Comparative Effectiveness Review
Number 264

Social and Structural Determinants of Maternal Morbidity and Mortality: An Evidence Map

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None of the investigators have any affiliations or financial involvement that conflicts with the material presented in this report.

The information in this report is intended to help healthcare decision makers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of healthcare services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information, i.e., in the context of available resources and circumstances presented by individual patients.

A representative from AHRQ served as a Contracting Officer's Representative and reviewed the contract deliverables for adherence to contract requirements and quality. AHRQ did not directly participate in the literature search, determination of study eligibility criteria, data analysis, interpretation of data, or preparation or drafting of this report.

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Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-based Practice Centers (EPCs), sponsors the development of evidence reports and technology assessments to assist public- and private-sector organizations in their efforts to improve the quality of healthcare in the United States.

The National Institutes of Health Office of Disease Prevention requested this report from the EPC Program at AHRQ as part of a Pathways to Prevention (P2P) Workshop: Identifying Risks and Interventions to Optimize Postpartum Health. AHRQ assigned this report to the following EPC: Minnesota Evidence-based Practice Center (Contract Number: 75Q80120D00008).

The reports and assessments provide organizations with comprehensive, evidence-based information on common medical conditions and new healthcare technologies and strategies. They also identify research gaps in the selected scientific area, identify methodological and scientific weaknesses, suggest research needs, and move the field forward through an unbiased, evidence-based assessment of the available literature. The EPCs systematically review the relevant scientific literature on topics assigned to them by AHRQ and conduct additional analyses when appropriate prior to developing their reports and assessments.

To bring the broadest range of experts into the development of evidence reports and health technology assessments, AHRQ encourages the EPCs to form partnerships and enter into collaborations with other medical and research organizations. The EPCs work with these partner organizations to ensure that the evidence reports and technology assessments they produce will become building blocks for healthcare quality improvement projects throughout the Nation. The reports undergo peer review and public comment prior to their release as a final report.

AHRQ expects that the EPC evidence reports and technology assessments, when appropriate, will inform individual health plans, providers, and purchasers, as well as the healthcare system as a whole, by providing important information to help improve healthcare quality.

If you have comments on this evidence report, they may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 5600 Fishers Lane, Rockville, MD 20857, or by email to epc@ahrq.hhs.gov.

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Technical Expert Panel

In designing the study questions and methodology at the outset of this report, the EPC consulted several technical and content experts. Broad expertise and perspectives were sought. Divergent and conflicting opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Therefore, in the end, study questions, design, methodologic approaches, and/or conclusions do not necessarily represent the views of individual technical and content experts.

Technical Experts must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their unique clinical or content expertise, individuals with potential conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any potential conflicts of interest identified.

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Peer Reviewers

Prior to publication of the final evidence report, EPCs sought input from independent Peer Reviewers without financial conflicts of interest. However, the conclusions and synthesis of the scientific literature presented in this report do not necessarily represent the views of individual reviewers. AHRQ may also seek comments from other Federal agencies when appropriate.

Peer Reviewers must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their unique clinical or content expertise, individuals with potential nonfinancial conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any potential nonfinancial conflicts of interest identified.

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Social and Structural Determinants of Maternal Morbidity and Mortality: An Evidence Map

Structured Abstract

Objective. The purpose was to review available evidence of risk factors associated with maternal morbidity and mortality in the United States during the prenatal and postpartum periods to inform a National Institutes of Health Pathways to Prevention Workshop: Identifying Risks and Interventions to Optimize Postpartum Health, held November 29–December 1, 2022.

Data sources. We searched MEDLINE®, CINAHL®, and the Social Sciences Citation Index through November 2022.

Review methods. We searched for observational studies examining exposures related to social and structural determinants of health and at least one health or healthcare-related outcome for pregnant and birthing people. We extracted basic study information and grouped studies by social and structural determinants of health domains and maternal outcomes. We prioritized studies according to study design and rigor of analytic approaches to address selection bias based on the ROBINS-E. We summarize all included studies and provide additional descriptions of direction of association between potential risk exposures and outcomes.

Results. We identified 8,378 unique references, with 118 included studies reporting social and structural determinants of health associated with maternal health outcomes. Studies covered risk factors broadly, including identity and discrimination, socioeconomic, violence, trauma, psychological stress, structural/institutional, rural/urban, environment, comorbidities, hospital, and healthcare use factors. However, the risk factors we identified represent only a subset of potential social and structural determinants of interest. We found an unexpectedly large volume of research on violence and trauma relative to other potential exposures of interest for pregnant people. Outcome domains included maternal mortality, severe maternal morbidity, hypertensive disorders, gestational diabetes, cardio/metabolic disorders, weathering (the physiological effect of premature aging caused by chronic stressful experiences), depression, other mental health or substance use disorders, and cost/healthcare use outcomes. Depression/other mental health outcomes represented a large proportion of medical outcomes captured. Risk of bias was high, and rarely did studies report the excess risk attributable to a specific exposure.

Conclusions. Identifying risk factors pregnant and birthing people face is vitally important. Limited depth and quality of available research within each social and structural determinant of health impeded our ability to outline specific pathways, including risk factor interdependence. While more recently published literature showed a trend toward increased rigor, future research can emphasize techniques that estimate the causal impacts of risk factors. Improved reporting in studies, along with organized and curated catalogues of maternal health exposures and their presumed mechanisms, would make it easier to examine exposures in the future. In the longer term, the field could be advanced by datasets designed to more fully capture the data required to robustly examine racism and other social and structural determinants of health, in combination with their intersections and feedback loops with other biologic/medical risk factors.

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Executive Summary

Main Points

- Included study exposures broadly covered social-structural determinants of health for pregnant and birthing people; however, the identified determinants still represent only a subset of potential social-structural determinants of interest and did not address interdependence of risk factors, including biological/medical risk factors.
- Limited depth and quality of available research within each risk factor domain—including racism and other forms of discrimination—impeded our ability to understand pathways connecting social-structural determinants of health and maternal health outcomes.
- We found an unexpectedly large volume of research on violence and trauma relative to other potential social determinants of health for pregnant people.
- For outcome domains, depression/other mental health outcomes represented a large proportion of the health outcomes captured.
- We found one study investigating patterns of intersecting social-structural determinants of health that is an exemplar of new approaches to risk factor research.
- Rarely did studies report the excess risk attributable to a specific exposure. Of note, very recent studies, mostly limited geographically, reported:
    - Income inequality was associated with a 14 percent increase in excess risk of death for Black pregnant women relative to white women in Virginia; prolonged 5-year income inequality was associated with a 20 percent increase.
    - Hispanic birthing women were more likely to deliver at hospitals with higher risk-adjusted severe maternal morbidity; delivery location may contribute up to 37 percent of ethnic disparity in severe maternal morbidity in New York City.
    - Combined race and income segregation was associated with increased severe maternal morbidity in birthing women in New York City; delivery hospitals accounted for 35 percent of the attributable risk, and 50 percent of comorbidities.
    - Nationally, if rural Indigenous birthing women experienced severe maternal morbidity and mortality at the same rate as urban white women, they would see a 49 percent reduction in cases.

Background and Purpose

Despite spending more on maternity care than any other country, the United States has seen maternal deaths rise since 2000, and risk of death from complications related to pregnancy and childbirth in the United States exceeds that of any other high-income country.[1] This becomes more alarming considering that maternal morbidity and mortality serve as key indicators of the health and well-being of a country. Furthermore, risk of maternal morbidity and mortality is unevenly distributed among populations in the United States, with Black and Indigenous women three to four times more affected than their white counterparts.[2] Efforts to explain such high rates of maternal morbidity and mortality along with pronounced inequities in maternal outcomes have largely fallen short, in part because research has focused mainly on birth and infant outcomes, with limited consideration of the multiple factors that broadly affect maternal health.

To better understand racism and the social and structural determinants of health (hereafter referred to as social-structural determinants of health) that underlie maternal morbidity and

mortality in the United States, the Office of Disease Prevention requested this systematic review to inform the November 29 – December 1, 2022 Pathways to Prevention workshop cosponsored by the National Institutes of Health's Office of Research on Women's Health, the National Heart Lung and Blood Institute, the National Institute of Minority Health and Health Disparities, and the Eunice Kennedy Shriver National Institute of Child Health and Human Development. The Office of Disease Prevention anticipated that the risk of postpartum maternal morbidity and mortality would be influenced by the complex interplay between individual, family, community, and social-structural factors that drive health. Therefore, we focused mainly on research that specifically examined factors to which pregnant and birthing people have been exposed and that may underlie poor perinatal health outcomes.

Methods

The methods for this systematic review follow the Agency for Healthcare Research and Quality Methods Guide for Effectiveness and Comparative Effectiveness Reviews. See the review protocol (https://effectivehealthcare.ahrq.gov/products/maternal-morbidity-mortality/protocol) and the full report of the review for additional details. Briefly, we searched MEDLINE®, CINAHL®, and Social Sciences Citation Index through November 2022 for observational studies examining exposures related to social determinants of health and at least one health or healthcare-related outcome. Our focus was studies that attempted to examine pathways underlying risks.

Results

We identified 8,378 unique references, with 118 included studies reporting observational risk factors associated with maternal health outcomes. An overwhelmingly large number of studies used correlational study designs, and the studies that used quasi-experimental techniques showed high risk of bias. Therefore, we approached results from the perspective of supporting future researchers in generating hypotheses for risk factors to test with potential interventions. Overall, we found the study exposures or risk factors of interest for both pregnant and birthing people broadly covered social-structural determinants of health; however, these exposures represent only a subset of social-structural determinants of health that may affect maternal morbidity and mortality. Limited depth and quality of available research within each social determinant of health impeded our ability to understand the mechanisms by which these social determinants of health affect maternal health. We found an unexpectedly high volume of research on violence and trauma relative to other social-structural factors of interest for pregnant people. This likely stemmed from the fact that a number of states have added violence-related questions to the Center for Disease Control and Prevention's Pregnancy Risk Assessment Monitoring System questionnaire. Depression and other mental health outcomes were very common for both pregnant and birthing people, even compared with mortality and other severe maternal morbidity outcomes. We found one study investigating patterns of intersecting social-structural determinants of health that is an exemplar of new approaches to risk factor research.[3]

Very few studies reported the excess risk attributable to a specific social-structural determinant of health. One study reported that for pregnant women, income inequality was associated with a 14 percent increase in excess risk of death for Black women relative to white women in Virginia; prolonged income inequality was associated with a 20 percent increase.[4] In one study, Hispanic birthing women were more likely to deliver at hospitals with higher risk-adjusted severe maternal morbidity, contributing up to 37 percent of ethnic disparity in severe

maternal morbidity in New York City.[5] Another found an association between combined race and income segregation and increased severe maternal morbidity in birthing women in New York City; of the attributable risk, 35 percent was accounted for by delivery hospitals, and 50 percent by comorbidities (including prepregnancy body mass index, diabetes, hypertension, cardiac disease, renal disease, pulmonary disease, musculoskeletal disease, blood disorders, mental disorders, central nervous system disorders, rheumatic heart disease, anemia, and asthma).[6] Finally, if rural Indigenous birthing women experienced severe maternal morbidity and mortality at the same rate as urban white women, they would see a 49 percent reduction in cases.[7]

Strengths and Limitations

The methods we selected for this review provided a detailed map of the research connecting racism and other social-structural determinants of health to maternal health and morbidity for observed pregnancies. We purposefully focused on studies that examined risk factors that operated interpersonally. Such high-level mapping seeks to help researchers—who are often still siloed in particular areas of expertise or interest—gain a wider perspective on the breadth of literature within which their specific practice and advocacy resides. Our inclusion criteria required studies to examine the impact of a social determinant of health. As such, many studies that examined only comorbidities or other medical risk factors were ultimately excluded. Most of these excluded studies used patient demographics as control or confounder variables and lacked description of exposures indicative of social or structural determinants of health.

Implications and Conclusions

Identifying the risk factors pregnant and birthing people face in relation to postpartum health is vitally important. Limited depth and quality of available research within each risk factor impeded our ability to outline specific pathways underlying the impact of social-structural determinants of health on maternal health. Literature published within the last three years did show a definite trend toward improved rigor and analysis of risk attributed to social-structural drivers of maternal health for pregnant and birthing people. However, future research can emphasize techniques that improve the ability to estimate causal impacts. Improved study reporting, along with organized and curated catalogues of maternal health exposures and their mechanisms, could make it easier to examine exposures in the future, including the interdependence of social-structural and biologic/medical risk factors. Longer term, the maternal health field would benefit from datasets designed to more fully capture the data needed to robustly examine racism, other social-structural determinants of health, biological/medical risk factors, and the ways they interact to impact maternal health and well-being outcomes.

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Chapter 1. Introduction

1.1 Background

Despite spending more on maternity care than any other country, the United States has the highest rate of maternal mortality among high-income counties.[1] Further, although maternal mortality—a key indicator of health and well-being of a country—is declining globally, the United States is one of only two nations seeing a rise since 2000 in deaths from complications related to pregnancy and childbirth.[2] Maternal mortality, as defined by the World Health Organization, refers to the death of an individual while pregnant or within the first 6 weeks after pregnancy ends from any cause related to or aggravated by pregnancy or childbirth.[3] Maternal deaths occurring after the first six weeks but prior to the first year postpartum are considered late maternal deaths.[4] However, maternal death represents the "tip of the iceberg" as an indicator of maternal health and maternal care quality, because far more pregnant and birthing people experience life-threatening complications of pregnancy and childbirth that can undermine their well-being and functional ability.[5] Maternal morbidity, as defined by the U.S. Centers for Disease Control and Prevention, refers to any short- or long-term health problem resulting from pregnancy and childbirth.[6]

Each year an estimated 700 pregnant and birthing people die in the United States due to pregnancy-related complications, with nearly three quarters of maternal deaths occurring either on the day of delivery or during the postpartum period.[7, 8] Risk of maternal morbidity and mortality is unevenly distributed in the United States, with Black and Indigenous women three to four times as affected as their white counterparts,[3, 9] and disparities in mortality worsened during the pandemic.[10] The determinants of maternal morbidity and mortality and associated racial/ethnic and social inequities are complex, multi-factorial, and less well understood. Still, experts agree that many maternal deaths are preventable.[11-14] Further, trends in maternal morbidity and mortality in the United States reflect increases in rates of cesarean birth,[15, 16] preexisting chronic medical conditions,[17, 18] and advanced maternal age.[16, 19] These individual-level factors do affect—but do not completely explain—the rise in maternal morbidity and mortality in the United States since 2000.[20]

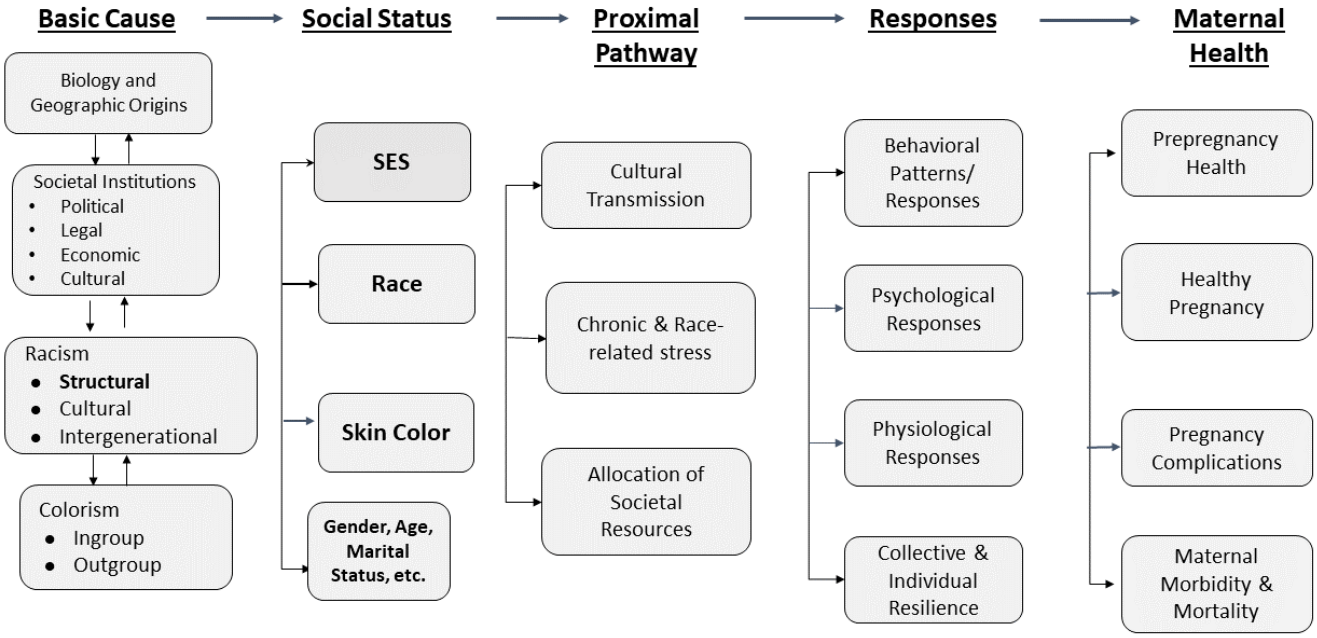
Efforts to explain the adverse maternal health outcomes have fallen short for reasons ranging from scope of the problem to methodology. For instance, maternal and infant health research has focused largely on infant outcomes, such as low birth weight and premature birth.[21] This narrow scope is compounded by methodological limitations that restrict the breadth of maternal outcomes studied, the window of study before, during, and after pregnancy, and levels of influence of health risk factors captured in measured exposures.

Likely drivers of population-wide increases in maternal morbidity and mortality include determinants operating on multiple levels of influence—individual, interpersonal, community, and societal.[22-25] Beyond the individual level, social determinants of health represent the conditions or circumstances in which people are born, grow, live, work and age –e.g., access to healthcare, socioeconomic status, education, neighborhood and physical environment, employment, and social support networks.[26-28] Figure 1.1 provides one such conceptual model. Social determinants lie "downstream" from structural determinants of health—the structural forces that shape how social determinants are experienced by people in their neighborhoods and communities and the ways that resources and quality are distributed across individuals and communities.[28] Together, these social-structural determinants of health work to shape and promote maternal health for people across the different levels of influence,[28] such as variation in

access to midwife-attended births,[29] linguistically and culturally appropriate care,[30-32] and geographic/local access to and use of maternity units.[33] For example, a pregnant person's likelihood of being screened for medical risk factors such as high blood pressure, preeclampsia, cardiovascular disease, diabetes, and substance misuse is affected by social-structural factors such as systemic racism,[34, 35] lack of stable housing[36] lack of food,[37, 38] and incarceration.[39, 40] Even properly identified medical risk factors of postpartum health may not be adequately addressed due to systemic biases (racial, ethnic, and other prejudices) during referral processes[39, 40] or follow-up appointments (e.g., failed shared decision-making reduces treatment adherence).[41]

The concept of social-structural determinants of health is broadly accepted across the public health and healthcare communities, as is the concept of "social needs," which focuses on the individual or family and includes real-time gaps that affect health, well-being, and safety. Unfortunately, the two terms are often used interchangeably, which can create confusion. Imprecise use of the terminology can overstate the reach of an intervention. Some efforts that claim to address social-structural determinants of health are not actually addressing a community's underlying social and economic conditions, but rather aiming to mitigate the current social needs of individuals. For example, providing fresh produce to people struggling to afford food mitigates an immediate individual need, but does not address the underlying systemic issues that cause food insecurity. Addressing the social needs of an individual and the social determinants of a community require different study design approaches, unique partnerships, and innovations.

Figure 1.1. Williams framework for study of racism and health, adapted for colorism and maternal health



Williams (2013)[42] as adapted by Dr. Jaime Slaughter-Acey.

Abbreviations: SES= Socioeconomic Status

Current research focuses disproportionately on risk factors at the individual levels, particularly those representative of social identity (e.g., race, education-level, gender). This

unbalanced approach has obscured the role of social-structural determinants of health as the root cause of health inequities in maternal morbidity and mortality that affect marginalized or vulnerable people, including Black, Indigenous, People of Color (BIPOC) individuals.[43] Notably, race itself is not a risk factor; rather, racism puts BIPOC mothers at risk. Race is a social construct[44] used to categorize people within a hierarchical system of unearned advantage (privilege) and power that unequally provides access to material, cultural, and psychological resources based on presumed value judgements related to racial status. In turn, unequitable access to resources along with high exposure to cumulative stress resulting from discrimination and marginalization creates a "web of missed opportunities" (e.g., differential access to care and treatment, lack of coordinated care, missed or delayed diagnoses, and unrecognized warning signs by patient or provider related to pregnancy-related death and morbidity).[45] Such missed opportunities threaten maternal health and deepen health inequities. Additionally, BIPOC mothers and their family members experience higher rates of incarceration, illness, and death than their white counterparts. Lost or systematic removal of family members in BIPOC communities severs access to practical knowledge of pregnancy, birthing, breastfeeding, and postpartum health.[46] Not only do individuals who have lost their own mothers, either through death or disconnection, often experience profound grief during and after pregnancy. And to continue the example of racism, this information void created by maternal loss is further compounded by the lack of social and medical capital BIPOC people disproportionately experience.

Just as problematic, maternal health literature tends to assume that the role of motherhood and the experiences attached to the identity of motherhood are shared similarly by all pregnant or birthing people—regardless of socioeconomic status, geographic location, racial or ethnic background, age, or other group identities. For example, literature often reports differing rates of maternal morbidity and mortality according to social group category without acknowledging experiences of violence, trauma, or privilege.[25, 47-49] The overuse of social group categories as proxies for experience obscures the unique concerns and priorities of vulnerable or underserved pregnant and birthing people. This practice also stands in the way of addressing the root causes that are *central* to creating unique and/or marginalizing experiences of motherhood associated with race, gender, class, disability, and maternal morbidity and mortality inequities. We need to better understand how unfair treatment and structural barriers associated with race, sex, gender, class, and disability impact postpartum health for birthing people.[50] Intersectionality offers a valuable framework for illuminating inequities in maternal morbidity and mortality, because it allows us to examine how people and their health are affected by two or more intersecting social forces that affect social position and access to resources (e.g., racism, classism) and shape experience (e.g., unfair treatment, discrimination).[29-41, 51] While each potential pregnant or birthing person will confront their own unique patterns of individual risk, research that identifies themes and patterns at the population level can help highlight opportunities to deliver interventions that address the impact of these determinants of health.

Research often describes comorbid conditions such as obesity, chronic hypertension, and mental health disorders as intrinsic or independent biomedical risk factors for poor health outcomes. However, these conditions are often the physiologic consequences of transgenerational stress and protracted exposure to racial discrimination for BIPOC people.[52] These conditions (and others including cardiovascular disease and diabetes) have short- and long-term impacts on women and birthing people's health, and significantly contribute to the disparities in maternal health outcomes. Importantly, an interacting framework allows us to

examine how people and their health are affected by multiple intersecting social forces. Such a framework also shifts away from examining these comorbidities as inherent and one-directional, opting instead to view the interactions as a multidimensional feedback loop that compounds risk.

1.2 Terminology

We acknowledge that terms labeling racial and ethnic identities are embedded in a history that includes problematic and painful political and cultural experiences of many groups. Further, terms describing racialized people and marginalized groups have shifted over the years, merging and diverging categories in ways that make simple aggregation impossible. Medical terminology has also shifted; for example, the term pregnancy-induced hypertension is no longer used. Therefore, we chose to use the same language with which study authors presented their results. We also recognize that not all people who become pregnant or give birth identify as women and have attempted to use gender-neutral language to reflect the diversity of the birthing and postpartum experience where possible. We likewise acknowledge that there are women who may object to what may be felt as an erasure of a long history of advocating for women's rights, and that finding the language balance is fraught. When citing specific study outcomes that identify "mothers" or "women," we have used those terms for consistency with the research. However, when discussing risk factors such as racial discrimination, we use the word "reported" rather than "perceived," regardless of study author choices. In this way, we seek to highlight the fact that perception in this case is the act of recognizing the presence of discrimination. While academic fields use the term to denote a necessary step in an appraisal process, this usage could be misread as questioning the validity of "reported" experiences of discrimination.

1.3 Purpose and Scope of the Systematic Review

To better understand the factors underlying postpartum maternal morbidity and mortality in the United States, the Office of Disease Prevention requested this systematic review of available evidence to inform the November 29 – December 1, 2022 Pathways to Prevention workshop, "National Institutes of Health Pathways to Prevention Workshop: Identifying Risks and Interventions to Optimize Postpartum Health," cosponsored by the National Institutes of Health's Office of Research on Women's Health, the National Heart, Lung, and Blood Institute, the National Institute of Minority Health and Health Disparities, and the Eunice Kennedy Shriver National Institute of Child Health and Human Development. The Office of Disease Prevention anticipated complex patterns associated with social and structural drivers of health, including maternal health at the intersections of race and other social group memberships. Therefore, we focused mainly on research examining factors to which pregnant and birthing people have been exposed that may underlie poor postpartum health outcomes. Our scope does not include assessing the effectiveness of interventions aimed at improving maternal morbidity and mortality. Our results will inform research on approaches to address risk factors and improve health outcomes over the postpartum period.

Chapter 2. Methods

2.1 Review Approach

The methods for this systematic review followed the Agency for Healthcare Research and Quality Methods Guide for Effectiveness and Comparative Effectiveness Reviews (available at https://effectivehealthcare.ahrq.gov/topics/cer-methods-guide/overview), modified slightly to support a mixed-studies approach. This systematic review also reports in accordance with the Preferred Items for Reporting in Systematic Reviews and Meta-Analyses (PRISMA) and the RepOrting standards for Systematic Evidence Syntheses (ROSES) flow-diagram.[53, 54] The protocol was posted online December 9, 2021 and amended effective February 22, 2022. (https://effectivehealthcare.ahrq.gov/products/maternal-morbidity-mortality/protocol). We registered the protocol on PROSPERO (CRD42022300617).

2.1.1 Key Questions

- **Key Question 1:** From a pregnant person's potential entry into prenatal care, what combinations of risk indicators have the greatest prediction of poor postpartum health outcomes?
  - **Key Question 1a:** To what extent did these patterns of predictors of poor postpartum health outcomes vary by the person's race/ethnicity?
- **Key Question 2:** Immediately before or immediately after delivery and before release from birthing-related hospitalization/clinical care, what combinations of risk indicators to the birthing person have the greatest prediction of poor postpartum health outcomes?
  - **Key Question 2a:** To what extent did these patterns of predictors of poor postpartum health outcomes vary by the race/ethnicity of the birthing person?

Table 2.1 provides details on the population, exposures/comparators, outcomes, timing, and setting for the research questions.

