

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

September 23, 2024

## Abstract

Perinatal depression affects around 1 in 7 pregnant people, many of whom never receive any treatment. For low-income women, the rate is 1 in 4. Black mothers experience lower rates of depression screening and treatment. Amongst policymakers there is increasing attention in developing strategies to improve the mental health of low-income mothers during pregnancy and postpartum. We evaluate the impact of a canonical programme, the Nurse Family Partnership (NFP), on mental health related outcomes using a large-scale randomised controlled trial recently conducted in South Carolina. We find that NFP had no impacts on mental health diagnoses and treatment for the full study population. We also find evidence that Black mothers have different experiences in the programme compared to their White counterparts. Despite the fact that non-Hispanic Black mothers are more likely than their White counterparts to present with depressive symptoms during early pregnancy, they have lower diagnosis, screening, and referral rates by the programme. Furthermore, we find racial differences in the impact of NFP. White mothers randomised to NFP were more likely to receive treatment (medication) than the control group, whereas Black treatment mothers were less likely to receive treatment compared to control mothers. These findings suggest careful consideration of how community based perinatal providers address mental health in Black populations and support them with culturally competent care.

# 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, so the systematic screening during pregnancy and postpartum that occurs during intensive nurse home visiting programmes is a way to identify undiagnosed mothers. 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 (USPSTF, 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 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 programs 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 programs may also increase the identification and treatment of depression and anxiety during pregnancy and postpartum. For example, these programs 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). There are challenges, however, in implementing home visiting programmes to best serve people with mental health conditions. Mothers suffering from depression and anxiety may struggle to engage with the programme, and delivery of the programme relies on nurses gaining access to mothers in their homes (Duggan et al., 2018). The existing literature on the impacts of NFP on substance use and domestic violence is inconclusive. Few U.S. trials 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, and the programmes are not necessarily designed to serve this aim.

In this paper, we evaluate the effects of an intensive nurse home visiting programme on maternal mental health diagnoses and treatment, leveraging a large-scale randomised controlled trial of the Nurse-Family Partnership (NFP) in South Carolina that enrolled between 2016 and 2020, following 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. 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. In terms of treatment, 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. Black mothers participating in NFP were less likely to be screened at recommended intervals and referred to mental health services by NFP nurses.

The remainder of the paper proceeds as follows. Section 2 provides background on the Nurse Family Partnership. Next, we discuss methods in Section 3. We then present our empirical results in Section 4. Finally, 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. The nurses spoke English or Spanish, and translation services are available for mothers who speak 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. 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. Nurses are mandated reporters of child abuse and neglect. The NFP nurses tailor their visits and visit content to the clients' needs and preferences, but have some 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 would 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.

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 is financed through a Pay for Success model, so that later funding is delivered by SCDHHS if evaluation of the trial finds impact estimates that exceed pre-specified thresholds.<sup>1</sup> NFP is well-established in South Carolina, as it has operated in the state since 2009. This means that referral pathways 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](#)), or prenatal care ([Gourevitch et al., 2023](#)). While this paper explores mental health outcomes, other outcomes including postpartum care utilisation, contraception and birth spacing, and child health 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. 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

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

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 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, counseling 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. 6% of NFP intervention participants received at least one of these visits. 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. 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 the NFP on maternal mental health. 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 including 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 and substance use. 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. 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”. 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. Appendix Tables A1 and A2 show that there is balance across the arms for these two subgroups.



