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Preventing Infant Mortality Through Medicaid-Administered Prenatal Care Coordination: Evidence From Wisconsin

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ABSTRACT

Objective: To estimate associations between Wisconsin Medicaid's Prenatal Care Coordination (PNCC) program and infant mortality.

Data Sources and Study Setting: We analyzed birth records, Medicaid claims, and infant death records for all resident and in-state Medicaid-paid live deliveries during 2010–2018.

Study Design: We measured PNCC exposure during pregnancy dichotomously (none; any) and categorically (none; assessment/care plan only; service receipt). Our outcome was infant mortality (death at age < 365 days). Adjusted binary logit regressions and propensity score weighted regressions tested associations between PNCC receipt and infant mortality, and we estimated probabilities and average marginal effects of infant mortality. We also executed regressions with interactions on maternal race/ethnicity to determine if associations varied across Black non-Hispanic (NH), Hispanic, and White NH births.

Data Collection/Extraction Methods: Our sample consisted of 231,540 Medicaid-paid births during 2010–2018. PNCC is only available to pregnant Medicaid beneficiaries.

Principal Findings: Infant mortality was lower among PNCC assessment/care plan only births (5.0 deaths/1000 births) and PNCC service receipt births (6.1 deaths/1000 births) relative to non-PNCC births (6.8 deaths/1000 births). This pattern was consistent in Black NH and Hispanic subgroups, but infant mortality did not vary by PNCC among White NH deliveries. Overall, adjusted binary logit regressions indicated that the probabilities of infant mortality were 0.70% for no PNCC and 0.53% for any PNCC, yielding an average marginal effect of −0.17 percentage points (95% confidence interval −0.22 percentage points, −0.11 percentage points). This association did not vary by PNCC exposure level. PNCC-infant mortality associations were significantly stronger for Black NH births relative to White NH births. Results were consistent in propensity score weighted regressions.

Conclusions: PNCC during pregnancy is associated with a lower probability of infant mortality, particularly in Black NH families. The benefit of PNCC on infant mortality may not depend on receiving services beyond care planning.

Summary

- What is known on this topic
  - Medicaid obstetric care coordination programs provide tailored medical, educational, and social services during pregnancy to improve maternal and infant health.
  - Receipt of care coordination services during pregnancy reduces the risk of adverse birth outcomes—in particular, low birth weight and preterm birth.
  - Two prior studies, both of which are based in Michigan, found that obstetric care coordination receipt may prevent infant mortality (death within the first 365 days of life).
- What this study adds
  - Exposure to Wisconsin Medicaid's Prenatal Care Coordination program is associated with lower probabilities of infant mortality and neonatal mortality (death within the first 28 days of life).
  - This association is strongest in the Black (non-Hispanic) population of Medicaid births.
  - Prevention of adverse birth outcomes via care coordination may explain the association between Prenatal Care Coordination receipt and infant mortality.

1 | Introduction

Infant mortality (death < 365 days post-birth) is a critical public health problem in the United States [1]. In 2022, the national infant mortality rate (IMR) was 5.6 deaths per 1000 births, representing > 20,500 deaths [2]. There are also substantial racial disparities in infant mortality. The 2022 IMR was greatest for Black non-Hispanic (NH) infants at 10.9 per 1000 births—more than double that of White NH infants (4.5 per 1000 births)—and the Black–White disparity in infant mortality has persisted for nearly a century [2, 3]. Further, the IMR for American Indian/Alaska Native NH and Pacific Islander NH infants also exceeds the national average [2]. Infant mortality has declined steadily in the United States by 19% since 2005 and by nearly half since 1990 [4, 5]. Nonetheless, the United States has the greatest incidence of infant mortality among high-income nations globally [6]. Thus, preventing infant mortality remains a national priority.

There are two oft-cited explanations for sharp infant mortality reductions over the past 35 years: technological and quality advancements in neonatal intensive care unit services for preterm or low birth weight infants [7–9] (notably, the widespread adoption of surfactant to treat respiratory distress syndrome [7, 10, 11]); and Medicaid expansion for pregnant beneficiaries and infants [12–15]. Federal reforms in the late 1980s broadened eligibility and services for pregnancy-related care to prevent adverse birth outcomes and, thusly, infant mortality. A 1996 study found that Medicaid expansion during this period reduced infant mortality incidence, particularly among the lowest-income populations [16]. Subsequent research found that Medicaid expansion following the 2010 Patient Protection and Affordable Care Act—which broadened prenatal and reproductive healthcare coverage—was associated with declining infant mortality among Black NH and Hispanic infants [17, 18].

While evidence suggests that Medicaid coverage and service expansion reduced infant mortality, it is less certain whether specific Medicaid benefits and programs impacted infant mortality. One advent of federal Medicaid expansion in the late 1980s included the widespread implementation of state-administered and Medicaid-funded obstetric care coordination programs [19, 20]. Obstetric care coordination supplements prenatal care with tailored services that target behavioral and social risk factors of adverse birth outcomes [21, 22]. Nearly four decades of scholarship suggests that obstetric care coordination prevents both low birth weight and preterm birth [23–29], which are leading causes of infant mortality [4, 30]. Consequently, receipt of obstetric care coordination services may also improve infant survival.

To date, there are only two published studies on Medicaid obstetric care coordination and infant mortality, and both evaluated Michigan's Maternal Infant Health Program (MIHP). The first study examined any MIHP exposure among Medicaid-paid births during 2009–2012 [31]. The authors found that any MIHP receipt—including screening without further follow-up—was negatively associated with infant mortality and mediated by preterm birth. Additionally, this association did not vary between Black and non-Black births. A subsequent analysis of the same cohort found no difference in infant mortality between MIHP-screened births and MIHP-service recipient births [32]. These results are promising, but we can reexamine this relationship with more recent data in a different population to interrogate the temporal and geographic generalizability of these findings. Further, and like the Michigan studies, we can evaluate differential mortality outcomes by race to determine whether obstetric care coordination reduces racial disparities in infant mortality.

We investigate participation in Wisconsin's Prenatal Care Coordination (PNCC) program [33] and its association with infant mortality among Medicaid-paid births during 2010–2018. Additionally, we examine differential associations by maternal race/ethnicity (Black NH; Hispanic; White NH). We hypothesize that PNCC is negatively associated with infant mortality and that associations differ by race/ethnicity due to Wisconsin's demographic makeup and geographic variation in PNCC services. Most of Wisconsin's Black NH population resides in highly urbanized areas with prevalent and well-resourced PNCC services, whereas other racial/ethnic populations are dispersed across more rural regions with low PNCC availability [34–36].

2 | Methods

2.1 | PNCC

PNCC is a Wisconsin Medicaid benefit that is administered through local public health departments and approved independent care coordination providers throughout the state [33]. This program provides medical, educational, and social services

to pregnant beneficiaries with the goal of improving maternal and infant health. Program services are varied and tailored to the beneficiary's needs. Additionally, these services target social and behavioral factors that elevate the risk of adverse pregnancy health outcomes. Examples of PNCC services include psychosocial therapy, alcohol and drug cessation, continuing employment support, and nutrition counseling [33, 37].