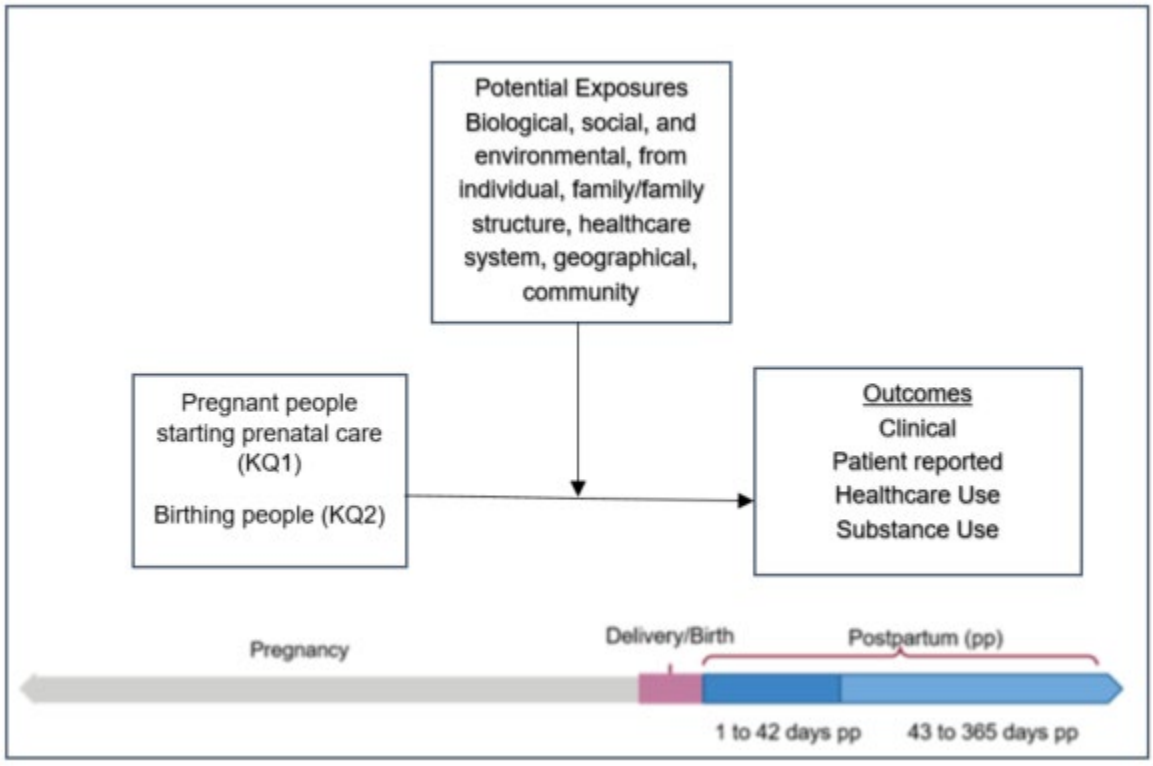
Table 2.1. Population, exposure/comparators, outcomes, timing, and setting

Element	Key Question 1	Key Question 2
Population	Pregnant people at potential entry into prenatal care	Birthing people just prior to, during, or immediately following delivery (before release from birthing setting)
Exposure/ Comparator	Include biological, social, and environmental factors from the individual, family/family structure, healthcare system, geographical and community levels, with a special interest in predictors related to access to quality care, patient-provider dynamics, and social and structural determinants of health, including racism.	Include biological, social, and environmental factors from the individual, family/family structure, healthcare system, geographical and community levels, with a special interest in predictors related to access to quality care, patient-provider dynamics, and social and structural determinants of health, including racism.
Outcomes	Postpartum health status outcome such as pregnancy-related or pregnancy-associated death, severe postpartum conditions (such as peripartum cardiomyopathy [PPCM], postpartum preeclampsia/eclampsia, and postpartum venous thrombosis), onset of new conditions (such as hypertension and diabetes), emergency room visits, need for rehospitalization, medical appointments, reports in medical records, patient reported outcomes, and misuse of substance/substance use disorder.	Postpartum health status outcome such as pregnancy-related or pregnancy-associated death, severe postpartum conditions (such as peripartum cardiomyopathy [PPCM], postpartum preeclampsia/eclampsia, and postpartum venous thrombosis), onset of new conditions (such as hypertension and diabetes), emergency room visits, need for rehospitalization, medical appointments, reports in medical records, unnecessary medical procedures, patient reported outcomes, and misuse of substance/substance use disorder.
Timing	Outcomes of interest will be from the time of release from the birthing setting across the 1-year postpartum period.	Outcomes of interest will be from the time just prior to, during, or immediately following delivery (before release from birthing setting) across the 1-year postpartum period.
Setting	Non-U.S. excluded	Non-U.S. excluded

2.1.2 Analytic Framework

Figure 2.1 offers a visual representation of the analytic framework for the Key Questions, illustrating the relationship of populations, exposures, and outcomes. The outcomes listed are general outcome categories representing the more detailed outcomes noted in Table 2.1.

Figure 2.1. Analytic framework



Abbreviation: KQ = Key Question

2.2 Study Selection

Based on the framework outlined in Table 2.1, we selected studies if they were published in English in a peer-reviewed journal. For Key Question 1, study participants needed to have been pregnant for 20 or more weeks (we based this inclusion criteria on obstetric terminology and convention which informs many disease definitions, such as preeclampsia and gestational hypertension, and on categorization of loss of pregnancy under 20 weeks as miscarriage). For both Key Questions, we selected observational studies that were 1) designed to be comparative and 2) included some method to control for selection bias (e.g., propensity scores, instrumental variables, multivariate regression) and 3) examined the impact of at least one risk factor indicative of social determinants of health. We only included studies that examined risk factors that operated interpersonally. For example, social stigma related to substance use and its impact on depression would be interpersonal, but the mere existence of substance use would be intrapersonal. Because of our focus on broad populations, we excluded studies if they looked solely at risk factors in pregnant or birthing people with specific medical conditions diagnosed prior to pregnancy that would necessitate specialty care (e.g., multiple sclerosis). Likewise, we excluded exposures related to assistive reproductive technologies because those are less available and therefore less often used by marginalized populations. Natural disasters and other immutable exposures are not in and of themselves social-structural determinants of health, therefore we included studies with these exposures only if they directly linked to social-structural determinants of health that could explain differences in maternal health outcomes of pregnant or birthing people.

We excluded studies with only intermediate outcomes (e.g., blood pressure, lab values, or psychometric scales not intended for diagnostics) unless the studies used those intermediate

outcomes explicitly to explain pathways through which social-structural determinants of health might work. Studies that examined only physiological or psychological stress outcomes needed to use them as a global measure of stress to be included—for example, using chronic inflammation or reactivation of Epstein-Barr virus as indicators of stress-induced homeostatic weakness. We did include studies with reported stress scales scores if they used the scale as a direct measure of response to social determinants of health, but we excluded studies that used only specific biological stress responses such as cortisol levels.

We searched for literature in the following databases: MEDLINE® (via Ovid), CINAHL® (via EBSCOHost), and Social Sciences Citation Index (via Web of Science) through November 2022. The searches included controlled vocabulary terms (e.g., MeSH or CINAHL headings), along with free-text words related to maternal morbidity and mortality, pregnancy, prenatal care, postpartum care, health disparities, and measures of risk indices. See the protocol and Appendix A, Methods – Search Strategy, for full details. We searched reference lists of relevant existing systematic reviews for additional eligible studies.

We screened search results using PICO Portal (www.picoportal.org, New York, NY). Two trained, independent investigators screened titles and abstracts based on the Table 2.1 framework and study design. Two independent investigators then performed full-text screening to determine whether studies met inclusion criteria. Differences in screening decisions were resolved by consultation between investigators, and, if necessary, consultation with a third investigator. We documented the inclusion and exclusion status of citations at full-text screening, noting reasons for exclusion. Throughout the screening process, team members met regularly to discuss training materials, refinement of inclusion criteria, and issues that arose to ensure consistency of inclusion criteria application. Given the unexpectedly large number of eligible studies after full text screening along with the complexity of the topic and the heterogeneity of exposure domains captured in the studies, we performed an additional full-text appraisal to focus on the studies best designed, including analytical approaches, to answer the Key Questions. That is, we focused on the research that attempted to explain the mechanisms underlying the disparities. We did not focus on research that merely described the disparities.

2.3 Data Extraction and Risk of Bias Assessment

Studies meeting inclusion criteria were distributed among investigators for data extraction. Data fields included author, year of publication, region, Key Question designation, PubMed Identification Number (if available), sample size including data source, population, exposure(s), outcomes, covariates, timing, and social determinant of health domain. One reviewer extracted data to evidence tables and a second reviewer verified for accuracy.

To assess risk of bias, we started with the Risk of Bias Non-randomized Studies of Exposures (ROBINS-E) tool, designed specifically to address risk-factor research.[55, 56] We classified overall risk of bias assessments for studies as low, moderate, serious, or critical based on the rationale and judgement as to the overall predicted direction of bias for each outcome. To focus risk of bias assessments on the studies most likely to achieve low or moderate risk of bias, we subjectively prioritized studies according to study design and rigor of analytic approaches for addressing selection bias based on the ROBINS-E. When no high-potential study was able to achieve this rating, we determined that all included studies were high risk of bias from a causal standpoint. Therefore, we continued with the review from the perspective of supporting future researchers in generating hypotheses for risk factors to test potential interventions.

2.4 Data Synthesis

We grouped studies by the main exposure or determinant of interest, based on a subjective reading of the study. If study time periods were unclear or covered both Key Question 1 and Key Question 2 periods, we grouped the studies into Key Question 1. We did not group studies further by discrete postpartum periods because the literature was already highly dispersed. For studies that examined an interaction of more than one social-structural determinant of health, we reported the outcome in the major exposure or determinant result section, rather than in both—and we prioritized the domain of Identity and Discrimination. If a study reported on more relevant risk factors than the one main one, we note those studies in that risk factor category as studies with other "exposures of interest." We summarized results in evidence tables and synthesized evidence for each exposure or determinant and outcome combination. Given the volume and heterogeneity of the evidence related to the Key Questions, this strategy helped us to adequately synthesize and interpret results. We acknowledge that our categorization scheme represents broad definitions, that our assignments may be imprecise, and that other researchers may arrive at different categorizations based on their chosen theoretical or conceptual frameworks. We likewise categorized outcomes into broad domains. We used the term "severe maternal morbidity" when study authors did, regardless of whether authors used the Centers for Disease Control and Prevention composite. We used alluvial graphs to display the aggregated connections, the patterns, between the social-structural determinants of health and outcomes. These graphs display the assigned exposure and outcome domains in the outer columns, and list in the inner columns the exposures and outcome variables as named in individual studies. Since an individual study may have more than one exposure or outcome, the number of individual exposures is greater than the number of included studies. Likewise, a single study may observe more than one relevant outcome. We supplemented graphs with qualitative narrative summaries. Because of the risk of bias issues noted above, we report the direction of the adjusted association between risk factors and outcomes of interest. We report numerical results if a study attempted to explain the results by how much a specific risk factor contributes to differences or disparities.

2.5 Grading Strength of Evidence

Because no studies met a moderate or lower risk of bias, we did not evaluate overall strength of evidence for any reported outcomes.

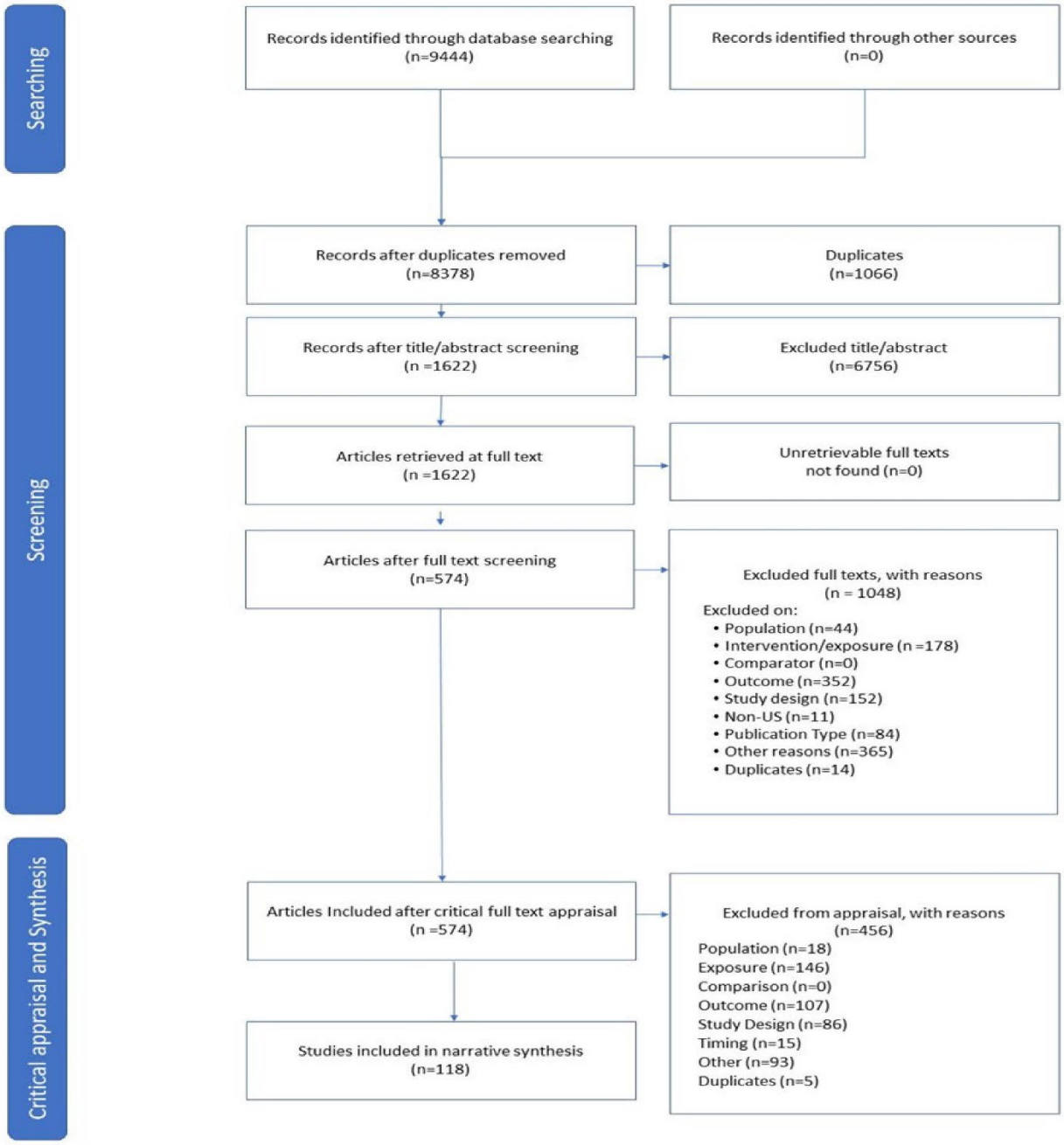
2.6 Author Statement

We acknowledge that all team members come to this project with experiences and perspectives that could be labeled as personal bias or even as intellectual conflict of interest. Because of this, we committed to individual and team reflexivity during the review planning and conduct. Our team holds a range of perspectives, but practices respect for each team member. If there is commonality, it is in the belief that race as a social construct is a settled matter. Nonetheless, we remain committed to respectful discourse with people—including all stakeholders—who hold views different from those held by the team.

Chapter 3. Search Results

Our search identified 8,378 unique publications for screening. Based on inclusion criteria, we identified 118 eligible studies. We list all studies excluded at full text appraisal, by exclusion category, in Appendix B. Exclusions captured under "other reasons" are varied and overlapping, so often not easily placed into a more singular category. For example, an "other reasons" exclude might have been for both study quality and a challenging interpretation on whether the risk factors were interpersonal in nature. See Figure 3.1 for details of the screening process.

Figure 3.1. Literature flow diagram



Abbreviations: n = number

3. Search Results

The 118 included studies were published between 2000 and 2022. The studies contained 221 specifically named exposures or factors of interest. While many of these exposures or factors of interest are comparable or overlap, studies used various language and operational definitions for them. Using the named exposures, we categorized the studies into 11 broad exposure domains based on the main social-structural determinant of health. Table 3.1 presents the number of included studies by Key Question and exposure domain. The exposure domains are illustrated by example named exposure or factor of interest. Some studies used data that focused on particular populations, such as Black, Hispanic, or military veterans. As shown in Table 3.1, these populations represent only a subset of the many potential populations of interest.

Table 3.1. Identified eligible studies by major exposure domain

Key Question, Number of Studies	Exposure Domain	Special Populations
KQ1 – 27 studies KQ2 – 11 studies	**Identity and Discrimination** *Race or Ethnicity, Including Nativity, and Acculturation* *Reported racial discrimination* *Spatial polarization (segregation)* *Rural/urban* *Socioeconomic factors* *Disparities in care* *Gender or sexual minority* *Patterns of SDOH*	Black African American White Hispanic Asian Immigrants 2nd or 3rd generation immigration status
KQ1 – 9 studies KQ2 – 3 studies	**Socioeconomic status** *Maternity leave* *Household income* *Public insurance* *State income inequality* *Unstable housing* *Homelessness* *Food insecurity (in combination)*	Low-income Homeless
KQ1 – 12 studies	**Violence** *Intimate Partner Violence* *Domestic Violence*	Latina Low-income Urban
KQ1 – 4 studies	**Trauma** *Childhood Trauma/ ACEs* *Lifetime trauma exposure* *Reported racial discrimination* *Military sexual trauma*	African American Veterans
KQ1 – 3 studies	**Psychosocial Stress** *Stressful life events* *Partner-related stress* *PTSD*	None
KQ1 – 17 studies KQ2 – 11 studies	**Structural/Institutional** *Obstetrical unit closure* *Maternity care deserts* *Payment policies* *Neighborhood physical disorders* *Food deserts* *Incarceration* *Municipal expenditures*	Rural Urban Medicaid

3. Search Results

Key Question, Number of Studies	Exposure Domain	Special Populations
KQ1 – 3 studies KQ2 – 3 studies	Rural/Urban	Rural Urban
KQ1 – 6 studies	**Environmental** *Green factors* *Pollution* *Heat exposure*	Urban
KQ1 – 2 studies KQ2 - 1 study	**Comorbidities** *Pre-existing psychopathy* *Substance use* *HIV* *SARS-CoV-2*	Women living with HIV
KQ2 – 4 studies	**Hospital** *Quality of care* *Safety-net burden* *Teaching affiliation*	Rural Medicaid
KQ1 – 1 study KQ2 – 1 study	**Healthcare Use** *Access to healthcare* *Late entry to prenatal care*	Rural/Urban

Abbreviations: KQ=Key Question; N=number; ACEs=adverse childhood events; PTSD=post-traumatic stress disorder; SDOH=social determinants of health

Table 3.2 presents the number of included studies by Key Qquestion, outcome domain, and special populations for those outcomes. The outcome domains are illustrated by examples of named outcome variables from included studies.

Table 3.2. Identified eligible studies by outcome domain

Key Question, Number of Studies	Outcome Domain	Special Populations
KQ1 – 4 KQ2 - 5	**Cost/Healthcare Use** *Postpartum Emergency Department use* *Postpartum readmission* *Maternal Intensive Care Unit admission* *Cost* *Maternal hospital stay length*	African American Urban Homeless
KQ1 - 37 KQ2 - 1	**Depression** *Postpartum depressive symptoms* *Depressed mood* *Depressive disorder*	Black White Arabic descent Immigrants Women living with HIV US & foreign-born Latinas Veterans Mexican descent Women who worked during pregnancy
KQ1 - 7 KQ2 - 1	**Diabetes** *Gestational diabetes*	Medicaid insured women Hispanic Non-Hispanic White
KQ1 - 18 KQ2 - 3	**Hypertensive Disorders** Hypertension Pregnancy-induced hypertension Hypertensive disorders Preeclampsia	Non-Hispanic Black women Urban Medicaid insured

3. Search Results

Key Question, Number of Studies	Outcome Domain	Special Populations
KQ1 - 10 KQ2 - 6	**Maternal Mortality** *Pregnancy-related death* *Preventable in-hospital mortality* *In-hospital death*	Black White Rural Low-income
KQ1 - 10	**Other Mental Health or Substance Use** *PTSD* *Suicidal ideation* *Substance use* *Anxiety* *Stress*	Latina
KQ1 - 23 KQ2 - 23	**Severe Maternal Morbidity** *Blood transfusion* *Postpartum hemorrhage* *Major laceration* *Major puerperal infection* *Obstetric complications*	Black African American White Indigenous Somali immigrants Sexual or gender minority US military, active or veteran Women experiencing loss of nearest obstetric unit
KQ1 - 4	**Weathering*** *Epstein-Barr virus reactivation* *Chronic placental inflammation* *Excess heart age*	African American Caucasian White
KQ1 – 2 KQ2 - 1	**Cardio/metabolic-Disorders** *Peripartum cardiomyopathy* *Cardiometabolic disorders*	Low-income African American White Hispanic

* Weathering is the physiological effect of premature aging caused by chronic stressful experiences
Abbreviations: KQ=Key Question; N=number; ACEs=adverse childhood events; PTSD=post-traumatic stress disorder

As shown in Table 3.3, included data varied widely in sample size and source. Sample sizes ranged from as small as 16 women whose deaths were examined for potential preventability, to several million pregnant or birthing people. Categories of data sources are provided in Table 3.3. Nine studies used Pregnancy Risk Assessment Monitoring System data.

Table 3.3. Data sources, number of studies, and sample size ranges

Data Source Categories	N Studies	Sample Size Range
Clinic	5	115 - 498
Single Hospital	11	100 – 34,383
Hospital System	5	16 – 675,553
Programs	25	56 – 10,038
City	6	191,947 – 591,455
State (4 PRAMS)	33	118 – 3,020,525
Multi-State (5 PRAMS)	11	1,717 – 6,879,332
Regional	2	301 – 38,915
National (3 PRAMS)	16	501 – 138,311,788
Secondary analysis of Randomized Controlled Trial data	5	930 – 5,759

Abbreviations: PRAMS=Pregnancy Risk Assessment Monitoring System

Chapter 4. Risk Factors for Pregnant People During the Prenatal Period

4.1 Key Points

- Included study exposures broadly covered social-structural determinants of health; however, the identified determinants included still represent only a subset of potential social-structural determinants of interest and did not address intersections with biologic/medical risk factors.
- Limited depth and quality of available research within each risk factor domain, including racism and other forms of discrimination, impeded our ability to understand pathways connecting social determinants of health, medical comorbidities, and maternal health outcomes.
- We found an unexpectedly large volume of research on violence and trauma relative to other potential social determinants of health.
- Among outcome domains, depression/other mental health outcomes were a large proportion of the health outcomes captured.
- We found one study investigating patterns of intersecting social-structural determinants of health that is an exemplar of new approaches to risk factor research.
- Only one study reported the excess risk attributable to a specific exposure; this study reported that income inequality was associated with a 14 percent increase in excess risk of death for Black women relative to white women in Virginia; prolonged 5-year income inequality was associated with a 20 percent increase.

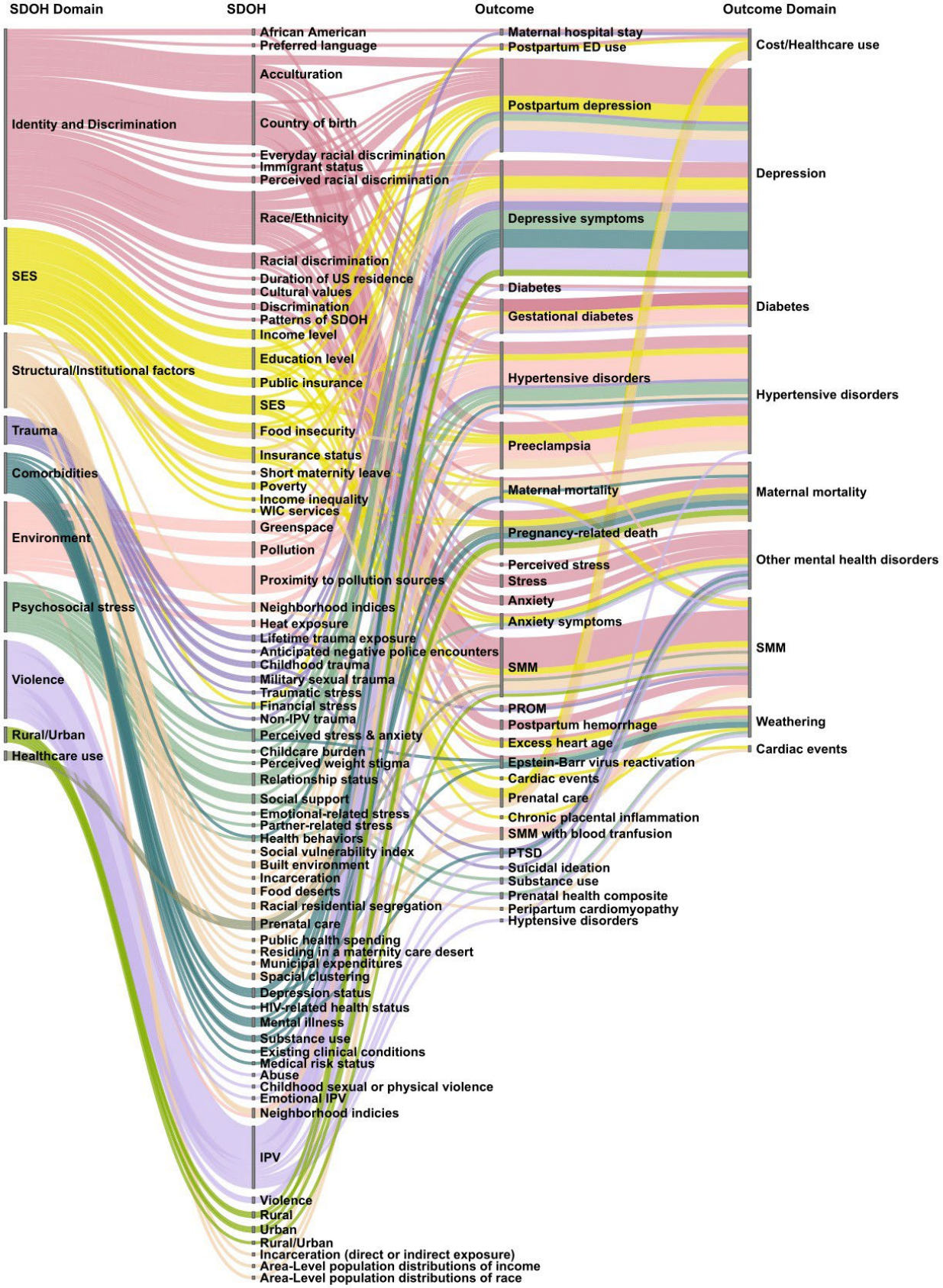
This chapter addresses Key Question 1 and includes studies that examined social-structural determinants of health for pregnant people during the prenatal period. We categorized studies according to 10 major exposure domains. We assigned categories based on subjective reading of the studies because this literature, especially studies examining interactions between factors, is interconnected. Therefore, we sought to present findings with a clear narrative flow. Because so many studies used correlational designs, and due to high risk of bias for those using quasi-experimental techniques, we approached this chapter from the perspective of supporting future researchers in generating hypotheses for risk factors to test potential interventions. Therefore, we report the direction of the adjusted association between risk factors and outcomes of interest. We report numbers if a study attempted to explain the results by how much a specific risk factor contributes to differences or disparities.

