BMC Pregnancy and Childbirth

RESEARCH

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The impact of social determinants of health on infant and maternal health using a reproductive justice lens

Kathryn J. Malin[1*], Ashelee J. Vance[2], Stephanie E. Moser[3], Jessica Zemlak[1], Cherise Edwards[1], Rosemary White-Traut[4], Rebecca Koerner[5], Jacqueline McGrath[6] and Kelly McGlothen-Bell[6]

Abstract

Background Rates of preterm birth, low birth weight, and Neonatal Intensive Care Unit (NICU) admissions continue to rise in the United States (US). Social determinants of health (SDOH) are recognized as significant contributors to infant and maternal health, underscoring the need for use of research frameworks that incorporate SDOH concepts. The Restoring Our Own Through Transformation (ROOTT) theoretical framework is rooted in reproductive justice (i.e. reproductive rights and social justice-based framework) and emphasizes both structural and social determinants as root causes of health inequities. The impact of SDOH on maternal and infant mortality and morbidity can often be traced to structural determinants unique to the US, including slavery, Jim Crow laws, redlining, and the GI Bill.

Aims Using data from the Pregnancy Risk Assessment Monitoring System (PRAMS) 8 database, we aimed to evaluate relationships between SDOH (as guided by the ROOTT Framework) and maternal and infant health outcomes.

Methods Data were analyzed from 11 states that included the SDOH supplement in their PRAMS 8 data collection. We used bivariate analyses to examine relationships between SDOH measures guided by the ROOTT framework (e.g. abuse during pregnancy, access to prenatal care, housing stability and education) and maternal morbidity (i.e., gestational hypertension and gestational diabetes) and infant outcomes (i.e., preterm birth, NICU admission, breastfeeding). Pre-identified covariates were controlled for in the logistic and linear regression models.

Results Preterm birth, NICU admission, breastfeeding, and maternal morbidities were significantly associated with SDOH measures linked to structural determinants in the US. Abuse during pregnancy, access to prenatal care, housing, and education were all significantly associated with poorer infant health outcomes in the final regression models. Women who received prenatal care beginning in the 3rd trimester were twice as likely to develop gestational hypertension.

Conclusions SDOHs rooted in structural determinants are important predictors of poorer maternal and infant health outcomes. Evaluating health outcomes using a reproductive justice framework reveals modifiable risk factors, including access to stable healthcare, safety, and housing. Comprehensive healthcare provision must ensure early and consistent access to healthcare and resources for safety and housing stability to support maternal and infant health.

Keywords PRAMS, Access, Pregnancy, Perinatal health, Maternal health, Social determinants of health, Structural determinants of health

*Correspondence:
Kathryn J. Malin
Kathryn.malin@marquette.edu
Full list of author information is available at the end of the article

Background

Birthing individuals and infants born in the United States (US) continue to experience worsening health outcomes despite improvements in access to and quality of perinatal healthcare services compared to other countries [1, 2]. Maternal mortality rates in the US continue to rise [1, 3]. In the US, the average maternal mortality rate between 2018-2021 was 23.5 per 100,000 and then increased to 32.6 per 100,000 in 2022 [4]. These data are strikingly higher than the Health People 2030 goal of 15.7 per 100,000 [2]. Similarly, preterm birth rates, incidence of low birth weight, and need for hospitalization in the neonatal intensive care unit (NICU) remain above the Healthy People 2030 goal levels, with the preterm birth rate in the US 10.4% in 2022 [2].

These poorer health outcomes disproportionally impact birthing individuals and infants of color, those who receive Medicaid, birthing individuals of older age, and those experiencing chronic health conditions [3, 5]. When compared to their White counterparts, preventable pregnancy-related complications such as gestational hypertension (GHTN) and gestational diabetes (GDM), contribute to higher maternal mortality rates for non-Hispanic Black, American Indian/Alaska Native, and Puerto Rican women [6]. For example, Muchira et al. found that the clustering of several risk factors, including history of hypertension, history of smoking, and obesity increased the risk of cardiovascular-related adverse childbirth outcomes for non-Hispanic Black, Hispanic, and American Indian/Alaska Native women [6]. Similar disparities were seen in infant morbidity rates, wherein cardiovascular related disorders, including GHTN, was a strong predictor of having a low-birth weight infant [6]. These startling statistics have sparked a concerted effort by researchers to identify modifiable factors to reduce racial and other inequities among birthing individuals and infants in the US.

It has become clear that the social determinants of health; those non-medical factors such as where a person is born, grows, works, lives and ages, greatly influence the health outcomes for birthing individuals and infants [7]. Findings from several studies suggest that factors such as place of residence, education, and income level play an important role in the proliferation of maternal-infant health disparities. Claridy et al. found that when comparing individuals in the US who lived in rural areas to those in urban areas, non-Hispanic Black women and other women of color were more likely to experience severe maternal morbidity as compared to White and Asian/Pacific Islander women in rural areas; similarly, non-Hispanic Black women from lower income communities were also more likely to experience severe maternal morbidity as compared to White and Asian/Pacific Islander women [8]. These findings suggest intersectional contributors to health disparities, highlighting the importance of looking beyond pure biological contributions to health, but considering unique forms of oppression and disadvantage.

Building on this, frameworks have emerged to guide research aimed at reducing the health inequities birthing individuals and infants experience. The Restoring Our Own Through Transformation (ROOTT) theoretical framework [3, 9] is one that utilizes concepts associated with reproductive justice, a feminist perspective, which posits that birthing people should have specific rights including bodily autonomy, reproductive choice, and the right to parent children with the resources needed to raise them in a healthy and safe environment [10]. The ROOTT theoretical framework was developed by a Black women-led reproductive and birthing justice organization in the US [3]. A major component of the ROOTT framework is the need to identify both structural and social determinants of health as root causes for health inequities including threats to reproductive justice and maternal and infant health [9, 11]. The ROOTT framework was developed to identify the social determinants of Black maternal health and asserts that structural acts of racism perpetuated in the US, such as the GI Bill and Jim Crow, are directly connected to the social determinants that largely contribute to the health disparities that affect Black and other historically disenfranchised birthing individuals [11]. Figure one displays our modified ROOTT framework with associated variables that were operationalized to measure the social determinants of health.

While historically, there has been greater attention paid to the biological contributions to health disparities [12], there is also a need to evaluate birthing individual and infant health outcomes during the perinatal period in the US using a framework that accounts for root causes of health inequity. Importantly, there is a need for frameworks to reflect the relationships among structural and social determinants on health. As such, we aim to address the research question: Based on the ROOTT framework, which SDOH are associated with maternal-infant health outcomes? To answer this question, we utilized the Pregnancy Risk Assessment Monitoring System (PRAMS) 8 database to conduct a bivariate analyses to assess pathways between SDOH factors guided by the ROOTT framework (e.g. abuse during pregnancy, access to prenatal care, housing, and education) and maternal morbidity (i.e., GHTN and GDM) and infant outcomes (i.e., preterm birth, NICU admission, breastfeeding). We hypothesized that poorer SDOH factors (e.g., reports of abuse, less access to prenatal care, unstable housing, and

less education) will contribute to poorer maternal and infant outcomes.

