity analysis on a sample of mothers with any Medicaid coverage in the postpartum period and on a sample of mothers with continuous Medicaid coverage up to 60 days postpartum can be found in Supplemental Appendix Tables 10 and 11. In Supplemental Appendix Table 12, we estimate the treatment-on-the-treated effects by instrumenting whether the mother received NFP visits to 60 days postpartum with randomisation into the NFP treatment arm. We find no statistically significant TOT effects either.

Table 4. Treatment effects of NFP, full sample

	Treatment Mean	Control Mean	Unadjusted ITT	ITT	
Any OP diagnosis/medication/therapy	31.81	33.17	-1.36	-1.34	[-3.80, 1.11]
Any OP diagnosis	28.44	29.99	-1.56	-1.55	[-3.95, 0.84]
Any Medication	13.20	13.19	0.01	0.06	[-1.84, 1.95]
Any Therapy	5.01	4.64	0.36	0.41	[-0.77, 1.59]
Any IP/ED visit	13.93	12.34	1.59	1.47	[-0.37, 3.31]
Num. IP/ED visits	0.24	0.21	0.03	0.03	[-0.02, 0.08]
Treatment follow up	8.86	8.67	0.19	0.14	[-1.39, 1.68]
Any substance use	21.49	22.42	-0.93	-0.47	[-2.57, 1.62]
Any domestic violence	1.67	1.65	0.02	0.01	[-0.75, 0.77]

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Full sample N = 4,932. “ITT” is the intent-to-treat effect. For the “Any” variables, the means and effects are percentages. For the “Num” variable, the means and effects are numbers. “Any OP diagnosis/medication/therapy” is any outpatient diagnosis for depression or anxiety, medication, or therapy. “Any IP/ED visit” is an inpatient or emergency department visit with a postpartum depression or anxiety diagnosis, excluding labour and delivery. “Num. IP/ED” is defined the same, but counts the number of visits. “Treatment follow up” is a second prescription or therapy visit within 120 days of first prescription or therapy visit. 95% confidence intervals in brackets. All “ITT” models control for implementing NFP agency, age groups, race and ethnicity, gestational age at time of study enrolment, relationship with father of the child, education, employment, receipt of social services, housing stability, health status, psychological state, access and utilisation of health care, alcohol and smoking use, stress, pregnancy risk factors, family planning metrics, and dummies for missing baseline covariates.

Table 5. Treatment effects of NFP, by race

	White		Black		Difference
	Control Mean	ITT (1)	Control Mean	ITT (2)	(1)-(2) P
Any OP diagnosis/medication/therapy	47.23	0.71 [-4.02, 5.44]	26.95	-1.76 [-5.10, 1.57]	0.40
Any OP diagnosis	43.21	-1.83 [-6.55, 2.88]	23.64	-0.58 [-3.78, 2.61]	0.66
Any Medication	20.65	4.35 * [0.17, 8.53]	10.28	-2.69 * [-5.02, -0.36]	0.00
Any Therapy	6.12	1.89 [-0.53, 4.30]	3.78	-0.22 [-1.70, 1.26]	0.14
Any IP/ED visit	16.25	3.16 + [-0.57, 6.88]	10.99	0.56 [-1.87, 3.00]	0.25
Num. IP/ED visits	0.29	0.05 [-0.06, 0.16]	0.18	0.02 [-0.03, 0.08]	0.71
Treatment follow up	14.72	1.74 [-1.77, 5.25]	5.67	-0.43 [-2.19, 1.34]	0.27
Any substance use	31.55	-1.26 [-5.31, 2.80]	18.32	0.10 [-2.72, 2.91]	0.59
Any domestic violence	0.57	0.34 [-0.52, 1.19]	2.13	-0.03 [-1.27, 1.21]	0.63

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Non-Hispanic White sample N= 1,604. Non-Hispanic Black sample N= 2,551. “ITT” is the intent to treat effect. For all variables, the means and ITT are percentages. For the “Any” variables, the means and effects are percentages. For the “Num” variable, the means and effects are numbers. “Any OP diagnosis/medication/therapy” is any outpatient diagnosis for depression or anxiety, medication, or therapy. “Any IP/ED visit” is an inpatient or emergency department visit with a postpartum depression or anxiety diagnosis, excluding labour and delivery. “Num. IP/ED” is defined the same, but counts the number of visits. “Treatment follow up” is a second prescription or therapy visit within 120 days of first prescription or therapy visit. 95% confidence intervals in brackets. All models control for implementing NFP agency, age groups, race and ethnicity, gestational age at time of study enrolment, relationship with father of the child, education, employment, receipt of social services, housing stability, health status, psychological state, access and utilisation of health care, alcohol and smoking use, stress, pregnancy risk factors, family planning metrics, and dummies for missing baseline covariates.