Overall, we identified 65 unique studies that addressed Key Question 1, which focuses on (1) the combination of risk indicators that predict poor postpartum health outcomes for pregnant people upon their potential entry into prenatal care, and (2) the extent to which the combination of predictors vary by race/ethnicity. Figure 4.1 uses colored paths to show connections between social-structural determinants of health and outcome domains. Ten exposure domains mapped to nine outcome domains. The most commonly examined outcome domain was depression, with other major domains of interest being maternal mortality, severe maternal morbidity, and hypertensive disorders. Weathering, physiological changes and premature aging caused by extended exposure to stressful experiences, was a smaller outcome domain.[57] The figure displays the complexity of the connections. In the following sections, we present brief summaries and

detailed graphs of the ten identified major factors grouped into nine subsections. Detailed evidence tables can be found in Appendix C.

4. Risk Factors for Pregnant People

Figure 4.1. Reported exposures and outcomes for pregnant people



Note: The figure displays colored paths connecting risk factor and outcome domains. Each outcome domain is represented by a different color and by following the colors from left to right from the SDOH domain a reader can see which outcomes a social determinant of health is impacting. The outer two columns display the social determinant of health and outcome domains categorized in this review. The inner two columns give more detailed information about the specific exposure or outcome measures named in the studies. The unit of display is the individual risk factor or outcome; therefore, the total number of individual risk factors, or individual outcomes, may be greater than the total number of studies. Thicker lines indicate more studies examined a given risk factor or outcome; thinner lines indicate less studies.
Abbreviations: ED=emergency department; IPV=intimate partner violence; PROM=premature rupture of membranes; PTSD=post-traumatic stress disorder; SDOH=social-structural determinants of health; SES=socioeconomic status; SMM=severe maternal morbidity; WIC=women, infants, and children

4.2 Identity and Discrimination

We identified and categorized 27 unique studies that examined factors related to identity and discrimination. One unique study deserves special attention for investigating patterns of intersecting social-structural determinants of health.[58] Using a sample of 5,763 people with singleton pregnancies who participated in the Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-to-Be (nuMoM2b), the study conducted a latent class analysis to identify six subgroups of people, or phenotypes, based on their interrelated social determinants of health. These six subgroups were then used to predict maternal health. Two subgroups in particular predicted worse scores of a composite postpartum maternal morbidity measure: young people living close to the federal poverty level with lower levels of educational attainment (subgroup 6) and people with limited English language proficiency who have lived in the United State for the shortest time (subgroup 2). The study sample was restricted to people without significant comorbidities prior to pregnancy.

The remaining 26 unique studies examined factors related to identity and discrimination, including nativity (place of birth), and acculturation.[59-79] Studies sourced data from clinic records or community-based research projects and programs,[60-64, 71, 72, 75, 79-82] national data sets,[59, 65, 77] multi-state records,[83, 84] state records,[66, 67, 69, 73, 76, 78, 85] city records,[68] and secondary randomized controlled trial data.[74]

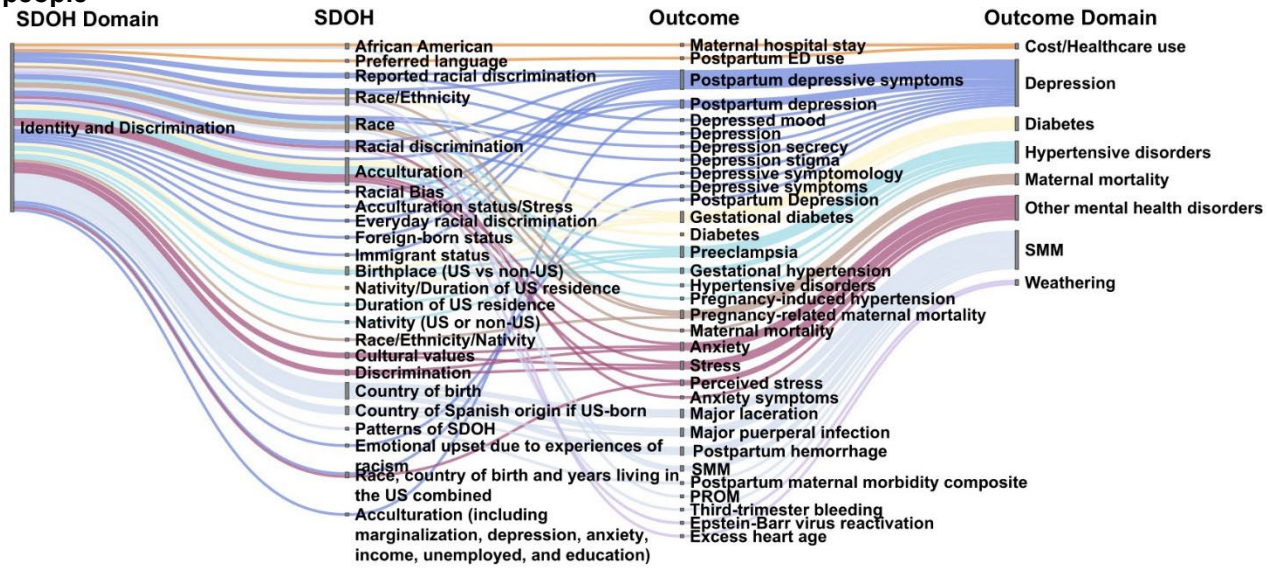
Thirteen studies examined acculturation or nativity within the context of racial/ethnic disparities in maternal morbidity and mortality. Four studies focused on acculturation and postpartum depression risk for women of Arab descent,[60] Mexican descent,[86] Hispanic subgroups,[61] and Latinas.[70] Additional studies that focused on acculturation examined the association between acculturation and psychosocial stress among Latinas,[63] pregnancy-induced hypertension in low- and high-acculturated Hispanic women relative to pregnancy-induced hypertension in non-Hispanic white women,[79] preeclampsia by nativity (U.S.-born versus foreign born women) and duration of United States residence among non-Hispanic Black women,[62], gestational diabetes by nativity and duration of United States residence among Hispanic and non-Hispanic Black and White women,[81] trends in and causes of pregnancy-related mortality by race, ethnicity, and nativity;[65]and acculturation and preeclampsia or eclampsia across racial or ethnic groups.[71] One study examined the role of race, ethnicity, and immigration status on prenatal perceived stress and depressive symptomatology trends across pregnancy in a low-income, minority population of pregnant women in an urban city.[82] Two studies sought to assess maternal health disparities in maternal morbidity during labor and delivery among Mexican-born and U.S.-born white, non-Latina women[66] and differentials in maternal morbidity and mortality between foreign and U.S.-born women.[66, 67]

Seven studies examined how racial discrimination and bias impacts maternal health.[64, 74, 76, 78, 80, 83, 84] One study examined associations of Epstein-Barr virus reactivation with racial discrimination in African-American and non-Hispanic white women during pregnancy,[64] while

others aimed to investigate associations between reported racial discrimination[76] or racial bias exposure[78] and postpartum depression.[83, 84] Two studies examined patterns of change over time to assess the effects of discrimination on pregnancy and postpartum mental health outcomes.[74, 80]

The remainder of included studies investigated and compared across the following focal areas: Black-white disparity in mortality in women with severe maternal morbidity;[87] severe maternal morbidity risk factors and effect of race/ethnicity on severe maternal morbidity risk;[68] disparities in the prevalence of excess heart age (a measure for excess cardiovascular disease risk) among women with a recent live birth;[69] associations between race/ethnicity and antenatal and postpartum depressive symptoms;[72] and risk of prenatal depression across racial/ethnic groups.[77] An additional five studies examined race/ethnicity factors as an exposure of interest.[88-91] Although studies used "race/ethnicity" as an exposure, neither race nor ethnicity are the exposure itself but, rather, each is a marker of multiple potential exposures. However, rarely did studies thoroughly explore specific aspects of the interaction between race/ethnicity and maternal health outcomes in the United States to identify the true association. Figure 4.2 displays the studies' connections between race/ethnicity factors and eight outcome domains.

Figure 4.2. Reported outcomes for studies with identity and discrimination factors for pregnant people



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Abbreviation: ED=emergency department; SDOH=social-structural determinants of health; SMM=severe maternal morbidity; PROM=premature rupture of membranes

Among acculturation studies, one study found no effect of acculturation on postpartum depression in Arab women.[60] One study of Hispanic mothers identified single marital status as a risk factor for postpartum depression, and specifically those of Puerto Rican descent who also had a cesarean birth had higher rates of postpartum depression.[61] One study found that discrimination predicted depressive symptoms one month postpartum in Latina women.[70] Another study noted that among Latina women, higher bicultural acculturation was associated

with lower overall pregnancy stress compared with lower acculturation.[63] One study of women of Mexican descent found that sociocultural stressors decrease in the postpartum period for those who identify with Mexican culture and that increases in Mexican orientation are associated with less postpartum depressive symptoms.[86] One study found higher prevalence of preeclampsia and other cardiovascular disease among U.S.-born non-Hispanic Black women versus foreign-born non-Hispanic Black women, though the differences appeared to converge over longer periods of U.S. residence.[62] One study found an association between more acculturation and hypertension disorders, but no association for self-reported race or ethnicity,[71] while another study found higher substance abuse and interpersonal violence as well as pregnancy-induced hypertension in non-Hispanic white women compared with Hispanic women.[79] One study found foreign-born non-Hispanic Black women with a duration of U.S. residence of less than 10 years had higher odds of having gestational diabetes compared with their U.S.-born counterparts, whereas foreign-born Hispanic women with a duration of U.S. residence of less than 10 years had lower odds of having gestational diabetes.[81] One study found that Mexican-born women compared with white non-Latina women were less likely to have one or more maternal morbidities, but more likely to have complications related to the quality of intrapartum care they received.[66] One study found that Mexican-born women compared with Mexican-American women had lower odds of overall maternal morbidity, but higher odds of postpartum hemorrhage, lacerations, and major puerperal infections, indicating suboptimal intrapartum obstetric care.[67] One study found Black women had higher perceived stress and higher odds of probable depression compared with U.S.-born Hispanic women.[82]

Looking at racial discrimination and bias, one study found African American women compared with white women showed higher levels of Epstein-Barr antibody titers (a measure of stress-induced immune dysregulation), especially among those that reported higher levels of racial discrimination.[64] One study of Black and Latina women found that changes in reported discrimination predicted symptoms of depression and anxiety at future time points, with discrimination more strongly predicting anxiety when food insecurity was also present.[74] One study of multiple racial groups found that participants who experienced racial discrimination had higher odds of experiencing a depressed mood,[76] another study found that experiences of emotional upset due to racism are associated with an increased prevalence of postpartum depression symptoms,[84] while a third found non-Hispanic Black women had higher odds of experiencing racial bias but found no relationship between racial bias exposure and postpartum depression after adjusting for confounders.[78] One study found being upset from racial discrimination increased the odds of postpartum depression with the highest odds reported by women of color with some college education followed by women of color with less than a high school education.[85] One study found a variety of associations between cultural identity and discrimination and maternal health (both positive and negative aspects) in people of American and Latino cultural orientations.[80]

Several studies reported nuanced findings for mortality outcomes. One study found that income inequality at 1 and prolonged inequality at 5 years was associated with a 14 percent and 20 percent increase, respectively, in excess risk of death for Black women relative to white women.[59] One study found that all racial/ethnic/nativity groups (with the exception of foreign-born white women) had higher risk of pregnancy-related mortality than U.S.-born white women.[65] One study found the greatest odds of racial disparity in mortality between Black and white women in groups with the lowest risk of pregnancy-related death, but noted no significant disparity in women at the highest risk of pregnancy-related death.[87] One study found an

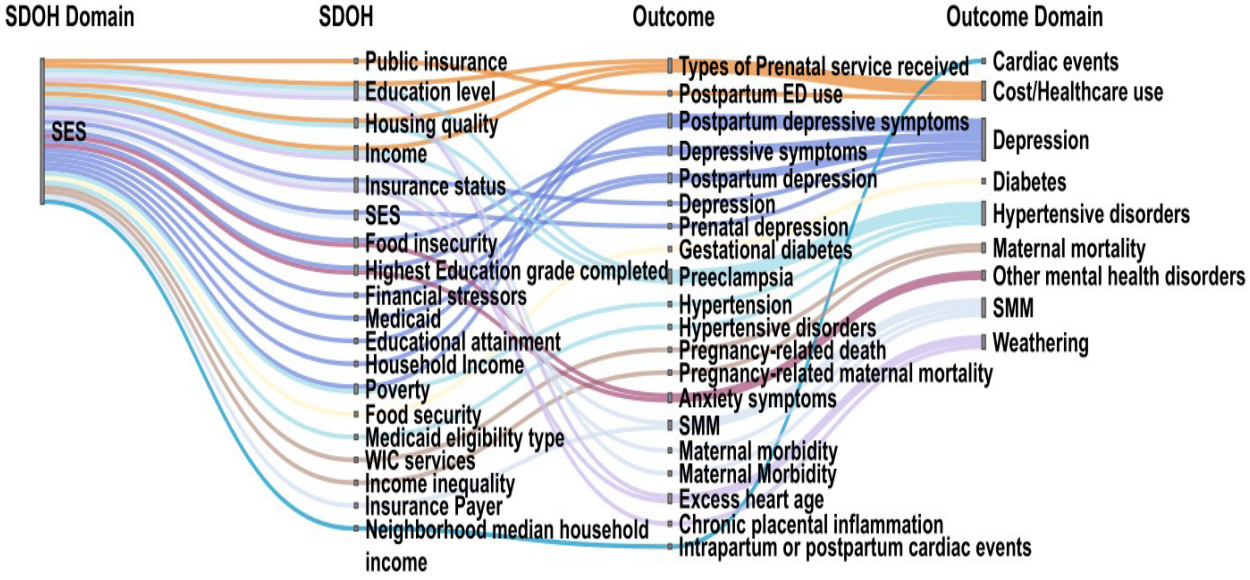
association between race/ethnicity and severe maternal morbidity, with greater risk among low-income Latinas and Asian-Pacific Islanders compared with white non-Latinas.[68] The same study found that living in the poorest neighborhoods increased risk of severe maternal morbidity for Black non-Latinas and Latinas.[68] Another study found a higher proportion of African American and Hispanic women compared with white women died within seven days of giving birth.[73]

For other outcomes, one study found non-Hispanic Black women had higher prevalence of excess heart age compared with non-Hispanic white women and Hispanic women; excess heart age prevalence was highest among women who lacked health insurance.[69] One study found that depression was not associated with race for Black and Hispanic mothers after accounting for financial hardship and other comorbidities.[72] One study found that African American, Hispanic, and women of other races had lower odds of depression before delivery than white women, with interaction effects observed between race/ethnicity and insurance status.[77]

4.3 Socioeconomic Factors

We identified and categorized nine unique studies that examined socioeconomic factors as the primary social-structural determinants of interest.[89, 92-99] The studies collected data from a multi-center cesarean registry,[94] single hospital,[98] hospital systems,[89, 92, 99] states,[96] smaller research programs,[93, 97] and secondary data from a randomized controlled trial.[95] Four studies focused on income and its association with cardiac events,[98] chronic placental inflammation,[93] depressive symptomology,[95] and severe maternal morbidity.[89] Two studies aimed to assess the impact of education levels on maternal morbidity.[94, 97] One study sought to identify sociodemographic risk factors association to postpartum emergency department visits.[92] One study explored how maternal sociodemographic, clinical, and care utilization characteristics are related to hypertension disorders diagnoses in the South.[96] One study sought to evaluate associations between food security and women diagnosed with gestational diabetes mellitus.[99] Eleven additional studies examined socioeconomic status as an exposure of interest.[59, 69, 70, 72, 74, 83, 91, 100-102] Figure 4.3 shows the studies' connection between socioeconomic factors and nine outcome domains.

Figure 4.3. Reported outcomes for studies with socioeconomic factors for pregnant people



Note: The figure displays colored paths connecting risk factor and outcome domains. Each outcome domain is represented by a different color and by following the colors from left to right from the SDOH domain a reader can see which outcomes a social determinant of health is impacting. The outer two columns display the social determinant of health and outcome domains categorized in this review. The inner two columns give more detailed information about the specific exposure or outcome measures named in the studies. The unit of display is the individual risk factor or outcome; therefore, the total number of individual risk factors, or individual outcomes, may be greater than the total number of studies. Thicker lines indicate more studies examined a given risk factor or outcome; thinner lines indicate less studies.
Abbreviation: ED=emergency department; SDOH=social-structural determinants of health; SES=socioeconomic status; SMM=severe maternal morbidity; WIC=women, infants, and children

Eight of the studies with socioeconomic status as the major exposure found mixed or no association with maternal outcomes.[89, 92-98] One study of women undergoing cesarean birth found women with elementary or high school education had higher odds of maternal morbidity compared with women with a college degree.[94] Another larger study of a hospital system found no association with neighborhood crime and severe maternal morbidity.[89] One study found lack of insurance prior to pregnancy was associated with pregnancy-related hypertensive disorders,[96] while a smaller study of 200 women found no association between public insurance and emergency department visits after delivery.[92] One study of 152 women reported lower income was associated with chronic placental inflammation.[93] However, another smaller study of 379 high-risk pregnant women found no association between preeclampsia and food insecurity, housing quality, income, or education.[97] One study of 1,044 Black, urban, high-risk pregnant women found no association between depressive symptoms and socioeconomic status (approached as education, employment status, and public assistance).[95] While no significant difference in cardiac events rates was found between patients from low versus high income neighborhoods in another study, patients from lower income neighborhoods had higher antepartum hospitalization rates.[98] In contrast, one study found more patients in food insecure households were diagnosed with gestational diabetes compared with food secure households.[99]

Studies that examined socioeconomic status, but not as their primary focus, reported mixed findings. Women with public insurance experiencing intimate partner violence had higher odds of hypertension and substance abuse,[100] while lack of insurance was associated with excess heart age.[69] However, education was not associated with depressive or anxiety symptoms[72, 74] or pregnancy-related death.[101] This study also found no association between income and pregnancy-related death.[101] One study found no association between poverty and postpartum depression,[70] but other studies did report such associations.[72, 102]

4.4 Violence, Trauma, and Psychosocial Stress Factors

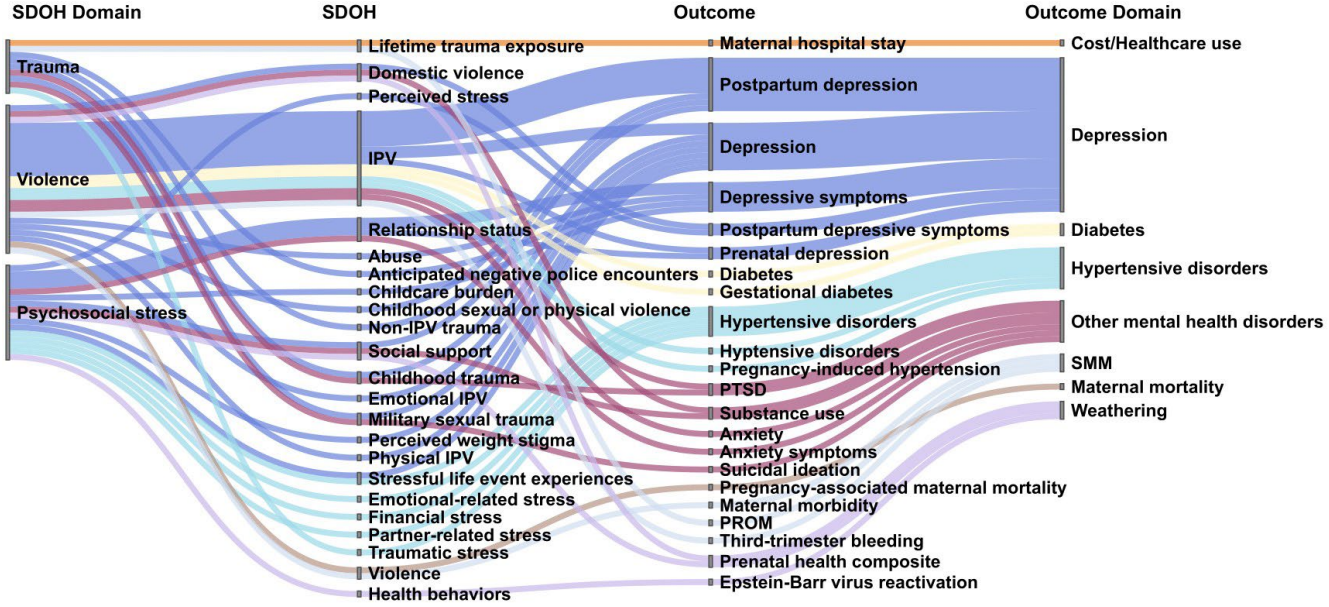
We identified and categorized three unique studies that examined psychosocial stress factors.[103-105] The studies collected data from states[103, 104] and study surveys.[105] Two studies focused on the impacts of stressful life events on maternal morbidity.[103, 104] One sought to evaluate links between preconception life stressors (partner, traumatic, financial, and emotional) and prevalence of hypertensive disorders of pregnancy.[103] The other aimed to identify groups of women with similar patterns of antenatal stressful life experiences, and to examine their sociodemographic correlates.[104] The third study in the psychosocial category focused on the experience of weight stigma and subsequent depressive symptoms and reported stress.[105] An additional seven studies examined psychosocial stress factors as an exposure of interest.[64, 74, 75, 95, 106-108]

We identified and categorized four unique studies examining trauma factors.[88, 109-111] The studies sourced data from clinic-based studies or programs. These studies varied in focus,

examining associations between the following: post-traumatic stress disorder and dissociation at the time of the traumatic experience;[109] antenatal depressive symptoms and anticipated negative police youth encounters;[111] lifetime trauma exposure and perinatal health outcomes in low-income African American women;[88] and military sexual trauma and risk of depression and suicidal ideation during and after pregnancy.[110] An additional two studies examined trauma as an exposure of interest.[103, 107]

We identified and categorized 12 unique studies examining violence factors.[100, 107, 108, 112-119] Studies collected data via national data sets,[120] state health records,[113, 114] clinic medical records,[100, 107, 112, 117, 119] community program survey,[108, 115, 118] and secondary program data.[116] All included violence studies examined intimate violence and domestic violence impact on maternal health outcomes. One study also focused on violence against women and experiences of childhood violence in addition to intimate partner violence.[113] An additional five studies examined violence factors as an exposure of interest.[70, 78, 79, 95, 106] Figure 4.4 displays the studies' connections between violence, trauma, and psychosocial stress factors and eight outcome domains.

Figure 4.4. Reported outcomes for studies with violence, trauma, and psychosocial stress factors for pregnant people



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Abbreviation: IPV=intimate partner violence; PROM=premature rupture of membranes; PTSD=post-traumatic stress disorder; SDOH=social-structural determinants of health; SMM=severe maternal morbidity

Among the studies focused on psychosocial stress, the two that examined life stress events found a positive correlation with maternal morbidity. All four types of life stress (partner, traumatic, financial, and emotional) were linked with increased prevalence of pregnancy-related hypertensive disorders, with the strongest association observed for financial stress.[103] The

highest prevalence of severe pregnancy-associated nausea/vomiting and postpartum depression occurred in those experiencing multiple types of stress.[104] The other included study suggested that experiencing weight stigma may contribute to unfavorable physical and mental health outcomes for pregnant and postpartum women.[105]

All studies focused on factors related to trauma found that experiences of trauma were associated with negative maternal health outcomes. Race-related anticipatory stress around potential negative youth-police experiences was associated with antenatal depressive symptoms for expectant African American mothers.[111] Women with maltreatment history and post-traumatic stress disorder were at higher risk of experiencing re-traumatization or becoming overwhelmed and experiencing dissociation while giving birth.[109] Military sexual trauma was associated with higher pre- and postnatal symptoms of depression and suicidal ideation.[110] Lifetime trauma exposure was significantly associated with depressive symptoms, anxiety, and generalized stress. This study found 87 percent of the women reported at least one traumatic life event.[88]

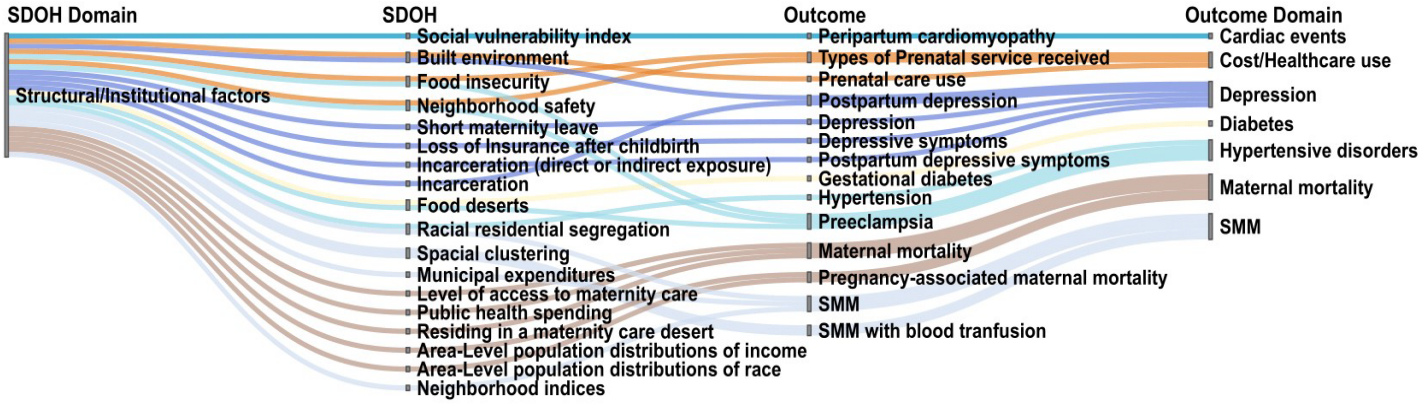
Among the studies focused on the domain of violence, all studies on intimate partner violence found the violence to have a negative effect on maternal health outcomes.[100, 107, 108, 112-120] In a predominately Latina sample, one in five mothers exposed to intimate partner violence showed depressive symptoms when screened during the perinatal period.[112] Recent intimate partner violence exposure was found to be a prenatal predictor of postpartum depression[118, 119] and post-traumatic stress among Latinas.[117, 118] A history of experiencing violence, including intimate partner violence increased medical and obstetrical complications, including perinatal and postpartum depressive symptoms across populations.[100, 108, 113, 115, 116] One study also noted that the association between intimate partner violence and postpartum depression persisted regardless of socioeconomic status.[115] One study sourced from the National Inpatient Sample found when compared to those with no exposure, individuals of all ethnic groups exposed to violence had increased risk of all adverse maternal/fetal outcomes.[120] Another study reported domestic violence contributed to death in 14 percent of cases of maternal mortality in their sample, with 65 percent of cases considered preventable.[114]

4.5 Structural/Institutional Factors

We identified and categorized 17 unique studies that examined structural/institutional factors as the primary social-structural determinants of interest.[102, 121-133] The studies sourced data from city public health records,[121] state/county records,[102, 122, 124, 128, 132, 134, 135] multi-state data,[136-138] national data,[123] and records from a single hospital.[91, 125-127, 130, 139] Structural/ institutional factors explored in this literature set include the relationship between urban food deserts and obstetric outcomes,[121] associations between residing in a maternity care desert and risk of death during pregnancy,[129] associations between family leave after childbirth and maternal outcomes for mental and physical health,[123] impacts of pregnancy-related public health programs,[122] municipal expenditures,[137] incarceration exposure during pregnancy,[102, 136] neighborhood indices on maternal health outcomes[125-128, 130] and severe maternal morbidity,[91] and area-level population distributions of race and income to predict death during pregnancy or up to 1 year postpartum.[124] Another study used Black-White racial segregation along with pandemic timing to examine racial disparities,[135] while another aimed to identify the geographic distribution of and disparities in cardiomyopathy outcomes.[139] One study sought to identify the effects of the Affordable Care Act's non-Medicaid provisions on insurance coverage and postpartum depressive symptoms.[138] An additional three studies examined structural/institutional factors as an exposure of interest.[89,

[97, 140] Figure 4.5 displays the studies' connections between structural/institutional factors and outcomes.