Methods

Birthing individuals are defined as anyone who gives birth to an infant, and this is the language that we have elected to use. We acknowledge that while this language is more inclusive, the data described in our background and throughout this manuscript are provided in a way that is consistent with how the data was collected.

Ethical/IRB approval

This study received an exemption from the Marquette University Institutional Review Board. The Centers for Disease Control (CDC) and Prevention Pregnancy Risk Assessment Monitoring System team granted access to and approval for the use of the data for research purposes in March 2024. The CDC's institutional review board has approved the overall PRAMS procedures and protocols. Each survey packet includes an informed consent document outlining participants rights. Written consent is not required; by completing the survey, participants provide implied consent. These methods are described in greater detail elsewhere [13].

Data source description

The genesis of the Pregnancy Risk Assessment Monitoring System (PRAMS) began in 1987 by the US Centers for Disease Control and Prevention (CDC) as a tool to collect, analyze, and disseminate population-base data [13]. Weighted PRAMS data covers approximately 83% of all births in the Unites States, and comes from all states and 4 territories except California, Idaho, and Ohio [13]. Data is compiled using information from birth certificates (e.g., maternal race/ethnicity, maternal age, marital status, education, and trimester of entry into prenatal care) and questionnaire responses (e.g., type of insurance coverage during prenatal care, enrollment in the Special Supplemental Nutrition Program for Women, Infants, and Children [WIC], family income, pre-pregnancy depression diagnosed by a health care professional, receipt of provider counseling on depression, pregnancy intention, alcohol use and cigarette smoking before and/or during pregnancy, and maternal stress items) [14]. The PRAMS questionnaire consists of three parts. Part 1 contains core questions that are mandatory for all participating PRAMS sites. Part 2 consists of standardized questions developed by the CDC that are available for all participating sites. Part 3 contains site specific questions that are developed by the specific state site. Members of the PRAMS team use mixed modes of data collection including two types of questionnaires for Phase 1–8 data collection: self-administered paper questionnaire by mailing and an interviewer-administered questionnaire, used by phone. Both types of questionnaires have the same questions; however, some questions had been formatted differently to aid in the interview mode. PRAMS 8 data were collected between the years of 2016-2022.

The core questions in the phase 8 survey (i.e., PRAMS 8 survey) encompasses topics such as: attitudes and feelings about pregnancy, preconception and prenatal care, breastfeeding, Medicaid and WIC participation, alcohol and tobacco use, health insurance coverage, physical abuse, infant health care, and contraceptive use. The addition of multiple supplemental questionnaires to the PRAMS 8 survey offers more in-depth data such as: evaluation of social determinants of health and maternal COVID-19 experiences. The PRAMS Social determinants of health (SDOH) supplemental dataset include participant questions focused on housing, food stability, and access to care. Thirteen sites added the SDOH supplement to the phase 8: AZ, CO, KS, MA, ME, MO, NY, PA, RI, SD, UT, VT, WI. Therefore, data from these eligible states were included in our analysis. However, data from ME and VT were not included due to incomplete and missing data for the variables of interest.

Sample description

We merged PRAMS 8 data consisting of 249,970 observations with the SDOH supplemental dataset (n = 13,389). This merger resulted in an unweighted sample of 13,389 observations with both primary and supplemental SDOH data. Missing data for all variables of interest was assessed (12% or less missing data per variable of interest). Once observations with missing data were removed, a complete case analysis, inclusive of 11 states (Pennsylvania, New York, Massachusetts, Colorado, Missouri, Arizona, Wisconsin, Utah, Kansas, South Dakota, and Rhode Island) with an unweighted sample of 7,861 (analysis weighted sample n = 430,383) was used to answer the questions of our analysis.

Study variables

In the current study, we examined 8 primary predictors of interest: partner/spousal abuse during pregnancy, housing insecurity, urban/rural, struggles paying for housing, food insecurity, trimester of first PNC visit, and maternal education. Trimester of first PNC visit was calculated as a categorical variable from the existing continuous variable, month of first PNC visit. Respondents who indicated they did not receive prenatal care (PNC_VST = 0 or PNC_MTH = 88), were coded as "0" on trimester of first PNC visit (PNC_Trimester), those with a first visit during months 1–3 were coded "1", between months 4–6 were coded "2")), and between months 7–9 were coded "3". Maternal

education was calculated as a 4-category variable (1 = Less than HS diploma, 2 = HS diploma, 3 = Some college/associate's degree, 4 = Bachelor's degree or higher), modifying the existing education variable with 5 categories. These primary predictors were operationalized using variables available in the PRAMS 8 dataset to align with the SDOH outlined in the original ROOTT framework. We did not include measures of incarceration and income secondary to limitations associated with the data (Fig. 1).

We focused on 2 maternal outcomes: gestational diabetes and gestational hypertension. We also focused on three infant outcomes: admission to NICU, gestational age in weeks at birth, and whether the mother ever breastfeed the infant.

Control variables or covariates included measures of pre-pregnancy diabetes, asthma, age, insurance, substance use, delivery mode, partner status, race, maternal nativity, previous preterm birth, planned pregnancy, multiple gestation, and pre-pregnancy weight. The decision to use these variables was based on availability of variables in the PRAMS 8 data as well as previous literature identifying risk for poor maternal and infant health outcomes [15, 16]. Importantly, while racism is an important SDOH, it is not explicitly measured in the PRAMS 8 data and so race was controlled for in our modeling.

Statistical analysis

All analyses were conducted using PRAMS 8 survey analysis weights and only weighted results are reported throughout. Analyses were conducted using Stata version 18 [17]. Univariate descriptive statistics including mean and standard deviation (continuous variables) and frequencies and percentages (categorical variables) were calculated for each variable. Bivariate analyses with each predictor/control variable and each dependent variable were conducted using linear regression or logistic regression, as appropriate for each dependent variable type. A two-step process was employed for testing multivariable relationships between the primary predictors and each dependent variable. First, full regression models with all predictors and control variables were conducted for each dependent variable (linear or logistic multiple regression as appropriate for each dependent variable type). Second, trimmed simultaneous regression models containing only primary predictors with p-values <.20 in the full model were conducted. All original control variables were included in the final trimmed models. This method was employed to select parsimonious models focusing on the primary predictors with the strongest relationships to each dependent variable. Other methods of variable selection, such as backward stepwise approaches, were not available with survey-weighted data. Multicollinearity was assessed and all variance inflation