Pregnant Medicaid beneficiaries enroll in PNCC by completing an eligibility questionnaire at a certified clinical or community-based service agency [37]. Individuals may seek assessment independently or they may receive a referral from a health care professional. The questionnaire consists of 31 risk factors of adverse pregnancy outcomes that relate to sociodemographic background (e.g., no college education), living circumstances (e.g., unstable housing), health behavior (e.g., cigarette smoking), and pregnancy history (e.g., prior preterm delivery) [38]. A beneficiary is eligible for services if they are < 18 years-old at assessment or report 4+ risk factors on the questionnaire [37]. PNCC eligibility is intentionally broad to maximize program uptake. The questionnaire is available in the English, Hmong, and Spanish languages [38].

PNCC enrollees meet with a care coordinator to develop their care plan [37]. Care coordinators can bill for services once per 30 days, and Medicaid covers PNCC services from enrollment to 60-day postpartum. PNCC-providing institutions submit management plans to the Wisconsin Department of Health Services to prove their ability to administer assessments, care plans, and services. PNCC is a state-mandated program, but local public health departments (county or city) can prioritize populations or services for PNCC administration [37]. This may manifest geographic variation in PNCC outreach [36, 39]. We describe PNCC measurement in Section 2.3.

2.2 | Data

The Wisconsin Department of Health Services furnished all birth records for live, in-state resident deliveries during 2010–2018 alongside linked infant death records for 2010–2019. We accessed maternal Medicaid claims and encounters (henceforth, "claims")—including pharmaceutical claims—for 2009–2018 from the Wisconsin Administrative Data Core (WADC) [40]. Medicaid is a federal- and state-funded health insurance program for low-income United States residents [41]. Tables S1 and S2 contain all billing codes for analyses.

Birth records linked to WADC with a complex matching strategy. Non-study team programmers created maternal identifiers for birth records and matched mothers across birth records on name (first; middle initial; last; suffix) and birthdate. Additionally, programmers assigned the same maternal identifier to near-matches due to name changes or typos. Maternal identifiers on the birth record allowed us to generate family clusters. Programmers then linked birth record maternal identifiers to WADC identifiers on name (first; middle initial; last; suffix) and birthdate. Near-matches due to name changes or typos were assigned perfect 1:1 maternal links between birth records and the WADC. Otherwise, a maternal birth record identifier could link to multiple WADC identifiers.

We sampled Medicaid-paid births during 2010–2018 with complete information on selected birth record variables. PNCC participation is limited to pregnant Medicaid beneficiaries [37, 38], and we identified Medicaid payment of live birth with Current Procedural Technology codes (Table S1) [42]. Additionally, we required complete information on several analyzed birth record variables that we used for regression analyses: maternal age, race/ethnicity, nativity, education, marital status, smoking, chronic hypertension, chronic diabetes, and residence county; and infant birth order and plurality.

There were 576,266 unique birth records for deliveries during 2010–2018. Of these, 15,188 birth records (2.6%) linked to multiple maternal WADC identifiers. Absent shared variables to break ties among multiple identifier linkages, we randomly selected one match and discarded others. We then identified 233,920 births (40.6% of the sampling pool) that linked to a Medicaid live delivery claim. Finally, we excluded 2380 births (1.0% of Medicaid-paid births) with missing information on analyzed birth record variables. Variables that accounted for the greatest missingness were maternal education (1563 births), race/ethnicity (335 births), and nativity (207 observations). This yielded a final analytical sample of 231,540 births, representing 99% of all Medicaid-paid live, in-state, resident births during 2010–2018.

We then conducted power calculations to determine minimum sample sizes for regressions with interactions on race/ethnicity (Table S3) [43]. Using White NH as the reference, we had sufficiently large samples for Black NH and Hispanic births to detect interactions, but our sample sizes for American Indian/Alaska Native NH, Asian/Pacific Islander NH, multiple race NH, or other race NH births were too small. Thus, we only considered results for Black NH, Hispanic, and White NH births for all race/ethnicity-stratified analyses.

2.3 | Variables

Our exposure was PNCC receipt during pregnancy (≤ 8 months pre-delivery), which we identified with Health Care Procedure Coding System values in Medicaid claims (Table S1). We coded PNCC dichotomously (none; any) and categorically (none; assessment/care plan only; service receipt). The categorical measure distinguishes assessed beneficiaries who may have a care plan ("assessment/care plan only") from beneficiaries who received services after care planning ("service receipt"). PNCC services are billed as "education," "follow-up home visits," or "case management" in Medicaid claims, although specific types of services are unknown (e.g., smoking cessation therapy).

Our primary outcome was infant mortality (death at age < 365 days [1 year]). Secondary outcomes were neonatal mortality (death at age 0–28 days) and postneonatal mortality (death at age 29–364 days). We calculated survival time in days with birthdates and death dates.

Analyzed birth record variables included maternal characteristics (age; race/ethnicity; nativity; education; marital status; smoking during pregnancy; chronic hypertension; chronic diabetes; residence county urbanicity using the 2013 National Center for Health Statistics urban–rural classification

scheme [44]) and infant characteristics (birth order; plurality; birth year; gestational age in completed weeks; birth weight in grams). From Medicaid claims, we measured binary variables during pregnancy: a substance use disorder (SUD) diagnosis, identified with International Classification of Diseases codes (Table S1); receipt of United States Food and Drug Administration-approved medications for opioid use disorder (MOUD), identified with generic drug names for buprenorphine, methadone, and naltrexone in the Medicaid pharmaceutical data [45]; and receipt of mental health medications (anticonvulsants; psychotherapeutic agents; anxiolytics; sedatives; hypnotics), identified with American Hospital Formulary Service codes (Table S2).

2.4 | Analysis

We cross-tabulated infant mortality outcomes and sample characteristics by PNCC receipt. Additionally, we cross-tabulated PNCC receipt and maternal residence county by race/ethnicity (Black NH, Hispanic, and White NH only). Kaplan–Meier survival plots tracked infant mortality by PNCC receipt—overall and within Black NH, Hispanic, or White NH births—and corresponding log-rank tests computed differences in mortality by PNCC receipt.

A conceptual model guided covariate selection for adjusted regressions (Figure S1). We hypothesized that observed maternal characteristics confounded the relationship between PNCC receipt and infant death. First, there are several maternal characteristics that determine PNCC eligibility: low or high age (< 20 years old or 35+ years old), being non-White NH, having limited English language proficiency (correlated with being born outside of the United States [46]), incomplete high school education, being unmarried, currently smoking, having diabetes or hypertension, SUD, and a mental health diagnosis [37, 38]. Further, these maternal characteristics are associated with the risk of infant mortality [47–53]. Second, PNCC uptake varies by county urbanicity in Wisconsin [36]—as such, beneficiary lives likely impacts whether they receive PNCC services—and infant mortality also varies by county urbanicity [54, 55]. For non-maternal characteristics, we hypothesized that birth year confounded the relationship between PNCC receipt and infant mortality because both PNCC receipt and infant mortality have declined over time in Wisconsin [36, 56]; and latter birth order and plural birth may increase the risk of infant mortality [57–59]. Adjustment for these variables should reduce bias and improve precision in regressions.