Figure 4.5. Reported outcomes for studies with structural/institutional factors for pregnant people



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Abbreviation: SDOH=social-structural determinants of health; SMM=severe maternal morbidity

Two studies found that racial residential segregation was negatively associated with maternal health, with higher rates of hypertensive disorders,[127] severe maternal morbidity, [135] and increased risk for pregnancy-associated death[124] among those living in neighborhoods with high proportions of low-income and Black residents. Other neighborhood indices, such as crime[126] and adverse neighborhood physical environment traits, were associated with an increase in hypertensive disorders,[125] while neighborhood walkability decreased risk for pregnancy-related hypertension.[128] One study found after adjustment, there was no association between neighborhood deprivation and severe maternal morbidity. [91] One study found patients with severe peripartum cardiomyopathy were more likely to live in communities with greater social vulnerability.[139] In an urban setting, multipurpose and walkable communities were associated with a lower risk of postpartum depression.[130]

Risk of death during pregnancy and up to 1 year postpartum was higher among women who lived in maternity care deserts than women in areas with greater access.[129] Study authors noted that racial inequity in risk persisted above and beyond differences in geographic access to maternity care.[129] For individuals residing in urban food deserts, mothers were more likely to be younger, obese, and of minority race/ethnicity; however, they did not experience worse perinatal health outcomes.[121] For mothers who worked prior to childbirth and returned in the first year, having less than 12 weeks of maternal leave and less than 8 weeks of paid maternal leave was associated with increased depressive symptoms and reduced overall health status.[123] Exposure to incarceration (personally or through a romantic partner's incarceration) was associated with postpartum depression, but not more so than other typical stressors such as financial hardship.[102] Another study identified increased odds of prepregancy hypertension and pre- or postpartum depression in women with incarceration exposure.[136] One study found that increased public-

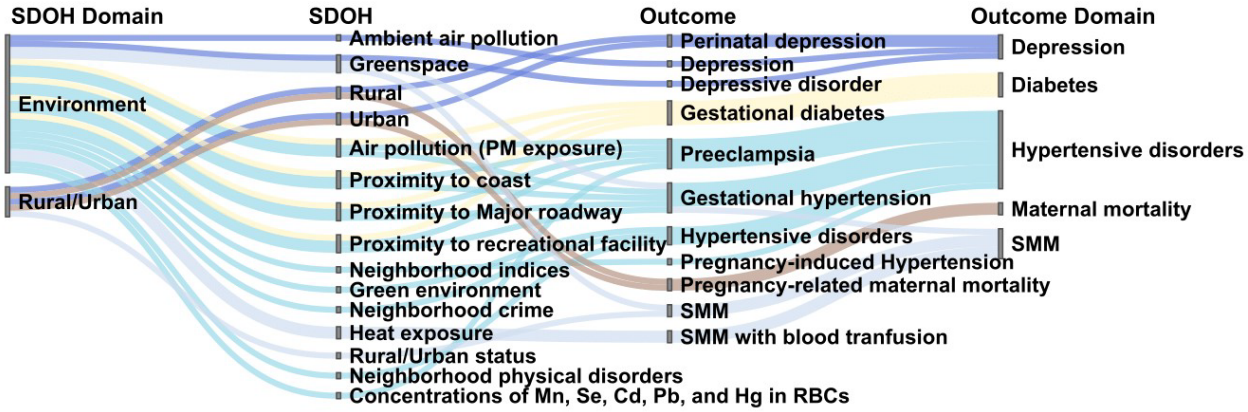
health spending reduced mortality rates among Black mothers and narrowed Black-white outcome disparities.[122] One study found reduced odds of severe maternal morbidity in areas where annual municipal expenditures (such as fire, ambulance, transportation, health, housing and libraries) were $1000 higher per capita. The same study found higher expenditures on police were associated with increased odds of severe maternal morbidity.[137] One study found the Affordable Care Act's non-Medicaid provision expansion was associated with increased retention of postpartum insurance and reductions in postpartum depression after controlling for maternal characteristics.[138]

4.6 Rural/Urban and Environment Factors

We identified three studies that examined rural/urban factors using nationwide data sources as the primary social-structural determinant of interest.[90, 141, 142] One examined geographic variations in 3,747 pregnancy-related deaths from 2011 to 2016 among Hispanic, non-Hispanic white, American Indian or Alaska Native, and Asian or Pacific Islander women (using National Center for Health Statistics Urban-Rural Classification Scheme for Counties to determine urban-rural groupings).[90] Another study included 17,229 perinatal women from 14 states and examined differences in risk of perinatal depression between women in rural and urban areas.[141] The third study aimed to evaluate how rural/urban status along with other risk factors alter a women's risk of severe maternal morbidity at delivery using Kentucky state delivery hospitalization records.[142]

We identified and categorized six unique studies examining environmental factors.[143-147] Studies collected data from states,[143, 147] city programs,[144, 146] and a single hospital.[145] Two studies focused on air pollution, one on associations between proximity of key land features and risk of negative health outcomes,[143] and the other on ambient air pollution as a modifiable risk factor for postpartum depression.[146] One study examined the association between exposure to trace minerals and heavy metals and preeclampsia.[144] Two studies examined associations between neighborhood greenness and hypertensive disorders[145] and how greenspace may positively impact pregnancy health for racially and economically minoritized populations.[147] One study examined special clustering of severe maternal morbidity across South Carolina and its associations with place-based social and environmental factors, primarily heat exposure.[140] Figure 4.6 displays the studies' connections between rural/urban and environment factors and five outcome domains.

Figure 4.6. Reported outcomes for studies with rural/urban and environment factors for pregnant people



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Abbreviation: ED=emergency department; PM=Particulate Matter; SDOH=social-structural determinants of health; RBC= red blood cells; SMM=severe maternal morbidity

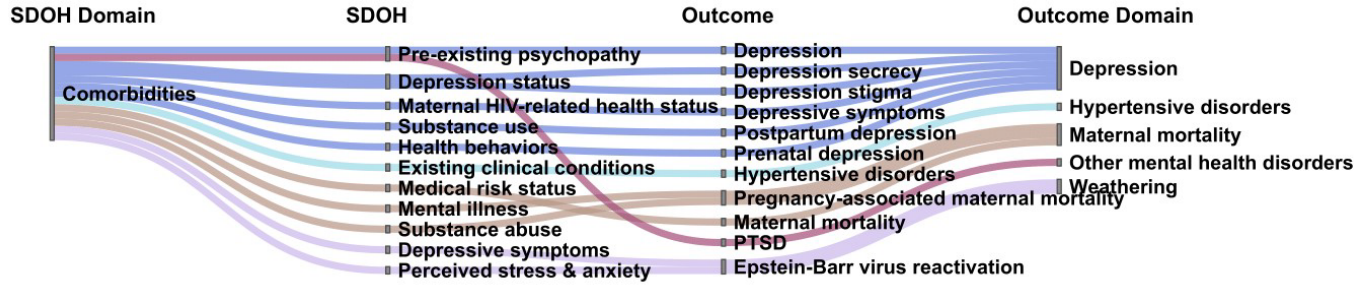
One rural/urban study reported that in small metro, micropolitan populations (10,000 to 50,000), and rural counties, pregnancy-related mortality ratios were 2 to 3 times higher among non-Hispanic, American Indian or Alaska Natives than among non-Hispanic white women in the same areas.[90] Black women had a pregnancy-related mortality ratio 3 to 4 times higher than white women in the same area regardless of urban-rural classification.[90] One study found that the percentage of delivery hospitalizations with severe maternal morbidity was higher for women with rural vs metro vs metro-adjacent residence.[142] Findings from one study suggested the odds of perinatal depression were higher among rural than urban women. Non-Hispanic Black women were more likely to report perinatal depression than non-Hispanic white women in rural areas.[141]

All six studies found negative associations between environmental factors and maternal health outcomes. One study found that second trimester exposure to ambient particulate matter and living close to a major roadway were associated with higher odds of gestational diabetes mellitus, and that living more than 500 meters from a recreational facility was associated with lower odds of gestational hypertension.[143] None of these factors were associated with preeclampsia.[143] One study found an association between higher manganese concentration in maternal red blood cells and lower risk of preeclampsia, and another association between higher cadmium concentration and higher risk of preeclampsia.[144] One study found an association between lower levels of neighborhood tree canopy cover and higher odds of hypertensive disorders in an urban population, and this association was stronger among non-Hispanic Black women.[145] One study found an association between increased odds of postpartum depression for Hispanic/Latina and second trimester exposure to nitrogen dioxide and particulate matter.[146] One study found that those with the lowest access to publicly available and accessible greenspace had an increased risk for mental disorders, depressive disorders, and gestational diabetes.[147] One study identified an impact of hot ambient temperatures on maternal morbidity.[140]

4.7 Comorbidity Factors

We identified and categorized two unique studies that examined comorbidity factors as major exposures.[106, 148] The first study examined medical records of Black women living with HIV,[106] and the other recruited women who were seeking prenatal medical care from four Midwestern clinics.[148] An additional five studies examined comorbidities as an exposure of interest.[95, 96, 109, 112, 114] Comorbidities in these studies included mental illness,[109, 114] existing clinical conditions,[96] stress and anxiety,[106, 148] and substance use.[95, 112, 114] Figure 4.7 displays the studies' connections between comorbidities and five outcome domains.

Figure 4.7. Reported outcomes for studies with comorbidity factors for pregnant people



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Abbreviations: SDOH=social-structural determinant of health; PTSD=post-traumatic stress disorder

One study reported low income, exposure to intimate partner violence, and childcare burden as having a negative impact on the psychological health of Black peripartum women living with HIV.[106] The other study reported a positive correlation for white women between their beliefs about keeping depression a secret and experiencing depression; however, secrecy and depression were uncorrelated for Black women.[148]

Studies that examined comorbidities as an additional factor of interest reported mixed findings. Lifetime post-traumatic stress disorder contributed, independent of other factors, to dissociation in delivery,[109] while substance use was independently associated with depression,[112] and illicit drug and alcohol use was associated with depressive symptoms in African-American expecting mothers.[95] However, substance use and mental illness did not lead to more preventable deaths.[114] Obesity and diabetes were associated with hypertensive disorders.[96]

4.8 Hospital and Healthcare Use Factors

We identified and categorized one unique study that examined healthcare use factors as a major exposure.[101] The study sourced data from North Carolina state death certificate codes and linkage of birth and death files to determine pregnancy-related death among all cesarean births and all vaginal births for a 7-year period. Receipt of any prenatal care was associated with a decreased risk for pregnancy-related mortality. An additional study examined healthcare use factors as an exposure of interest.[68]

Chapter 5. Risk Factors for Birthing People Immediately Before, During, or After Birth

5.1 Key Points

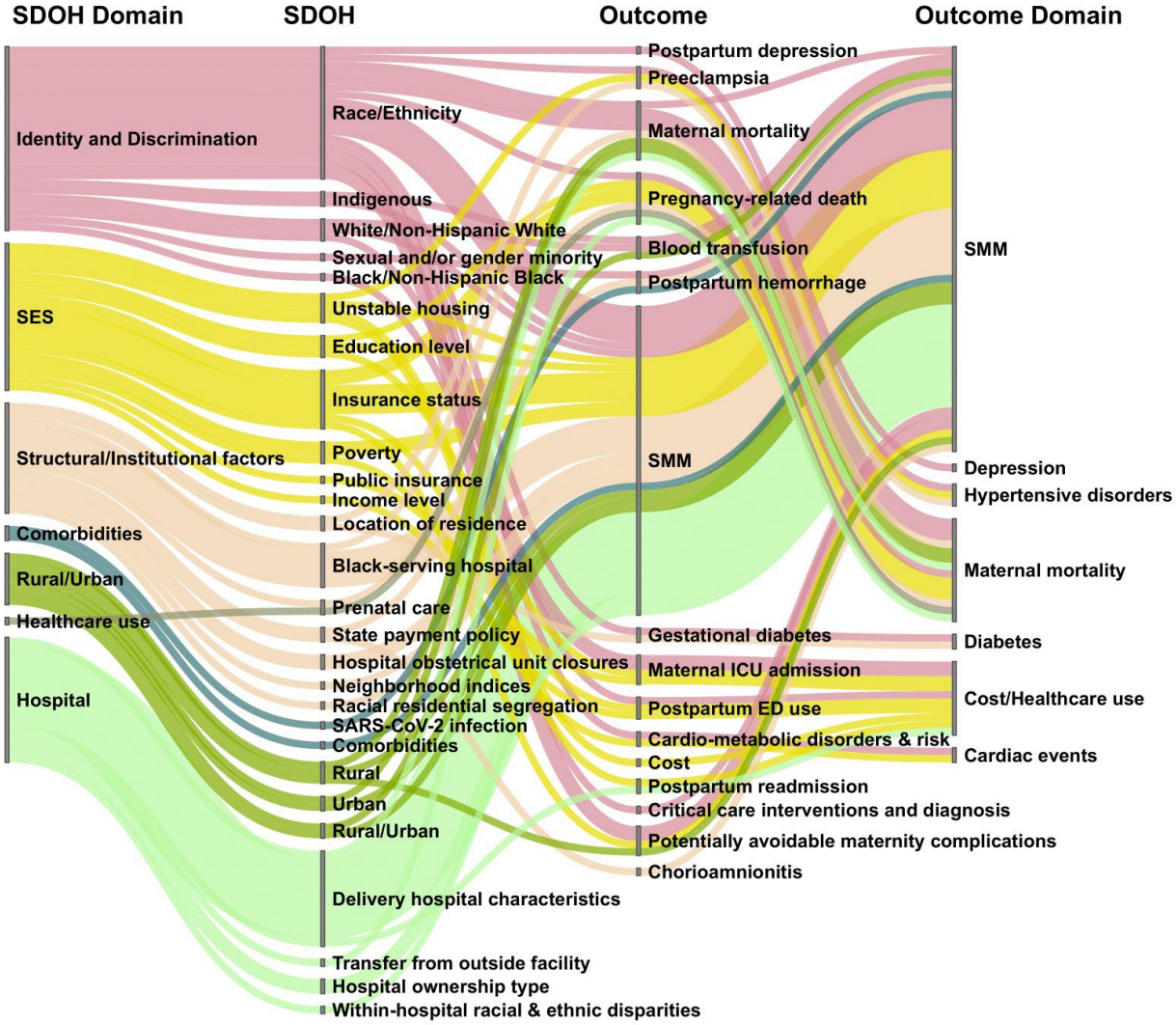
- Included study exposures broadly covered social-structural determinants of health; however, the identified determinants included still represent only a subset of potential social-structural determinants of interest and did not address intersections with biologic/medical risk factors.
- Limited depth and quality of available research within each risk factor domain, including racism and other forms of discrimination, impeded our ability to understand pathways connecting social determinants of health and maternal health outcomes.
- For outcome domains, depression/other mental health outcomes represented a large proportion of the health outcomes captured.
- Few studies reported the excess risk attributable to a specific exposure. Very recent studies reported:
    - Hispanic birthing women were more likely to deliver at hospitals with higher risk-adjusted severe maternal morbidity; delivery location may contribute up to 37 percent of ethnic disparity in severe maternal morbidity in New York City.
    - Combined race and income segregation was associated with increased severe maternal morbidity in birthing women in New York City; delivery hospitals accounted for 35 percent of the attributable risk, and comorbidities 50 percent.
    - Nationally, if rural indigenous birthing women experienced severe maternal morbidity and mortality at the same rate as urban white women, they would see a 49 percent reduction in cases.

This chapter addresses Key Question 2 and includes studies that examined social-structural determinants of health for birthing people during the time period just prior to delivery through just before release from birthing-related hospitalization/clinical care. We categorized studies according to seven major exposure domains. We assigned categories based on subjective reading of the studies because this literature, especially studies examining interactions between risk factors, is interconnected. Therefore, we sought to present findings with a clear narrative flow. Because so many studies used correlational designs, and because we found high risk of bias for those using quasi-experimental techniques, we approached this chapter from the perspective of risk factor hypothesis generation that could inform interventions. Therefore, we report the direction of the adjusted association between risk factors and outcomes of interest. We report numbers if a study attempted to explain the results by how much a specific risk factor contributes to differences or disparities.

Overall, we identified 31 unique studies that addressed Key Question 2. Figure 5.1 uses colored paths to show connections between social-structural determinants of health and outcome domains. Seven risk-factor domains mapped to seven outcome domains, with all seven risk factors mapping to severe maternal morbidity, and all but environmental factors mapping to maternal mortality. Less commonly examined outcome domains included cardio/metabolic disorders, diabetes, hypertension disorders, depression, and cost/healthcare use, all of which connected to four or fewer risk-factor domains. The figure displays the complexity of the

connections. In the following sections, we present brief summaries and detailed graphs of the nine identified major factors. Detailed evidence tables can be found in Appendix C.

Figure 5.1. Reported exposures and outcomes for birthing people



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Abbreviation: ED=emergency department; ICU = Intensive Care Unit; SDOH=social-structural determinants of health; SES = Socioeconomic Status; SMM=severe maternal morbidity

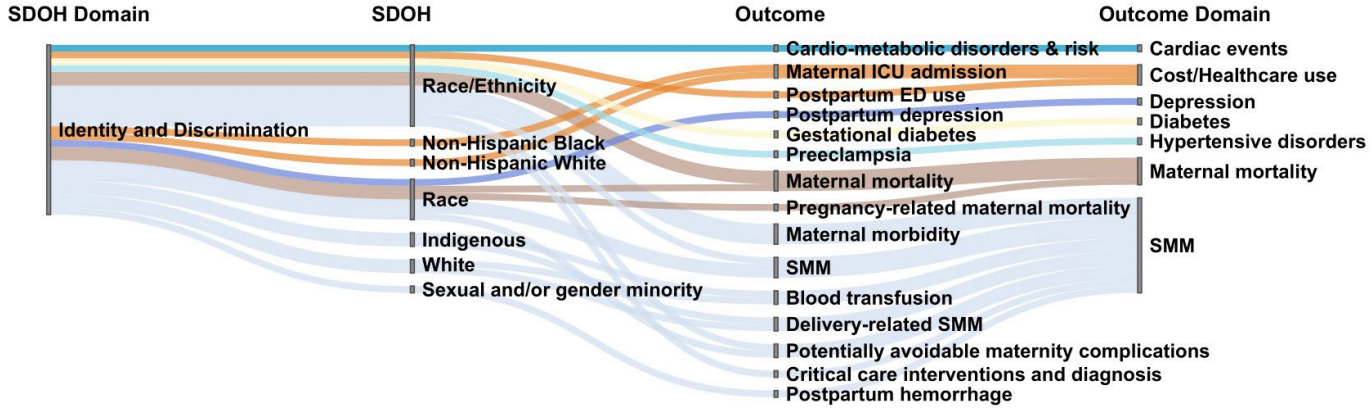
5.2 Identity and Discrimination

We identified and categorized eleven unique studies that examined identity or discrimination factors as the primary factor.[87, 149-158] Studies collected data at various levels, including individual hospital,[150] health system,[154] state,[149, 151, 152, 158] multi-state,[155] secondary randomized controlled trial data analysis,[157] and national.[87, 153, 156] Nine studies examining race/ethnicity as

the primary social-structural determinant of interest focused on African American or Black women compared with other racial groups.[87, 149-156] One study conducted a secondary analysis of randomized controlled trial data to evaluate race and ethnicity differences on maternal morbidity for non-Hispanic Black, Hispanic and non-Hispanic white participants.[157] One study sought to evaluate obstetrical outcomes comparing couples who are likely sexual and/or gender minority patients, which include but are not limited to lesbian, gay, bisexual, and/or transgender people, to those who are not likely sexual and/or gender minority patients.[158]

Five additional studies evaluated race/ethnicity as an exposure of interest.[159-163] Although studies used "race/ethnicity" as an exposure, neither race nor ethnicity is an exposure but each are markers of multiple potential exposures. However, rarely did studies thoroughly explore specific aspects of the interaction between race/ethnicity and maternal health outcomes in the United States to identify the true association. Figure 5.2 displays the studies' connections between race/ethnicity factors and seven outcome domains.

Figure 5.2. Reported outcomes for studies with identity and discrimination factors for birthing people



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Abbreviations: ED=emergency department; ICU=intensive care unit; SDOH=social-structural determinant of health; SMM=severe maternal morbidity

Looking at the studies that compared Black women with other groups, one study found younger Black women who had low incomes and were insured by Medicaid had higher likelihood of emergency department care within 90 days following birthing discharge.[149] One study found that compared with Hispanic women, African-American women had higher rates of preeclampsia but no difference in gestational diabetes mellitus.[150] One study found the cumulative incidence of hospital-based care of postpartum depression was highest for Black women and lowest for Asian women.[151] One study reported greater risk of death and of critical-care diagnosis for non-Hispanic Black women compared with non-Hispanic white women,[153] while another reported that for those women with low risk of mortality, Black women had higher odds of mortality compared with white women.[87] The study reported no difference for women at high-risk for mortality. One study reported that African-American women had higher risk than

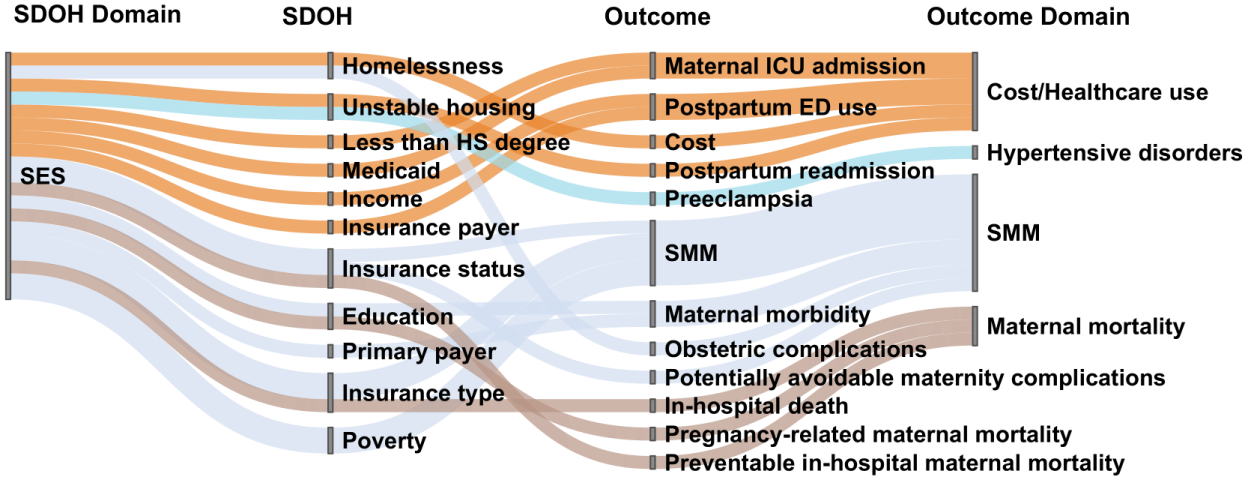
white women for potentially avoidable maternity complications, and white women had higher risk than Asian women, but universal health coverage mitigated this effect between African-American and white women.[154] One study reported African-American women had higher risk of postpartum cardio/metabolic diseases than non-Hispanic white or Latina women.[155] One study identified greater risk of admission to an intensive care unit for Black women than for white or Hispanic women; socioeconomic factors included Medicaid but not education or supplemental nutrition programs for women, infants, and children.[156] One study examined the relationship between race/ethnicity and severe maternal morbidity and mortality, and found that Somali women had higher risk of cesarean birth, gestational diabetes, and perineal lacerations than Black or white women.[152]

Of the additional studies that evaluated race/ethnicity as an exposure of interest, one found Black women at higher risk of maternal mortality than white women across different hospital types.[159] Another found that African American women had higher risk of avoidable maternity complications than non-Hispanic white women in rural hospitals, but that risk did not differ significantly in urban hospitals. The same study found that Asian and Hispanic women also had lower risk of avoidable maternity complications than non-Hispanic white women in urban hospitals.[160] One study found higher odds of severe maternal morbidity and mortality for Black, Hispanic, and Native American women than for white women across hospital locations.[161] In one study that examined birth outcomes in patients who were likely gender or sexual minority couples, birthing mothers with mother partners experienced higher risk of labor induction, postpartum hemorrhage, and severe morbidity. Birthing fathers with any partnership were not observed to have any increased risk in the study's outcomes of interest.[158] Non-Hispanic Black and Hispanic people experienced higher relative risk of cesarean birth compared to non-Hispanic white people, which explained a portion of the excess maternal morbidity experienced by non-Hispanic Black and Hispanic people.[157] One study found that Black women had the highest rates of severe maternal morbidity, followed by Hispanic women compared with white women, with the highest likelihood of severe maternal morbidity existing for all women that delivered in a Black-serving obstetrical unit.[162]

5.3 Socioeconomic Factors

We identified and categorized three unique studies that examined socioeconomic factors as the primary social-structural determinants of interest.[164-166] The studies collected data from state or multi-state hospital discharge records,[164, 165] and one study used Healthcare Cost and Utilization Project for three states.[166] Ten additional studies examined socioeconomic status as an exposure of interest,[87, 149, 154-156, 163, 167-170] examining education,[87, 156, 163] income,[149, 155, 169] insurance payer or type,[149, 154, 156, 163, 164, 167, 168] and homelessness or unstable housing.[165, 166] Figure 5.3 displays the studies' connections between socioeconomic status factors and four outcome domains.