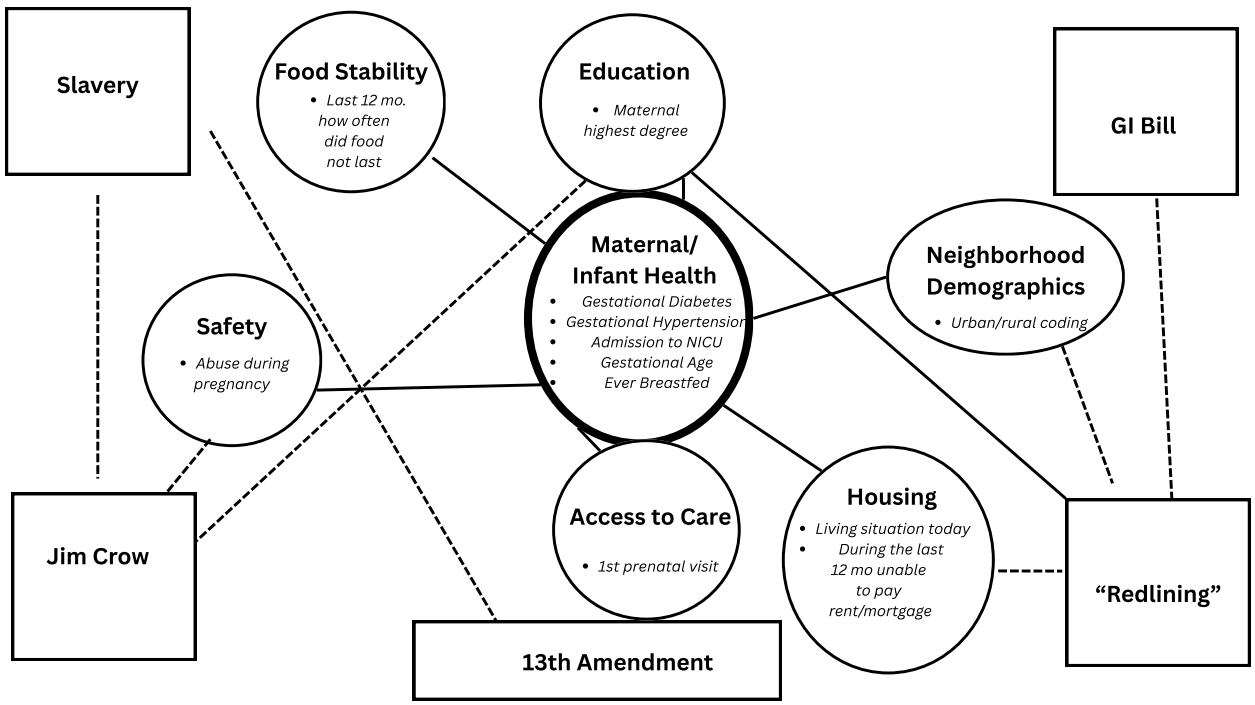

Fig. 1 The modified Web of Causation as Guided by the ROOTT framework with associated PRAMS variables (in italics) that were operationalized to measure the social determinants of health

factors (VIF) were less than 5, indicating no issues with multicollinearity.

Results

The unweighted sample included 7,861 birthing individuals from 11 states. For our analysis, the weighted sample was used and included 430,383 birthing individuals. Nine percent of birthing individuals had an infant admitted to the NICU and 92% of birthing individuals reported having "ever breastfed". Of the weighted sample, 9% of birthing individuals reported being diagnosed with GDM and 10% reported experiencing GHTN. Full sample statistics, stratified by timing of prenatal care are displayed in Table 1.

Social determinants of health predict maternal and infant health outcomes

Several social determinants of health and many covariates were associated with both infant and birthing individual health outcomes in bivariate analysis (Table 2). Several SDOH variables, including abuse during pregnancy, access to prenatal care, housing stability and the birthing individual's educational attainment, were significantly associated with infant outcomes (i.e., NICU admission, ever breastfed, and gestational age at birth) and maternal outcomes (GDM and GHTN).

Abuse during pregnancy

In bivariate analysis, abuse during pregnancy was positively associated with NICU admission and negatively associated with gestational age at birth. The full models including all the primary predictors and covariates, showed that abuse during pregnancy was associated with NICU admission ($p = 0.08$), and gestational age at birth ($p = 0.054$) (Table 3). The final trimmed models demonstrate that birthing individuals who experienced abuse during pregnancy are two times more likely to have had an infant admitted to the NICU (OR: 2.04, 95% CI: 0.90 - 4.62) and their infants were born on average 4 days earlier (Coeff: −0.57, 95% CI: −1.16 - 0.01) (Fig. 2).

Access to prenatal care

The timing of the first prenatal care visit was associated with gestational age at birth and positively associated with ever breastfeeding in the bivariate analysis. The full models, including all the primary predictors and covariates, demonstrated that birthing individuals who had no prenatal care were more likely to have had an infant admitted to the NICU ($p = 0.028$), lower gestational age at birth ($p = 0.047$), were less likely to have ever breastfed ($p = 0.056$) than those who had care in the first trimester. Similarly, birthing individuals who did not receive prenatal care until the 3rd trimester were more likely to develop GDM ($p = 0.056$) than those who had care in the first trimester (Table 3). The final trimmed models demonstrate that birthing individuals who do not receive prenatal care are 2.6 times more likely to have an infant requiring NICU hospitalization (OR 2.6, 95% CI: 1.09 - 6.20), their infants were approximately one week younger in gestational age at birth (OR −0.9, CI: −1.8 - −0.01), and were less likely to have ever breastfed (OR 0.45, CI: 0.18–1.09) than those who had care in the first trimester (Fig. 2).

Current living situation

The current living situation, as reported by housing stability (answer to the question "what is your living situation today?") was associated with several maternal and infant outcomes. The responses of "not having a steady place to live" or "having a place to live but worried about losing" were combined and found to be negatively associated with ever breastfeeding, GDM, and GHTN. Additionally, there was a positive significant relationship between reporting the inability to pay rent/mortgage in the last 12 months and NICU admission as well as lower gestational age at birth and breastfed ever (Table 2). The full simultaneous regressions showed that individuals who reported difficulty in paying rent/mortgage in the last 12 months were more likely to deliver their infants at a younger gestational age ($p = 0.045$) and those who reported worry about losing their place to live were less likely to have breastfed ever ($p = 0.06$) (Table 3). In the final trimmed models, birthing individuals with insecure housing delivered infants on average 1.5 days later in gestation (Coeff: 0.22, 95% CI: 0.002–0.449) (Fig. 2).

Level of education

The educational attainment of the birthing individual was associated with ever breastfeeding, with those who had less education more likely to report never breastfeeding. The full simultaneous regressions demonstrated that those with a bachelor's degree or higher delivered their infants closer to term gestation ($p = 0.03$) than those with less than a high school degree. Additionally, birthing individuals with some college education were more likely to have ever breastfed ($p < 0.001$) than those with less than HS (Table 3). In the final trimmed model, level of education was positively associated with ever breastfeeding. Specifically, birthing individuals with a bachelor's degree or higher were 3.8 times more likely to have ever breastfed (OR: 3.8, 95% CI: 2.44–5.98) than those with less than a high school degree (Fig. 2).