Table 1. Balance table

Variables	Treatment Mean	Control Mean	Difference 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
- Asian, Indigenous, Native Hawaiian/Pacific Islander, 2+ race, Non-Hispanic	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 (%)			
- Less than high school diploma	22.62	21.70	0.47
- High school diploma or equivalent	36.00	34.27	0.23
- Some college, less than bachelor's degree	33.89	36.05	0.13
- Bachelor's degree or higher	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
- Received mental health treatment in last year	13.79	13.54	0.81
- Reported drinking alcohol in 3 months before pregnancy	50.72	51.32	0.69
- Reported smoking cigarettes in 3 months before pregnancy	25.05	27.03	0.14
Other health indicators (%)			
- Used ED in 6 months before enrolment	51.11	52.26	0.44
- Reported health as fair/poor	12.79	11.04	0.08
Family planning indicators (%)			
- Has access to family planning or birth control	55.88	55.42	0.76
- Reported desire for mother children in future	67.62	67.73	0.94
Pregnancy indicators at baseline			
- Gestational age at enrolment (weeks)	14.867	14.52	0.07
- Received $\geq 1$ prenatal visit before enrolment (%)	85.08	84.04	0.34
Socioeconomic indicators (%)			
- Received $\geq 1$ social service programs	65.46	66.81	0.35
- Worked for pay at time	52.94	52.63	0.83
- Lived with parents	43.30	44.34	0.49
- Experienced housing insecurity	16.50	17.51	0.37
Observations	3295	1637	4932

Notes: Survey data collected after enrolment and before randomisation between 2016 and 2020. "BMI" is body mass index. "ED" is emergency department. "High stress" is a Perceived Stress Scale 4 score of  $\geq 4$ . "Depressive symptoms" is a Patient Health Questionnaire 2 score of  $\geq 3$ . Social service programs include Temporary Assistance for Needy Families; Supplemental Nutrition Assistance Program; Supplemental Security Income; Special Supplemental Nutrition Programme for Women, Infants, and Children; 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 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 Appendix Tables A3, A4, A5, A6, and A7. 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. Sixty days postpartum is significant 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.

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

pression 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 perinatal mental health screening through routine health care delivery. 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 Medicaid mothers, 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 counselling 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 individual 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 ([SCHHS, 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. The recommended depression screening tool is a standardised tool such as 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 Gynaecologists (ACOG) recommends that all women are screened for perinatal mental health conditions, and 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 (ACOG, 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). Infants are due a well-child visit at 3-5 days, one month, and two months after birth. 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. Finally, in order to understand patterns of differential treatment impacts on study outcomes across race, we look at screening prevalence and 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. We examine the rates of depression screening, SBIRT screening, and SBIRT referrals in the sample in the prenatal period, from birth to sixty days postpartum, and a combination of these two periods.

### 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 MJ, 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, but there is variation in the level of participation in the programme. Furthermore, mothers in the control group may still 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.

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 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.

### 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

Table 2. Participation in NFP

	Prenatal %/Num.	60 days postpartum %/Num.
<b>Programme encounters</b>		
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
<b>Visit duration</b>		
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.

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, with 24% of all mothers (both treatment and control) being screened across the study period. There is almost no depression screening by Medicaid providers during pregnancy. After birth, in the postpartum period, 24% of mothers receive a depression screening. This figure is low given the guidance to screen in the postpartum period (ACOG, 2024), and the fact that providers can bill depression screens for mothers during well-child visits. Instead, 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
<b>Panel A: NFP</b>		
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)
<b>Panel B: Medicaid</b>		
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=4,932 for “Panel B: Medicaid” sample. N=2,509 for “Panel A: NFP - Prenatal” sample. N=2,315 for “Panel A: NFP - 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 of 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. As we test for multiple hypotheses, Appendix Table shows the q-values calculated using the [Benjamini and Hochberg \(1995\)](#) procedure.

We do find heterogenous NFP programme effects by race; Table 4 also 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 are 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 (Appendix Table [A13](#)). 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 Appendix Tables [A14](#) and [A15](#).