Figure 5.3. Reported outcomes for studies with socioeconomic status factors for birthing people



Note: The figure displays colored paths connecting risk factor and outcome domains. Each outcome domain is represented by a different color and by following the colors from left to right from the SDOH domain a reader can see which outcomes a social determinant of health is impacting. The outer two columns display the social determinant of health and outcome domains categorized in this review. The inner two columns give more detailed information about the specific exposure or outcome measures named in the studies. The unit of display is the individual risk factor or outcome; therefore, the total number of individual risk factors, or individual outcomes, may be greater than the total number of studies. Thicker lines indicate more studies examined a given risk factor or outcome; thinner lines indicate less studies.
Abbreviations: ED=emergency department; HS=High School; ICU=intensive care unit; SDOH=social-structural determinant of health; SMM=severe maternal morbidity

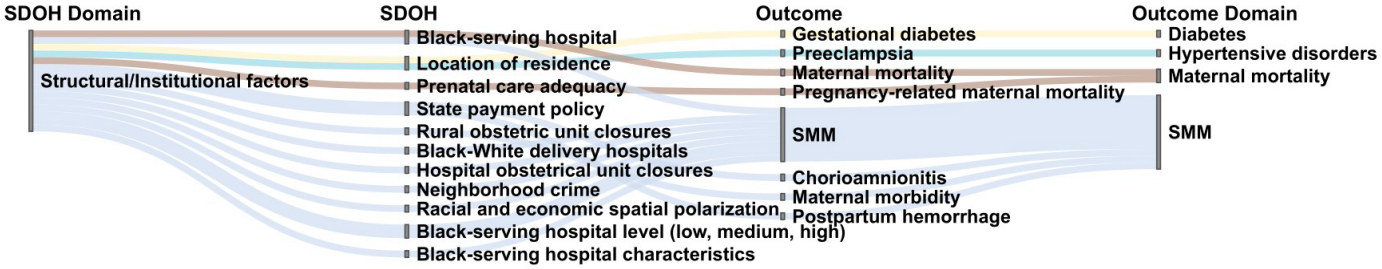
One study found an association between unstable housing and emergency department visits and readmissions (but not preeclampsia) at 3 months and 1 year postpartum.[165] Another study found an association between homelessness and higher delivery-associated costs.[166] Compared with private managed care, Medicaid managed care was associated with higher rates of eclampsia, but not with differences in in-hospital maternal mortality.[164]

Of the studies that examined socioeconomic status as an important factor, education was associated with healthcare use patterns[155, 163] but not mortality,[87] income was associated with emergency department visits,[149] and insurance payer or type was associated with emergency department visits, care in intensive care units, healthcare use patterns, and preventable mortality.[149, 156, 163, 168]

5.4 Structural/Institutional Factors

We identified and categorized 11 studies that examined structural/institutional factors as the primary social-structural determinants of interest.[159, 162, 163, 167, 169-175] These exposures included Black-serving hospitals,[170, 171, 174, 176] delivery hospitals,[159, 167, 173] segregation measured as racial and economic spatial polarization,[169] hospital obstetrical closures,[162, 163] and a state payment policy.[175] Studies collected state-level vital statistics or hospital discharge data from three states,[162, 163, 170, 171] nationwide data samples,[174, 176] and vital statistics records linked with discharge datasets for a large city,[167, 169] and, for two studies, regional data. Two additional studies examined structural/institutional factors as an exposure of interest.[87, 150] Figure 5.4 displays the studies' connections between structural/institutional factors and four outcome domains.

Figure 5.4. Reported outcomes for studies with structural/institutional factors for birthing people



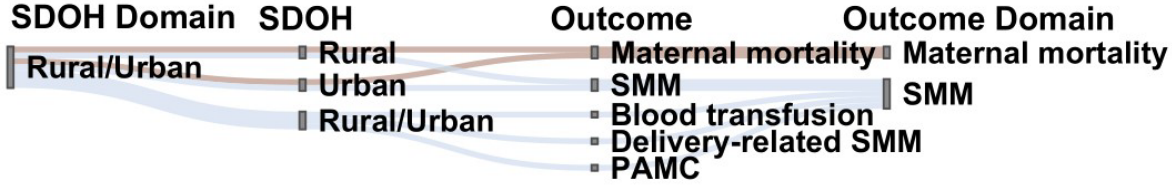
Note: The figure displays colored paths connecting risk factor and outcome domains. Each outcome domain is represented by a different color and by following the colors from left to right from the SDOH domain a reader can see which outcomes a social determinant of health is impacting. The outer two columns display the social determinant of health and outcome domains categorized in this review. The inner two columns give more detailed information about the specific exposure or outcome measures named in the studies. The unit of display is the individual risk factor or outcome; therefore, the total number of individual risk factors, or individual outcomes, may be greater than the total number of studies. Thicker lines indicate more studies examined a given risk factor or outcome; thinner lines indicate less studies.
Abbreviations: SDOH=social-structural determinant of health; SMM=severe maternal morbidity

Eight structural/institutional factors studies examined severe maternal morbidity.[162, 167, 169-171, 173, 174, 176] One study reported severe maternal morbidity risk was higher among Black women than white women in low and medium Black-serving hospitals in Washington State.[171] One study of 4.6 million deliveries nationwide reported that Black women who delivered at high black-serving hospitals had the highest risk of severe maternal morbidity.[172] One study found an association between higher-risk adjusted severe maternal morbidity hospitals and disparities between Hispanic mothers and non-Hispanic white mothers in New York City.[173] One study found that insurance type had no effect on higher severe maternal morbidity within New York City hospitals for Black and Latina women compared with white women.[167] One study reported 47 percent of the Black-white in-hospital mortality disparity in nonteaching hospitals was attributable to delivering at a Black-serving hospital.[159] One study examined differences in pre- versus post-closure of hospital based obstetric services on maternal morbidity outcomes in rural North Carolina.[163] One study reported greater increases in postpartum hemorrhage among Black women than white women after a blended payment policy for Medicaid was adopted in Minnesota to reduce financial incentives for cesarean birth.[175] One study reported Black women that delivered in high Black-serving hospitals had higher odds of severe maternal morbidity compared with white women that delivered in low Black-serving hospitals.[170] One study reported disparities in services from the lowest to the highest Black-serving hospitals, with the lowest Black-serving hospital carrying the lowest risk for severe maternal morbidity.[174]

5.5 Rural/Urban and Environmental Factors

No studies examined environmental factors. We identified three unique studies examining rural/urban factors as the primary social-structural determinants of interest, all of which used national databases.[160, 161, 177] Exposures included rurality, race,[161, 177] and access to rural or urban healthcare in mothers insured by Medicaid.[160] Figure 5.5 displays the studies' connections between rural/urban factors and two outcome domains.

Figure 5.5. Reported outcomes for rural/urban and environment factors for birthing people



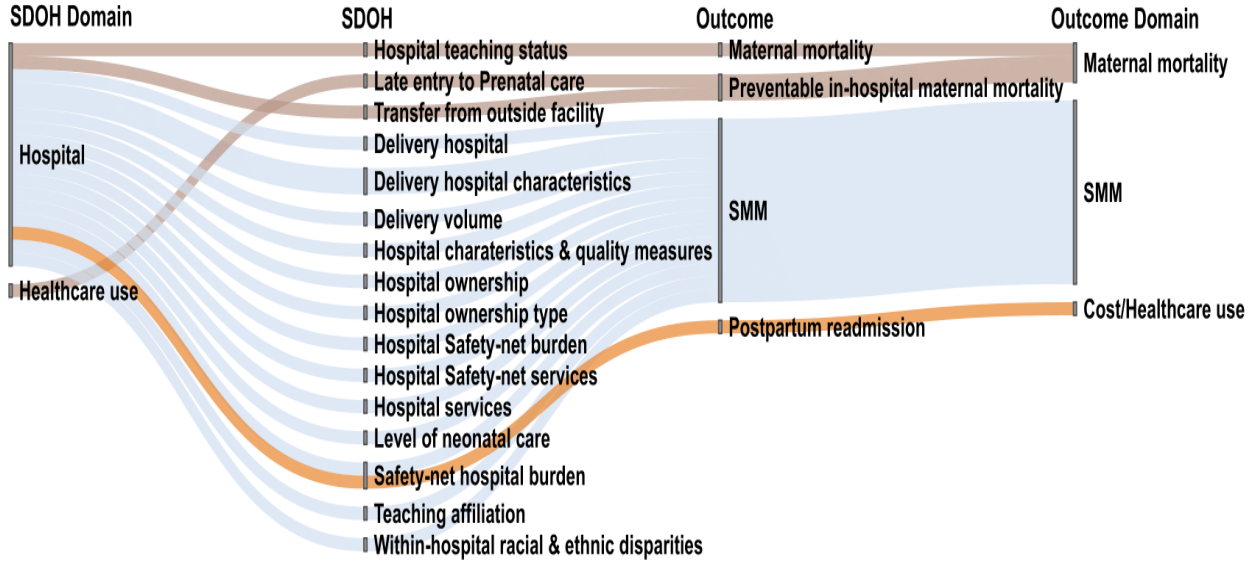
Note: The figure displays colored paths connecting risk factor and outcome domains. Each outcome domain is represented by a different color and by following the colors from left to right from the SDOH domain a reader can see which outcomes a social determinant of health is impacting. The outer two columns display the social determinant of health and outcome domains categorized in this review. The inner two columns give more detailed information about the specific exposure or outcome measures named in the studies. The unit of display is the individual risk factor or outcome; therefore, the total number of individual risk factors, or individual outcomes, may be greater than the total number of studies. Thicker lines indicate more studies examined a given risk factor or outcome; thinner lines indicate less studies.
Abbreviations: PAMC= Potentially avoidable maternity complications; SDOH=social-structural determinant of health; SMM=severe maternal morbidity

One study reported that women in the most urban and the most rural areas had higher odds of severe maternal morbidity and mortality, compared to small cities.[161] Black women with the highest odds of severe maternal morbidity and mortality were in urban and micropolitan areas (populations 10,000 to 50,000). Among white women, those in noncore rural counties (counties without metro areas or towns of over 2,500 residents) had the highest odds of severe maternal morbidity and mortality.[161] One study reported rural hospitals having a higher risk for potentially avoidable maternity complications.[160, 161] Compared with non-Hispanic white women, Black women in rural but not urban hospitals were at higher risk for complications, and Hispanic and Asian women were at lower risk in urban hospitals. Another study focused specifically on Indigenous women found that if rural Indigenous women experienced severe maternal morbidity and mortality at the same rate as urban white women, they would have a 49 percent reduction in cases.[177]

5.6 Hospital and Healthcare Use Factors

We identified and categorized four unique studies that examined hospital factors as a major exposure,[173, 178-180] and one examined healthcare use.[168] The studies collected data from one large city's vital statistics,[173] hospital discharge records from three states,[168, 178, 180] and, for one study, nationwide data.[179] One study focused on Hispanic versus non-Hispanic white women,[173] while two also examined excess risk for racial and ethnically minoritized women compared with non-Hispanic white women.[179, 180] Three additional studies examined hospital factors as an exposure of interest.[159, 169, 174] Figure 5.6 displays the studies' connections between hospital and healthcare use factors and three outcome domains.

Figure 5.6. Reported outcomes for studies with hospital and healthcare use factors for birthing people



Note: The figure displays colored paths connecting risk factor and outcome domains. Each outcome domain is represented by a different color and by following the colors from left to right from the SDOH domain a reader can see which outcomes a social determinant of health is impacting. The outer two columns display the social determinant of health and outcome domains categorized in this review. The inner two columns give more detailed information about the specific exposure or outcome measures named in the studies. The unit of display is the individual risk factor or outcome; therefore, the total number of individual risk factors, or individual outcomes, may be greater than the total number of studies. Thicker lines indicate more studies examined a given risk factor or outcome; thinner lines indicate less studies.
Abbreviations: SDOH=social-structural determinant of health; SMM=severe maternal morbidity

All hospital factor studies examined the relationship to severe maternal morbidity. Two studies found higher risk of severe maternal morbidity associated with teaching hospital status,[179] higher safety net burden,[178] or lower clinical care quality.[180] One study found Hispanic women more likely to deliver at hospitals with higher risk-adjusted severe maternal morbidity, contributing up to 37 percent of ethnic disparity to this outcome in New York City.[173] This pattern generally held among Puerto Rican, Dominican, and Mexican subgroups.[173] However, one study reported excess increased risk among racially and ethnically minoritized women beyond the risk contributed by teaching hospital status.[179] Another study using New York City data found combined race and income segregation was associated with increased severe maternal morbidity.[169] The study reported that the hospital accounted for 35 percent of the attributable risk.

One healthcare use factor study used state data to examine in-hospital deaths of 16 women for preventability and reported associations with late entry to prenatal care, transfer to the hospital, and insurance status.[168]

5.7 Comorbidity Factors

One study examined comorbidities as the major exposure.[181] This study evaluated the impact of SARS-CoV-2 on maternal birth outcomes for Black and underserved populations in Brooklyn, New York. In this predominantly Black population, SARS-CoV-2 infection did not confer increased risk of adverse obstetric outcomes despite the prevalence of comorbidities.[181]

An additional study, categorized as Structural/Institutional for the major exposure, examined comorbidities as an exposure of interest.[169] Using New York City data, this study found an association between combined race and income segregation and increased severe maternal morbidity. This study found that comorbidities, including prepregnancy body mass index, diabetes, hypertension, cardiac disease, renal disease, pulmonary disease, musculoskeletal disease, blood disorders, mental disorders, central nervous system disorders, rheumatic heart disease, anemia, and asthma, accounted for 50 percent of the attributable risk.[169]

Chapter 6. Discussion

6.1 Overview

This review sought to provide a broad overview of research that examined exposures related to social-structural determinants of health and at least one health or healthcare-related outcome affecting postpartum health. Strengths of our report include a comprehensive search and inclusion of observational studies most relevant to the topic, high-level mapping of the research on social-structural determinants and outcome domains identified from the studies, and suggestions for new research based on our findings.

Our review identified 118 studies categorized to eight outcome domains and 11 domains related to social-structural determinants of health representing 221 specifically named exposures of interest. Identified domains of social-structural determinants of health included race/ethnicity, socioeconomic, violence, trauma, psychological stress, structural/institutional, rural/urban, environment, comorbidities, hospital, and healthcare use factors. Broad outcome domains included maternal mortality, severe maternal morbidity, hypertensive disorders of pregnancy, gestational diabetes, cardio/metabolic disorders, weathering (the physiological effect of premature aging caused by chronic stressful experiences), depression, other mental health or substance use disorders, and cost/healthcare use outcomes. A large proportion of studies examined depression and other mental health outcomes for both pregnant and birthing people, even compared with mortality and other severe maternal morbidity outcomes.

Overall, study exposures broadly covered the social-structural determinants of health for both pregnant and birthing people; however, these included exposures represent only a subset of potential social-structural determinants that may affect the health and care of pregnant and birthing people. Further, no studies examined interdependencies with biologic/medical risk factors. Limited depth and quality of available research within each risk factor domain impeded our ability to understand the pathways connecting social-structural determinants of health and maternal health outcomes. We found an unexpectedly large volume of research in the domain of violence and trauma relative to other domains of social-structural determinants of health for pregnant people. Likely this stems in part from the addition of violence-related questions in the Centers for Disease Control and Prevention's Pregnancy Risk Assessment Monitoring System (PRAMS). This system, an ongoing collaboration between state, territory, and local departments of health and the Center for Disease Control and Prevention, is a "population-based surveillance system designed to identify groups of women and infants at high risk for health problems, to monitor changes in health status, and to measure progress towards goals in improving the health of mothers and infants."[182]

Across all domains related to social-structural determinants of health, an overwhelmingly large number of studies used correlational study designs to describe associations between social-structural determinants of health and outcomes. Fewer studies used analytic approaches that would allow one to try to untangle the causal relationship, such as experimental designs or quasi-experimental designs or analytic methods. Experimental designs were lacking because randomization is difficult if not inappropriate to conduct, since randomizing pregnant and birthing people to different levels of a social-structural determinant of health is unethical. Perhaps not surprisingly, we found all studies to be at high risk for alternative explanations. Therefore, we approached study-reported results from the perspective of supporting future researchers in generating hypotheses for risk factors to test with potential interventions. Only a handful of studies used analytic methods to explore cause-and-effect relationships using

approaches such as propensity score methods, difference-in-difference, and instrumental variable methods. Even fewer studies attempted to break differences in a particular outcome into separate risk components for pregnant and birthing people experiencing different levels of a social-structural determinant of health. We note that studies that were more likely to use analytic methods that would allow reporting the excess risk attributable to a specific exposure are mostly from the past three years, and our findings point to the need for more of this. This increased rigor would bolster an evidence base that helps us understand the potential mechanisms through which social determinants of health—including racism— work, and thereby design effective interventions.

6.2 Future Research

Identifying the social-structural determinants of health that affect pregnant and birthing people is of vital importance. Not only do pregnant and birthing people face an unacceptably high risk of maternal morbidity and mortality in the United States,[1] but that risk is unevenly distributed, with Black and Indigenous women three to four times as affected as their white counterparts.[9] While each pregnant or birthing person will confront their own unique risk factors, individuals can benefit when research identifies themes and patterns at the population level that suggest opportunities to deliver interventions that address the impact of social and structural determinants of health, not just social needs. Our review overall identified a great number of potentially eligible studies. However, even after narrowing the included literature to only the studies better designed to address our Key Questions, we remain unable to draw strong conclusions due to the study design, conduct, and dispersion reasons stated above. Deeper investigation of an individual risk factor and its mechanisms would require more study designs than we included here. Such a mixed studies review would be best approached through targeted reviews of specific scope. And while the literature published in the last three years showed a definite trend toward improved rigor, much remains to be addressed. In concert with standards recently suggested for publishing research on racial health inequities,[44] we outline below several future research areas that could inform research, practice, and policy.

In addition, we noted in this literature a widespread "deficit" perspective. That is, researchers often describe disparities and adverse outcomes as expected in individuals and populations who experience structural vulnerability and violence. Future research and approaches to addressing maternal morbidity and mortality would benefit from a shift towards a "strengths-based" approach, wherein researchers intentionally explore what exposures might be health-enhancing and health-promoting even in the face of structural vulnerability. Such a strengths-based approach supports thinking expansively about how to reduce barriers and achieve optimal perinatal outcomes.

6.2.1 Methodological Rigor

As noted, the overwhelming majority of included studies were designed to answer whether two or more things were associated with each other rather than whether one thing could cause another. Because we grouped studies according to their stated purpose and approach, we constrained our review to a likewise hypothesis-generating approach. Indeed, it would be unethical to use traditional gold-standard experimental methodologies that would randomly assign study participants to factors that could harm their health. A few recent studies used quasi-experimental approaches to address the selection bias problems of nonrandomized studies, such as instrumental variables, propensity score matching, or decomposition analysis, to try to identify

important drivers of poor maternal health outcomes and maternal health disparities. Future research can emphasize such techniques that improve the ability of observational research to estimate causal impacts.

Assessing methodological rigor is a challenging task. We were struck by a lack of adherence to basic reporting standards for observational studies within these publications. Incompletely reported details, in particular about analytic approaches, further hindered our ability to assess study rigor. It would be easier to assess the rigor of exposures studies if we knew the ideal study design as the standard against which to measure the conduct of studies included in the review. To design studies ideally suited to produce reliable results in this field would require understanding the critical co-exposures and confounders to include in the analysis. Confounders would likely be things along the mediating pathway, and incorporating such things into analyses is difficult to do without inserting bias, especially with incomplete understanding of the mediating pathway. In addition, each study purpose, from the broad array present in the included studies, could require its own enumeration of co-exposures and confounders. Organized and curated catalogues of maternal health exposures and their presumed mechanisms could facilitate future examinations of exposures. More widespread adoption of these approaches could improve rigor of the conduct and reporting of future maternal health exposure studies, increasing the overall quality of the literature.

6.2.2 Populations and Data Sources

During the topic refinement phase of this review, stakeholders very much wanted an inclusive approach to pregnant and birthing populations. A few notable studies focused on specific populations of concern, such as disaggregating social identities within broader racial and ethnicity categories,[173] or groups situated at intersections of social-structural determinants of health, such as race/ethnicity and rurality for Indigenous pregnant women.[177] However, the majority of included studies were constrained by the available demographic labels used in established datasets. In addition, many studies used enrollment or inclusion criteria that by design excluded the most vulnerable populations, resulting in under-representation of groups such as women who were HIV positive or incarcerated. Indigenous women continue to be grouped in "other" categories in studies because of "small numbers," rendering them invisible in the literature. Similarly, we did not identify studies that examined the risk factors specifically related to trans- and gender diverse populations and their experiences of pregnancy and birth. Considerable opportunities exist for supporting research infrastructure that ensures these groups are accurately accounted for in future studies.

In addition to the inexact demographics, the data sources themselves can be a source of bias. These structural research resources were generally created under structurally biased conditions, raising concerns for where and how the population sampling was done, as well as the choice of individual, family, community, and social-structural constructs included. The selection and measurement error in the datasets contribute to the under-specification of "disparities" and exploration of causal mechanism through which social-structural drivers of maternal health work. In the near term, research programs and publishing guidelines can encourage analytic approaches discussed earlier, such as instrumental variable or propensity score methods, to try to address the bias inherent in the conditions under which the data was collected. Researchers can name the form of racism being examined, the mechanisms by which it may work, and other intersecting factors that may compound its effect.[44] Future research programs can also take up

longer-term solutions and create datasets designed to more fully capture the data needed to robustly examine racism and other social determinants of health.

6.2.3 Exposures

While we cannot discuss in detail the wide array of exposures our review covered, we note a few of particular interest. We identified few studies that attempted to measure reported racism or racial discrimination as an exposure. No included study used a measure for intersectionality or approached exposure research from a position of intersectionality. In fact, a recent systematic review of intersectionality in quantitative research noted that researchers need to better understand key features that define quantitative intersectionality analyses.[183] Future research would benefit from incorporating approaches and measurement tools explicit to racism and intersectionality. One approach of particular interest is the recent development of a measurement tool that captures the multidimensionality of structural racism.[184] Other examples of measurement tools do exist.[185, 186]

Closer to healthcare delivery, much remains to be understood about how aspects of healthcare delivery contribute to health disparities. Limited work has examined this relationship, and the majority of reported findings that noted attributable risk examined healthcare delivery-related risk factors. For example, no study examined continuity of care or access to prenatal care provided from sources beyond obstetrics as risk or protective factors for maternal outcomes. Rural locations received some attention, but considerable work remains to be done to understand the underlying drivers, such as distance to prenatal or specialized care, delivery centers (or transitions to final delivery location), or deliveries at home or enroute to a delivery center. Because rural health remains a resource-challenged issue, this may also be an area where collaborations to improve data collection may be vital.

6.2.4 Outcomes

Considerable opportunities exist for future research to improve the outcomes measured and captured. We were dismayed to note the amount of research excluded because it captured neonatal but not maternal outcomes. The Centers for Disease Control and Prevention created the Severe Maternal Morbidity measure to track changes over time in the immediate perinatal period that might contribute to maternal mortality. However, the ubiquity of the measure in research can focus attention away from the common postpartum challenges and outcomes most important to birthing people across a wider time period. Our review identified eight outcome domains, including depression and other mental health concerns such as anxiety, which overlap with some of the most common postpartum challenges,[187] but the literature did not examine all of these challenges.

Another theme (outside the scope of our review) that arose during topic refinement was an eagerness among key informants and content experts to press beyond maternal or infant mortality and continue research on downstream effects on maternal and infant/young children's health problems.

Similar to concerns about dataset impact on populations available to study, longer-term solutions will require datasets designed to more fully capture the outcome data needed. Increasing the availability of longitudinally linked datasets is vital. We find examples in the datasets being supported by the Office of the Secretary's Patient-Centered Outcomes Research Trust Fund (OS-PCORTF) in the Office of the Assistant Secretary for Planning and Evaluation at the Department of Health and Human Services.[188, 189] Another needed advance would involve

improving the ability to link and use electronic health records to enrich the available clinic-based variables and link parent and infant records over time. Community-relevant variables and outcomes likely require expansion of data collection beyond the medical encounter; planning new survey-based data designed to improve the ability to link the data to other existing or planned datasets.

6.2.5 Other Research Approaches

Qualitative research fell outside the scope of this review, but our screening process suggested it would be valuable to explore this subset of the literature. Sophisticated analytic approaches can help researchers investigate how segregation, as well as location relative to neighborhood and environmental exposures, affect access to care.[190] Qualitative research provides rich data based on listening to the experiences of birthing people. In one example drawn from our screening process, qualitative researchers explored the experiences that pregnant and birthing women of color had while interacting with healthcare providers.[191] Supporting this, stakeholders during the topic refinement and protocol development phases noted the importance of qualitative research as counter-argument to traditional philosophy of science approaches and systematic review methodology. They noted that prioritizing only quantitative research that investigates causation hinders and devalues the ability to move a research field forward through hypothesis generating activities. Ultimately, all inquiry begins with direct observation and curiosity, which form the foundation of "good science."

6.3 Strengths and Limitations of the Review

The methods we selected for this review provided a detailed map of the research connecting racism and social determinants of health exposures to maternal health and morbidity. We purposefully focused on risk factors that operated interpersonally to capture literature most likely to address this intersection. Such high-level mapping will help provide researchers, who are often still siloed in their particular areas of expertise or interest, a wider perspective on the breadth of literature within which their specific practice and advocacy resides.

Our inclusion criteria required studies to examine the impact of a social determinant of health. As such, many studies that only examined comorbidities and medical risk factors were ultimately excluded. Most of these excluded studies not only used patient demographics as control or confounder variables, but also lacked exposures indicative of social determinants of health. This review does not address the large literature exploring many biomedical conditions as risk factors for maternal health. Even more regrettably, this siloed approach to risk factor research meant that the interdependencies, intersections, and feedback loops that can compound risks remain generally unaddressed.

Because of our wide scope, we focused on quantitative epidemiologic studies and similar research. We cannot escape the possibility of publication bias in our review. Not only would papers with statistically significant results be viewed as interesting to publish, but also, registering a protocol prior to conducting a secondary analysis of a dataset remains an uncommon practice. The included studies did not fit cleanly into discrete groups, which required us to categorize exposures subjectively. Likewise, the extreme heterogeneity of the studies in exposures and designs led to a subjective risk of bias assessment; however, we tested our approach by identifying the most rigorous study designs and analytic approaches for deeper assessments in order to confirm that subjecting the full literature set to formal assessment lacked value. Further, the included studies only addressed observed pregnancies.