Discussion

In this study, we aimed to evaluate relationships between SDOH (as guided by the ROOTT Framework) and maternal and infant health outcomes. Our research

Table 1 Cohort characteristics by prenatal care groups

	Total Sample (Weighted)	Timing of First Prenatal Care Visit			
		No Prenatal Care	1st Trimester	2nd Trimester	3rd Trimester
Cohort Sample *M* (%)	430,383	3,429 (0.8%)	366,111 (85.1%)	48,981 (11.4%)	11,862 (2.8%)
Race					
White	343,497 (79.8%)	1,551 (45.2%)	298,083 (81.4%)	35,438 (72.4%)	8,424 (71.0%)
Black	33,539 (7.8%)	830 (24.2%)	26,238 (7.2%)	5,369 (11.0%)	1,102 (9.3%)
Other/Multiple Race	30,916 (7.2%)	814 (23.7%)	23,237 (6.3%)	5,819 (11.9%)	1,046 (8.8%)
Asian	17,546 (4.1%)	17 (0.5%)	15,337 (4.2%)	1,237 (2.5%)	955 (8.1%)
American Indian	4,325 (1.0%)	217 (6.3%)	2,750 (0.8%)	1,031 (2.1%)	327 (2.8%)
Hawaiian/Pacific Islander	560 (0.1%)	0 (0.0%)	466 (0.1%)	86 (0.2%)	7 (0.1%)
Ethnicity (Hispanic)	74,917 (17.5%)	667 (20.7%)	58,948 (16.2%)	12,591 (25.8%)	2,711 (23.0%)
Maternal Education					
Less than HS/No diploma	29,846 (6.9%)	786 (22.9%)	19,575 (5.3%)	7,861 (16.1%)	1,623 (13.7%)
High School Graduation/GED	100,115 (23.3%)	1,134 (33.1%)	81,894 (22.4%)	13,457 (27.5%)	3,630 (30.6%)
Some College/no degree	101,997 (23.7%)	809 (23.6%)	86,027 (23.5%)	11,897 (24.3%)	3,264 (27.5%)
Bachelors/Masters/Doctorate	198,425 (46.1%)	700 (20.4%)	178,615 (48.8%)	15,765 (32.2%)	3,345 (28.2%)
Marital Status					
Married	296,934 (69.0%)	1,355 (39.5%)	259,470 (70.9%)	29,405 (60.0%)	6,705 (56.5%)
Other	133,450 (31.0%)	2,075 (60.5%)	106,642 (29.1%)	19,576 (40.0%)	5,157 (43.5%)
Income					
0 - $24,000	82,057 (19.1%)	1,393 (40.6%)	61,359 (16.8%)	15,078 (30.8%)	4,226 (35.6%)
$24,001 – $48,000	81,848 (19.0%)	580 (16.9%)	66,661 (18.2%)	10,645 (21.7%)	3,962 (33.4%)
$48,001 – $73,000	70,466 (16.4%)	340 (9.9%)	60,736 (16.6%)	8,122 (16.6%)	1,268 (10.7%)
$73,001 +	196,012 (45.5%)	1,115 (32.5%)	177,356 (48.4%)	15,135 (30.9%)	2,405 (20.3%)
Delivery Type					
Vaginal	298,133 (69.3%)	2,448 (71.4%)	253,019 (69.1%)	34,371 (70.2%)	8,295 (69.9%)
Primary Cesarian	74,540 (17.3%)	548 (16.0%)	64,960 (17.7%)	7,408 (15.1%)	1,624 (13.7%)
Repeat Cesarian	44,934 (10.4%)	318 (9.3%)	37,532 (10.3%)	5,369 (11.0%)	1,714 (14.5%)
Vaginal Delivery after Cesarian	12,777 (3.0%)	115 (3.4%)	10,600 (2.9%)	1,833 (3.7%)	229 (1.9%)
Previous Preterm Birth	19,948 (4.6%)	36 (1.0%)	16,763 (4.6%)	2,602 (5.3%)	547 (4.6%)

Table 1 (continued)

	Total Sample (Weighted)	Timing of First Prenatal Care Visit			
		No Prenatal Care	1st Trimester	2nd Trimester	3rd Trimester
Social Determinates					
Current Living Situation					
Steady place to live	404,990 (94.1%)	2,478 (72.3%)	348,354 (95.1%)	44,083 (90.0%)	10,075 (84.9%)
Place to live but worried about losing it	20,446 (4.8%)	702 (20.5%)	14,985 (4.1%)	3,943 (8.0%)	816 (6.9%)
No steady place to live	4,948 (1.1%)	249 (7.3%)	2,773 (0.8%)	955 (2.0%)	971 (8.2%)
Geographic Region					
Urban	371,405 (86.3%)	2,956 (86.2%)	315,953 (86.3%)	42,548 (86.9%)	9,948 (83.9%)
Rural	58,979 (13.7%)	474 (13.8%)	50,159 (13.7%)	6,433 (13.1%)	1,913 (16.1%)
Abuse During Pregnancy (yes)	4,302 (1.0%)	262 (7.6%)	3,462 (0.9%)	463 (0.9%)	115 (1.0%)
Difficulty paying rent/mortgage *M* (SD)[a]	1.162 (0.368)	1.329 (0.474)	1.151 (0.358)	1.216 (0.411)	1.215 (0.412)
Food Insecure (food did not last) *M* (SD)[b]	4.580 (0.843)	4.101 (0.867)	4.609 (0.828)	4.462 (0.865)	4.303 (1.045)

Question Details:

[a] Difficulty paying rent/mortgage: 1 = No, 2 = Yes

[b] During the last 12 months- how often food did not last? 1 = always, 2 = usually, 3 = sometimes, 4 = rarely, 5 = never

presents a novel use of the PRAMS dataset to explore social and structural health determinants on the health of the maternal-infant dyad. Previous researchers have utilized PRAMS to explore concepts related to SDOH, intimate partner violence (IPV), and relationships to maternal-infant health but often with smaller subsets of PRAMS data (e.g. one state) [18–20] or exploring related but different concepts (e.g. neighborhood contexts) [20]. Using data from the PRAMS 8 database, we identified several SDOH variables including abuse during pregnancy, access to prenatal care, current living situation, and level of education associated with adverse outcomes including infant admitted to the NICU, lower gestational age at birth, lower likelihood to ever breastfeed, GDM, and GHTN. These SDOH are directly influence by the structural determinants of health in the US that have their origins in structurally racist polices. Through use of the ROOTT Framework, our analysis builds on previous research pointing to structural racism, and not simply race, as a salient risk for adverse maternal-infant health outcomes [21].

Abuse during pregnancy

In our study, inclusive of 11 states with complete SDOH supplemental data, we identified intimate partner violence (IPV) to be an important predictor of worse maternal and infant outcomes when controlling for covariates. These findings add to previous research using PRAMS data, which has examined the prevalence of abuse during pregnancy and its impact on health outcomes in specific sub-populations or at the state level [22]. Our study aligned with previous research identifying associations between IPV and hypertensive disorders during pregnancy finding a significant association between abuse and GHTN [23]. These findings support the critical nature of screening birthing individuals for experiences of violence to not only develop safety planning strategies but also monitor for adverse health outcomes including GHTN.