Our primary regression analyses consisted of conventional binary logit regressions and propensity score weighted (PSW) regressions. For each combination of a PNCC exposure and mortality outcome, we executed conventional binary logit regressions that were unadjusted or adjusted for maternal characteristics (age; race/ethnicity; nativity; education; marital status; smoking; resident county urbanicity; chronic diabetes; chronic hypertension; SUD diagnosis; MOUD receipt; mental health medication receipt) and infant characteristics (birth order; plurality; birth year). Following each regression, we calculated predicted probabilities of mortality at each PNCC exposure level and average marginal effects of PNCC on mortality. For PSW regressions, we calculated the probability of PNCC exposure for each observation (separately for dichotomous and categorical exposures) in our full sample conditional on our previously listed control variables to better account for selection into PNCC. We executed 5000 iterations of weighting with covariate balance on mean effect size, and graphical diagnostics indicate strong balance of covariates between PNCC exposure levels (Figures S2–S9). We then executed PSW regressions and estimated the average treatment effect (ATE)—the average effect of PNCC on mortality for the full population of Medicaid births. Likewise, we calculated corresponding predicted probabilities of outcomes and average marginal effects. We used Stata's Twang and MNPS packages to conduct PSW analyses [60, 61]. In all regressions, we clustered standard errors at the county-level to account for geographic variation in PNCC services [36].

We then repeated adjusted conventional binary logit regressions and PSW regressions with interactions between maternal race/ethnicity (referent: White NH) and PNCC receipt to determine whether PNCC-mortality associations varied by race/ethnicity. Afterward, we calculated corresponding predicted probabilities of outcomes and average marginal effects for Black NH, Hispanic, and White NH births. Again, we did not consider other racial/ethnic subgroups due to insufficient sample size for detecting interactions.

We also conducted several supplementary analyses. First, we repeated all adjusted conventional regressions and PSW regressions (with and without interactions by race/ethnicity) with singleton births only ($N = 225{,}026$ births; 97.2% of the sample). Plural birth increases the risk of infant mortality, so this analysis determines if PNCC-mortality associations hold for lower-risk births [57, 58]. Second, we executed PSW regressions to estimate the average treatment effect on the treated (ATT) in the any PNCC group ($N = 54{,}309$ births) and in the PNCC service receipt group ($N = 36{,}486$ births). Unlike the ATE, the ATT estimates the expected difference in mortality between births with PNCC exposure to the same births had they been unexposed to PNCC, which should further allay bias from selection into treatment [60, 61]. We computed weights over 5000 iterations on our same set of control variables, and we executed PSW ATT regressions with and without interactions on race/ethnicity. Graphical diagnostics indicated good balance on covariates for PSW ATT regressions (Figures S10–S17). Third, we conducted a three-part mediation analysis with a subsample that had complete information on gestational age and birth weight ($N = 230{,}994$ births; 99.7% of the sample). Prior literature indicates that birth outcomes mediate the association between obstetric care coordination receipt and infant mortality [31]. To explore this, we executed adjusted logit binary regressions of preterm birth (gestational age < 37 weeks) or low birth weight (< 2500 g) on PNCC receipt to determine if PNCC was associated with birth outcomes; repeated our primary adjusted binary logit regression analysis while controlling for gestational age and birth weight to determine if adjustment for birth outcomes attenuated PNCC-mortality associations; and conducted causal mediation analysis to estimate how much gestational age or birth weight explained observed PNCC-mortality associations [62]. Finally, we executed adjusted sibling fixed effects (FE) linear probability models (LPM) to test associations

between PNCC receipt and infant mortality. Despite a broad set of covariates, there may be unobserved confounders—such as health-seeking behavior or genetic risk of adverse birth outcomes [63, 64]—that bias our estimates. Sibling FE regressions offset unobserved family-level factors that equally affect siblings' outcomes (i.e., infant mortality), thereby reducing confounding bias [65]. FE regressions only use in-sample siblings ($N = 120{,}070$ births; 51.9% of the sample), and estimates rely on sibling clusters with differential exposure. Thus, these estimates only apply to families with mixed uptake of PNCC across pregnancies. We opted for LPMs over binary logit regressions for this analysis because LPMs produce more accurate predicted probabilities in FE regressions with rare binary outcomes [66]. We did not test for interaction by race/ethnicity due to insufficient sample sizes. Likewise, we did not execute FE regressions with neonatal mortality or postneonatal mortality due to small mortality counts.

We conducted analyses with Stata Statistical Software: Release 18 [67]. The University of Wisconsin-Madison minimal risk institutional review board approved study procedures.

3 | Results

3.1 | Descriptive Results

On average, the pool of mothers who received PNCC services were younger, more racially diverse, had less formal education, were less likely to be married, and were more likely to reside in Milwaukee County (i.e., Wisconsin's sole large central metropolitan county) relative to non-recipient mothers (Table 1). Additionally, PNCC service-recipient births had higher proportions of first-births and low birth weight relative to non-PNCC births. The overall IMR was 6.6 deaths/1000 births, and the IMR was greater in the no PNCC group (6.8 deaths/1000 births) relative to the PNCC service receipt group (6.1 deaths/1000 births) and the PNCC assessment/care plan only group (5.0 deaths/1000 births). We observed similar patterns in neonatal mortality, while postneonatal mortality was more balanced by PNCC exposure. In Kaplan–Meier plots, the most rapid declines in survival occurred in the neonatal period (Figure 1; log-rank tests in Table A4). Mortality trends are similar in the sibling-only sample (Table A5).

Focusing on maternal race/ethnicity, approximately 31% of Black NH or Hispanic births connected to any PNCC receipt, compared to only 19% of White NH births (Table A6). We observed the most pronounced absolute differences in mortality by PNCC receipt among Black NH births. Compared to the no PNCC group (12.8 deaths/1000 births), the IMR was 36% lower in the PNCC assessment/care plan only group (8.2 deaths/1000 births) and 28% lower in the PNCC service receipt group (9.2 deaths/1000 births). Much like results from the full sample, we observed similar patterns in neonatal mortality but less variation by PNCC receipt in postneonatal mortality. Compared to Black NH births, absolute differences in IMR by PNCC status were smaller among Hispanic births—from 4.5 deaths/1000 births in the no PNCC group to 3.3 deaths/1000 births in the PNCC service receipt group. Similarly, there was little variation in IMR by PNCC status among White NH births (~5.3 deaths/1000 births). Furthermore, there was urban–rural variation in racial/ethnic distributions (Table A7). Milwaukee County accounted for 74% of Black NH births, 42% of Hispanic births, and 9% of White NH births (notably, highly rural counties accounted for 67% of White NH births). Among PNCC service recipient-births, Milwaukee County accounted for 82% of Black NH births, 56% of Hispanic births, and 7% of White NH births.

3.2 | Primary Regressions

Adjusted conventional regressions indicated that PNCC receipt was associated with a lower probability of infant mortality (Table 2). The predicated probabilities of infant mortality were 0.70% (95% CI 0.66%, 0.73%) for no PNCC and 0.53% (95% CI 0.49%, 0.57%) for any PNCC. Correspondingly, any PNCC was associated with a significant reduction in the probability of infant mortality (change in probability −0.17 percentage points [pp]; 95% CI −0.22 pp, −0.11 pp). Estimates did not vary by PNCC level among exposed (assessment/care plan only vs. service receipt). These patterns and associations were consistent with neonatal mortality, but there was no association between PNCC receipt and postneonatal mortality. Unadjusted results were similar (Table A8). Additionally, PSW ATE regressions generated nearly identical estimates.