6.4 Conclusion

Identifying the risk factors faced by pregnant and birthing people is vitally important. Limited depth and quality of available research within each social-structural determinant of health impeded our ability to understand underlying risk pathways. While the most recently published literature showed a definite trend toward improved rigor, future research can emphasize techniques that improve the ability to estimate causal impacts. Improved reporting in studies, along with organized and curated catalogues of maternal health exposures and their recognized mechanisms, could make it easier to examine exposures in the future. In the longer term, future research needs datasets designed to more fully capture the data required to robustly examine racism and other social-structural determinants of health and their intersections with other biologic/medical risk factors.

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Appendixes

Appendix A. Methods – Search Strategy

Appendix B. Studies Excluded at Full Text

Appendix C. Evidence Tables

Appendix A. Methods – Search Strategy

The search strategy was designed and conducted by an experienced systematic review librarian with input from investigators. Another librarian peer reviewed the Medline search strategy using the PRESS checklist. To improve sensitivity, the searches were revised to include terms for racial disparities. We also broadened terms to the specific stages of care during and after pregnancy. MEDLINE, CINAHL, and WOS search strategies were run on August 25, 2021. Revised search strategies for all three databases were run Oct 21, 2021 and updated Nov 3, 2022). Duplicates were removed using EndNote and PICO Portal and records were screened in PICO Portal. To find additional relevant studies, reference lists of relevant systematic reviews were manually screened. (Wang, 2020) We applied the following limits or filters to the database searches:

- Date: There were no limits for the date.
- Language: Publications were excluded if they were written in a language other than English. This was due to resource constraints.
- Publication Status: We searched for published studies.
- Study design. The search was not restricted by study design.
- Other limits. We limited by Geographic Subset: USA in the CINAHL search and the Social Sciences Citation Index search was limited to United States.
- Other filters. We used a filter to identifying studies conducted in the United States in the Ovid Medline search.

We conducted a comprehensive literature search through November 3, 2022. We searched the following databases:

- MEDLINE (OVID) and and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions(R)
- CINAHL (EBSCOHost)
- SSCI Social Sciences Citation Index (Web of Science)

Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions(R) <1946 to August 20, 2021>

1 Pregnancy/ or exp Pregnancy Complications/ or Pregnant Women/ or Parturition/ or exp Birth Setting/ or Birthing Centers/ or exp Labor Onset/ or Prenatal Care/ or Pregnancy, High-Risk/ or Obstetrics/ or Delivery, Obstetric/ or Labor, Obstetric/ or Postpartum Period/ or Peripartum Period/ or (obstetric* or peripartum or parturition or postpartum or puerperium or puerperal or pregnan* or postnatal or prenatal).ti,ab,kw.
2 Maternal Health/ or Maternal Morbidity/ or Maternal Mortality/ or Maternal Death/ or (maternal adj3 (death* or health or morbidit* or mortalit* or outcome*)).ti,ab,kw.
3 ((postpartum or post-partum) adj3 (death* or mortalit* or morbidit* or complication* or outcome*)).ti,ab,kw.
4 (wom?n adj3 (death* or mortalit* or mordbid* or complication* or outcome*)).ti,ab,kw.
5 (birthing adj5 (death or mortalit* or morbidit* or complication* or outcome*)).ti,ab,kw.
6 or/2-5

7 1 and 6
8 quality assurance, health care/ or near miss, healthcare/ or health status indicators/ or apache/ or patient acuity/ or "severity of illness index"/ or early warning score/ or organ dysfunction scores/ or sickness impact profile/ or "outcome and process assessment, health care"/ or outcome assessment, health care/ or patient outcome assessment/ or treatment outcome/ or watchful waiting/ or process assessment, health care/ or risk/ or logistic models/ or Probability/ or Predictive Value of Tests/ or risk assessment/ or risk management/ or risk factors/ or uncertainty/ or forecasting/ or early diagnosis/ or "reproducibility of results"/ or Regression Analysis/ or Quality Improvement/ or Practice Patterns, Physicians'/
9 ("health status indicators" or "apache" or "patient acuity" or "quality improvement" or "outcome assessment" or "patient assessment" or "process assessment" or "reproducibility of results" or "early warning" or "organ dysfunction scores" or "watchful waiting" or "regression analysis" or regression model* or "correlation analysis" or "predictive value" or hazard model* or logistic regression or "near miss").ti,ab,kw.
10 (risk* adj3 (assess* or factor? or score? or model*)).ti,ab,kw.
11 Health Status Disparities/ or Healthcare Disparities/ or exp "Social Determinants of Health"/
12 (health adj3 (disparit* or social determinant*)).ti,ab,kw.
13 or/8-12
14 exp United States/ or ("United States" or USA or "US").ti,ab,kw.
15 african americans/ or alaskan natives/ or american natives/ or asian americans/ or hispanic americans/ or mexican americans/ or exp ethnic groups/ or Medicaid/ or indigenous peoples/ or inuits/ or (American? or Alaskan natives or hispanic? or non-hispanic? or latino or Alabama or Alaska or Arizona or Arkansas or California or Colorado or Connecticut or Delaware or Florida or Georgia or Hawaii or Idaho or Illinois or Indiana or Iowa or Kansas or Kentucky or Louisiana or Maine or Maryland or Massachusetts or Michigan or Minnesota or Mississippi or Missouri or Montana or Nebraska or Nevada or New Hampshire or New Jersey or New Mexico or New York or North Carolina or North Dakota or Ohio or Oklahoma or Oregon or Pennsylvania or Rhode Island or South Carolina or South Dakota or Tennessee or Texas or Utah or Vermont or Virginia or Washington or West Virginia or Wisconsin or Wyoming or Appalachian or Atlanta or Chicago or District of Columbia or Philadelphia or New England or Boston or Los Angeles or San Francisco or San Diego or Miami or Minneapolis or Saint Paul or Detroit or Phoenix or New Orleans or Dallas or Houston or Seattle or Portland or Denver or Salt Lake City or Cincinnati or Cleveland or Pittsburgh or Medicaid).ti,ab,kw,ia.
16 14 or 15
17 7 and 13 and 16
18 limit 17 to english language
19 limit 18 to (editorial or guideline or lecture or legal case or legislation or letter or news or newspaper article or practice guideline or preprint)
20 18 not 19
21 exp "review"/ or exp overall/ or case reports/ or clinical conference/
22 20 not 21

Revised Search Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions(R) <1946 to November 3, 2022>

1 Birth Setting/ or Delivery, Obstetric/ or Labor, Obstetric/ or exp Labor Onset/ or Obstetrics/ or Parturition/ or Prenatal Care/ or Postpartum Period/ or Pregnancy/ or exp Pregnancy Complications/ or Pregnant Women/ or Pregnancy, High-Risk/ or (antenatal* or ante-natal* or antepartum or ante-partum or birth or birthing or intrapartum or intra-partum or obstetric* or parturition or parturient* or peripartum or peri-partum or postpartum or post-partum or pregnan* or prenatal* or pre-natal* or puerperium).ti,ab,kw.
2 Maternal Death/ or Maternal Health/ or Maternal Mortality/ or (maternal adj3 (adverse or comorbid* or complication* or death* or health or morbid* or mortalit* or outcome*)).ti,ab,kw
3 ((intrapartum or intra-partum or obstetric* or parturition or parturient* or peripartum or peri-partum or postpartum or post-partum or puerperal or puerperium) adj3 (adverse or comorbid* or complication* or death* or health or morbid* or mortalit* or outcome*)).ti,ab,kw.
4 (wom?n* adj3 (adverse or comorbid* or complication* or death* or health or morbid* or mortalit* or outcome*)).ti,ab,kw.
5 (birthing adj (people or person or persons) adj5 (death or mortalit* or morbidit* or complication* or health or outcome*)).ti,ab,kw.
6 or/2-5
7 1 and 6
8 quality assurance, health care/ or near miss, healthcare/ or health status indicators/ or apache/ or patient acuity/ or "severity of illness index"/ or early warning score/ or organ dysfunction scores/ or sickness impact profile/ or "outcome and process assessment, health care"/ or outcome assessment, health care/ or patient outcome assessment/ or treatment outcome/ or watchful waiting/ or process assessment, health care/ or risk/ or logistic models/ or Probability/ or Predictive Value of Tests/ or risk assessment/ or risk management/ or risk factors/ or uncertainty/ or forecasting/ or early diagnosis/ or "reproducibility of results"/ or Regression Analysis/ or Quality Improvement/ or Practice Patterns, Physicians'/
9 ("health status indicators" or "apache" or "patient acuity" or "quality improvement" or "outcome assessment" or "patient assessment" or "process assessment" or "reproducibility of results" or "early warning" or "organ dysfunction scores" or "watchful waiting" or "regression analysis" or regression model* or "correlation analysis" or "predictive value" or hazard model* or logistic regression or "near miss").ti,ab,kw.
10 (risk* adj3 (assess* or factor* or score* or model*)).ti,ab,kw.
11 Health Status Disparities/ or Healthcare Disparities/ or Race Factors/ or Racism/ or exp Socioeconomic Factors/ or exp "Social Determinants of Health"/
12 ((health adj3 (discriminat* or disparit* or social determinant*)) or sociodemographic* or socio-demographic* or socioeconomic* or socio-ecomonic* or racism).ti,ab,kw.
13 (ethnic* adj3 (differen* or discriminat* or disparit* or inequality or inequity or social determinant* or unequal)).ti,ab,kw.
14 ((racial or racist or race) adj3 (differen* or discriminat* or disparit* or inequality or inequity or social determinant* or unequal)).ti,ab,kw.
15 or/8-14
16 7 and 15
17 United States/ or African Americans/ or Alaskan Natives/ or American Natives/ or Asian Americans/ or exp Ethnic Groups/ or Hispanic Americans/ or Indians, North American/ or

Medicaid/ or Mexican Americans/ or ("United States" or USA or American* or Alaskan natives or Chicana* or Hispanic* or Nonhispanic* or Non-hispanic* or Latina* or Alabama or Alaska or Arizona or Arkansas or California or Colorado or Connecticut or Delaware or Florida or Georgia or Hawaii or Idaho or Illinois or Indiana or Iowa or Kansas or Kentucky or Louisiana or Maine or Maryland or Massachusetts or Michigan or Minnesota or Mississippi or Missouri or Montana or Nebraska or Nevada or New Hampshire or New Jersey or New Mexico or New York or North Carolina or North Dakota or Ohio or Oklahoma or Oregon or Pennsylvania or Rhode Island or South Carolina or South Dakota or Tennessee or Texas or Utah or Vermont or Virginia or Washington or West Virginia or Wisconsin or Wyoming or Appalachia* or Albuquerque or Anchorage or Atlanta or Austin or Baltimore or Billings or Baton Rouge or Boise or Boston or Birmingham or Charlotte or Cheyenne or Chicago or Cincinnati or Cleveland or Columbus or Dallas or Denver or Des Moines or Detroit or District of Columbia or Fargo or Houston or Honolulu or Indianapolis or Jacksonville or Lafayette or Las Vegas or Little Rock or Lexington or Los Angeles or Louisville or Miami or Milwaukee or Minneapolis or Nashville or New England or New Orleans or Newark or Omaha or Philadelphia or Phoenix or Pittsburgh or Portland or Providence or Richmond or Rochester or San Antonio or Salt Lake City or San Francisco or San Diego or Sacramento or Seattle or Sioux Falls or St Paul or Tampa or Wichita or Medicaid).ti,ab,kw.
18 16 and 17
19 limit 18 to english language
20 exp "review"/ or exp congress/ or case reports/ or clinical conference/ or (editorial or guideline or lecture or legal case or legislation or letter or news or newspaper article or practice guideline or preprint).mp.
21 19 not 20

Database - CINAHL Plus with Full Text
Interface - EBSCOhost Research Databases
Limiters - Research Article; Peer Reviewed; English Language; Exclude MEDLINE records; Geographic Subset: USA
Date of search: November 3, 2022

S1 (MH "Pregnancy+") OR (MH "Postnatal Period") OR (MH "Puerperium") OR (MH "Obstetric Care+") OR antenatal* or ante-natal* or antepartum or ante-partum or birth or birthing or intrapartum or intra-partum or obstetric* or parturition or parturient* or peripartum or peri-partum or postpartum or post-partum or pregnan* or prenatal* or pre-natal* or puerperium
S2 (MH "Maternal Mortality") OR maternal N3 adverse OR maternal N3 comorbid* OR maternal N3 complication OR maternal N3 death OR maternal N3 health OR maternal N3 morbidity OR maternal N3 mortality OR maternal N3 outcome*
S3(MH "Risk Assessment") OR (MH "Risk Factors") OR risk N3 factor* OR risk N3 assessment OR risk N3 score* OR risk N3 model*
S4 (MH "Social Determinants of Health") OR (MH "Quality Improvement+") OR (MH "Quality Assessment+") OR (MH "Healthcare Disparities") OR (MH "Health Status Disparities") OR (MH "Race Factors") OR (MH "Racism") OR (MH "Socioeconomic Factors+") OR quality

improvement OR outcome assessment OR process assessment OR "near miss" OR "reproducibility of results" OR "early warning" OR "organ dysfunction scores" OR "watchful waiting" OR "regression analysis" OR regression model* OR "correlation analysis" OR "predictive value" OR hazard model* OR logistic regression OR "social determinants of health" OR health N3 disparit* OR adverse N3 outcome* OR adverse N3 effect* OR race factors OR racism OR sociodemographic* OR socio-demographic* OR socioeconomic* OR socio-economic* OR racial N3 differences OR racial N3 discriminat* OR racial N3 disparit* OR racial N3 inequality OR racial N3 inequity OR racial N3 unequal OR ethnic* N3 differences OR ethnic* N3 discriminat* OR ethnic* N3 disparit* OR ethnic* N3 inequality OR ethnic* N3 inequity OR ethnic* N3 unequal
S5 S3 OR S5
S6 S1 AND S2 AND S5
6 4 or 5
7 3 and 6
8 (MH "Retrospective Design")
9 (MH "Prospective Studies+")
10 8 or 9
11 7 and 10

Web of Science SSCI Date of Search: August 22, 2021
TS=(postpartum) OR TS=(pregnan*) OR TS=(prenatal) OR TS=(obstetric*) OR TS=(peripartum) OR TS=("birth setting") OR TS=(postnatal) OR TS=("birth setting") OR TS=(parturition) OR TS=("labor onset") OR TS=("birthing centers") OR TS=(puerperal) OR TS=(antepartum) OR TS=(intrapartum) AND TS=(maternal NEAR/3 complications) OR TS=(maternal NEAR/3 health) OR TS=(maternal NEAR/3 morbidit*) OR TS=(maternal NEAR/3 mortalit*) OR TS=(maternal NEAR/3 outcome*) OR TS=(birthing NEAR/3 death) OR TS=(birthing NEAR/3 outcome) OR TS=(birthing NEAR/3 mortalit*) OR TS=(birthing NEAR/3 morbidit*) OR TS=(maternal NEAR/3 death*) OR TS=(postpartum NEAR/3 death*) OR TS=(postpartum NEAR/3 mortalit*) OR TS=(postpartum NEAR/3 morbidit*) OR TS=(postpartum NEAR/3 complication*) OR TS=(postpartum NEAR/3 outcome*) OR TS=(wom?n NEAR/3 mortalit*) OR TS=(wom?n NEAR/3 morbidit*) OR TS=(wom?n NEAR/3 outcome*) OR TS=(wom?n NEAR/3 complication*) **AND** TS=(risk NEAR/2 factor$) OR TS=(risk NEAR/2 assessment) OR TS=(risk NEAR/2 score$) OR TS=(risk NEAR/2 model*) OR TS=("quality improvement") OR TS=(process NEAR/3 assessment) OR TS=("near miss") OR TS=(outcome NEAR/3 assessment) OR TS=("health" NEAR/3 disparities) OR TS=(healthcare NEAR/3 disparities) OR TS=("social determinants of health") OR AB=(probability) OR AB= ("regression analysis") OR TS=("predictive value of tests") OR TS=("health status indicator$") OR TS=("early warning score") OR TS=("organ dysfunction score") OR TS=("sickness impact profile") OR TS=("logistic models") OR TS=(forecasting) OR TS=("quality improvement") OR TS=("reproducibility of results") OR TS=("watchful waiting") OR TS=("physicians practice patterns") OR TS=("early diagnosis") or TS=(health disparities) OR TS=(healthcare disparities) OR TS=("social determinants of health") OR TS=(racism) OR TS=(socioeconomic factors) OR TS=(race factors) OR TI=(racial differences) OR TI=(ethnic differences) and USA (Countries/Regions)

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Revised search Web of Science SSCI
November 3, 2022
TS=(maternal NEAR/3 complications) OR TS=(maternal NEAR/3 health) OR TS=(maternal NEAR/3 morbidit*) OR TS=(maternal NEAR/3 mortalit*) OR TS=(maternal NEAR/3 outcome*) OR TS=(birthing NEAR/3 death) OR TS=(birthing NEAR/3 outcome) OR TS=(birthing NEAR/3 mortalit*) OR TS=(birthing NEAR/3 morbidit*) OR TS=(maternal NEAR/3 death*) OR TS=(postpartum NEAR/3 death*) OR TS=(postpartum NEAR/3 mortalit*) OR TS=(postpartum NEAR/3 morbidit*) OR TS=(postpartum NEAR/3 complication*) OR TS=(postpartum NEAR/3 outcome*) OR TS=(wom?n NEAR/3 mortalit*) OR TS=(wom?n NEAR/3 morbidit*) OR TS=(wom?n NEAR/3 outcome*) OR TS=(wom?n NEAR/3 complication*) AND TS=(postpartum) OR TS=(pregnan*) OR TS=(prenatal) OR TS=(obstetric*) OR TS=(peripartum) OR TS=("birth setting") OR TS=(postnatal) OR TS=("birth setting") OR TS=(parturition) OR TS=("labor onset") OR TS=("birthing centers") OR TS=(puerperal) AND TS=(risk NEAR/2 factor$) OR TS=(risk NEAR/2 assessment) OR TS=(risk NEAR/2 score$) OR TS=(risk NEAR/2 model*) OR TS=("quality improvement") OR TS=(process NEAR/3 assessment) OR TS=("near miss") OR TS=(outcome NEAR/3 assessment) OR TS=("health" NEAR/3 disparities) OR TS=(healthcare NEAR/3 disparities) OR TS=("social determinants of health") OR AB=(probability) OR AB= ("regression analysis") OR TS=("predictive value of tests") OR TS=("health status indicator$") OR TS=("early warning score") OR TS=("organ dysfunction score") OR TS=("sickness impact profile") OR TS=("logistic models") OR TS=(forecasting) OR TS=("quality improvement") OR TS=("reproducibility of results") OR TS=("watchful waiting") OR TS=("physicians practice patterns") OR TS=("early diagnosis") OR TS=(health disparities) OR TS (healthcare disparities) OR TS=("social determinants of health")
Refined by: document types: (article) and countries/regions: (usa) and web of science index: (wos.ssci) and languages: (english)

Appendix B. Studies Excluded at Full Text

P= Population
E=Exposure
O=Outcome
T=Timing
S= Study Type
OT=Other Reasons
D= Duplicate

1. Aaron E, Bonacquisti A, Geller PA, et al. Perinatal Depression and Anxiety in Women with and without Human Immunodeficiency Virus Infection. Womens Health Issues. 2015 Sep-Oct;25(5):579-85. doi: 10.1016/j.whi.2015.04.003. PMID: 26093677. E

2. Abdou CM, Dunkel Schetter C, Campos B, et al. Communalism predicts prenatal affect, stress, and physiology better than ethnicity and socioeconomic status. Cultur Divers Ethnic Minor Psychol. 2010 Jul;16(3):395-403. doi: 10.1037/a0019808. PMID: 20658883. O

3. Admon LK, Winkelman TNA, Moniz MH, et al. Disparities in Chronic Conditions Among Women Hospitalized for Delivery in the United States, 2005-2014. Obstet Gynecol. 2017 Dec;130(6):1319-26. doi: 10.1097/AOG.0000000000002357. PMID: 29112666. E

4. Adynski H, Zimmer C, Thorp J, Jr., et al. Predictors of psychological distress in low-income mothers over the first postpartum year. Res Nurs Health. 2019 Jun;42(3):205-16. doi: 10.1002/nur.21943. PMID: 30888077. T

5. Afana M, Brinjikji W, Kao D, et al. Characteristics and In-Hospital Outcomes of Peripartum Cardiomyopathy Diagnosed During Delivery in the United States From the Nationwide Inpatient Sample (NIS) Database. J Card Fail. 2016 Jul;22(7):512-9. doi: 10.1016/j.cardfail.2016.02.008. PMID: 26923643. S

6. Agunwamba AA, Finney Rutten LJ, St Sauver JL, et al. Higher Rates of Cesarean Sections Found in Somali Immigrant Women in Minnesota. J Racial Ethn Health Disparities. 2021 Jul 26. doi: 10.1007/s40615-021-01113-5. PMID: 34309817. O

7. Ahmadzia HK, Khorrami N, Carter JA, et al. Impact of human immunodeficiency virus, malaria, and tuberculosis on adverse pregnancy outcomes in the United States. J Perinatol. 2020 Feb;40(2):240-7. doi: 10.1038/s41372-019-0512-9. PMID: 31591488. E

8. Aitken ME, Warden CR, Critchlow CW. The effect of health maintenance organization vs commercial insurance status on obstetrical management and outcome. Arch Pediatr Adolesc Med. 1997 Nov;151(11):1104-8. doi: 10.1001/archpedi.1997.02170480034005. PMID: 9369871. E

9. Akinbode TD, Pedersen C, Lara-Cinisomo S. The Price of Pre-adolescent Abuse: Effects of Sexual Abuse on Perinatal Depression and Anxiety. Matern Child Health J. 2021 Jul;25(7):1083-93. doi: 10.1007/s10995-020-03088-x. PMID: 33206305. O

10. Akobirshoev I, Mitra M, Parish SL, et al. Racial and Ethnic Disparities in Birth Outcomes and Labor and Delivery Charges Among Massachusetts Women With Intellectual and Developmental Disabilities. Intellect Dev Disabil. 2020 Apr;58(2):126-38. doi: 10.1352/1934-9556-58.2.126. PMID: 32240049. O

11. Alhusen JL, Frohman N, Purcell G. Intimate partner violence and suicidal ideation in pregnant women. Arch Womens Ment Health. 2015 Aug;18(4):573-8. doi: 10.1007/s00737-015-0515-2. PMID: 25753680. OT

12. Alrahmani L, Abdelsattar ZM, Adekola H, et al. Risk-profiles and outcomes of multi-foetal pregnancies in adolescent mothers. J Obstet Gynaecol. 2016 Nov;36(8):1056-60. doi: 10.1080/01443615.2016.1196477. PMID: 27624001. E

13. Altman MR, Oseguera T, McLemore MR, et al. Information and power: Women of color's experiences interacting with health care providers in pregnancy and birth. Soc Sci Med. 2019 Oct;238:112491. doi: 10.1016/j.socscimed.2019.112491. PMID: 31434029. OT

14. Anand KJS, Rigdon J, Rovnaghi CR, et al. Measuring socioeconomic adversity in early life. Acta Paediatr. 2019 Jul;108(7):1267-77. doi: 10.1111/apa.14715. PMID: 30614554. OT

15. Anderson BA, Marshak HH, Hebbeler DL. Identifying intimate partner violence at entry to prenatal care: clustering routine clinical information. J Midwifery Womens Health. 2002 Sep-Oct;47(5):353-9. doi: 10.1016/s1526-9523(02)00273-8. PMID: 12361347. E

16. Andrikopoulou M, Madden N, Wen T, et al. Symptoms and Critical Illness Among Obstetric Patients With Coronavirus Disease 2019 (COVID-19) Infection. Obstet Gynecol. 2020 Aug;136(2):291-9. doi: 10.1097/AOG.0000000000003996. PMID: 32459701. E

17. Andriotti T, Ranjit A, Hamlin L, et al. Psychiatric Conditions During Pregnancy and Postpartum in a Universally Insured American Population. Mil Med. 2021 Apr 21. doi: 10.1093/milmed/usab154. PMID: 33881522. E

18. Arab K, Spence AR, Czuzoj-Shulman N, et al. Pregnancy outcomes in HIV-positive women: a retrospective cohort study. Arch Gynecol Obstet. 2017 Mar;295(3):599-606. doi: 10.1007/s00404-016-4271-y. PMID: 28097445. E

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20. Attanasio L, Kozhimannil KB. Relationship Between Hospital-Level Percentage of Midwife-Attended Births and Obstetric Procedure Utilization. J Midwifery Womens Health. 2018 Jan;63(1):14-22. doi: 10.1111/jmwh.12702. PMID: 29144586. E

21. Avalos LA, Nance N, Iturralde E, et al. Racial-Ethnic Differences in Treatment Initiation for New Diagnoses of Perinatal Depression. Psychiatr Serv. 2022. doi: 10.1176/appi.ps.20220173. PMID: 36226373. S

22. Aziz A, Gyamfi-Bannerman C, Siddiq Z, et al. Maternal outcomes by race during postpartum readmissions. Am J Obstet Gynecol. 2019 May;220(5):484 e1- e10. doi: 10.1016/j.ajog.2019.02.016. PMID: 30786255. E

23. Badreldin N, Grobman WA, Yee LM. Racial Disparities in Postpartum Pain Management. Obstet Gynecol. 2019 Dec;134(6):1147-53. doi: 10.1097/AOG.0000000000003561. PMID: 31764723. E

24. Baer RJ, Altman MR, Oltman SP, et al. Maternal factors influencing late entry into prenatal care: a stratified analysis by race or ethnicity and insurance status. J Matern Fetal Neonatal Med. 2019 Oct;32(20):3336-42. doi: 10.1080/14767058.2018.1463366. PMID: 29631462. O

25. Baghlaf H, Spence AR, Czuzoj-Shulman N, et al. Pregnancy outcomes among women with asthma. J Matern Fetal Neonatal Med. 2019 Apr;32(8):1325-31. doi: 10.1080/14767058.2017.1404982. PMID: 29166819. E

26. Bajema KL, Stankiewicz Karita HC, Tenforde MW, et al. Maternal Hepatitis B Infection and Pregnancy Outcomes in the United States: A Population-Based Cohort Study. Open Forum Infect Dis. 2018 Jun;5(6):ofy134. doi: 10.1093/ofid/ofy134. PMID: 29992174. E

27. Balayla J, Lasry A, Badeghiesh A, et al. Mode of delivery is an independent risk factor for maternal mortality: a case-control study. J Matern Fetal Neonatal Med. 2022 May;35(10):1962-8. doi: 10.1080/14767058.2020.1774874. PMID: 32498579. E