Experience of IPV for the birthing person had implications for infant health in our study. Consistent with previous literature [24], in our sample, birthing individuals with a history of abuse were more likely to deliver their infant preterm or at higher risk for admission to the NICU. Breastfeeding is associated with improved health outcomes for infants and may be negatively impacted in the context of IPV [25, 26]. Interestingly, we did not find a significant relationship between abuse during pregnancy and breastfeeding. In previous research conducted by Kanichy et al. examining IPV's role in breastfeeding disparities in North Dakota, the researchers found that American Indian women had 45% reduced odds of breastfeeding initiation compared to White women [27]. However, in this research IPV did not explain these disparities. These results and our study findings suggest a

Table 2 Bivariate relationships between infant & maternal outcomes and SDOH

Infant Outcomes					
	Admission to NICU[a] (*n, %*)		Breast Feed Ever[a] (*n, %*)		Gestational Age at Birth (weeks)[b] (M, SD)
	No	Yes	No	Yes	
N	391,566 (91.0%)	38,817 (9.0%)	35,051 (8.1%)	395,332 (91.9%)	38.5 (1.7)
Maternal Education	*p =.19*		*p* <.01		*p* <.01
Less than HS/No diploma	27,538 (7.0%)	2,308 (5.9%)	5,464 (15.6%)	24,382 (6.2%)	38.4 (1.88)
High School Graduation/GED	90,002 (23.0%)	10,113 (26.1%)	11,321 (32.3%)	88,794 (22.5%)	38.5 (1.81)
Some College/no degree	91,966 (23.5%)	10,032 (25.8%)	8,644 (24.7%)	93,354 (23.6%)	38.4 (1.79)
Bachelors/Masters/Doctorate	182,060 (46.5%)	16,365 (42.2%)	9,622 (27.5%)	188,803 (47.8%)	38.6 (1.55)
Timing of First Prenatal Care Visit	*p* =.10		*p* <.01		*p* =.07
No prenatal care	2,775 (0.7%)	654 (1.7%)	738 (2.1%)	2,691 (0.7%)	37.5 (2.84)
1 st Trimester	332,741 (85.0%)	33,370 (86.0%)	27,801 (79.3%)	338,310 (85.6%)	38.5 (1.70)
2nd Trimester	45,350 (11.6%)	3,631 (9.4%)	5,578 (15.9%)	43,403 (11.0%)	38.7 (1.60)
3rd Trimester	10,700 (2.7%)	1,162 (3.0%)	933 (2.7%)	10,928 (2.8%)	38.5 (1.55)
Current Living Situation	*p* =.31		*p* <.01		*p* =.82
Steady place to live	369,189 (94.3%)	35,801 (92.2%)	31,284 (89.3%)	373,706 (94.5%)	38.5 (1.69)
Place to live but worried about losing it	18,028 (4.6%)	2,417 (6.2%)	3,048 (8.7%)	17,398 (4.4%)	38.6 (1.78)
No steady place to live	4,349 (1.1%)	599 (1.5%)	719 (2.1%)	4,229 (1.1%)	38.6 (1.74)
Neighborhood	*p* =.04		*p* =.22		*p* =.87
Urban	337,046 (86.1%)	34,358 (88.5%)	29,342 (83.7%)	342,063 (86.5%)	38.6 (1.70)
Rural	54,520 (13.9%)	4,459 (11.5%)	5,709 (16.3%)	53,270 (13.5%)	38.5 (1.65)
Abuse during pregnancy	*p* =.01		*p* =.91		*p* =.03
No	388,181 (99.1%)	37,901 (97.6%)	34,681 (98.9%)	391,400 (99.0%)	38.6 (1.7)
Yes	3,385 (0.9%)	917 (2.4%)	370 (1.1%)	3,932 (1.0%)	37.8 (2.3)
Difficulty paying rent/mortgage	*p* =.04		*p* <.01		*p* <.01
No	329,633 (84.2%)	31,158 (80.3%)	27,116 (77.4%)	333,675 (84.4%)	38.6 (1.66)
Yes	61,933 (15.8%)	7,659 (19.7%)	7,935 (22.6%)	61,658 (15.6%)	38.3 (1.85)
Food Security[c]	*p* =.04		*p* <.01		*p* <.01
	4.6 (0.8)	4.5 (0.9)	4.4 (1.0)	4.6 (0.8)	a.
Maternal Outcomes					
	Gestational Diabetes[a] (*n, %*)		Gestational Hypertension [a] (*n, %*)		
	No	Yes	No	Yes	
N	392,427 (91.2%)	37,957 (8.8%)	386,085 (89.7%)	44,299 (10.3%)	
Maternal Education	*p* =.24		*p* =.56		
Less than HS/No diploma	26,872 (7.0%)	2,974 (6.7%)	26,872 (7.0%)	2,974 (6.7%)	
High School Graduation/GED	90,016 (23.3%)	10,099 (22.8%)	90,016 (23.3%)	10,099 (22.8%)	
Some College/no degree	90,220 (23.4%)	11,778 (26.6%)	90,220 (23.4%)	11,778 (26.6%)	
Bachelors/Masters/Doctorate	178,977 (46.4%)	19,448 (43.9%)	178,977 (46.4%)	19,448 (43.9%)	
Timing of First Prenatal Care Visit	*p* =.11		*p* =.49		
No prenatal care	3,298 (0.8%)	131 (0.3%)	3,108 (0.8%)	321 (0.7%)	
1 st Trimester	333,959 (85.1%)	32,152 (84.7%)	327,367 (84.8%)	38,744 (87.5%)	
2nd Trimester	45,110 (11.5%)	3,871 (10.2%)	44,571 (11.5%)	4,410 (10.0%)	
3rd Trimester	10,059 (2.6%)	1,803 (4.7%)	11,039 (2.9%)	822 (1.9%)	
Previous preterm births	*p* =.14		*p* =.01		
No	374,826 (95.5%)	35,609 (93.8%)	369,412 (95.7%)	41,023 (92.6%)	
Yes	17,601 (4.5%)	2,348 (6.2%)	16,673 (4.3%)	3,276 (7.4%)	
Social Determinants					
Current Living Situation	*p* <.01		*p* <.01		
Steady place to live	368,018 (93.8%)	36,972 (97.4%)	362,059 (93.8%)	42,930 (96.9%)	

Table 2 (continued)

Place to live but worried about losing it	19,545 (5.0%)	900 (2.4%)	19,260 (5.0%)	1,186 (2.7%)
No steady place to live	4,864 (1.2%)	85 (0.2%)	4,766 (1.2%)	183 (0.4%)
Geographic Region	*p* =.54		*p* =.02	
Urban	338,251 (86.2%)	33,153 (87.3%)	331,372 (85.8%)	40,032 (90.4%)
Rural	54,175 (13.8%)	4,804 (12.7%)	54,713 (14.2%)	4,266 (9.6%)
Abuse during pregnancy	*p* =.54		*p* =.26	
No	388,369 (99.0%)	37,712 (99.4%)	382,458 (99.1%)	43,624 (98.5%)
Yes	4,057 (1.0%)	245 (0.6%)	3,627 (0.9%)	675 (1.5%)
Difficulty paying rent/mortgage	*p* =.85		*p* =.86	
No	329,110 (83.9%)	31,681 (83.5%)	323,795 (83.9%)	36,996 (83.5%)
Yes	63,316 (16.1%)	6,276 (16.5%)	62,290 (16.1%)	7,302 (16.5%)
Food Security[c]	*p* =.69		*p* =.88	
	4.6 (0.8)	4.6 (0.8)	4.6 (0.8)	4.6 (0.9)

a. Summary statistics not provided as Food Security and Gestational Weeks are both continuous variables

[a] Chi-square tests

[b] Linear regression

[c] Means and SDs presented, 5-point Likert-scale with lower scores indicate less food security (food insecurity)

need to examine historical and cultural factors affecting breastfeeding.