Conventional and PSW ATE regressions with interactions on maternal race/ethnicity indicated that the magnitude of the negative association between any PNCC or PNCC service receipt and infant mortality was stronger among Black NH births relative to White NH births (Table 3). However, these associations did not significantly vary between Hispanic and White NH births. Predicted probabilities and average marginal effects reflected these patterns. For example, focusing on results from conventional binary logit regressions, the predicted probabilities of infant mortality among Black NH births were 1.19% (95% CI 1.09%, 1.28%) for no PNCC and 0.83% (95% CI 0.76%, 0.90%) for PNCC service receipt (Table 4). Subsequently, PNCC service receipt was associated with a 0.36 pp decrease (95% CI −0.42 pp, −0.30 pp) in the probability of infant mortality. The predicted probabilities of infant mortality for Hispanic and White NH births hovered around 0.40%–0.60% regardless of PNCC exposure level, and PNCC was not associated with infant mortality in either subgroup. Similar patterns emerged for neonatal mortality, although there were no significant associations for postneonatal mortality (Tables S9–S14).

3.3 | Supplemental Analyses

Excluding plural births did not notably alter regression estimates (Tables S15–S22). PSW ATT regressions estimates also indicated that PNCC was negatively associated with infant and neonatal mortality, although there was no significant variation by race/ethnicity (Tables S23–S28). Additionally, we found evidence of mediation by birth outcomes (Tables S29–S31): PNCC was associated with preterm birth and low birth weight; birth outcome adjustment attenuated associations between PNCC and mortality; and gestational age explained roughly half of the observed association between any PNCC receipt and infant

TABLE 1 | Baseline characteristics of the sample.

		Prenatal Care Coordination receipt during pregnancy			
	Overall	**None**	**Any**	**Assessment/care plan only**	**Service receipt**
Sample size, *N* (Row %)	231,540 (100.0)	177,231 (76.5)	54,309 (23.5)	17,823 (7.7)	36,486 (15.8)
Mortality outcomes					
Infant mortality, *N* (Deaths/1000 births)[a]	1517 (6.6)	1204 (6.8)	313 (5.8)	90 (5.0)	223 (6.1)
Neonatal mortality, *N* (Deaths/1000 births)[b]	923 (4.0)	750 (4.2)	173 (3.2)	52 (2.9)	121 (3.3)
Postneonatal mortality, *N* (Deaths/1000 births)[c]	594 (2.6)	454 (2.6)	140 (2.6)	38 (2.1)	102 (2.8)
Maternal characteristics					
Age (years), mean (SD)	26.2 (5.6)	26.6 (5.5)	24.9 (5.6)	25.7 (5.5)	24.6 (5.7)
Age, *N* (%)					
< 20 years	23,619 (10.2)	14,330 (8.1)	9289 (17.1)	2129 (12.0)	7160 (19.6)
20–24 years	74,462 (32.2)	54,889 (31.0)	19,573 (36.0)	6229 (35.0)	13.344 (36.6)
25–29 years	70,937 (30.6)	56,756 (32.0)	14,181 (26.1)	5254 (29.5)	8927 (24.5)
30–34 years	42,128 (18.2)	34,578 (19.5)	7550 (13.9)	2897 (16.3)	4653 (12.8)
35+ years	20,394 (8.8)	16,678 (9.4)	3716 (6.8)	1314 (7.4)	2402 (6.6)
Race/ethnicity, *N* (%)					
AI/AN NH	4667 (2.0)	3575 (2.0)	1092 (2.0)	527 (3.0)	565 (1.6)
Asian/PI NH	10,818 (4.7)	9070 (5.1)	1748 (3.2)	793 (4.5)	955 (2.6)
Black NH	45,009 (19.4)	30,979 (17.5)	14,030 (25.8)	2574 (14.4)	11,456 (31.4)
Hispanic	36,918 (15.9)	25,574 (14.4)	11,344 (20.9)	3490 (19.6)	7854 (21.5)
White NH	126,613 (54.7)	102,322 (57.7)	24,291 (44.7)	9898 (55.5)	14,393 (39.5)
Multiple NH	6261 (2.7)	4640 (2.6)	1621 (3.0)	506 (2.8)	1115 (3.1)
Other NH	1254 (0.5)	1071 (0.6)	193 (0.3)	35 (0.2)	148 (0.4)
Nativity, *N* (%)					
US-born	200,779 (86.7)	154,271 (87.0)	46,508 (85.6)	15,426 (86.6)	31,082 (85.2)
Foreign-born	30,761 (13.3)	22,960 (13.0)	7801 (14.4)	2397 (13.4)	5404 (14.8)

(Continues)

TABLE 1 | (Continued)

		Prenatal Care Coordination receipt during pregnancy			
	Overall	**None**	**Any**	**Assessment/care plan only**	**Service receipt**
Education, *N* (%)					
No HS diploma	46,520 (20.1)	31,500 (17.8)	15,020 (27.7)	4104 (23.0)	10,916 (29.9)
HS diploma/equivalent	95,310 (41.2)	71,903 (40.6)	23,407 (43.1)	7530 (42.3)	15,877 (43.5)
Some college	72,807 (31.4)	58,793 (33.2)	14,014 (25.8)	5347 (30.0)	8667 (23.8)
Undergraduate degree	14,183 (6.1)	12,594 (7.1)	1589 (2.9)	728 (4.1)	861 (2.4)
More than undergraduate degree	2720 (1.2)	2441 (1.4)	279 (0.5)	114 (0.6)	165 (0.5)
Marital status, *N* (%)					
Unmarried	156,983 (67.8)	114,928 (64.8)	42,055 (77.4)	12,705 (71.3)	29,350 (80.4)
Married	74,557 (32.2)	62,303 (35.2)	12,254 (22.6)	5118 (28.7)	7136 (19.6)
Resident county urbanicity, *N* (%)[d]					
Large central metro	67,212 (29.0)	47,434 (26.8)	19,778 (36.4)	4179 (23.5)	15,599 (42.8)
Large fringe metro	19,733 (8.5)	13,384 (7.6)	6349 (11.7)	3789 (21.3)	2560 (7.0)
Medium metro	30,511 (13.2)	26,928 (15.2)	3583 (6.6)	936 (5.3)	2647 (7.3)
Small metro	55,524 (24.0)	42,154 (23.8)	13,370 (24.6)	5292 (29.7)	8078 (22.1)
Micropolitan	28,431 (12.3)	23,210 (13.1)	5221 (9.6)	1871 (10.5)	3350 (9.2)
Noncore	30,129 (13.0)	24,121 (13.6)	6008 (11.1)	1756 (9.9)	4252 (11.7)
Smoking during pregnancy, *N* (%)					
No	166,551 (71.9)	128,556 (72.5)	37,995 (70.0)	12,251 (68.7)	25,774 (70.6)
Yes	64,989 (28.1)	48,675 (27.5)	16,314 (30.0)	5572 (31.3)	10,742 (29.4)
Chronic hypertension, *N* (%)					
Not reported	226,137 (97.7)	173,197 (97.7)	52,940 (97.5)	17,494 (98.2)	35,446 (97.1)
Reported	5403 (2.3)	4034 (2.3)	1369 (2.5)	329 (1.8)	1040 (2.9)
Chronic diabetes, *N* (%)					
Not reported	228,843 (98.8)	175,211 (98.9)	53,632 (98.8)	17,630 (98.9)	36,002 (98.7)
Reported	2697 (1.2)	2020 (1.1)	677 (1.2)	193 (1.1)	484 (1.3)