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29. Bartlett LA, Berg CJ, Shulman HB, et al. Risk factors for legal induced abortion-related mortality in the United States. Obstet Gynecol. 2004 Apr;103(4):729-37. doi: 10.1097/01.AOG.0000116260.81570.60. PMID: 15051566. E

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42. Blakeney EL, Herting JR, Bekemeier B, et al. Social determinants of health and disparities in prenatal care utilization during the Great Recession period 2005-2010. BMC Pregnancy Childbirth. 2019 Oct 29;19(1):390. doi: 10.1186/s12884-019-2486-1. PMID: 31664939. O

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Appendix C. Evidence Tables

Table C-1. Evidence table for risk factor studies for Key Question 1

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
O'Mahen 2011[1] Midwest KQ1 21451350	498; Questionnaire given at 4 midwestern OBGYN clinics	Black and white low-income inner-city women	Depression status (EPDS); secrecy, (LSCS) and race	Antenatal depression (EPDS); stigma (LSCS) Depression secrecy and depression were uncorrelated for Black women	Socioeconomic and depression status	Antenatal	Comorbidities
Ojukwu 2021[2] South FL KQ1 33593501	143; Retrospective secondary data analysis patient's medical files	Black women w/ HIV	Race/Ethnicity, HIV	Depressive symptoms (HC provider notes in EHD) Low income, exposure to intimate partner violence, childcare burden had negative impact	Age, income, and adequacy of prenatal care utilization (A-PNCU index) IPV/Abuse; childcare burden (self-reports and/or HC provider assessments)	Peripartum, delivery, and 1 year postpartum	Comorbidities
Keenan-Devlin 2017[3] Illinois KQ1 28384838	152; Survey data of household income, placenta collection at delivery, & postpartum chart review (SIPS, SPAH studies)	Enrolled in two prenatal clinics in associated with Northwestern in Chicago, IL, >18 age, <26 weeks gestation at enrollment	Maternal household income (survey)	Chronic placental inflammation Lower income associated with chronic placental inflammation	Race, BMI, employed, education, income, marital status, preterm delivery, preeclampsia, cesarean delivery	Delivery	SES

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Molina 2011[4] Washington D.C KQ1 21565525	1,044 Recruited from community based prenatal care clinics	Black urban, high risk pregnant women	Socioeconomic (Education, employment status, public assistance. WIC, food stamps, (phone interview); IPV (CTS2), coping resources (NMRS)	Depressive symptoms (HSCL) Lower income associated with chronic placental inflammation	Substance abuse, independent dichotomous variables	Pregnancy	SES
Kern-Goldberger 2020[5] KQ1 33317357	10,344; Medical records from Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Maternal–Fetal Medicine Units (MFMU) cesarean registry Retrospective nested cohort study	Women undergoing cesarean delivery	Education level (self-reported from medical records)	Cesarean complications including hysterectomy, uterine atony, blood transfusion, surgical injury, arterial ligation, infection, wound complication (medical records) Lower education associated with higher complications	Age, pre-pregnancy BMI, married, race/ethnicity, smoking, substance use, diabetes, asthma, hypertension, heart disease	Delivery	SES

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Tannis 2018[6] New York KQ1 31762934	379; Served by LSA Family Health Service Maternal Outreach program Retrospective chart review	East Harlem Maternal Outreach Program January 2015-December 2017	Low education, food insecurity, income, housing quality, neighborhood safety	Preeclampsia No association with SES exposures	Race/ethnicity, type of LSA service received	Psychosocial risk factors at program intake with preeclampsia during pregnancy	SES
Moore 2021[7] Alabama KQ1 34115529	32,761; Medicaid delivery claims	AL Medicaid maternity population w/ HDP diagnosis	Insurance coverage, race/ethnicity	Hypertensive disorders (ICD-9 and ICD-10 code)	Clinical comorbidities, care utilization, preconception insurance	Prenatal - postpartum	SES
Meeker 2021[8] Pennsylvania KQ1 33831923	64,334; Medical records data Retrospective cohort study	All pregnancies delivered in the University of Pennsylvania Health System, 2010 and 2017	Individual-level & neighborhood-level risk factors	SMM (ICD-9 & 10 codes) Neighborhood crime not associated; Black associated with increased SMM	Neighborhood-level covariates: poverty rate, owner-renter ratios, median family income, % of women in labor force, % of women receiving public assistance, % of women graduated high school (US Census, Open Data Philly); individual covariates: BMI, age, marital status, neonatal outcomes	Delivery	SES

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Sheen 2019[9] Bronx, New York KQ1 30627950	100 matched pairs; Administrative data and chart review	Deliveries nationwide	Race/ethnicity Interaction effect between maternal age and marital status	Postpartum emergency department visit	Univariate and multivariable analyses, age, marital status, primiparous, insurance,	Within 42 days of delivery	SES
Carland 2022[10] California KQ1 35819577	206, Hospital electronic medical records	Lower- and upper-income neighborhoods	Household income level based on neighborhood (US Census Data)	Intrapartum or postpartum cardiac events (pulmonary edema, chest pain, hypotension, arrythmia, heart failure, thrombotic events, hypoxia, myocardial infarction, spontaneous coronary artery dissection, aortic dissection, and cerebral vascular accident) There was no significant difference in the rates of intrapartum cardiac events, postpartum cardiac events	Race, insurance type, gravida, parity, cardiac diagnoses, comorbidities, late initiation of prenatal care, limited prenatal care	Delivery	SES

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Cooper 2022[11] Connecticut KQ1 158722082	70, Hospital study questionnaire, electronic medical records	Women who delivered term infants and had prenatal care at resident clinics in hospital system	U.S. Household Food Security Survey Module (US HFSSM)	GDM (electronic medical records) More patients in food insecure households, were diagnosed with GDM, compared with food secure households	Age, BMI, race delivery site, multiparity, mode of delivery	1 day postpartum	SES
Coonrod 2004[12] Arizona KQ1 14976790	1,172; Chart review by surveyor and patient survey Cross-sectional study	Women who delivered at a public hospital serving the indignant in Phoenix, AZ with a gestational age >20 weeks in 1995-1996	Acculturation (modified Cuellar scale: self-identity, ethnic identity of parents, language spoken)	Hyperemesis, pregnancy - induced hypertension, diabetes, third-trimester bleeding, pyelonephritis (medical records), Greater prevalence of pregnancy induced hypertension and diabetes in high acculturation Hispanics compared to low acculturation Hispanics, with non-Hispanic whites having higher risk of all than both Hispanic groups	Age, race, marital status, estimated gestational age, prenatal care & date initiated, substance use, domestic violence & sexual abuse (AAS)	Pregnancy	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Vilda 2019[13] Nationwide KQ1 31517017	Race-specific 5-year pregnancy-related mortality for all 50 states & DC derived from annual mortality and natality files, data provided by the NCHS Ecological study	Non-Hispanic black and non-Hispanic white women delivered 2011-2015 (death & live birth records)	State-level income inequality (Gini coefficient)	Pregnancy-related mortality (ICD-10 code) Income inequality associated with a 14% increase in excess risk of death for black women relative to white	5-year average of state-level median income, percentage of black population, percentage of college graduates, percent unemployed	<1 year postpartum	Identity and Discrimination
Christian 2012[14] Ohio KQ1 22940537	56; Survey data	Women recruited from prenatal clinic Ohio	Racial differences (EOD Scale; STAI; CES-D; PSS; PSQI; NUPDQ)	Epstein-Barr virus reactivation (lab tests) Compared White women, African-American women showed higher levels of EBV VCA IgG antibody titers. The observed effect was more pronounced among African American women reporting higher levels of racial discrimination.	Stress and health behaviors	1st, 2nd, and 3rd trimesters and at 4–9 weeks postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Creanga 2012[15] Nationwide KQ1 22825083	7,487; Pregnancy Mortality Surveillance System (CDC).	U.S. and foreign-born women pregnancy related deaths	Race/ethnicity; nativity	Mortality With the exception of foreign-born white women, all other racial/ethnic/nativity groups had higher risk of pregnancy related mortality than U.S.-born white women	Unclear	<1 year postpartum	Identity and Discrimination
Mpofu 2020[16] 30 states KQ1 31393215	137,181; PRAMS	Non-Hispanic Blacks, non-Hispanic white, and Hispanic women w/ a recent live birth	Race/ethnicity insurance status	Excess heart age (cardiovascular risk based on presence or absence of CVD risk factors) Non-Hispanic Black women had higher prevalence of excess heart age compared to non-Hispanic white women and Hispanic women; excess heart age prevalence was highest among women without health insurance	Age, education level, PIR, Pre-pregnancy health insurance, pre-pregnancy BMI, substance use	Preconception, prenatal and delivery data collected	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Rich-Edwards 2006[17] Nationwide KQ1 16476752	1662; participants in Project Viva, prospective, cohort study	Participants who delivered a live infant	Race/ethnicity, age, finances, and partnership status	Antenatal and postpartum depressive symptoms (EPDS) Black and Hispanic mothers experienced higher prevalence of symptoms of depression than non-Hispanic White mothers; Taking into account financial hardship, unwanted pregnancy, history of depression, and poor pregnancy outcomes, minority mothers had the same risk of antenatal and postpartum depressions symptoms as white mothers.	Parity or delivery of LBW; secondary analysis history of depression	Antenatal - 6 months postpartum	Identity and Discrimination
Rosenberg 2006[18] Illinois KQ1 16023371	246 maternal deaths and 76,627 high risk survivors; IL vital records data	High risk pregnant women—both deaths and survivors in Illinois	Medical factors and labor/delivery complications to assess the disparity between black and white women	Maternal mortality (PMSS)	unclear; models adding parity and entry into prenatal care were assessed with the linked deaths only	Within 90 days of pregnancy or 1 year postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Shen 2010[19] Nationwide KQ1 20178180	877,579; NIS, cross-sectional	Women who delivered in a hospital	Race/ethnicity interactive effects of race and Medicaid/uninsured	Depression at admission delivery (ICD-CM-9 code) African American, Hispanic, and women of other races were found to have lower odds of depression before delivery than white women. Interaction effects between race/ethnicity and insurance status.	Patients' demographics, health insurance status, income level, and hospital characteristics	Delivery	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Rosenthal L New York City 2015[20] KQ1 24922166	1233; Data derived from RCT, medical records, survey interviews	Black and Latina socioeconomically disadvantaged young women	Discrimination (Everyday Discrimination Scale 10-item, social support: MPSS-12 item; Race, Nativity, Socioeconomic Status (interviews, self-reported)	Pre/postpartum mental health-depression (CESDS), anxiety (GAD-7) Among Black and Latina women, changes in reported discrimination predicted changes in symptoms of depression and anxiety at future time points. Discrimination strongly predicted anxiety among participants reporting food insecurity.	Race, highest grade completed, born outside US, food insecurity, in a relationship	<1 year postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Howland 2019[21] New York City KQ1 30712089	588,232; Hospital deliveries, NYC birth certificates matched with hospital discharge records for maternal deliveries	Delivery hospitalizations	Race/ethnicity, socioeconomic factors income (Medicaid Status), education, neighborhood poverty (American Community Survey 2011-2013)	SMM composite (defined by CDC algorithm) Race/ethnicity was associated with SMM with greater risk among low-income Latinas and Asian-Pacific Islanders compared to white non-Latinas; additionally living in the poorest neighborhoods increased SMM risk for black non-Latinas and Latinas.	Maternal education, age, birthplace, and income in the adjusted analysis.	Delivery	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Shour 2021[22] Wisconsin KQ1 33819399	125,581; Wisconsin PRAMS	2,609 women who responded to PRAMS within 12 months of giving birth (deliveries between 2016-2017	Racial Bias IPV 12 months before pregnancy (self-reported yes/no)	Postpartum depression (self-reported) Non-Hispanic Black women had higher odds of racial bias exposure than other racial/ethnic groups. After adjusting for socioeconomic position no association between racial bias and postpartum depression.	Adjusting for confounders in 6 models—socioeconomic position, psychosocial factors, health risk behaviors, health care access, stress/obesity, and disease conditions.	<1 year postpartum	Identity and Discrimination
Boakye 2021[23] Boston KQ1 33563008	2697; non-Hispanic black women Boston Birth Cohort 1998-2016	Non-Hispanic black women	Race, nativity country of birth/length of time in US	Preeclampsia and CVD risk factors (medical records) Prevalence of preeclampsia and other cardiovascular disease was higher in US-born non-Hispanic Black women compared to foreign-born non-Hispanic Black women	Maternal age, hypertension, parity, BMI, diabetes, education, smoking, and general stress	Delivery	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Guendelman 2005[24] California KQ1 16257944	862,723; Hospital discharge and birth certificate data for 1996–1998	Mexican-born and US-born, non-Latina women residing in CA	Nativity, social profile (age, parity, education, economic status), access to health care services	Obstetric complications (ICD-9 codes) Mexican-born women were significantly less likely to have 1 or more maternal morbidities than White, non-Latina women. Mexican-born women were more likely to have complications that reflect the quality of intrapartum care.	Maternal age, parity, education, prenatal care initiation, payment source, hospital quality of care	Labor and delivery	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Guendelman 2006[25] California KQ1 170522821	628,281; Hospital discharge and birth certificate data for 1996-1998	Mexican-American and Mexican born women.	Nativity, social profile (age, parity, education, economic status), access to health care services	Maternal morbidity and obstetric complications Mexican-born women had lower odds of maternal morbidity than Mexican American women. Mexican-born women had higher odds of postpartum hemorrhage, lacerations and major puerperal infections than Mexican-American women	Maternal age, parity, education, prenatal care initiation, payment source, hospital quality of care	Labor and delivery	Identity and Discrimination
Chasan-Taber 2020[26] Massachusetts KQ 1 31203485	1426; Survey data assessed early, mid, and late pregnancy Prospective cohort	Women born in PR or DR, parent born in PR or DR or have 2 grandparents born in PR or DR, <20 weeks gestation at time of enrollment in Proyecto Buena Salud	Acculturation (PAS, language preference, & generation in US)	Stress (Cohen's 14-item PSS) Higher levels of bicultural acculturation were associated with lower level of stress in overall pregnancy among Latina women.	Age, marital status, education, number of adults in household, number of children in household, health insurance, household income, living with partner, behavioral factors, medical history	Pregnancy	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Premkumar 2020[27] Nationwide KQ1 31923068	10,038; Secondary analysis of data from the nuMoM2b study that included 3 interviews during pregnancy and 1 at delivery Prospective observational cohort study	Women were enrolled in nuMoM2b after sonographic confirmation of viable, singleton birth between 6-13 weeks at 8 academic health centers in the US	Acculturation is defined by birthplace (US versus non-US), language used during study visits (English or Spanish), and self-rated English proficiency.	Preeclampsia, gestational hypertension, GDM, neonatal outcomes (medical records) Acculturation was associated with higher odds of preeclampsia or eclampsia, preeclampsia without severe features, and gestational hypertension with no significant differences found between self-reported race or ethnicity	Age, gravidity, poverty (FPL), race or ethnicity, education, insurance, pregestational diabetes, smoking, chronic hypertension, obesity	Pregnancy-delivery	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Beck 2005[28] Connecticut, Texas KQ1 16132006	377 (phase 1), 150(phase 2); Secondary analysis of data collected to assess the psychometrics of the PDSS	Hispanic women, phase 1: ~10 weeks post-delivery, phase 2: 1 month postpartum in CT & TX	Acculturation (SAS)	Postpartum depression (DSM-IV, PDSS) Puerto Rican descent and caesarean delivery were predictors of postpartum depression in Hispanic mothers. Single marital status was also a risk factor for postpartum depression	Hispanic subgroup, marital status, delivery type, infant feeding method, age, education	<1 month postpartum	Identity and Discrimination
Alhasanat-Khalil 2019[29] Michigan KQ1 30456725	115; Interview data Cross-sectional study	Postpartum immigrant women of Arabic descent, age 18-45, immigrated to US >age 14, enrolled in WIC clinic in MI	Acculturation (AArC, AAmC)	Postpartum depression (EDPS) Arabic women with higher marginalization reported higher levels of PPD. Higher education, and antenatal anxiety were also correlated with PPD symptoms.	Age, age at time of immigration to US, length of US residence, months PP, number of children, language preferred, country of origin, married, unemployed, WIC services received, health insurance, gravida	<12 months postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Sanchez 2020[30] California KQ1 31021137	159; In-clinic and in-home survey data Prospective longitudinal study	Pregnant women of Mexican descent, recruited early in pregnancy care from community clinics in Southern CA	Acculturation (ARSMA-II)	Postpartum depression (CESDS), perceived stress (PSS), acculturative stress (SAFE), perceived discrimination (DSS)	Age, education, language, birthplace, gravidity, employment status, income, marital status	Pregnancy- ~4 weeks postpartum	Identity and Discrimination
Ponting 2020[31] California, Illinois, Washington, DC, Maryland, North Carolina KQ1 32105108	537; Secondary analysis of interview data collected by CCHN	Low-income U.S.-born and foreign-born Latina mothers residing in US >6 months, 18-40	Contextual & cultural stressors: poverty (US Census Bureau WAPT, FPL) , domestic violence (HITS), discrimination (EDS)	Postpartum depression Discrimination and domestic violence predicted higher depressive symptoms. Poverty not associated with depression.	Age, education, negative life events (life events checklist), marital status	1,6,12 months postpartum	Identity and Discrimination
Segre 2021[32] Iowa KQ1 33637396	3,032; Data collected via telephone interview and medical records	Pregnant woman from Iowa between 2013 and 2015, who perceived discrimination	Perceived racial discrimination	Stress domains on depressed mood (PRAMS) Participants that experienced racial discrimination had higher odds of experiencing a depressed mood.	Race, ethnicity, age, education, poverty level, marital status, medical indication of depression	1 year before birth and mother's lifetime	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Weeks 2022[33] 7 states KQ1 34967671	12,587; PRAMS	Delivered live infant, excluding white women, from 2012-2015 in Iowa, Louisiana, Minnesota, New York City, North Carolina, Ohio, Utah, Virginia, Wisconsin	Racial discrimination experienced within 12 months of giving birth, educational attainment (self-reported, PRAMS)	Postpartum depressive symptoms (self-reported, PRAMS) Women who reported experiencing racial discrimination also reported a much higher prevalence of PPDS compared with those who did not	Maternal education, smoking in last 3 months of pregnancy, marital status, prenatal care adequacy, parity, birth payer, prepregnancy BMI, household poverty level	2-6 months postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Fox 2021[34] California KQ1 WOS:000720732900001	361; Questionnaire data in Wave 1 of the Mothers' Cultural Experiences (MCE) study.	Latina pregnant and postpartum women	Acculturation (ARSMA-II), cultural values (MACVS), mental Health (EDPS), discrimination (PEDQ-CV)	Stress (PSS), anxiety (STAI), depression (EDPS), happiness (OHQ) American and Latino cultural values systems had opposite relationships with depression, with the latter protective and also positively associated with happiness. Social adversity and cultural identity and values influence maternal psychology	SES, relationship status, age, pregnant vs postpartum	Pregnant up to 1 year postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Erickson 2022[35] 8 states KQ1 35312992	5763; Secondary analysis of nuMoM2b dataset	Racially, ethnically, and geographically diverse group with singleton pregnancies affiliated with 8 clinical research centers	Patterns of SDOH Grouped by 6 domains of SDOH: sociodemographic, psychological, behavioral, individual-level social relationships & living conditions, and neighborhoods & communities	Postpartum maternal morbidity composite score Latent class analysis of six groups. Groups with the highest odds of maternal morbidity consisted of participants of the lowest income and highest stress, and those that lived in the United States the shortest amount of time.	Mode of labor, spontaneous labor, dilation on admission, closed cervix, hypertensive disorder, mode of birth, BMI, unplanned cesarean birth, healthy eating index score, exercise, age	<14 days postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Bossick 2022[36] 11 states + New York City KQ1 35504987	632,287; PRAMS	Other Asian, Black, American Indian, Chinese, Japanese, Filipino, Hawaiian, Other Non-white, Alaskan Native, or Mixed race	Experiences of emotional upset due to racism (EUR)(PRAMS question)	PPD (PHQ-2) Experiences of EUR are associated with an increased prevalence of PPD symptoms	Age, education, timely prenatal care, total stressors during pregnancy (i.e., having someone close die, drugs, partner or self in jail, couldn't pay bills, partner didn't want pregnancy, arguing, stress apart from partner separate from work-related, partner or self-reduction in work or pay, the birthing person lost job, partner lost employment, homeless, moved, divorced, family member ill)., method of payment, pre-pregnancy depression diagnosis	12 weeks postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Toledo-Corral 2022[37] California KQ1 156746925	442; MADRES study	US-born Hispanic, Black women, Hispanic immigrants	Race, country of birth and years living in the USA combine	Depressive symptomatology, perceived stress (CES-D) Black women had higher perceived stress and higher odds of probable depression.	Age, self-reported pre-pregnancy weight and height, gestational age, parity, preferred language, employment status, marital status, education level, household income	1st study visit occurs at 28-36 weeks, followed by 2 visits prior to delivery	Identity and Discrimination
Shah 2022[38] Massachusetts KQ1 35734520	6088; Boston birth cohort	Non-Hispanic Black, Hispanic, non-Hispanic White	Race/ethnicity, nativity/duration of US residency	GDM (electronic medical records) foreign-born NHB women with a duration of US residence of < 10 years had higher odds of having GDM compared with their US-born counterparts, whereas foreign-born Hispanic women with a duration of US residence of < 10 years had lower odds of having GDM	Marital status, maternal age at delivery, education, self-reported perceived stress, comorbidities	24-72 hours postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Harper 2003[39] North Carolina KQ1 12907099	118; Pregnancy-related deaths Population-based, case-control study	Pregnancy-related deaths in North Carolina from 1992–1998 (ICD-9 codes 630-676)	Maternity care coordination services, WIC enrollment, Care in public health department, Cesarean, prenatal care receipt, prenatal care adequacy	Pregnancy-related death No association with maternity care coordination, WIC, income, education	Medical risk factors, age, labor & delivery complications, income (by zip code) derived from birth certificate	Postpartum	Healthcare use
Mayne 2018[40] Illinois KQ1 29305526	34,383; EHR data from Northwestern Medicine Enterprise Data Warehouse Cross-sectional analysis	Women delivery singleton births at Northwestern Prentice Women's Hospital in Chicago, IL 2008-2013	Neighborhood crime rates via residential addresses & crime data (City of Chicago's Data Portal)	Hypertensive disorders Negative physical environment traits increase in hypertensive disorders	Race/ethnicity, insurance status, multiparity, medical history, substance use, neighborhood poverty (census tract)	Delivery	Structural/ Institutional Factors
Mayne 2019[41] Illinois KQ1 31728900	14,309; EHR data from Northwestern Medicine Enterprise Data Warehouse Cross-sectional analysis	Women delivery singleton births at Northwestern Prentice Women's Hospital in Chicago, IL 2015-2017	Neighborhood physical disorder (trained raters in Google Street View) on randomly selected blocks in each Chicago census tract (809) (Trash, abandoned car, graffiti, building condition, etc)	HDP Crime associated with high risk of hypertensive disorders of pregnancy	Women delivery singleton births at Northwestern Prentice Women's Hospital in Chicago, IL	Delivery	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Wallace 2021[42] Louisiana KQ1 33069560	125, 537; Data provided by the March of Dimes Retrospective analytic cohort	Deaths were verified as pregnancy-associated (death during pregnancy or up to 1 year postpartum from any cause) if a death record linked to a live birth or fetal death within 1 year and/or via the death record.	Maternity care deserts (counties with no hospitals offering obstetric care and no OB/GYN or certified nurse midwife providers)	Maternal mortality (ICD-10) Risk of death higher among women residing in maternity care deserts	Age, race/ethnicity, education	Pregnancy-1 year postpartum	Structural/ Institutional Factors
Vinikoor-Imler 2011[43] North Carolina KQ1 21920650	38,915; Birth records from North Carolina State Center for Vital Statistics Cohort study	Women residing in neighborhoods of low SES in 4 central NC counties 2001-2005	Observed street-level data (5 neighborhood indices: Physical incivilities, social spaces, walkability, borders, arterial features), Race	Pregnancy-induced hypertension/ eclampsia, weight gain, neonatal outcomes, pregnancy related behaviors Walkability decreased risk for pregnancy-related hypertension	Age, education, marital status, number of previous pregnancies	Delivery	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Dyer 2021[44] Louisiana KQ1 34148221	125,537; Vital records from Louisiana Department of Health Retrospective analytic cohort	Verified pregnancy associated death + all live births to living women in LA, 2016-2017	Household income as a proxy of structural racism (ICE tertials)	Pregnancy-associated death (death records with additional review & verification by Bureau of Family Health Regional Maternal and Child Health Coordinators) Racial segregation Associated with increased risk for pregnancy-associated death	Age, education, race, urbanicity	<1 year postpartum	Structural/ Institutional Factors
Zhang 2021[45] New York KQ1 34481472	8,949; EHR data Retrospective observational study	Women who had a live delivery at an urban academic medical center in NY from 2015-2017	Built environment factors: accessibility to public transportation (ArcGIS 10.6), exposure to traffic (NYBPM, VKT), land use (LUM, RetFar), air pollution (LUR), patterns of prenatal care (EHR)	Postpartum depression (SNOMED) Walkable communities associated with lower risk of PPD	Age, pregnancy-BMI, gestational week, race, marital status, cesarean, insurance type	<1 year postpartum	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Banner 2021[46] Illinois KQ1 32120416	191,947; Birth certificate data geo mapped by census tract Retrospective cohort study	Women living in Chicago, IL 2010-2014	Food deserts (USDA Food Access Research Atlas)	GDM, preeclampsia, chorioamnionitis, cesarean delivery, neonatal outcomes (medical records) Residing in a food desert did not explain poorer health outcome	Age, obesity, race, prenatal care, Medicaid funding for prenatal care, WIC enrollment, nulliparous, gestational age at delivery, preterm birth, mode of delivery	Delivery	Structural/ Institutional Factors
Bernet 2020[47] Florida KQ1 31943403	FLHealthCharts delivery data by county	67 FL counties	Public health spending (Maternal Health & Improved Pregnancy Outcomes, Healthy Start, WIC) (FDOH)	Maternal mortality (ICD-10 codes) Each 10% increase in pregnancy-related public health expenditures was associated with a 13% decline in MMR among blacks and a 20% reduction in black-white disparities	Race	Delivery to 1 year postpartum	Structural/ Institutional Factors
Mayne 2018[40] Illinois KQ1 30010764	4748 births in non-Hispanic black women in Chicago, IL	non-Hispanic black women in Chicago, IL giving birth at Prentice Women's Hospital	Residential segregation	HDP Racial residential segregation increases hypertensive disorders of pregnancy	Age, insurance status, poverty, multiparity, smoking, pre/gest diabetes, chronic hypertension	Delivery	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Chatterji, P. 2012[48] National KQ1 22813939	3,350; Data collected via interview and administrative records	Adult parents, either biological or adoptive, working part or full-time during pregnancy, and who returned to part or full-time work at 9 months interview	Maternity leave (ECLS-B)	Depression (CES-D) Less than 12 weeks of maternal leave and having less than 8 weeks of paid maternal leave is associated with increases in depressive symptoms, overall health	Race, marital status, education	9 months postpartum	Structural/ Institutional Factors
Testa, A. 2020[49] Texas KQ1 31918349	Non-disclosed; Data collected via survey, telephone interview, and medical records	Mothers exposed to incarceration within 12 months of live birth within state	Incarceration	Postpartum depression (PRAMS) Exposure to incarceration is associated with postpartum depression	Maternal age, maternal race, marital status, previous live birth(s), maternal weight gain, pre-pregnancy BMI category, stressors	2-6 months postpartum	Structural/ Institutional Factors
Lee 2022[50] 36 states + NYC KQ1 35301904	146,329; PRAMS data (36 states + New York City)	Women who delivered a live infant who reported they or their husband/partner spent time in jail 12 months prior to giving birth	Incarceration or indirect exposure to incarceration through partner	Postpartum depressive symptoms (PHQ-2) Women with incarceration exposure had increased odds of postpartum depressive symptoms	Age, race, marital status, education, health insurance for prenatal care, behavioral and environmental risk factors	2-6 months postpartum	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Schuster 2022[51] Missouri, Nebraska, Oklahoma, Utah, Wyoming KQ1 34670222	9,472; PRAMS	Women with incomes at 100%–400% of the federal poverty level who had prenatal insurance and completed the Pregnancy Risk Assessment Monitoring System (2012–2015).	Pre-ACA and post-ACA trends in the proportion of women self-reporting loss of insurance after childbirth and symptoms of postpartum depression.	Effects of the ACA's non-Medicaid provisions on women's postpartum insurance coverage and depressive symptoms in non-expansion states ACA non-Medicaid provisions were associated with large increases in retention of postpartum	Age, race, Hispanic ethnicity, educational level, marital status, parity, pregnancy intendedness, insurance type for prenatal care, stressors in 12 months before delivery, conditions before pregnancy (depression, hypertension, diabetes, prescription drug use besides birth control) IPV, income	2-6 months postpartum	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Robbins 2022[52] Alabama KQ1 36309247	100; Hospital electronic medical records	Patients were included if they self-reported either Black or White race, reported a residential address, were managed by Cardiology at UAB, and met National Heart, Lung, and Blood Institute criteria for peripartum cardiomyopathy	Social Vulnerability Index (SVI): (1) socioeconomic, (2) household composition/disability, (3) minority status/language, and (4) housing type/transportation The US census tract for each address was identified and linked to the CDC SVI.	Severe peripartum cardiomyopathy, less severe peripartum cardiomyopathy (ICD-9-CM, ICD-10-CM) Patients with severe PPCM outcomes were more likely to live in communities with greater social vulnerability.	Race, age, marital status, payor source, smoking status, gestational age at delivery, mode of delivery	Delivery - 1 year postpartum	Structural/ Institutional
Freeman 2022[53] Georgia KQ1 36038962	25,257; Hospital electronic medical records	All deliveries in a single hospital between January 1, 2011, and March 31, 2020.	Using residential zip codes, calculated neighborhood deprivation index based on data from the US Census.	SMM (ICD-9-CM, ICD-10-CM) After adjustment, there was no association between neighborhood deprivation and SMM	Age, insurance payer, primiparous, comorbidities	Delivery-42 days postpartum	Structural/ Institutional