Table 4. Treatment effects of NFP

	Treatment Mean	Control Mean	Unadjusted Effect	Adjusted Effect	
<b>Full sample</b>					
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]
<b>Non-Hispanic White sample</b>					
Any OP diagnosis/medication/therapy	47.55	47.23	0.32	0.71	[-4.02, 5.44]
Any OP diagnosis	41.07	43.21	-2.14	-1.83	[-6.55, 2.88]
Any Medication	24.24	20.65	3.59	4.35 *	[0.17, 8.53]
Any Therapy	7.77	6.12	1.65	1.89	[-0.53, 4.30]
Any IP/ED visit	19.33	16.25	3.08	3.16 +	[-0.57, 6.88]
Num. IP/ED visits	0.33	0.29	0.04	0.05	[-0.06, 0.16]
Treatment follow up	16.47	14.72	1.74	1.74	[-1.77, 5.25]
Any substance use	29.69	31.55	-1.85	-1.26	[-5.31, 2.80]
Any domestic violence	0.93	0.57	0.35	0.34	[-0.52, 1.19]
<b>Non-Hispanic Black sample</b>					
Any OP diagnosis/medication/therapy	24.87	26.95	-2.08	-1.76	[-5.10, 1.57]
Any OP diagnosis	22.82	23.64	-0.83	-0.58	[-3.78, 2.61]
Any Medication	7.74	10.28	-2.54	-2.69 *	[-5.02, -0.36]
Any Therapy	3.81	3.78	0.03	-0.22	[-1.70, 1.26]
Any IP/ED visit	11.61	10.99	0.62	0.56	[-1.87, 3.00]
Num. IP/ED visits	0.21	0.18	0.03	0.02	[-0.03, 0.08]
Treatment follow up	5.40	5.67	-0.28	-0.43	[-2.19, 1.34]
Any substance use	18.30	18.32	-0.02	0.10	[-2.72, 2.91]
Any domestic violence	2.29	2.13	0.16	-0.03	[-1.27, 1.21]

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

Notes: Full sample N = 4,932. Non-Hispanic White sample N = 1604. Non-Hispanic Black sample N = 2551. For all variables, the means and effects are percentages. “OP” stands for outpatient. “L&D” stands for labour and delivery. “IP” stands for inpatient. “ED” stands for emergency department. “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.

## 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 5. 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 Appendix Table A10. 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 5. 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. “Black” refers to non-Hispanic Black mothers. “White” refers to non-Hispanic White mothers. “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 6 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 (Appendix Table A11).

One potential reason for the different 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 6 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 (Appendix Table A9), 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 Table A9. 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**

We move on to examine screening and referral rates by race within the NFP programme. Lower rates of mental health diagnoses and treatment amongst Black women could be due to differences in screening and referral for Black participants. Table 6 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. Notably, White mothers were referred for mental health services at a higher rate than Black mothers. Appendix Table [A12](#) 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 [6](#) 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. Whatever dynamics are driving lower rates of mental health screenings in NFP do not appear to be present when screening is undertaken by Medicaid providers.

Table 6. 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
<b>NFP</b>									
<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
<b>Medicaid</b>									
<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 sample of non-Hispanic Black mothers. N=1,604 for 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 enrollment 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 7 shows the extent to which Black and White mothers had racially concordant and discordant nurses.

The racial concordance analysis is presented in Table 8. 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 vari-

ables. 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 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 outcomes. In fact, 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 7. Racial composition of nurses and mothers

	Full sample %	Black %	White %
<b>Main nurse</b>			
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)
<b>Any nurse</b>			
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 8. 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 (1.48)	-1.64* (0.66)	-0.11 (0.12)	-0.03 (0.02)	-0.04 (0.03)
Black Mother, Black Nurse	-0.02 (0.03)	-4.55*** (1.16)	-0.55 (0.52)	0.08 (0.09)	0.04 (0.02)	-0.07** (0.02)
Black Mother, White Nurse	-0.04 (0.02)	-0.62 (0.92)	-1.09** (0.41)	-0.15* (0.07)	0.01 (0.02)	-0.02 (0.02)
Observations	1951	1950	1951	1951	1951	1951
Adjusted $R^2$	0.040	0.131	0.142	0.123	0.026	0.080
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: 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 programs, housing insecurity, high risk pregnancy. 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. Yet there is limited treatment amongst these mothers - 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](#)), and 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](#)). Given this range of potential drivers, approaches to target perinatal mental health based around care coordination 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 of 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 the other cited papers use depression scales. 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. We find no statistically significant effects of NFP on substance use and maternal experience of violence and homicide. This is aligned with some of the prior literature. Other RCT evaluations of NFP find no programme effects on substance use and abuse ([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](#)) for mothers in the treatment group.

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 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 for some populations.