(Continues)

TABLE 1 | (Continued)

		Prenatal Care Coordination receipt during pregnancy			
	Overall	**None**	**Any**	**Assessment/care plan only**	**Service receipt**
Substance use disorder diagnosis, *N* (%)					
No	219,745 (94.9)	168,819 (95.3)	50,926 (93.8)	16,958 (95.1)	33,968 (93.1)
Yes	11,795 (5.1)	8412 (4.7)	3383 (6.2)	865 (4.9)	2518 (6.9)
Medication for opioid use disorder, *N* (%)[e]					
No	228,276 (98.6)	174,644 (98.5)	53,632 (98.8)	17,592 (98.7)	36,040 (98.8)
Yes	3264 (1.4)	2587 (1.5)	677 (1.2)	231 (1.3)	446 (1.2)
Mental health medication, *N* (%)[f]					
No	197,630 (85.4)	152,038 (85.8)	45,592 (83.9)	14,976 (84.0)	30,616 (83.9)
Yes	33,910 (14.6)	25,193 (14.2)	8717 (16.1)	2847 (16.0)	5870 (16.1)
Infant characteristics					
Birth order					
First birth	83,399 (36.0)	58,580 (33.1)	24,819 (45.7)	6840 (38.4)	17,979 (49.3)
Second birth	64,922 (28.0)	51,640 (29.1)	13,282 (24.5)	5046 (28.3)	8236 (22.6)
Third birth	42,405 (18.3)	34,074 (19.2)	8331 (15.3)	3195 (17.9)	5136 (14.1)
Fourth or later birth	40,814 (17.6)	32,937 (18.6)	7877 (14.5)	2742 (15.4)	5135 (14.1)
Plurality					
Singleton-born	225,026 (97.2)	172,342 (97.2)	52,684 (97.0)	17,359 (97.4)	35,325 (96.8)
Plural-born	6514 (2.8)	4889 (2.8)	1625 (3.0)	464 (2.6)	1161 (3.2)
Gestational age (weeks), mean (SD)[g]	38.5 (2.2)	38.5 (2.2)	38.5 (2.2)	38.6 (2.1)	38.5 (2.2)
Preterm birth (gest. age < 37 weeks), *N* (%)					
No	207,049 (89.4)	158,312 (89.3)	48,737 (89.7)	16,108 (90.4)	32,629 (89.4)
Yes	24,492 (10.3)	18,369 (10.4)	5572 (10.3)	1715 (9.6)	3857 (10.6)
Missing	550 (0.2)	550 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)
Birth weight (grams), mean (SD)[h]	3247.0 (598.7)	3255.3 (601.6)	3220.0 (588.3)	3268.5 (570.0)	3196.3 (595.6)

(Continues)

TABLE 1 | (Continued)

	Overall	Prenatal Care Coordination receipt during pregnancy			
		None	Any	Assessment/care plan only	Service receipt
Low birth weight (< 2500 g), *N* (%)					
No	211,322 (91.3)	162,021 (91.4)	49,301 (90.8)	16,488 (92.5)	32,813 (89.9)
Yes	20,165 (8.7)	15,166 (8.6)	4999 (9.2)	1331 (7.5)	3668 (10.1)
Missing	53 (0.0)	44 (0.0)	9 (0.0)	4 (0.0)	5 (0.0)

Abbreviations: AI/AN, American Indian/Alaska Native; HS, high school; NH, non-Hispanic; PI, Pacific Islander; SD, standard deviation; US, United States.

[a]Death at < 365 days post-birth.

[b]Death at 0–28 days post-birth.

[c]Death at 29–364 days post-birth (excludes 923 neonatal deaths; 0.4% of sample).

[d]Residence county urbanicity was measured with the National Center for Health Statistics 2013 urban–rural classification scheme. Milwaukee County is the only large central metro county in Wisconsin.

[e]Includes buprenorphine, methadone, and naltrexone.

[f]Includes anticonvulsants, psychotherapeutic agents, anxiolytics, sedatives, and hypnotics.

[g]Excludes 550 infants with missing gestational age information on the birth record.

[h]Excludes 53 infants with missing birth weight information on the birth record.

mortality. Sibling FE models indicated stronger effects compared to primary regressions (Table S32). Both any PNCC receipt (−0.39 pp; 95% CI −0.59 pp, −0.19 pp) and PNCC service receipt (−0.50 pp; 95% CI −0.73 pp, −0.27 pp) were associated with decreased probabilities of infant mortality, although there was no significant association between PNCC assessment/care plan only and infant mortality. However, we note that sibling FE results only apply to with differential PNCC receipt across pregnancy [65].

4 | Discussion

Medicaid-funded obstetric care coordination programs aim to improve birth outcomes. In turn, these programs may also improve infant survival. We examined the relationship between Wisconsin's PNCC program and infant mortality in nearly all Medicaid-paid births statewide during 2010–2018. PNCC was associated with a reduced probability of infant mortality, and this association did not notably vary by exposure level (assessment/care plan only vs. service receipt). PNCC participation was also negatively associated with neonatal mortality but with postneonatal mortality. Further, these associations were stronger among Black NH births compared with White NH births. Thus, significant estimates in the overall sample may be largely driven by Black NH births.

Improved birth outcomes are the likely mechanism in this association. Preterm birth and low birthweight are leading causes of infant mortality in the United States [4, 30], and recent analyses indicate that PNCC service receipt lowers risks of preterm birth and low birth weight by 17% and 14%, respectively [29]. In turn, PNCC may improve infant survival by preventing adverse birth outcomes. Supplemental findings support this hypothesis: PNCC was associated with birth outcomes, controlling for birth outcomes attenuated PNCC-mortality associations, and gestational age largely mediated the association between PNCC and infant mortality. We also consider how PNCC is associated with neonatal mortality but not with postneonatal mortality. Preterm birth is a common cause of neonatal mortality [68–70]. In contrast, congenital malformations and sudden unexpected death in infants are the most frequent causes of postneonatal mortality in the United States [71]. It is unclear how PNCC would prevent either cause of postneonatal death.