Access to prenatal care

Access to and timing of prenatal care were salient risks for adverse maternal (GDM) and infant health outcomes (admission to the NICU, lower gestational age, and ever breastfeeding) in our study. We found that birthing individuals who did not receive prenatal care until the third trimester were more likely to be diagnosed with GDM. Previous research using PRAMS data has identified that after 2020, receipt of adequate prenatal care significantly decreased, mostly in Hispanic individuals, followed by Black and Asian birthing persons, who are all significantly more likely to be diagnosed with GDM [28]. According to Healthy People 2030, only White birthing individuals have met the target goal of 80.5% of birthing individuals receiving early and adequate prenatal care in 2022 [29]. Only 77.5% of Asian birthing persons, 72.4% of multiracial individuals, 66.9% of Black individuals, and 60.8% of American Indian or Alaskan Natives receive adequate prenatal care [29]. Earlier prenatal visits can identify birthing individuals at risk for GDM, with earlier screening in addition to education on weight gain during pregnancy, which is a significant risk factor for GDM [30, 31]. Without these screening and learning opportunities, birthing individuals are at a disadvantage, and thus, may be at increased GDM risk.

Our findings demonstrate that maternal access to care has lasting effects on infant outcomes. For example, there were significant associations among birthing individuals who received no prenatal care and an increase in admission to the NICU and ever breastfeeding. These results indicate that any prenatal care, even if later during pregnancy, is protective of the infant. The nature of healthcare professionals' communication with birthing individuals about prenatal care and obstetric services impact health outcomes and may worsen existing disparities. When healthcare professionals fail to create environments for shared decision making or "shame" birthing persons, there is a risk for decreased access to health care and less likelihood breastfeeding [32, 33]. Furthermore, these results offer a strength-based opportunity to engage with birthing individuals who may struggle with accessing healthcare. Providing support for and celebration of a birthing person's ability to access care offers healthcare providers important tools for effective communication.

While provision of human milk and direct breastfeeding is accepted as the gold standard for nutrition, like our findings, Mills et al. found that direct breastfeeding and duration of breastfeeding with preterm infants in the NICU was significantly related to SDOH factors [34]. They also found breastfeeding could be positively modified with lactation support. Moreover, it is important to note that delayed prenatal care was highly related to the infant ever breastfeeding or to breastfeeding duration overtime. Kopp et al. found that intent to breastfeed is related to SDOH as well as prenatal care with breastfeeding education [35].

Current living situation

Housing stability and neighborhood (rural versus urban) were associated with GDM and GHTN in our research. In bivariate analyses, we identified significant associations with housing stability and risk of developing GHTN and GDM. These findings support the critical importance of housing stability on the health of the maternal-infant

Table 3 Simultaneous regression analysis for infant & maternal outcomes (Model 2)[a]

	NICU Admission					
	OR	SE	*t*	*p* > *t*	95% CI	
Current Living Situation						
Steady place to live[1]						
Place to live but worried about losing it	1.39	0.35	1.29	0.1	0.84	2.30
No steady place to live	1.37	0.76	0.58	0.5	0.46	4.11
Geographic Region						
Urban[1]						
Rural	0.70	0.11	−2.11	0.03*	0.51	0.97
Maternal Education						
Less than HS/No diploma[1]						
High School Graduation/GED	1.29	0.30	1.11	0.26	0.81	2.05
Some College/no degree	1.25	0.29	0.97	0.33	0.79	1.98
Bachelors/Masters/Doctorate	1.14	0.28	0.55	0.58	0.70	1.87
Timing of 1st Prenatal Care Visit						
1st Trimester[1]						
No Prenatal Care	2.65	1.18	2.19	0.02*	1.10	6.36
2nd Trimester	0.78	0.14	−1.33	0.18	0.55	1.12
3rd Trimester	1.08	0.38	0.24	0.81	0.54	2.17
Abuse During Pregnancy	2.06	0.85	1.75	0.08	0.91	4.66
Difficulty paying rent/mortgage	1.03	0.15	0.26	0.79	0.77	1.39
Previous Preterm Birth	0.41	0.07	−4.94	0.00*	0.29	0.58
	Breast Feed Ever					
	OR	SE	*t*	*p* > *t*	95% CI	
Current Living Situation						
Steady place to live[1]						
Place to live but worried about losing it	0.61	0.16	−1.87	0.06	0.36	1.02
No steady place to live	0.82	0.40	−0.4	0.69	0.31	2.16
Geographic Region						
Urban[1]						
Rural	1.04	0.19	0.22	0.82	0.72	1.49
Maternal Education						
Less than HS/No diploma[1]						
High School Graduation/GED	2.11	0.44	3.54	<0.001*	1.37	3.14
Some College/no degree	2.66	0.62	4.17	<0.001*	1.70	4.24
Bachelors/Masters/Doctorate	3.74	0.87	5.67	<0.001*	2.44	5.97
Timing of 1st Prenatal Care Visit						
1st Trimester[1]						
No Prenatal Care	0.42	0.19	−1.91	0.05*	0.17	1.02
2nd Trimester	0.75	0.14	−1.43	0.15	0.51	1.10
3rd Trimester	1.32	0.47	0.77	0.44	0.65	2.68
Abuse During Pregnancy	1.78	0.94	1.1	0.27	0.63	5.04
Difficulty paying rent/mortgage	1.07	0.20	0.37	0.71	0.74	1.54
Previous Preterm Birth	1.46	0.39	1.44	0.14	0.87	2.47
	Gestational Age at Birth (weeks)					
	OR	SE	*t*	*p* > *t*	95% CI	
Current Living Situation						
Steady place to live[1]						
Place to live but worried about losing it	0.23	0.11	2.01	0.04*	0.01	0.45
No steady place to live	0.23	0.19	1.16	0.24	−0.15	0.62

Table 3 (continued)

Geographic Region						
Urban[1]						
Rural	0.04	0.06	0.74	0.46	−0.07	0.16
Maternal Education						
Less than HS/No diploma[1]						
High School Graduation/GED	0.20	0.11	1.89	0.05*	−0.01	0.42
Some College/no degree	0.09	0.10	0.91	0.36	−0.11	0.30
Bachelors/Masters/Doctorate	0.23	0.10	2.21	0.02*	0.02	0.44
Timing of 1st Prenatal Care Visit						
1st Trimester[1]						
No Prenatal Care	−0.91	0.46	−1.98	0.04*	−1.81	−0.01
2nd Trimester	0.16	0.07	2.29	0.02*	0.02	0.30
3rd Trimester	0.01	0.13	0.07	0.94	−0.25	0.26
Abuse During Pregnancy	−0.57	0.29	−1.93	0.05*	−1.16	0.01
Difficulty paying rent/mortgage	−0.12	0.07	−1.69	0.09	−0.26	0.01
Previous Preterm Birth	1.32	0.15	8.7	0.00*	1.02	1.62
	Gestational Diabetes					
	OR	SE	*t*	*p* > *t*	95% CI	
Current Living Situation						
Steady place to live[1]						
Place to live but worried about losing it	0.41	0.14	−2.58	0.01*	0.21	0.81
No steady place to live	0.16	0.09	−3.00	0.00*	0.05	0.53
Geographic Region						
Urban[1]						
Rural	0.86	0.14	−0.89	0.37	0.62	1.19
Maternal Education						
Less than HS/No diploma[1]						
High School Graduation/GED	1.40	0.38	1.25	0.21	0.82	2.39
Some College/no degree	1.66	0.44	1.89	0.05*	0.98	2.81
Bachelors/Masters/Doctorate	1.58	0.43	1.67	0.09	0.92	2.72
Timing of 1st Prenatal Care Visit						
1st Trimester[1]						
No Prenatal Care	0.56	0.48	−0.65	0.51	0.09	3.12
2nd Trimester	0.91	0.19	−0.41	0.68	0.60	1.40
3rd Trimester	1.95	0.68	1.91	0.05*	0.99	3.87
Abuse During Pregnancy	0.75	0.58	−0.36	0.71	0.16	3.43
Difficulty paying rent/mortgage	1.01	0.19	0.06	0.95	0.69	1.46
Previous Preterm Birth	0.76	0.18	−1.11	0.26	0.47	1.22
	Gestational Hypertension					
	OR	SE	*t*	*p* > *t*	95% CI	
Current Living Situation						
Steady place to live[1]						
Place to live but worried about losing it	0.50	0.15	−2.17	0.03*	0.27	0.93
No steady place to live	0.33	0.15	−2.34	0.01*	0.13	0.83
Geographic Region						
Urban[1]						
Rural	0.54	0.10	−3.19	0.00*	0.37	0.79
Maternal Education						
Less than HS/No diploma[1]	0.77	0.18	−1.08	0.27	0.48	1.22
High School Graduation/GED	0.90	−0.45	−0.45	0.65	0.56	1.42
Some College/no degree	0.83	−0.77	−0.77	0.44	0.51	1.33