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 diagnoses 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 more likely to adhere to screening at 36 weeks of pregnancy and 1 to 8 weeks postpartum for White mothers. Furthermore, 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, postpartum based model that was offered universally. Overall, we need more evidence on the effects of nurse home visiting on maternal health by 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. African American 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](#)). 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 these differential treatment effects, though we lack sufficient data to be able to track the race of all nurses. Our findings may also be driven by the limitations relating to healthcare providers, nurses, and their tools. 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 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 the NFP programme, for a variety of reasons (including those discussed above).

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 whether Black mothers fear revealing information to providers of intensive home visiting programmes would also be a valuable contribution.

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## A Appendix Tables

Appendix Table A1. Balance table, non-Hispanic Black mothers

Variables	Treatment Mean	Control Mean	Difference P-val
Age (%)			
- 15-18	16.95	14.66	0.14
- 19-24	57.36	58.98	0.43
- 25-34	23.40	25.18	0.32
- 35+	2.29	1.18	0.06
BMI (%)			
- <18.5	4.28	4.54	0.77
- 18.5-24.9	35.99	34.36	0.43
- 25-29.9	22.00	23.07	0.55
- >30.0	37.73	38.04	0.88
Highest education level (%)			
- Less than high school diploma	18.64	16.88	0.28
- High school diploma or equivalent	38.80	37.46	0.51
- Some college, less than bachelor's degree	34.98	36.15	0.56
- Bachelor's degree or higher	7.52	9.51	0.09
Mental health/substance use (%)			
- Depressive symptoms	21.07	21.33	0.88
- High stress	66.55	65.83	0.72
- Received mental health treatment in last year	8.04	7.70	0.77
- Reported drinking alcohol in 3 months before pregnancy	50.83	53.16	0.27
- Reported smoking cigarettes in 3 months before pregnancy	16.80	18.61	0.26
Other health indicators (%)			
- Used ED in 6 months before enrollment	55.66	55.63	0.99
- Reported health as fair/poor	12.25	8.90	0.01
Family planning indicators (%)			
- Has access to family planning or birth control	59.58	59.38	0.93
- Reported desire for mother children in future	62.87	62.25	0.76
Pregnancy indicators at baseline (%)			
- Gestational age at enrollment (weeks)	1497.83	1455.67	0.11
- Received $\geq 1$ prenatal visit before enrollment (%)	85.14	84.53	0.69
Socioeconomic indicators (%)			
- Received $\geq 1$ social service programs	72.27	73.42	0.54
- Worked for pay at time	54.60	54.96	0.86
- Lived with parents	49.74	50.83	0.60
- Experienced housing insecurity	12.91	12.78	0.93
Observations	1705	846	2551

Notes: Survey data collected after enrollment and before randomisation between 2016 and 2020. Sample is non-Hispanic Black mothers. BMI is body mass index. ED is emergency department. High stress is a Perceived Stress Scale 4 score of  $\geq 4$ . Depressive symptoms is a Patient Health Questionnaire 2 score of  $\geq 3$ . Social service programs include Temporary Assistance for Needy Families; Supplemental Nutrition Assistance Program; Supplemental Security Income; Special Supplemental Nutrition Programme for Women, Infants, and Children; and unemployment benefits. Housing insecure is whether the mother moved at least twice in the previous 12 months.