We also observed racial/ethnic variation in PNCC-mortality associations. Specifically, PNCC was strongly associated with a lower probability of infant mortality in Black NH births, while the probabilities of infant mortality were balanced across levels of PNCC exposure in Hispanic and White NH births. This may be due to geographic variation of PNCC service provision and, consequently, racial/ethnic variation in the uptake of PNCC services. PNCC-providing institutions in urban areas are often more prevalent, resourced, and connected to other social service agencies relative to more rural areas of the state [35]. This yields significant urban–rural disparities in the quality and availability of PNCC. Indeed, recently analyses documented PNCC participation by urbanicity across Wisconsin during 2010–2019 [36]. PNCC receipt was greatest in Milwaukee County—Wisconsin's only large central

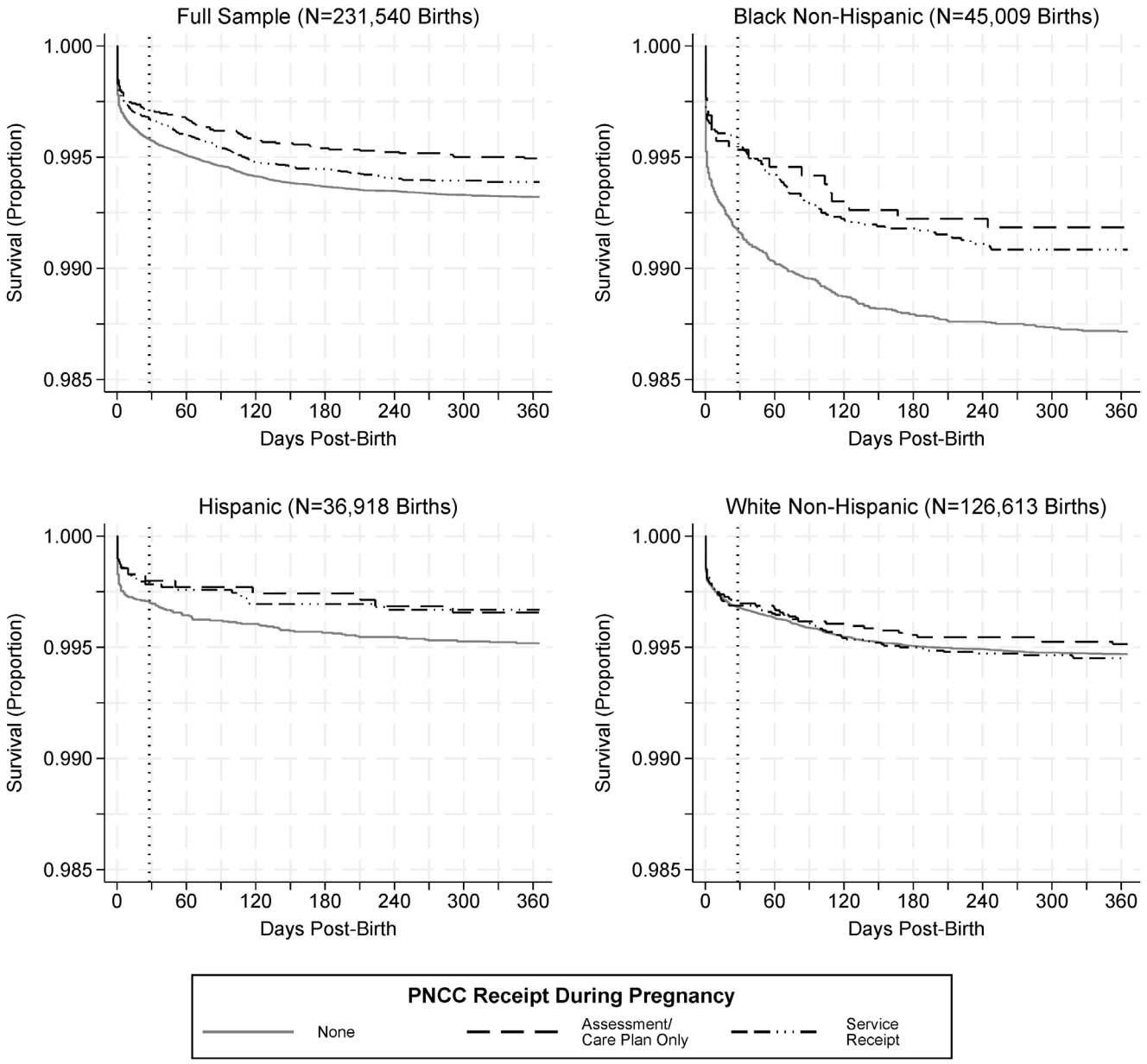

FIGURE 1 | Kaplan–Meier survival plots: Infant mortality by categorical Prenatal Care Coordination receipt during pregnancy. PNCC, Prenatal Care Coordination. The vertical dashed line indicates 28 days post-birth (i.e., the end of the neonatal period).

metropolitan county—and uptake remained high throughout the decade. However, PNCC receipt was relatively low and declining in rural counties. Simultaneously, nearly 70% of Black NH Wisconsin residents reside in Milwaukee County, and nearly 90% of Black NH Wisconsin residents reside in the six southeastern counties that encompass or surround the city of Milwaukee [34], whereas the White NH and Hispanic populations are more equally distributed across the state [36]. Our results reflected these trends: among PNCC service recipient-births, Milwaukee County accounted for more than 80% of Black NH births but only for 56% and 7% of Hispanic and White NH births, respectively. Thus, among PNCC service recipients, Black NH beneficiaries may be accessing more well-resourced PNCC providers compared to Hispanic or White NH beneficiaries. This variation in service—and service quality—may explain the variable associations by race/ethnicity.

Notably, the association between PNCC and infant mortality did not depend on PNCC exposure level in our primary analysis. This contrasts prior research—PNCC service receipt beyond care planning prevented adverse birth outcomes, but there was no such benefit for PNCC assessment/care planning only [29]. Our supplemental sibling FE analyses may illuminate this discrepancy. Sibling FE regressions accounted for unobserved sibling-invariant confounding, thus reducing bias in estimates. Here, only PNCC service receipt was negatively associated with infant mortality. This may signal that PNCC's benefit to infant survival depends on receiving program services, much like the documented effect of PNCC on birth outcomes. Still, we interpret these results cautiously; FE estimates depend on—and, thusly, only apply to—sibling clusters with differential PNCC exposure. A more conservative interpretation is that sibling FE results largely align with primary regression results.

TABLE 2 | Results from regressions of infant mortality outcomes on Prenatal Care Coordination receipt during pregnancy with corresponding predicted margins and average marginal effects ($N = 231{,}540$ births).

	Conventional adjusted binary logit regressions						Propensity score weighted regressions, ATE					
	Regression output		Predicted margins		Average marginal effects		Regression output		Predicted margins		Average marginal effects	
	Coef.	95% CI	Probability (percent)	95% CI	Change in probability (percentage point)	95% CI	Coef.	95% CI	Probability (percent)	95% CI	Change in probability (percentage point)	95% CI
Outcome: Infant mortality (Death at age < 365 days)												
Any PNCC												
No	Ref.	—	0.70	0.66, 0.73	Ref.	—	Ref.	—	0.70	0.66, 0.74	Ref.	—
Yes	−0.27	−0.37, −0.18	0.53	0.49, 0.58	−0.17	−0.22, −0.11	−0.20	−0.34, −0.06	0.58	0.50, 0.65	−0.12	−0.21, −0.04
Categorical PNCC												
None	Ref.	—	0.70	0.66, 0.73	Ref.	—	Ref.	—	0.70	0.66, 0.74	Ref.	—
Assessment/ care plan only	−0.27	−0.42, −0.12	0.53	0.46, 0.61	−0.16	−0.25, −0.08	−0.32	−0.57, −0.07	0.51	0.39, 0.64	−0.19	−0.32, −0.06
Service receipt	−0.28	−0.38, −0.17	0.53	0.48, 0.58	−0.17	−0.22, −0.11	−0.22	−0.39, −0.05	0.57	0.47, 0.66	−0.13	−0.24, −0.04
Outcome: Neonatal mortality (Death at age < 29 days)												
Any PNCC												
No	Ref.	—	0.43	0.40, 0.47	Ref.	—	Ref.	—	0.44	0.41, 0.47	Ref.	—
Yes	−0.40	−0.63, −0.16	0.29	0.24, 0.35	−0.14	−0.22, −0.07	−0.31	−0.49, −0.12	0.32	0.27, 0.38	−0.12	−0.18, −0.05