4.4 Exploring mechanisms for heterogeneity by race

Next, we investigate potential drivers of the heterogenous programme effects of NFP by race.

4.4.1 Racial differences in mental health prior to the intervention

Disparities in mental health treatment for Black and White mothers and a lower diagnosis rate for Black mothers could arise from racial differences in mental health status before the NFP intervention. Using data from the baseline survey, we investigate mental health symptoms upon intake, and treatment history by race. Non-Hispanic Black mothers were more likely than non-Hispanic White mothers to report depressive symptoms at intake during pregnancy, as exhibited in Table 6. 21% of non-Hispanic Black mothers scored at least three on the Patient Health Questionnaire 2, in comparison to 17% of non-Hispanic White mothers. Despite this difference in depressive symptoms by race, a much lower proportion of Black mothers had received mental health treatment in the year prior to NFP, 8%, relative to 24% of White mothers. Both of these racial differences are statistically significant. These findings hold when controlling for the nine different NFP Implementing Agencies (IA) and personal characteristics, as shown in Supplemental Appendix Table 13. Reductions in rates of mental health treatment for Black mothers participating in NFP do not seem to be driven by Black study participants experiencing fewer symptoms or being less in need of mental health treatment at baseline.

Table 6. Mental health status prior to intervention, by race

	Black (1) %	White (2) %	(1)-(2) P
Depressive symptoms	20.94 (40.70)	16.74 (37.35)	0.01
High stress	65.69 (47.49)	65.49 (47.56)	0.92
Received mental health treatment in last year	8.04 (27.19)	24.24 (42.87)	0.00

Notes: N= 1,705 for non-Hispanic Black mothers. N= 1,081 for non-Hispanic White mothers. Survey data collected after enrolment and before randomisation between 2016 and 2020. “Depressive Symptoms” is a Patient Health Questionnaire 2 score of at least 3. “High Stress” is a Perceived Stress Scale 4 score of at least 4.

4.4.2 Racial differences in participating in NFP

Differential NFP programme effects by race could be driven by differing levels of participation in the NFP programme. We examine this question in Table

7 Panel A. Non-Hispanic Black mothers were more likely to remain in NFP until birth, and there is no statistically significant difference in programme retention when we consider the full study period from pregnancy to 60 days postpartum. Controlling for the NFP implementing agencies (IAs) and a rich set of personal characteristics confirms that there is no statistically significant difference in retention in NFP by race (Supplemental Appendix Table 14).

Another potential reason for the differential impact of the NFP programme across race is because Black mothers received fewer, or shorter, nurse home visits. We explore whether there are racial differences in visit frequency and length. Table 7 Panel B shows that there is no difference in the average NFP home visit duration for non-Hispanic Black and White mothers. When we control for IA and personal characteristics (Supplemental Appendix Table 15), there is a small statistically significant reduction in the visit length of Black mothers relative to White mothers of 2 minutes. During pregnancy, the postpartum period up to 60 days following birth, and the combined study period, Black mothers had statistically significantly fewer visits than their White counterparts. Across the combined study period, Black mothers have 1.21 fewer visits than White mothers. This effect remains in the postpartum period when adding in controls, as shown in Supplemental Appendix Table 15. Differences in the number of visits could reflect patient preferences, nurse preferences, or a combination of both. Differences could also reflect the nature of the relationship between the nurse and client.

4.4.3 Racial differences in mental health screening and referral patterns by NFP

Lower rates of mental health diagnoses and treatment amongst Black women could be due to differences in screening and referral for Black participants. Table 7 Panel C shows screening and referral outcomes for non-Hispanic Black and White mothers in the intervention group. Nearly all mothers were screened for depression by NFP nurses at least once across the study period. Although the absolute differences are small, Black mothers have statistically significantly fewer depression screenings across the prenatal period and up to 60 days postpartum. According to programme guidelines, NFP nurses should screen mothers at intake, at 36 weeks of pregnancy, and between 1 to 8 weeks following birth. Around 87% of mothers were screened at intake, with no significant

difference by race. At 36 weeks into pregnancy (“Prenatal”), non-Hispanic White mothers were 9 percentage points more likely to be screened by NFP nurses than non-Hispanic Black mothers. At 1 to 8 weeks after birth (“60 days pp”), non-Hispanic White mothers were 4 percentage points more likely to be screened by NFP nurses than their Black counterparts. White mothers were also referred for mental health services at a higher rate than Black mothers. Supplemental Appendix Table 16 adds in controls for the NFP implementing agency and for a rich set of individual characteristics. Differences in mental health referrals between Black and White mothers remain.