Appendix Table A2. Balance table, non-Hispanic White mothers

Variables	Treatment Mean	Control Mean	Difference P-val
Age (%)			
- 15-18	18.50	20.08	0.45
- 19-24	52.91	52.39	0.84
- 25-34	25.90	25.81	0.97
- 35+	2.68	1.72	0.24
BMI (%)			
- <18.5	7.99	6.81	0.41
- 18.5-24.9	38.91	44.36	0.04
- 25-29.9	19.83	18.09	0.41
- >30.0	33.27	30.74	0.31
Highest education level (%)			
- Less than high school diploma	25.67	25.10	0.80
- High school diploma or equivalent	33.21	31.61	0.52
- Some college, less than bachelor's degree	34.42	38.12	0.15
- Bachelor's degree or higher	6.70	5.17	0.24
Mental health/substance use (%)			
- Depressive symptoms	16.82	17.12	0.88
- High stress	66.35	65.44	0.72
- Received mental health treatment in last year	24.28	23.61	0.77
- Reported drinking alcohol in 3 months before pregnancy	54.41	51.63	0.30
- Reported smoking cigarettes in 3 months before pregnancy	42.12	42.77	0.80
Other health indicators (%)			
- Used ED in 6 months before enrollment	48.84	51.43	0.33
- Reported health as fair/poor	14.03	14.04	1.00
Family planning indicators (%)			
- Has access to family planning or birth control	58.63	59.08	0.86
- Reported desire for mother children in future	71.14	74.38	0.17
Pregnancy indicators at baseline (%)			
- Gestational age at enrollment (weeks)	1435.52	1441.87	0.85
- Received $\geq 1$ prenatal visit before enrollment (%)	85.00	82.82	0.26
Socioeconomic indicators (%)			
- Received $\geq 1$ social service programs	59.72	63.69	0.13
- Worked for pay at time	54.63	50.77	0.15
- Lived with parents	36.26	38.31	0.43
- Experienced housing insecurity	21.13	23.71	0.24
Observations	1081	523	1604

Notes: Survey data collected after enrollment and before randomisation between 2016 and 2020. Sample is non-Hispanic White mothers. BMI is body mass index. ED is emergency department. High stress is a Perceived Stress Scale 4 score of  $\geq 4$ . Depressive symptoms is a Patient Health Questionnaire 2 score of  $\geq 3$ . Social service programs include Temporary Assistance for Needy Families; Supplemental Nutrition Assistance Programme; Supplemental Security Income; Special Supplemental Nutrition Programme for Women, Infants, and Children; and unemployment benefits. Housing insecure is whether the mother moved at least twice in the previous 12 months.

Appendix Table A3. Diagnosis codes for depression, anxiety, and stress-reactions

Description	ICD-10 code(s)
Depression	F53; O906; F99; O9934*; F32*; F33*
Anxiety	F41*
Stress-reaction	F43*

Source: [Sherman and Ali \(2018\)](#)

Appendix Table A4. Diagnosis codes for substance use

Description	ICD-10 code(s)
Neonatal abstinence disorder	P96.1, P04.2, P04.3, P04.4*, P04.8*, P04.9, P04.14, P04.16
Opioids	F11*
Tobacco	F17.2*; O99.33*; Z72.0
Alcohol	F10.*
Sedative	F13*
Cocaine	F14*
Amphetamines	F15*
Cannabis	F12*

Source: [Jarlenski et al. \(2020\)](#)

Appendix Table A5. Diagnosis codes for maternal experience of violence or homicide

Description	ICD-10 code(s)
Adult neglect	T74.01, T76.01
Adult physical abuse	T74.11, T76.11
Adult sexual abuse	T74.21, T76.21
Adult psychological abuse	T74.31, T76.31
Unspecified adult maltreatment	T74.91, T76.91
Husband, perpetrator of maltreatment	Y0701
Assault by unarmed brawl	Y040
Observation after rape	Z0441
Assault by other bodily force	Y048
Unspecified perpetrator of maltreatment	Y079
Other family member perpetrator of maltreatment	Y07499
Encounter for mental health services for victim of spousal or partner abuse	Z691*
Encounter for mental health services for victim or perpetrator of other abuse	Z698*
Encounter for observation following alleged adult physical abuse	Z0471

Sources: [Davidov et al. \(2017\)](#), [Schafer et al. \(2008\)](#)

Appendix Table A6. Therapeutic class codes for filled antidepressants or anxiolytics

Description	Therapeutic class codes
Antidepressants	281604
Anxiolytics	2824*

Appendix Table A7. Outpatient psychotherapy codes

Description	CPT codes
Psychotherapy (individual, family, or group)	90804-90815; 90832-90834; 90836- 90840; 90845-90847; 90849; 90853; 90857; 90862; 90875; 90876

Source: [Sherman and Ali \(2018\)](#)

Appendix Table A8. Sample definition

Sample measure	Data sources	Definition
Index birth	South Carolina vital records birth certificates and baseline survey	A birth identified by a matched birth certificate in Vital Records with a date of birth within 120 days before or after the estimated delivery date on the baseline survey.