(Continues)

TABLE 2 | (Continued)

	Conventional adjusted binary logit regressions						Propensity score weighted regressions, ATE					
	Regression output		Predicted margins		Average marginal effects		Regression output		Predicted margins		Average marginal effects	
	Coef.	95% CI	Probability (percent)	95% CI	Change in probability (percentage point)	95% CI	Coef.	95% CI	Probability (percent)	95% CI	Change in probability (percentage point)	95% CI
Categorical PNCC												
None	Ref.	—	0.43	0.40, 0.47	Ref.	—	Ref.	—	0.44	0.41, 0.47	Ref.	—
Assessment/ care plan only	−0.33	−0.56, −0.10	0.31	0.25, 0.37	−0.12	−0.20, −0.04	−0.33	−0.66, −0.01	0.31	0.22, 0.41	−0.12	−0.23, −0.02
Service receipt	−0.43	−0.71, −0.14	0.28	0.21, 0.36	−0.15	−0.24, −0.06	−0.29	−0.52, −0.06	0.33	0.26, 0.40	−0.11	−0.19, −0.03
Outcome: Postneonatal mortality (Death at age 29–364 days)[a]												
Any PNCC												
No	Ref.	—	0.27	0.25, 0.29	Ref.	—	Ref.	—	0.27	0.24, 0.29	Ref.	—
Yes	−0.09	−0.31, 0.13	0.24	0.20, 0.29	−0.02	−0.08, 0.03	−0.05	−0.26, 0.16	0.25	0.21, 0.30	−0.02	−0.07, 0.04
Categorical PNCC												
None	Ref.	—	0.27	0.25, 0.29	Ref.	—	Ref.	—	0.26	0.24, 0.29	Ref.	—
Assessment/ care plan only	−0.17	−0.41, 0.07	0.22	0.17, 0.27	−0.04	−0.10, 0.01	−0.29	−0.69, 0.10	0.20	0.12, 0.27	−0.06	−0.14, 0.02
Service receipt	−0.06	−0.29, 0.18	0.25	0.20, 0.30	−0.01	−0.07, 0.04	−0.11	−0.37, 0.14	0.24	0.18, 0.29	−0.02	−0.08, 0.04

Note: Conventional adjusted binary logit regressions controlled for maternal characteristics (age; race/ethnicity; nativity; education; marital status; smoking; resident county urbanicity; chronic diabetes; chronic hypertension; substance use disorder diagnosis during pregnancy; medication for opioid use disorder receipt during pregnancy; mental health medication receipt during pregnancy) and infant characteristics (birth order; plurality; birth year). Propensity score weighted regressions balanced covariates between treatment groups on all previously listed control variables.

Abbreviations: ATE, average treatment effect; CI, confidence interval; Coef., coefficient; PNCC, Prenatal Care Coordination; Ref., referent group.

[a]Excludes neonatal deaths ($N = 923$ births; 0.4% of sample).

TABLE 3 | Results from regressions of infant mortality (death at age < 365 days) on Prenatal Care Coordination receipt during pregnancy with interactions on maternal race/ethnicity ($N = 231{,}540$ births).

	Conventional adjusted binary logit regressions		Propensity score weighted regressions, ATE	
	Coefficient	**95% CI**	**Coefficient**	**95% CI**
Regressions with binary PNCC exposure				
Any PNCC				
None	Ref.	—	Ref.	—
Any	−0.09	−0.29, 0.10	−0.05	−0.27, 0.16
Maternal race/ethnicity				
AI/AN NH	0.24	−0.03, 0.52	0.33	−0.06, 0.72
Asian/PI NH	0.52	0.27, 0.78	0.15	−0.12, 0.42
Black NH	0.83	0.72, 0.94	0.86	−0.73, 0.99
Hispanic	0.06	−0.13, 0.25	−0.11	−0.31, 0.09
White NH	Ref.	—	Ref.	—
Multiple NH	0.57	0.27, 0.86	0.56	0.26, 0.87
Other NH	0.68	−0.18, 1.54	0.26	−0.45, 0.96
PNCC and race/ethnicity interaction				
Any*AI/AN NH	−0.64	−1.75, 0.47	−0.26	−1.40, 0.89
Any*Asian/PI NH	−0.56	−1.50, 0.38	−0.36	−1.30, 0.59
Any*Black NH	−0.28	−0.47, −0.10	−0.32	−0.62, −0.02
Any*Hispanic NH	−0.21	−0.62, 0.20	−0.16	−0.61, 0.30
Any*White NH	Ref.	—	Ref.	—
Any*Multiple NH	−0.27	−0.69, 0.14	−0.11	−0.84, 0.62
Any*Other NH	[Empty]	—	[Empty]	—
Regressions with categorical PNCC exposure				
Categorical PNCC				
None	Ref.	—	Ref.	—
Assessment/ care plan only	−0.12	−0.33, 0.08	−0.17	−0.49, 0.15
Service receipt	−0.08	−0.33, 0.18	0.02	−0.25, 0.29
Maternal race/ethnicity				
AI/AN NH	0.25	−0.03, 0.52	0.32	−0.07, 0.71
Asian/PI NH	0.52	0.27, 0.78	0.15	−0.12, 0.42
Black NH	0.83	0.72, 0.94	0.86	0.73, 0.99
Hispanic	0.06	−0.13, 0.25	−0.12	−0.32, 0.08
White NH	Ref.	—	Ref.	—
Multiple NH	0.57	0.27, 0.87	0.55	0.25, 0.86
Other NH	0.68	−0.18, 1.54	0.26	−0.45, 0.96
PNCC and race/ethnicity interaction				
ACP*AI/AN NH	−0.21	−1.08, 0.66	0.07	−1.22, 1.35

(Continues)

TABLE 3 | (Continued)

	Conventional adjusted binary logit regressions		Propensity score weighted regressions, ATE	
	Coefficient	**95% CI**	**Coefficient**	**95% CI**
ACP*Asian/PI NH	−0.09	−1.47, 1.29	0.35	−1.07, 1.77
ACP*Black NH	−0.32	−0.66, 0.02	−0.36	−0.98, 0.25
ACP*Hispanic NH	−0.17	−0.55, 0.20	−0.23	−1.00, 0.54
ACP*White NH	Ref.	—	Ref.	—
ACP*Multiple NH	−0.81	−2.14, 0.53	−0.65	−2.12, 0.83
ACP*Other NH	[Empty]	—	[Empty]	—
Service*AI/AN NH	−1.34	−3.15, 0.46	−1.85	−3.87, 0.17
Service*Asian/PI NH	−1.11	−2.55, 0.32	−1.09	−2.52, 0.35
Service*Black NH	−0.29	−0.54, −0.04	−0.46	−0.81, −0.11
Service*Hispanic NH	−0.23	−0.75, 0.29	−0.37	−0.90, 0.17
Service*White NH	Ref.	—	Ref.	—
Service*Multiple NH	−0.13	−0.62, 0.36	0.02	−0.83, 0.87
Service*Other NH	[Empty]	—	[Empty]	—