4.4.4 Racial differences in mental health screening and referral patterns by Medicaid providers

Next, we consider whether lower rates of screening and referral for Black compared to White mothers observed in the NFP programme data are also observed in screening and referral patterns in the Medicaid programme. We revisit the prevalence of mental health screening during pregnancy and the postpartum period (as in Table 3) and break down the Medicaid analysis by race in Table 7 Panel D. We see that across the whole study period, there is no statistically significant difference in receipt of depression or SBIRT screening by race. Non-Hispanic White mothers, however, were significantly more likely to receive an SBIRT referral than non-Hispanic Black mothers. These differences cannot be explained by racial differences in Medicaid coverage, as shown in Supplemental Appendix Table 18. The dynamics that drive lower rates of mental health screenings in NFP do not appear to be present when screening is undertaken by Medicaid providers. This is consistent with limited differences in routine utilisation of prenatal and postpartum care reported in other manuscripts on this trial population (Gourevitch et al., 2023). Furthermore, we do not find statistically significant NFP treatment effects on Medicaid screening and referral outcomes for non-Hispanic Black and White mothers (see Supplemental Appendix Table 17).

Table 7. Visits, mental health screening, and referral in the NFP programme and the healthcare system, by race

	Prenatal			60 days pp			Study period		
	Black (1)	White (2)	(1)-(2) P	Black (1)	White (2)	(1)-(2) P	Black (1)	White (2)	(1)-(2) P
NFP									
<i>Panel A: Retention</i>									
Visits across period	79.34 (40.50)	75.76 (42.87)	0.03	70.54 (45.60)	69.94 (45.88)	0.73	70.54 (45.60)	69.94 (45.88)	0.73
<i>Panel B: Visits</i>									
Avg. visit length	65.96 (22.52)	66.23 (21.05)	0.78	62.11 (36.59)	61.17 (24.78)	0.53	64.90 (22.23)	64.39 (17.99)	0.60
Visit count	11.05 (4.36)	11.98 (4.51)	0.00	5.09 (2.29)	5.44 (2.33)	0.00	16.35 (5.78)	17.56 (5.97)	0.00
<i>Panel C: Screening and Referral</i>									
Number of depression screenings	1.71 (0.67)	1.82 (0.60)	0.00	1.05 (0.79)	1.14 (0.92)	0.03	2.79 (1.11)	2.98 (1.17)	0.00
Any depression screening	96.67 (17.94)	98.05 (13.85)	0.06	82.78 (37.77)	84.79 (35.94)	0.24	98.75 (11.11)	99.74 (5.14)	0.02
Screening adherence by nurse	72.49 (44.68)	81.81 (38.60)	0.00	88.35 (32.09)	92.20 (26.84)	0.01	94.34 (23.11)	96.16 (19.22)	0.07
Any mental health referral	10.36 (30.48)	15.02 (35.75)	0.00	5.49 (22.79)	8.99 (28.63)	0.00	13.89 (34.60)	19.84 (39.91)	0.00
Medicaid									
<i>Panel D: Screening and Referral</i>									
Any depression screening	0.35 (0.06)	0.94 (0.10)	0.02	24.30 (0.43)	22.13 (0.42)	0.11	24.58 (0.43)	22.94 (0.42)	0.23
Any SBIRT screening	30.81 (0.46)	30.42 (0.46)	0.79	0.35 (0.06)	0.25 (0.05)	0.56	31.09 (0.46)	30.67 (0.46)	0.78
Any depression or SBIRT screening	31.13 (0.46)	31.36 (0.46)	0.87	24.58 (0.43)	22.32 (0.42)	0.10	48.37 (0.50)	46.57 (0.50)	0.26
Any SBIRT referral	6.82 (0.25)	11.16 (0.31)	0.00	0.04 (0.02)	0.19 (0.04)	0.13	6.82 (0.25)	11.16 (0.31)	0.00