Appendix Table A9. NFP visits, by race

	Visit length Prenatal	Visit length 60 days pp	Visit length Study period	Visit count Prenatal	Visit count 60 days pp	Visit count Study period
Black	-2.441** (0.845)	-2.340 (1.697)	-2.040** (0.789)	-0.180 (0.208)	-0.454*** (0.107)	-0.409 (0.295)
Observations	2733	2105	2734	2742	2144	2743
Adjusted $R^2$	0.111	0.038	0.122	0.083	0.153	0.110
Mean	65.89	62.02	64.83	9.792	4.914	13.63

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

Notes: Survey data collected after enrolment and before randomisation between 2016 and 2020. “Black” refers to non-Hispanic Black mothers. “60 days pp” denotes that the visit took place after delivery, up to 60 days postpartum. “Study period” includes the prenatal period, delivery, and up to 60 days postpartum. “Avg. visit length” in minutes. “Visit count” is the number of at home NFP completed visits. All models include 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 programs, housing insecurity, high risk pregnancy.

Appendix Table A10. Mental health status prior to intervention

	Depressive Symptoms	High Stress	Received MH Treatment
Black	0.0518*** (0.0133)	0.00877 (0.0160)	-0.150*** (0.0114)
Adjusted $R^2$	0.019	0.018	0.067
Mean	0.196	0.649	0.137

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

Notes: N=4,155. Survey data collected after enrolment and before randomisation between 2016 and 2020. “Black” refers to non-Hispanic Black mothers. “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. All models include 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 programs, housing insecurity, high risk pregnancy.

Appendix Table A11. Retention in NFP

	NFP to birth	NFP to 60 days pp	NFP to 1 year pp
Black	0.0284 (0.0168)	-0.00242 (0.0184)	-0.0295 (0.0198)
Adjusted $R^2$	0.025	0.040	0.069
Mean	0.779	0.703	0.523

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

Notes: N=2,786. Survey data collected after enrolment and before randomisation between 2016 and 2020. “Black” refers to non-Hispanic Black mothers. “NFP to birth” denotes that the mother remained in the NFP programme until birth. “NFP to 60 days pp” denotes that the mother remained in the NFP programme up to 60 days postpartum. “NFP to 1 year pp” denotes that the mother remained in the NFP programme up to 1 year postpartum. 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 programs, housing insecurity, high risk pregnancy.



Appendix Table A12. NFP mental health screening and referrals

	Screened at intake			Screened at 36w			Screened 1-8w pp			Num. screenings			Any screening			Any MH referral		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Black	0.02 (0.01)	0.03* (0.01)	0.03* (0.01)	-0.04* (0.02)	-0.02 (0.02)	-0.03 (0.02)	-0.02 (0.02)	0.00 (0.02)	-0.01 (0.02)	-0.08 (0.05)	0.02 (0.05)	-0.02 (0.05)	0.02 (0.01)	0.03* (0.01)	0.02* (0.01)	-0.04** (0.01)	-0.04** (0.01)	-0.04* (0.01)
Adjusted $R^2$	0.000	0.036	0.036	0.002	0.030	0.039	0.000	0.044	0.058	0.004	0.146	0.155	0.001	0.019	0.021	0.003	0.027	0.030
Mean	0.87	0.87	0.87	0.60	0.60	0.60	0.66	0.66	0.66	2.56	2.56	2.56	0.90	0.90	0.90	0.13	0.13	0.13
Controls	No	IA	Full	No	IA	Full	No	IA	Full	No	IA	Full	No	IA	Full	No	IA	Full

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

Notes: N=2,786. Survey data collected after enrolment and before randomisation between 2016 and 2020. “Black” refers to non-Hispanic Black mothers. “Screened at 36w” is screened at 36 weeks pregnant. “Screened 1-8w pp” is screened at 1-8 weeks after birth. “Any MH referral” is ever referred for mental health treatment. “IA” controls are controls for the NFP implementating agency (IA). “Full” controls include controls for the IA, teen mother, mother aged 28 and over, daily interaction with father, less than high school education, work status, receipt of social service programs, housing insecurity, high risk pregnancy. Standard errors in parentheses.