Note: Conventional adjusted binary logit regressions controlled for maternal characteristics (age; race/ethnicity; nativity; education; marital status; smoking; resident county urbanicity; chronic diabetes; chronic hypertension; substance use disorder diagnosis during pregnancy; medication for opioid use disorder receipt during pregnancy; mental health medication receipt during pregnancy) and infant characteristics (birth order; plurality; birth year). Propensity score weighted regressions balanced covariates between treatment groups on all previously listed control variables. Cells with "[Empty]" indicate no mortalities for that combination of PNCC exposure and maternal race/ethnicity.
Abbreviations: ACP, assessment/care plan only; AI/AN, American Indian/Alaska Native; ATE, average treatment effect; CI, confidence interval; NH, non-Hispanic; PI, Pacific Islander; PNCC, Prenatal Care Coordination; Ref., referent group.

To date, this is the third study to investigate Medicaid obstetric care coordination participation and infant mortality. Two prior studies examined Michigan's MIHP program—which is analogous to PNCC in Wisconsin—and infant mortality among Medicaid births during 2009–2012 [31, 32]. Results from these studies are akin our findings: program participation is negatively associated with infant mortality, and this association does not vary by service level. The main difference is that MIHP participation was negatively associated with postneonatal mortality, while we found no such association. Differences between MIHP and PNCC administration may explain this. MIHP beneficiaries receive care coordination services from enrollment to the infant's first birthday [31]. Participating families may thusly receive additional health and educational interventions that prevent causes of postneonatal mortality, including sudden unexpected death in infancy [72]. In contrast, PNCC services only cover beneficiaries from enrollment to 60 days postpartum [37]. This may limit the ability of care coordination services to intervene on the risk of postneonatal death, even for families that maintain Medicaid coverage after the postpartum period. Nonetheless, the cumulation of this evidence suggests that obstetric care coordination is a viable strategy for preventing infant mortality in the Medicaid population.

We note key limitations. While we control for a robust set of confounders on PNCC receipt and infant mortality, we do not observe factors in home and familial environments that likely confound PNCC participation and infant health (e.g., parental incarceration or housing instability [73, 74]). Additionally, the small samples of American Indian/Alaska Native NH and Asian/Pacific Islander NH births—and, consequently, the low number of mortalities therein—precluded us from examining PNCC-mortality associations in those subpopulations. Finally, we could not test whether PNCC-mortality associations varied by specific PNCC services because billing codes do not contain this information. Potential PNCC impact likely varies by service. For example, tobacco smoking cessation prevents adverse birth outcomes and, by extension, infant mortality [49, 75]. Conversely, the link between continuing education support and infant mortality is likely tenuous.

5 | Conclusion

We find evidence that participation in Wisconsin's PNCC program is associated with a lower probability of infant mortality in the state's Medicaid population. This underscores the opportunity for obstetric care coordination to improve infant survival—a public health priority in the United States. These results, in tandem with evidence of PNCC's benefit to infant and maternal health more generally, should inform stakeholders and policymakers to expand PNCC services in populations and regions with low program outreach [35, 36]. Future research should examine obstetric care coordination and infant mortality in other states as well as more thoroughly investigate the causal mechanisms of this association.

TABLE 4 | Predicted probabilities and average marginal effects of infant mortality (death at age < 365 days) across levels of Prenatal Care Coordination receipt by maternal race/ethnicity.

	Conventional adjusted binary logit regressions				Propensity score weighted regressions, ATE			
	Predicted margins		Average marginal effects		Predicted margins		Average marginal effects	
	Probability (percent)	95% CI	Change in probability (percentage point)	95% CI	Probability (percent)	95% CI	Change in probability (percentage point)	95% CI
Black NH								
Any PNCC								
No	1.19	1.09, 1.28	Ref.	—	1.29	1.16, 1.42	Ref.	—
Yes	0.82	0.75, 0.89	−0.37	−0.45, −0.29	0.89	0.73, 1.06	−0.40	−0.61, −0.19
Categorical PNCC								
None	1.19	1.09, 1.28	Ref.	—	1.29	1.16, 1.42	Ref.	—
Assessment/care plan only	0.77	0.58, 0.96	−0.42	−0.66, −0.18	0.76	0.37, 1.15	−0.53	−0.94, −0.12
Service receipt	0.83	0.76, 0.90	−0.36	−0.42, −0.30	0.83	0.67, 1.00	−0.46	−0.67, −0.25
Hispanic								
Any PNCC								
No	0.56	0.47, 0.64	Ref.	—	0.49	0.40, 0.58	Ref.	—
Yes	0.41	0.32, 0.51	−0.14	−0.28, −0.01	0.26	0.26, 0.54	−0.09	−0.26, 0.08
Categorical PNCC								
None	0.56	0.47, 0.64	Ref.	—	0.49	0.40, 0.58	Ref.	—
Assessment/care plan only	0.41	0.29, 0.54	−0.14	−0.31, 0.02	0.33	0.11, 0.55	−0.16	−0.40, 0.08
Service receipt	0.41	0.28, 0.54	−0.15	−0.31, 0.01	0.35	0.20, 0.49	−0.14	−0.31, 0.03
White NH								
Any PNCC								
No	0.52	0.48, 0.57	Ref.	—	0.55	0.51, 0.60	Ref.	—
Yes	0.48	0.39, 0.56	−0.04	−0.14, 0.05	0.52	0.42, 0.62	−0.03	−0.14, 0.08

(Continues)

TABLE 4 | (Continued)

	Conventional adjusted binary logit regressions				Propensity score weighted regressions, ATE			
	Predicted margins		Average marginal effects		Predicted margins		Average marginal effects	
	Probability (percent)	95% CI	Change in probability (percentage point)	95% CI	Probability (percent)	95% CI	Change in probability (percentage point)	95% CI
Categorical PNCC								
None	0.52	0.48, 0.57	Ref.	—	0.55	0.51, 0.60	Ref.	—
Assessment/care plan only	0.46	0.37, 0.56	−0.06	−0.16, 0.04	0.46	0.32, 0.60	−0.09	−0.24, 0.06
Service receipt	0.49	0.37, 0.60	−0.04	−0.16, 0.09	0.56	0.42, 0.70	0.01	−0.14, 0.16

Note: Estimates were generated from regressions with interactions on maternal race/ethnicity (Table 3). Conventional adjusted binary logit regressions controlled for maternal characteristics (age; race/ethnicity; nativity; education; marital status; smoking; resident county urbanicity; chronic diabetes; chronic hypertension; substance use disorder diagnosis during pregnancy; medication for opioid use disorder receipt during pregnancy; mental health medication receipt during pregnancy) and infant characteristics (birth order; plurality; birth year). Propensity score weighted regressions balanced covariates between treatment groups on all previously listed control variables.
Abbreviations: ATE, average treatment effect; CI, confidence interval; NH, non-Hispanic; PNCC, Prenatal Care Coordination; Ref., referent group.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data used for this analysis are not publicly available.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.