Notes: N= 1,352 for non-Hispanic Black mothers who completed NFP visits to birth, sample for “NFP - Prenatal”. N= 819 for non-Hispanic White mothers who completed NFP visits to birth, sample for “NFP - Prenatal”. N=1,202 for non-Hispanic Black mothers who completed NFP visits to 60 days postpartum, sample for “NFP - 60 days pp”/“Study period”. N=756 for non-Hispanic White mothers who completed NFP visits to 60 days postpartum, sample for “NFP - 60 days pp”/“Study period”. N=2,551 for “Medicaid” sample of non-Hispanic Black mothers. N=1,604 for “Medicaid” sample of non-Hispanic White mothers. “NFP” denotes visits, screening, and referrals that are observed in NFP survey data, for treatment mothers. NFP survey data collected after enrolment and before randomisation between 2016 and 2020. “Medicaid” denotes screenings and referrals that are observed in Medicaid claims data, for both treatment and control mothers. “Prenatal” denotes that the outcome took place during the prenatal period. For the NFP variables, the “Prenatal” statistics are calculated for the sample of mothers who had NFP visits until birth. For the Medicaid variables, the “Prenatal” statistics are calculated for all mothers. “60 days pp” denotes that the outcome took place after delivery, up to 60 days postpartum. For the NFP variables, the “60 days pp” statistics are calculated for the sample of mothers who had NFP visits until 60 days postpartum. For the Medicaid variables, the “60 days pp” statistics are calculated for all mothers. “Study period” denotes the prenatal period and up to 60 days postpartum. For the NFP variables, the “Study period” statistics are calculated for the sample of mothers who had NFP visits until 60 days postpartum. For the Medicaid variables, the “Study period” statistics are calculated for all mothers. The statistics for “Visits across period”, “Any depression screening”, “Screening adherence by nurse”, “Any mental health referral”, “Any SBIRT screening”, “Any depression or SBIRT screening”, and “Any SBIRT referral” are percentages. “Visits across period” is whether the mother received NFP visits within 14 days of the index birth for the “Prenatal” columns, and whether the mother received NFP visits up to 60 days postpartum for the “60 days pp” and “Study period” columns. “Avg. visit length” is the average (mean) NFP visit length in minutes for completed visits. “Visit count” is the number of at home NFP completed visits. “Screening adherence” is whether the mother was screened at 36 weeks pregnant for “Prenatal”, whether the mother was screened 1 to 8 weeks after birth for “60 days pp”, and whether the mother was screened at 36 weeks pregnant or 1 to 8 weeks after birth for “Study period”. “Any depression screening” is whether the mother received a depression screen (Edinburgh Postnatal Depression Scale) during any well-child visit. “Any SBIRT screening” is whether the mother received the “Screening, Brief Intervention, and Referral to Treatment” screen. “Any SBIRT referral” is whether the mother was referred to a specialist from an SBIRT screen. Standard errors in parentheses.

4.4.5 Racial concordance between the nurse and mother

Finally, we conduct descriptive analyses to examine whether racial concordance between mother and nurse is associated with different NFP programme outcomes for Black and White mothers. The NFP programme data includes some information on individual nurse characteristics, including race. The visit data has nurse identifiers, which we link with the nurse characteristics data, allowing us to identify the race of mothers' nurses. Prior work has found that racial concordance can result in increased take-up of preventive care and improved outcomes for Black patients (Alsan et al., 2019; Greenwood et al., 2018, 2020; Frakes and Gruber, 2022; Hill et al., 2023). These descriptive analyses cannot be interpreted as causal as nurses are not randomly assigned to mothers and mothers can switch nurses. For context, 15% of the nurses are of Black race, 34% are of White race, and we do not know the race of the remaining nurses.

We define the mother's "main" nurse as the nurse that they saw the most frequently. 68% of treated mothers only saw one nurse during the study period. The median number of nurses that mothers in the programme saw was 1 in both the full sample and the non-Hispanic Black and White subgroups. The mean number of nurses seen was 1.36 in the full sample, 1.34 in the non-Hispanic Black subgroup, and 1.36 in the non-Hispanic White subgroup. There is no statistically significant difference in the means for the non-Hispanic Black and White subgroups. Table 8 shows the extent to which Black and White mothers had racially concordant and discordant nurses.