Table 3 (continued)

Bachelors/Masters/Doctorate	1.02	0.32	−1.08	0.74	0.88	1.19
Timing of 1st Prenatal Care Visit						
1st Trimester[1]						
No Prenatal Care	0.88	0.63	−0.17	0.86	0.21	3.61
2nd Trimester	0.83	0.15	−1.02	0.30	0.58	1.18
3rd Trimester	0.64	0.25	−1.09	0.27	0.29	1.41
Abuse During Pregnancy	1.88	0.74	1.61	0.10	0.86	4.10
Difficulty paying rent/mortgage	0.94	0.15	−0.33	0.74	0.68	1.31
Previous Preterm Birth	0.56	0.12	−2.51	0.01*	0.36	0.88

[a] Model 2 analysis included all primary predictor variables and covariates (controls) using the survey weighted sample

[*] Significance was set at $p<0.05$

[1] indicates reference category

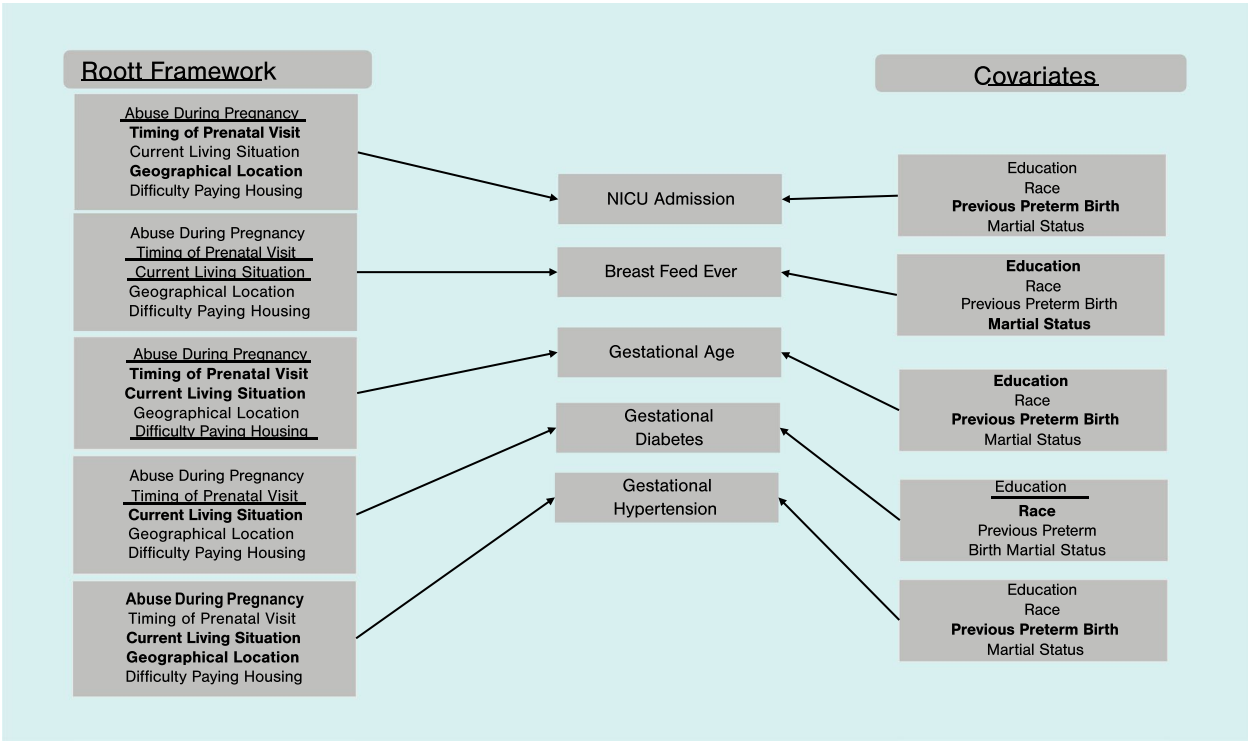

Fig. 2 The results of the final trimmed model, displaying relationships between infant and maternal health outcomes and social determinants of health

dyad. Other research groups have also reported significant increases in the risk of developing GDM in resource deprived neighborhoods [36, 37] and an increased risk of complications related to GDM in neighborhoods with more individuals living below the poverty level [38]. Research has shown that individuals and families experiencing housing insecurity are more likely to also experience food insecurity [39]. Previous findings demonstrate a link between food insecurity and higher rates of maternal morbidity including GDM [40, 41]. Additionally, individuals were more likely to be diagnosed with GHTN if they reported insecure housing or no steady place to live, which is consistent with the findings by Green et al. [42]. There is a paucity of literature evaluating associations with housing insecurity and specifically GHTN as opposed to chronic hypertension, preeclampsia, or a combined hypertensive disorders of pregnancy [43, 44]. Housing insecurity may contribute to poor cardiovascular outcomes due to increased stressors, depression,

suboptimal sleep, and lack of access to quality nutrition [45].

We identified that living in a rural area was associated with lower odds of developing GDM, which is dissimilar from other recent literature in the US [46, 47]. For example, Ali et al., 2024 collected maternal health indicators over a 15-year period and found an increased risk for GDM among maternal individuals residing in rural regions of the state of Kansas [47]. Similarly, Venkatesh et al. [46] found that individuals living in rural areas of the US were more likely to be diagnosed with GDM. This was especially true for those who self-identified as being of Hispanic descent and living in the Southern and Western regions of the US [46]. While our findings are inconsistent with this literature, it is important to note that no states from the South collected supplemental SDOH information, which may represent a gap in our findings. Our findings also suggest that living in a rural area was associated with lower odds of developing GHTN. Although Cameron et al. reported birthing individuals experienced increasing incidences in the onset of hypertensive disorders of pregnancy in both those living in rural and urban areas, there was an accelerated rate of onset in individuals living in urban areas when compared to those in rural areas [48]. These findings emphasize the importance of ongoing focus on developing targeted interventions that account for differences in rural and urban locations.