Appendix Table A13. Treatment effects of NFP, vulnerable subsample

	Treatment Mean	Control Mean	Unadjusted Effect	Adjusted Effect
Any OP diagnosis/medication/therapy	39.09	40.23	-1.14	-1.41 [-5.12, 2.30]
Any OP diagnosis	35.21	37.58	-2.37	-2.73 [-6.41, 0.96]
Any Medication	17.57	16.65	0.93	0.92 [-2.11, 3.95]
Any Therapy	8.25	8.45	-0.20	0.29 [-1.90, 2.48]
Any IP/ED visit	18.41	16.27	2.14	1.58 [-1.42, 4.59]
Num. IP/ED visits	0.34	0.31	0.03	0.03 [-0.07, 0.12]
Treatment follow up	13.51	13.62	-0.11	0.37 [-2.32, 3.05]
Any substance use	24.81	26.61	-1.80	-1.70 [-4.95, 1.54]

<sup>+</sup>  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Notes: N=2,616. Vulnerable sample comprises of those younger than 19 years, had not finished high school, or had challenges with mental health (PHQ-2 score of at least 3 at baseline or reported receiving mental health treatment in the year before enrolment). For the “Any” variables, the means and effects are percentages. For the “Num” variable, the mean and effects are numbers. “OP” stands for outpatient. “L&D” stands for labour and delivery. “IP” stands for inpatient. “ED” stands for emergency department. “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. “Any treatment follow up” is a second prescription or therapy visit within 120 days of first prescription or therapy visit. “Any treatment” is any medication or therapy visit. “Any therapy follow up” is a second therapy visit within 120 days of first therapy visit. “Any medication follow up” is a second medication fill within 120 days of first medication fill.

Appendix Table A14. Treatment effects of NFP, sample of mothers with any Medicaid coverage

	Treatment Mean	Control Mean	Unadjusted Effect	Adjusted Effect
Any OP diagnosis/medication/therapy	32.22	33.71	-1.49	-1.56 [-4.05, 0.92]
Any OP diagnosis	28.80	30.48	-1.67	-1.75 [-4.17, 0.67]
Any Medication	13.37	13.41	-0.04	-0.04 [-1.96, 1.88]
Any Therapy	5.07	4.72	0.35	0.38 [-0.81, 1.57]
Any IP/ED visit	14.02	12.35	1.67	1.49 [-0.36, 3.35]
Num. IP/ED visits	0.25	0.21	0.03	0.03 [-0.02, 0.08]
Treatment follow up	8.98	8.81	0.16	0.07 [-1.49, 1.63]
Any substance use	21.70	22.66	-0.95	-0.51 [-2.63, 1.61]

<sup>+</sup>  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Notes: N=4,864. Sensitivity analysis conducted on sample of mothers with any Medicaid coverage up to 60 days postpartum. For the “Any” variables, the means and effects are percentages. For the “Num” variable, the mean and effects are numbers. “OP” stands for outpatient. “L&D” stands for labour and delivery. “IP” stands for inpatient. “ED” stands for emergency department. “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. “Any treatment follow up” is a second prescription or therapy visit within 120 days of first prescription or therapy visit. “Any treatment” is any medication or therapy visit. “Any therapy follow up” is a second therapy visit within 120 days of first therapy visit. “Any medication follow up” is a second medication fill within 120 days of first medication fill.

Appendix Table A15. Treatment effects of NFP, sample of mothers with continuous Medicaid coverage

	Treatment Mean	Control Mean	Unadjusted Effect	Adjusted Effect	
Any OP diagnosis/medication/therapy	32.41	33.93	-1.51	-1.31	[-3.83, 1.20]
Any OP diagnosis	29.00	30.63	-1.63	-1.45	[-3.91, 1.00]
Any Medication	13.40	13.44	-0.04	0.07	[-1.88, 2.01]
Any Therapy	5.07	4.76	0.32	0.39	[-0.81, 1.59]
Any IP/ED visit	14.16	12.37	1.79	1.78 <sup>+</sup>	[-0.10, 3.66]
Num. IP/ED visits	0.25	0.21	0.04	0.04	[-0.01, 0.09]
Treatment follow up	8.96	8.88	0.08	0.08	[-1.49, 1.66]
Any substance use	21.64	22.70	-1.06	-0.39	[-2.53, 1.75]