The racial concordance analysis is presented in Table 9. The coefficient on "Black Mother, Black Nurse" gives the difference in outcomes for a non-Hispanic Black mother who saw a Black nurse relative to a non-Hispanic White mother who saw a White nurse. We see that there is no statistically significant difference in NFP programme participation, the number of nurse visits, and depression screening for Black mothers with Black nurses when compared to White mothers with White nurses. There is evidence of shorter visit length and a lower probability of a mental health referral for Black mothers with Black nurse relative to White mothers with White nurses.

Subtracting the coefficient on "Black Mother, White Nurse" from "Black Mother, Black Nurse" gives the difference in outcomes for a Black mother who saw a Black nurse relative to a Black mother who saw a White nurse. We

run F tests for “Black Mother, Black Nurse” = “Black Mother, White Nurse” on each of the outcome variables. Black mothers who see Black nurses have 4 minute shorter visits than Black mothers who see White nurses. Black mothers who see Black nurses receive more depression screenings than Black mothers who see White nurses. The magnitude of this effect is small (0.23 visits), but represents an 10% rise relative to the mean of 2.32 for “Black Mother, White Nurse”. Black mothers who see Black nurses are also 5 percentage points less likely than Black mothers who see White nurses to receive a mental health referral, a 38% decline relative to the mean of 0.13 for “Black Mother, White Nurse”. Amongst Black mothers, our results suggest that seeing a Black nurse is not associated with significant improvements in programme adherence. Seeing a Black nurse rather than a White nurse is associated with a substantial reduction in the probability of receiving a mental health referral despite a slightly higher chance of being screened for depression.

Table 8. Racial composition of nurses and mothers

	Full sample %	Black %	White %
Main nurse			
Black	18.02 (38.44)	21.41 (41.03)	14.39 (35.12)
White	53.43 (49.89)	47.53 (49.95)	60.89 (48.82)
Race unknown	28.55 (45.17)	31.07 (46.29)	24.72 (43.16)
Any nurse			
Black	21.08 (40.79)	24.51 (43.03)	17.61 (38.11)
White	62.33 (48.46)	55.93 (49.66)	68.37 (46.52)
Race unknown	32.63 (46.89)	34.53 (47.56)	28.88 (45.34)

Notes: N=3,236 for full sample, N=1,677 for non-Hispanic Black sample, N=1,056 for non-Hispanic White sample. Sample of index births who were assigned to the treatment group. “Full sample” refers to all index births who were assigned to the treatment group. “Black” refers to Black, non-Hispanic index birth mothers who were assigned to the treatment group. “White” refers to White, non-Hispanic index birth mothers who were assigned to the treatment group. For “Main nurse” and “Any nurse”, “Black” refers to Black nurses without restriction on Hispanic ethnicity due to missingness. “White” refers to White nurses without restriction on Hispanic ethnicity due to missingness. Standard errors in parentheses.

Table 9. Racial concordance analysis of NFP visits and screening

	Participation in programme	Avg. visit length	Visit count	Number of depression screenings	Any depression screening	Any mental health referral
White Mother, Black Nurse	-0.10* (0.04)	-2.54* (1.22)	-1.64* (0.69)	-0.11 (0.14)	-0.03 (0.03)	-0.04 (0.03)
Black Mother, Black Nurse	-0.02 (0.03)	-4.55*** (1.08)	-0.55 (0.51)	0.08 (0.10)	0.04 (0.02)	-0.07** (0.02)
Black Mother, White Nurse	-0.04 (0.02)	-0.62 (0.94)	-1.09* (0.43)	-0.15* (0.07)	0.01 (0.02)	-0.02 (0.02)
Adjusted R^2	0.04	0.13	0.14	0.12	0.03	0.08
Mean (White Mother, White Nurse)	0.76	62.65	15.09	2.48	0.92	0.16
P-value	0.46	0.00	0.25	0.01	0.20	0.02

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: N=1,951. Sample restricted to NFP treatment mothers of non-Hispanic ethnicity, of White or Black race, whose most frequent nurse is of Black or White race. “Black Mother” refers to Black, non-Hispanic mothers. “Black Nurse” refers to Black nurses without restriction on Hispanic ethnicity due to missingness. “White Mother” refers to White, non-Hispanic mothers. “White Nurse” refers to White nurses without restriction on Hispanic ethnicity due to missingness. The omitted category is “White Mother, White Nurse”. Variables are measured across pregnancy and up to 60 days postpartum. “Participation in programme” is whether the mother received NFP visits up to 60 days postpartum. “Avg. visit length” is the average (mean) NFP visit length in minutes for completed visits. “Visit count” is the number of at home NFP completed visits. “P-value” is for the test of “Black Mother, Black Nurse” = “Black Mother, White Nurse”. All models includes controls for IA, teen mother, mother aged 28 and over, daily interaction with father, less than high school education, work status, receipt of social service programmes, housing insecurity, high risk pregnancy. Robust standard errors in parentheses.