Level of education

Mills et al. [34] also found that younger and less educated mothers were less likely to choose to breastfeed, which concurs with our results. While not all these variables are easily modifiable, our findings do provide evidence for policy change and for the need to provide better support to growing families. These factors put infants at higher risk for both short- and long-term attachment and developmental issues that have long-lasting effects for the infant, family and for society at large [34, 49, 50].

Future research & policy recommendations

Our findings suggest that multiple forms of structural disadvantage play a significant role in maternal-infant health outcomes contributing to health disparities. Our work utilized a sub-set of the full PRAMS dataset inclusive of states that completed the SDOH supplemental questionnaire. Future research repeating or expanding on this study should be considered as more states include SDOH measurements. Importantly, data from geographic regions of the US known to have poor maternal-infant health outcomes was underrepresented in our analysis and should be included in the future. Additionally, we recommend that the SDOH supplemental database be included in future PRAMS iterations to allow for evaluative comparisons based on changes in the political and structural determinants of health landscape. For example, changes to Medicaid expansion and abortion care restriction may further contribute to inequities in housing stability and rates of abuse during pregnancy, respectively [51, 52], It is important to consider how changes in reproductive-related national policy may further exacerbate inequities in SDOH or provide support for improved health outcomes. This type of repeated research with an expanded national sample may help further inform interventions tailored to address social and structural drivers of health inequities nationally and improve reporting practices of SDOH. Our findings highlight the continued need for robust and accessible national datasets measuring important maternal-infant health outcomes.

As healthcare policies are implemented throughout the US, it is imperative that investigators continue to examine and advocate for health equity among structurally marginalized individuals. Important policies that incorporate concepts associated with reproductive justice include the expansion of both public and private coverage for health care services provided to birthing persons beyond 12 months postpartum, coverage of immunizations, and telehealth care services. Furthermore, policies that limit preventative health initiatives, such as newborn screening, and research focused on gender create more structural barriers to the health and wellbeing of the maternal-infant dyad.

Reproductive justice frameworks

Given our findings, we also recommend that researchers consider using the ROOTT framework and similar reproductive justice frameworks to guide their analysis as well as to make recommendations for future research and practice change. Historically and systematically underserved birthing individuals may experience health inequities on multiple, intersecting levels including threats to social, economic, and political power [53]. Application of the ROOTT framework and those rooted in reproductive justice can guide researchers to ask research questions that help uncover the wider sources of oppression and disadvantage that may contribute to maternal-infant health disparities [54]. Utilizing a reproductive justice, intersectional analysis approach can also guide researchers to statistically examine the complexity of interconnected forms of disadvantage and privilege [55, 56]. Furthermore, the use of theoretical frameworks that incorporate concepts of reproductive justice provide researchers the tools needed to integrate respectful and

inclusive partnerships with those whom they wish to learn more from [54].

Limitations

This study should be considered in light of key limitations. While use of a large, national dataset allowed for an adequate sample size for statistical modeling, it may also result in results that are statistically but not clinically significant. We utilized a sub-set of PRAMS data from states that completed the SDOH questionnaire. The generalizability of these results to regions of the US not included in this analysis are unknown, especially since no states from the South collected supplemental SDoH information. We did not stratify our analyses by race/ethnicity limiting our understanding of the contradictory associations we found with rurality and should be considered in the future. Another important limitation is the fact that PRAMS 8 includes data collected during the COVID-19 pandemic. It is not known how the pandemic influenced the results of our analysis, and it is possible that the pandemic influenced many of the SDOH and outcomes we measured. Finally, our research was grounded in a theoretical framework. Due to the nature of utilizing secondary data, we were unable to operationalize theoretical constructs such as incarceration in our analysis and used proxies (such as rural vs urban for neighborhood) which limits our ability to fully measure and these important constructs.

Conclusion

Given the proliferation of poor maternal and infant health outcomes in the US, it is important to consider the influences of SDOH rooted in structural determinants. Findings from our study reveal that risk factors, including access to prenatal care, safety, and housing largely are related to significant maternal-infant outcomes such as GHTN, GDM, and breastfeeding outcomes. To address these modifiable risk factors, our study findings highlight the need for the use of modern theoretical frameworks and large, national representative research examining SDOH and maternal-infant health, which may be useful in informing evidence-based, reproductive-related national policies. Comprehensive and targeted interventions are necessary to ensure early and consistent access to healthcare and resources to address and support maternal and infant health.

Abbreviations

GDM	Gestational diabetes
GHTN	Gestational hypertension
IPV	Intimate partner violence
NICU	Neonatal Intensive Care Unit
PRAMS	Pregnancy Risk Assessment Monitoring System
ROOTT	Restoring Our Own Through Transformation
SDOH	Social determinants of health

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12884-025-07693-y.

Supplementary Material 1.

Acknowledgements

We thank the PRAMS Working Group, which includes the PRAMS Team, Division of Reproductive Health, CDC and the following PRAMS sites for their role in conducting PRAMS surveillance and allowing the use of their data: Pennsylvania, New York, Massachusetts, Colorado, Missouri, Arizona, Wisconsin, Utah, Kansas, South Dakota, and Rhode Island.

Authors' contributions

KM, KMB, SM, AV, RWT: Conceived the study, designed the methodology, and conducted the data analysis. KM, SM, CE: Collected the data and performed statistical analysis. KM, KMB, JM, RK, AV, JZ, SM, CE: Contributed to the writing and review of the manuscript. KM, KMB, JM, RK, AV, JZ, SM, CE: Drafted and revised the manuscript for intellectual content. KM, KMB, JM, RK, AV, JZ, SM, CE, RWT: Provided critical revisions to the manuscript. KM, KMB: Managed the overall project and contributed to the manuscript's final editing and approval.

Funding

Marquette University's Institute for Women's Leadership Faculty Fellowship (KM); 1 K23 NR021043-01 A1 (KM).

Data availability

Data from The Centers for Disease Control and Prevention Pregnancy Risk Assessment Monitory System 8.

Declarations

Ethics approval and consent to participate

This study received an exemption from the Marquette University Institutional Review Board. Approval for use of the PRAMS Automated Research File Portal and data from the CDC was received in March 2024. The general PRAMS methodology and protocol have been reviewed and approved by the Centers for Disease Control and Prevention's institutional review board and informed consent documents are included within each survey packet explaining the participant's rights. No written consent is required, and consent is implied if the survey is completed [13].

Consent for publication

The Centers for Disease Control and Prevention Pregnancy Risk Assessment Monitoring System team has been notified of intention to publish these results, our team has not received a response.

Competing interests

The authors declare no competing interests.

Author details

[1]Marquette University, College of Nursing, Milwaukee, USA. [2]Henry Ford Health Center for Health Policy & Health Services Research, Detroit, MI, USA. [3]Independent Statistical Consulting, Detroit , MI, USA. [4]Department of Nursing Research, Children's Wisconsin, The University of Chicago Illinois, Illinois, USA. [5]The University of South Florida, Florida, USA. [6]The University of Texas, San Antonio, USA.

Received: 30 March 2025 Accepted: 6 May 2025
Published online: 16 May 2025

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