<sup>+</sup>  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Notes: N=4,770. Sensitivity analysis conducted on sample of mothers with continuous Medicaid coverage up to 60 days postpartum. For the “Any” variables, the means and effects are percentages. For the “Num” variable, the mean and effects are numbers. “OP” stands for outpatient. “L&D” stands for labour and delivery. “IP” stands for inpatient. “ED” stands for emergency department. “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. “Any treatment follow up” is a second prescription or therapy visit within 120 days of first prescription or therapy visit. “Any treatment” is any medication or therapy visit. “Any therapy follow up” is a second therapy visit within 120 days of first therapy visit. “Any medication follow up” is a second medication fill within 120 days of first medication fill.

Appendix Table A16. Adjusting for Multiple Hypothesis Testing

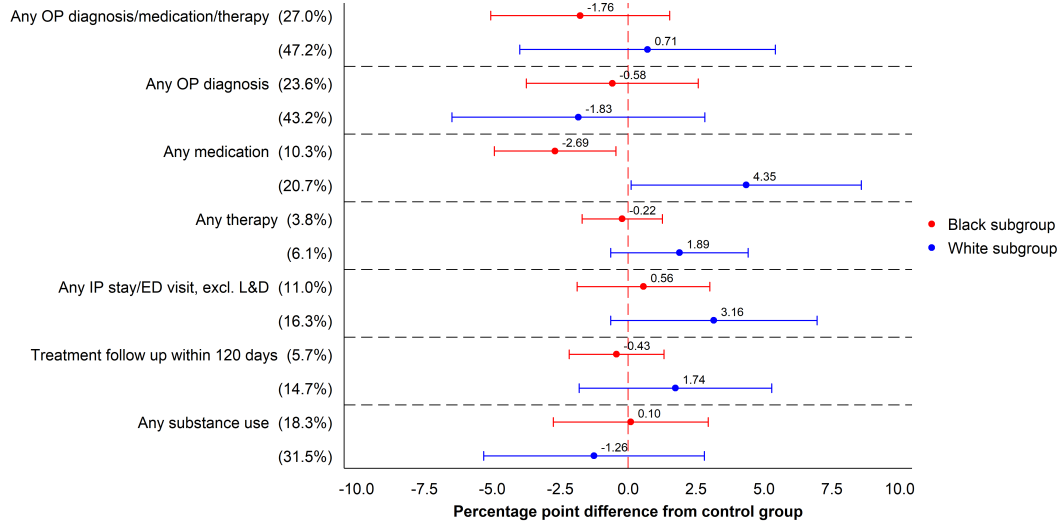
	Unadjusted P-value	Q-value
<b>Full sample</b>		
Any OP diagnosis/medication/therapy	0.28	0.64
Any OP diagnosis	0.20	0.61
Any Medication	0.95	0.97
Any Therapy	0.50	0.89
Any IP/ED visit	0.12	0.61
Num. IP/ED visits	0.20	0.61
Treatment follow up	0.86	0.97
Any substance use	0.66	0.97
Any domestic violence	0.97	0.97

<sup>+</sup>  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Notes: Full sample N =4,932. “OP” stands for outpatient. “Q-value” are calculated using the [Benjamini and Hochberg \(1995\)](#) procedure. “L&D” stands for labour and delivery. “IP” stands for inpatient. “ED” stands for emergency department. “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.

## B Appendix Figures

Appendix Figure B1. The effect of NFP on mental health outcomes, by race



Notes: Non-Hispanic White sample N = 1604. Non-Hispanic Black sample N = 2551. For all variables, the means and effects are percentages. “OP” stands for outpatient. “L&D” stands for labour and delivery. “IP” stands for inpatient. “ED” stands for emergency department. “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. “Treatment follow up within 120 days” is a second prescription or therapy visit within 120 days of first prescription or therapy visit.