5 Discussion and conclusion

In this analysis of a recent randomised control trial of the Nurse Family Partnership in South Carolina on maternal mental health we observe high rates of depression or anxiety during pregnancy through 60 days postpartum with approximately 30% of control group mothers receiving an outpatient diagnosis. Although a high proportion of mothers are diagnosed with depression or anxiety in our sample, this is likely to underestimate true prevalence as many mothers may be undiagnosed. This substantial mental health burden does not correspond to high rates of treatment; only 13% of control group mothers receive medication and 5% attend therapy. This treatment gap could be driven by a number of factors: stigma and shame around seeking treatment, limited access to treatment due to maternity and psychiatric care deserts (Wisner et al., 2024), or limited engagement by providers or lack of resources to engage with the referral and follow-up phase (Valdes et al., 2023; Byatt et al., 2012). Approaches that seek to improve perinatal mental health through increased access to screening and referral to existing resources alone may be insufficient.

We find that NFP has no statistically significant effects on mental health diagnoses or treatment in a sample of first-time mothers who were income-eligible for Medicaid. Prior work evaluating the effects of these programmes on the prevalence and treatment of perinatal mental health is inconclusive, and there is limited evidence of nurse home visiting improving maternal mental health outcomes in the U.S. An evaluation of a German intensive nurse home visiting programme finds reductions in self-reported depression and prescriptions of psycholeptics (Sandner et al., 2018), and there is evidence from the U.S. showing improvements in maternal mental health (Heckman et al., 2017; Michalopoulos et al., 2019). In contrast, Olds et al. (2004b) and Jacobs et al. (2015) find no significant effects on maternal depression or mental health service use. Our measures of mental health are utilisation based, meaning that they capture mothers who receive a mental health diagnosis and treatment from a Medicaid provider or the Department of Mental Health. This is similar to the approach taken in Sandner et al. (2018), whereas other studies directly measure maternal mental health using depression scales.

We find no statistically significant effects of NFP on substance use and maternal experience of violence and homicide. Other RCT evaluations of NFP find no programme effects on substance use (Robling et al., 2016; Olds et al.,

2019), and on domestic violence (Olds et al., 2004a). Some studies have found reductions in prenatal smoking behaviour (Catherine et al., 2020; Mejdoubi et al., 2014), physical assault (Mejdoubi et al., 2013), and domestic violence (Olds et al., 2004b).

There may be limits to nurses' ability to positively impact maternal mental health outcomes. NFP is broad in its scope; mental health is only one of the topics covered in the home visits. It is also one of the most challenging and sensitive topics to address, according to home visitors, along with substance use and intimate partner violence (Duggan et al., 2018). It may be the case that a more specific intervention targeting maternal mental health would be more effective. One of the attractive features of NFP is the personal relationship that a nurse can build with a mother, but this form of social support during the perinatal period may be insufficient in addressing maternal depression and anxiety during the sensitive period of pregnancy and postpartum.

Beyond the overall finding of limited effects of the programme on mental health outcomes, we find heterogeneous treatment effects by race. In the control group, non-Hispanic Black mothers were less likely than non-Hispanic White mothers to be diagnosed with a mental health condition (24% vs. 43%) and receive treatment in the form of therapy and medication (10% vs. 21% for medication, 4% vs. 6% for therapy). Participation in NFP reinforces these racial disparities. Non-Hispanic Black mothers assigned to NFP were less likely to receive medication for a mental health condition relative to control Black mothers (-3 percentage points), whereas non-Hispanic White mothers randomised to the treatment group were more likely to receive medication relative to White control mothers (+4 percentage points). We find statistically significant programme effects despite the fact that most mothers that are diagnosed with depression or anxiety do not receive treatment. We explore mechanisms that could explain our findings through analysis of pre-existing mental health conditions, intensity of participation in NFP, and mental health screening and referrals through both NFP and routine medical care. Differences in pre-existing symptoms of depression or anxiety cannot explain the diagnosis and treatment disparities. Non-Hispanic Black mothers were more likely to experience depressive symptoms at intake (21%) relative to White mothers (17%). The opposing results on depression medication for Black and White mothers could be driven by visit duration or frequency. However, whilst

Black mothers received significantly fewer NFP visits in the postpartum period, the differences were substantively small. We do not find large racial differences in screening rates, but NFP nurses were more likely to adhere to screening at 36 weeks of pregnancy and 1 to 8 weeks postpartum for White mothers. NFP nurses were more likely to refer White mothers for mental health services than Black mothers (14% of Black mothers referred versus 20% of White mothers). Increased referrals for White mothers could be a factor behind higher treatment levels for White mothers, and the differential NFP programme effects. Our findings contrast those in [Dodge et al. \(2022\)](#); the authors find statistically significant reductions in racial disparities in maternal anxiety and depression. Our results may differ because of programme differences. The authors study “Family Connects”, a short-term home visiting programme delivered only during the postpartum period that was offered universally. Overall, we need more evidence on the effects of nurse home visiting that are disaggregated by maternal race.

Previous research has documented substantial racial disparities in rates of diagnosis and treatment ([Kozhimannil et al., 2011](#); [Sidebottom et al., 2021](#)). The racial disparities observed in our medical claims and survey data, both in terms of baseline levels and differences in response to the treatment, are a function of maternal service utilisation, mothers’ revelation of information to healthcare providers, physician behaviour and beliefs, depression screening tools, and the accuracy of reporting. There may be racial differences in the willingness to report depressive symptoms due to fear of negative repercussions. Black mothers may be worried about being considered a poor mother, or being reported to child welfare services if symptoms are reported. Black families are more likely to be reported to child welfare services ([Krase, 2013](#)), judged unfit parents, and have their children taken away and placed in foster care relative to White mothers ([Yi et al., 2020](#)). Black and White mothers may have different preferences for mental health treatment; [Leis et al. \(2011\)](#) document that Black mothers fear that providers will jump to prescribing unwanted and unnecessary medication. Prior research also finds that Black patients have concerns as to whether mental health providers can culturally relate to them, particularly in the setting of therapy ([Jones et al., 2015](#); [Leis et al., 2011](#)). Symptoms of depression and anxiety differ by race, so providers may not notice subtle or uncommon presentations of depression and anxiety

(Bailey et al., 2019). Black mothers may use different language to describe depression (Baker, 2001), and may be more likely to report somatic rather than affective symptoms (Lara-Cinisomo et al., 2020). Further, few studies have tested the performance of depression screening tools among racially diverse groups of pregnant and postpartum women in the U.S. (Ukatu et al., 2018; Tandon et al., 2012). Additionally, nurses and medical providers may unconsciously or consciously be treating Black and White mothers differently, due to implicit bias or prejudice. There is a large literature documenting racial bias in the U.S. (e.g. Dehon et al. (2017); Williams and Wyatt (2015)). Screening, diagnosis, and treatment for depression and anxiety could all be influenced by provider bias. Lastly, we may not observe mental health treatment that mothers are receiving in our data. Services provided at community centres, such as peer support groups, will not appear in medical claims data. Black mothers may be referred to these services at a higher rate than White mothers, including by NFP, for many reasons (including those discussed above).

While racial concordance between patient and provider has been found to reduce racial disparities in other settings (Greenwood et al., 2020), we do not see strong evidence that racial concordance blunts the differential NFP treatment effects. In fact, Black mothers who see a Black nurse are significantly less likely to receive a mental health referral than White mothers who see a White nurse. One potential story is that Black nurses are able to provide more substantial social supports, reducing the incidence of mental health symptoms, though this cannot explain all the results we see since only 21% of Black mothers see a Black nurse. There are some important limitations to our concordance analysis. Only a small percentage of our sample represents Black mothers being seen by Black nurses, limiting power. We also lack sufficient data to be able to track the race of all nurses.

Future work could seek to isolate the role of specific mechanisms discussed in this paper to better understand the mental health diagnosis and treatment gap between Black and White mothers. For example, whether there are racial differences in preferences for depression treatment, and whether healthcare providers exhibit racial biases towards mothers with depression. Research that explores Black mothers' perceptions about the potential risks of revealing information to providers of intensive home visiting programmes would also be a valuable contribution.

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