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Hung 2022[54] South Carolina KQ1 36264572	166,791; State birth records	All deliveries in South Carolina between January 2018 and June 211	Black-White residential segregation (isolation index), categorizing US Census tracts in a county as low (<40%), medium (40%-59%), and high (60%) A pandemic indicator of childbirth delivery timing (prepandemic [January 2018 to February 2020] and peripandemic [March 2020 to June 2021])	SMM (ICD-10-CM) Black and Hispanic women living in high-segregated Black communities had higher odds of SMM than their counterparts living in less segregated communities. During the pandemic, Black vs White disparities in SMM persisted, while the Hispanic vs White disparities were exacerbated.	Maternal age at childbirth, maternal race and ethnicity, maternal education, primary payer, prepregnancy BMI, enrollment in WIC nutrition program, urban vs rural location of health care facility, chronic conditions	Delivery-60 days postpartum	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Muchomba 2021[55] New Jersey KQ1 34792591	1,001,410; New Jersey birth records	All births in New Jersey 2008-2018	Individual-level characteristics and per capita municipal expenditures on education; public health, fire and ambulance; parks, recreation, and natural resources; housing and community development; public welfare; police; transportation; and libraries	SMM (CDC diagnostic and procedure codes) Reduced odds of SMM when annual municipal expenditures per capita were $1000 higher in areas such as fire, ambulance, transportation, health, housing and libraries. Higher expenditures on police were associated with increased odds of SMM.	Race/ethnicity, maternal age, maternal education, parity, municipality-level variables	<42 days postpartum	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Mukherjee 2017[56] Florida KQ1 27810166	115,704 PRAMs survey respondents from 2009-2011	Women 2-4 months post-delivery. 2009-2011	Stressful life events (SLEs)	Hypertensive disorders, severe nausea/ vomiting/ dehydration, preterm labor, pre rupture of membranes, postpartum depression Postpartum depression was associated with multiple types of stress	Age, race/ethnicity, income, education, marital status, health insurance status	Survey mailed 2-4 months post delivery	Psychosocial stress
Morgan 2021[57] Utah KQ1 32567962	4378 PRAMs survey respondents linked to birth certificate information	Utah PRAMs survey respondents	Life stress (partner, traumatic, financial, and emotional-related)	Hypertensive disorders of pregnancy Reporting any of the 4-types of life stress was linked with increased prevalence of HDP	Age, race/ethnicity, pregnancy history (all from birth certificates) Maternal income, pregnancy intent, infertility treatment, lifestyle/psychosocial factors, pre-pregnancy weight/height/health status from PRAMs survey	37 weeks	Psychosocial stress

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Rodriguez 2019[58] Nationwide KQ1 31323540	143 pregnant, 358 postpartum; Survey data	Pregnant (>2nd trimester) and postpartum (<12 months) women recruited through social media and internet forums for pregnant women	Weight gain stigma experiences (Vartanian survey)	Depressive symptoms, perceived stress experiencing weight stigma may contribute to postpartum depressive symptoms	Pre-pregnancy BMI, multiparous, weeks of gestation, months postpartum	2nd, 3rd trimester,12 months postpartum	Psychosocial stress
Choi 2016[59] Michigan KQ1 26774007	564; Data collected via telephone interview and medical records	Women 18+, English-speaking, expecting first infant, and initiating prenatal care at less than 28 weeks gestation	Childhood trauma (STACY project)	PTSD symptoms (disassociation) (PDEQ) Maltreatment history and PTSD increases risk to be re-traumatized or overwhelmed by birth	Income, race	Initiation of prenatal care, 35 weeks gestation, 6 weeks postpartum	Trauma
Dailey 2011[60] California KQ1 18253820	116; Data collected via interview and medical records	African American women from two urban prenatal clinics, who are 18+, between 25-28 weeks gestation at baseline	Lifetime trauma exposure (THQ), (PSS), (CES-D)	PROM, maternal hospital stay length Trauma exposure was associated with depressive symptoms, anxiety 87% of the women reported at least one traumatic life event	Education, employment, income, marital status	1 month after delivery	Trauma

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Gross 2020[61] Multi-state KQ1 31560602	620; Data collected via interview	Pregnant veterans, who were women	Military sexual trauma (VA MST screening)	Depression, suicidal ideation (COMFORT Study) (EPDS) MST was associated with higher pre- and postnatal symptoms of depression and SI	Prenatal stress, maternal age, race, ethnicity, marital status, sexual orientation, living status	20 weeks gestation-16 weeks postpartum	Trauma
Jackson 2017[62] Georgia KQ1 28283944	100; Atlanta public health department participating in a home visitation program	Pregnant low-income African Americans in Atlanta, GA over age 20 enrolled in WIC	Anticipated negative experiences between black youth & police (study questionnaire)	Depressive symptoms (EPDS, JHP) Anticipated negative African American youth-police experiences by expected mothers were associated with antenatal depressive symptoms	Income, relationship status, education, sex & age of prior children	First & second trimester	Trauma

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Connelly 2013[63] California KQ1 23931153	1,186; Data obtained in screening interviews) Secondary RCT	Women receiving routine obstetrical services through 6-week postpartum follow-up visits from 10 community Ob/Gyn clinics in CA. English & Spanish speaking	IPV (AAS), substance use (TWEAK, DAST-10)	Depression (EPDS) 1 in 5 mothers exposed to IPV screened positive for depressive symptoms during the perinatal period	Race, marital status, educational level, employment model covariate - clinics	Pregnancy-6 weeks postpartum	Violence
Kothari 2016[64] Michigan KQ1 26955998	301; Data collected via cross-sectional telephone interviews & medical records	Women 2 months after delivery in Kalamazoo County, MI	IPV (3-question survey adapted from DVISQ), poverty assessed from insurance status	Postpartum depression (EPDS) Association of IPV and PPD was regardless of SES	Race, age, marital status, substance use, employment status, housing instability, life stressors	2 months postpartum	Violence
Velonis 2017[65] Washington DC, Maryland, California, Illinois, North Carolina KQ1 WOS:000412921000004	2510; Data collected via home interviews	Low-income mothers in 5 states from the Community Child Health Network	IPV (HITS)	Postpartum depression (EDPS), perceived stress (PSS)	Age, income, race, education	<12 months postpartum	Violence

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Valentine 2011[66] California KQ1 21052749	328; Data collected via prenatal and postnatal interviews Prospective observational study	Latina mothers recruited from the obstetric/ gynecologic clinics at two private nonprofit health care organizations in Los Angeles, CA, at least 12 weeks pregnant	IPV (AAS), non-IPV trauma (ACES) race	Postpartum depression (BDI) Recent IPV exposure was found as prenatal predictor of PPD	Foreign-born, time lived in US, social support, poverty index score	3,7,12 months postpartum	Violence
Rodriguez 2008[58] California KQ1 18195314	210; Data collected via structured interviews	Self-identified Latinas at least 12wks pregnant attending prenatal clinics in Los Angeles, CA	IPV (AAS)	Depression (BDI), PTSD (PCL-C) IPV exposure was found as prenatal predictor of PTSD	Employment status, age, poverty index, birthplace	<1 year postpartum	Violence
McMahon 2011[67] Multi-state KQ1 104594301	3961; Secondary data collected from interviews in the Fragile Families & Child Wellbeing Study	Mothers in 20 cities with populations over 200,000 who participated in both waves of FFCWS	IPV (physical & emotional victimization surveys)	Depression (CIDI-SF), overall health IPV was reported to increase medical and obstetrical complications, depressive symptoms	Race, age, education, family structure	1 year postpartum	Violence
Kavanaugh 2009[68] Virginia KQ1 19558308	121; Data obtained through death certificates, EHR	Women who had pregnancy-associated death in Virginia	Domestic violence, substance abuse, mental illness	Mortality, Depressive symptoms IPV contributed to preventable maternal death	Age, education, marital status, payment for care	<1 year postpartum	Violence

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Huth-Bocks 2002[69] Michigan KQ1 12033553	202; Interview data 2 months postpartum	Pregnant women enrolled in larger DV study during their third trimester, age 18-40, involved in romantic relationship for at least 6 weeks while pregnant	Domestic violence (SVAWS)	Depression (BDI), maternal social support (NSSQ), maternal & infant health, substance use IPV was reported to increase depressive symptoms	Age, gender of child, marital status, racial/ethnic group, education, income/month	2 months postpartum	Violence
Kearney 2003[70] Massachusetts KQ1 14735677	2052; Data extracted from medical records	Prenatal clients who enrolled at 13 eastern Massachusetts prenatal care sites in a 30-month period from 1996-1999	Domestic violence (AAS), substance use, mental illness	Preventable death, depression IPV contributed to preventable depressive symptoms and maternal death	Ethnicity, insurance status, marital status, education	<1 year postpartum	Violence
Thomas 2019[71] New York KQ1 31023259	930; Secondary RCT data	Low-income, urban, pregnant adolescents in New York City	IPV (RCTS), poverty, prenatal distress (PDQ)	Depression (CES-D), Anxiety (GAD-7) IPV exposure was found as prenatal predictor of PPD, PTSD	Age, education, employment, relationship status, race	Third trimester	Violence

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Garabedian 2011[72] Kentucky KQ1 21323583	5380; Kentucky Women's Health Registry data	Women who delivered in KY and completed KWHR questionnaire	IPV and child abuse histories (KWHR questionnaire items to ascertain violence and abuse exposures)	Postpartum depression (self-reported on KWHR) IPV & VAW contributed to depressive symptoms	Age, race, highest education attained, marital status, substance use,	<1 year postpartum	Violence
Greely 2022[73] National KQ1 35702758	138,311,788; National Inpatient Sample	Pregnancy-related hospitalizations	Intimate partner violence (ICD-10-CM)	Hypertensive disorders, GDM, (ICD-9-CM, ICD-10-CM) When compared to those with no exposure, individuals of all ethnic groups exposed to violence had increased risk of all adverse maternal/fetal outcomes.	Age, race, income, primary payer, hospital characteristics	Delivery	Violence

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Merkt 2021[74] Nationwide KQ1 33640361	3747; Pregnancy Mortality Surveillance System data Descriptive analysis	15-44 pregnancy related deaths (PMMS) across and within rural and urban counties	Urban/Rural location (National Center for Health Statistics Urban-Rural Classification Scheme for Counties)	Pregnancy-related mortality (PRMR) Within each urban-rural category, pregnancy-related mortality ratios were higher among non-Hispanic Black women than non-Hispanic White women. Non-Hispanic American Indian or Alaska Native pregnancy-related mortality ratios in small metro, micropolitan, and noncore counties were 2 to 3 times that of non-Hispanic White women in the same areas.	Race & ethnicity, age	Pregnancy	Rural/Urban
Nidey 2020[75] 14 states KQ1 31602705	17,229; 2016 PRAMS data collected through phone or mail surveys	6 months after birth residing in rural and urban locations across 14 states	Rurality (PRAMS)	Perinatal depression (PRAMS) No association	Race, age, marital status, insurance, education, WIC assistance	6 months postpartum	Rural/Urban

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Hansen 2022[76] Kentucky KQ1 33682958	48,608; State hospital discharge records	All delivery inpatient hospitalizations for KY residents in 2017 (ICD-10-CM, ICD-10-PCS)	Rural urban status (home residence from billing records, classified by county using 2013 RUCC)	Percentage of delivery hospitalizations with SMM Rural women in Kentucky are at an increased risk for SMM	Black, non-Black, age, non gestational hypertension, non gestational diabetes, anemia, obesity, smoking status, history of opioid use, history of previous cesarean section	Delivery	Rural/Urban
Choe 2018[77] Rhode Island KQ1 30248831	75,590; EHR data	Women who gave live birth at RI Women & Infants Hospital 2001-2012	Maternal address (ArcGIS) ambient levels of PM & BC	GDM, gestational hypertension, preeclampsia (ICD-9 codes) No associations for preeclampsia. Living close to a roadway associated with GDM; living close to coast associated with lower GDM; living close to recreational facility associated with lower gestational hypertension.	Age, race, education, marital status, insurance status, tobacco use, trimester, proximity to major roadway, distance to recreational facility, distance to coast, distance to fresh water, neighborhood SES	Pregnancy-delivery	Environment

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Liu 2019[78] Massachusetts KQ1 31426704	1273; Face to face interview, blood samples, EHR data	Pregnant women recruited from Boston Birth Cohort	Trace mineral and heavy metal concentrations of Mn, Se, Cd, Pb, and Hg in RBCs	Preeclampsia (EHR) women with lower blood concentration of Mn or higher Cd are more likely to develop preeclampsia	Age, black race, education level, nulliparous, married, smoking status, alcohol consumption, pregnancy BMI, GDM, offspring characteristics	24-72 hours after delivery	Environment
Tiako 2021[79] Pennsylvania KQ1 34450673	1943; Multiple psychosocial questionnaires during three study visits during pregnancy Secondary analysis of a prospective cohort	Women who received prenatal care at single tertiary academic medical center in Philadelphia, PA, 2013-2016	Greenness (measured by residential tree canopy cover 100-500 meters from participants homes (Philadelphia Tree Canopy assessment)	Hypertensive disorders of pregnancy (EHR) greenness was associated with lower hypertensive disorders of pregnancy odds.	Race/ethnicity. Insurance status, age at delivery, parity, diabetes history, smoking history and pre-pregnancy BMI	Gestational age of >20 weeks	Environment

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Harden 2022[80] South Carolina KQ1 35060067	860,535; South Carolina hospital delivery discharge records	Women who experienced SMM between ages of 10-55 years with gestation of 20-44 weeks	Heat exposure Spatial clustering of SMM (GEE models)	SMM with blood transfusion – SM21 and SMM without blood transfusion – SM20 (CDC definitions) GEE models revealed that the odds of living in a high-risk SMM21 higher among Black patients compared to those outside of a high-risk cluster.	Year of hospital delivery, age, race and ethnicity, insurance type, and zip code, HPSA scores, racial residential segregation, income inequality, racialized economic residential segregation (ICE)	Delivery	Environment
Runkle 2022[81] South Carolina KQ1 34871679	238,992; Hospital discharge records	Singleton pregnancies with at least 20 weeks gestation or more	Greenspace (PAD-US and Trust for Public Land's Parkserve)	Preeclampsia, mental disorder, depressive disorder, SMM (ICD-9 codes) Limited access to greenspace is associated with poor maternal outcomes	Maternal age, educational attainment, racial and ethnic group, insurance payor, Kotelchuck index adequacy of prenatal care, pre-existing chronic conditions, and ICE (race-poverty)	Delivery	Environment

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Bastain 2021[82] California KQ1 34838014	180; Prenatal data collected by interviewer-administered questionnaires, postpartum data collected via 5 phone questionnaires and in-person visits	Low-income Hispanic/Latina women participating in MADRES cohort	Prenatal ambient air pollution estimates of nitrogen dioxide (NO2), ozone (O3), and particulate matter (PM10 and PM2.5) were assigned to participant residences using inverse-distance squared spatial interpolation from ambient monitoring data	Maternal Depression at 12 months postpartum compared to third trimester (CES-D) Prenatal ambient air pollution, especially mid-pregnancy NO2 and PM2.5, increased the risk of depression at 12 months after childbirth	Recruitment site, maternal age, ethnicity, household income, education, air conditioning use during pregnancy, previous depression, average temperature over exposure period.	<30 weeks gestation - 12 months postpartum	Environment

Abbreviations: A-PNCU index= Adequacy of Prenatal Care Utilization; AAmC -attraction to American cultureAAP-American Academy of Pediatrics quality and standard of care guidelines; AArC -American Arabic cultureAAS -Abuse Assessment Screen; ACES -Adverse Childhood Experiences; AHA -American Hospital Association; AHAAS -American Hospital Association Annual Survey Databases; ARSMA-II -Acculturation Rating Scale for Mexican Americans; IICCHN -Community Child and Health Network cohort; CDI -Children's Depression Inventory; CDC PRMM -Centers for Disease Control and Prevention Retrospective Maternal Mortality Study; CES-D -Center for Epidemiologic Depression Scale; CHARS -Comprehensive Hospital Discharge Reporting System; CIDI-SF -Composite International Diagnostic Interview –Short Form; CTS2 -Revised Conflict Tactics Scale physical and sexual coercion subscales; DAST-10 -Drug Abuse Screening; DSM-IV -Diagnostic and Statistical Manual of Mental Disorders; DVISQ -Dysfunctional Voiding and Incontinence Symptom Questionnaire; EDS -Everyday Discrimination Scale; EOD= Experiences of Discrimination scale; EPDS -Edinburgh Postnatal Depression Scale; FPL -Federal Poverty Line; GAD-7 -General Anxiety Disorder -7; HCUP -HealthCare Utilization Project; HITS -Hurt, Insult, Threaten, Scream, IPV screening tool; HSCL-Hopkins Symptom Checklist-Depression Scale; ICE -Index of Concentration at the Extremes; JHP -Jackson, Hogue, Phillips contextualized stress measure; LUM -entropy-based land use mix index; LSCS -Link stigma scale; LUR -Land Use Regression models to estimate exposure to air pollution; NCHS -National Center for Health Statistics; NHDS -National Hospital Discharge Survey; NIS -Nationwide Inpatient Sample; NMRS -Negative Mood Regulation Scale, 15 item short version; NSSQ -Norbeck Social Support Questionnaire; NUPDQ -Revised Prenatal Distress Questionnaire; nuMoM2b -Nulliparous Pregnancy Outcomes Study; NYBPM -New York Best Practice Model for activity-based travel demand; OSHPD -CA -Office of Statewide Health Planning & Development; PAMCs -Potentially avoidable maternity complications; PAS -Psychological Acculturation Scale; PCL-C -PTSD Checklist -Civilian Version; PDQ -Perceived Deficits Questionnaire; PDSS -Postpartum Depression Screening Scale; PMSS -Pregnancy Mortality Surveillance System; PRAMS -Pregnancy Risk Assessment Monitoring System; PRMR Pregnancy-related Mortality Ratio; PSQI -Pittsburgh Sleep Quality Index; PSS -Perceived Stress Scale; RBC -red blood cellsRetFAR-retail floor area ratio, street connectivity, and sidewalk availability; RUCC -Rural-Urban Continuum Codes; SAS -Short Acculturation ScaleSID -State Inpatient Databases; SIP -Stress in Pregnancy Study; SNOMED -Systematized Nomenclature of Medicine; SPAH -Stress, Pregnancy, and Health Study; SPARCS=Statewide Planning and Research Cooperative System; STAI -State Anxiety Inventory; SVAWS -Severity of Violence Against Women Scales; TWEAK -Tolerance, Worried, Eye-opener, Amnesia, K-Cut Down; VKT -Vehicle kilometer traveled; WAPT -Weighted Average Poverty Thresholds

Table C-2. Evidence table for risk factor studies for Key Question 2

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Pantell 2019[83] California KQ2 33345843	2,794 (control: 2,895,241); hospital discharge records (ICD-9 codes) Retrospective cohort study	Singleton pregnancies, without birth defects, 20-42 weeks gestational age, coded with unstable housing (ICD-9)	Unstable housing (ICD-9 codes) during either an ED visit or admission within 1 year before or after their birth hospitalization or during their birth hospitalization.	Obstetric complications, ED use, hospital readmission, preterm birth Unstable housing associated with ED visits and readmission 3 mo, 1 yr.	Race/ethnicity, age, parity, prior PTB, BMI, substance use, maternal hypertension, mental health conditions during pregnancy	Delivery	SES
Oleske 2000[84] California, Florida KQ2 10636393	525,517; hospital discharge data (codes V30.00 or V30.01)	Maternal deliveries for singleton births from three payer groups, Medicaid managed care, Medicaid fee-for-service, and private managed care in 439 short-term-stay non-federal hospitals	Insurance payer groups (Medicaid managed care, Medicaid fee-for-service, private managed care)	In-hospital death, eclampsia, excessive blood loss (demonstrated by transfusion) Medicaid managed care associated with higher eclampsia rates but not in hospital mortality	Age, race, education, number of children born	Delivery	SES

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Yamamoto 2021[85] Florida, Massachusetts, New York KQ2 33885772	15,029 (control 308,242); State Inpatient Database, State Emergency Department Databases Cross-sectional study	15,029 pregnant women experiencing homelessness and 308,242 pregnant women not experiencing homelessness (ICD-9 codes)	Housing status at delivery hospitalization (ICD-9 codes)	Obstetric complications and, delivery-associated costs (ICD-9 codes) Homelessness associated with higher-delivery-associated costs	Age, insurance status, race/ethnicity, smoking, multiple births, hypertension, neurological disorder, chronic pulmonary disease	Delivery	SES
Chan 2021[86] CA KQ2 32474833	984,167; state-level administrative OSHPD, California Health and Human Services Agency	Primiparous women in California	Race/ethnicity	Depression (primary ICD-9-CM diagnosis code) Black associated with hospital-based postpartum depression care; inverse association for Asian and Hispanic	Maternal age, highest education level, insurance type, mode of delivery, multiple gestation, preterm delivery, stillbirth, and antepartum depression	Delivery hospitalization	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Rossi 2019[87] Nationwide KQ2 31306325	27,602; ICU admissions, NCHS U.S. live birth records, retrospective	All live births delivered between 20 and 44 weeks of gestation 2012–2016	Prenatal factors that contribute to ICU admin. (Obstetric factors, race, age, insurance, more)	Maternal ICU admission Predictive model included Medicaid but not education or WIC as social determinants; Black women higher odds compared with white and Hispanic women	Pre-pregnancy weight, pre-pregnancy BMI, maternal weight at delivery, and weight gain during pregnancy were all analyzed as both continuous and categorical variables	Peripartum period	Identity and Discrimination
Saftlas 2000[88] Nationwide KQ2 10981453	840/5437 white cases/controls, 448/1042 black cases/control; CDC- PRMMS	Black women and White women pregnancy related deaths w/ livebirths	race	Pregnancy-related mortality Black with lowest risk of mortality associated with higher disparity; high-risk for mortality no difference in actual mortality by race. Education, marital status, and area of residence not associated.	Marital status, birth weight, gest. age, livebirth order	<1 year postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Johnson 2005[89] Washington KQ2 16098873	5416; deliver hospitalizations from state birth certificate data linked to hospital discharge records (CHARS)	Somali immigrants, US-born blacks and whites in Washington state	race/ethnicity	Maternal Morbidity (preeclampsia, perineal lacerations, pp hemorrhage, transfusion (BERD) Somali women associated with cesarean delivery, gestational diabetes, perineal lacerations than Black or white women	Prior confounding factors for secondary obstetric outcomes included method of delivery, gestational age, and birth weight.	<1 year postpartum	Identity and Discrimination
Kern-Goldberger 2021[90] KQ2 Nationwide 33766807	2000-2014 Nationwide Inpatient Sample	Hospitalizations captured by NIS	Race/ethnicity ,payer information, income	Composite of critical care diagnoses Greater risk of maternal mortality and of critical care diagnosis in non-Hispanic Black compared to non-Hispanic-white women	Clinical variables, delivery factors, hospital teaching status, hospital region, hospital bed size	Delivery	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Ranjit 2021[91] Nationwide KQ2 31986540	675,553 deliveries insurance claims data from the Military Health System Data Repository (MDR)	Military racial minorities (African American and Asian) compared with White patients	Race/ethnicity mitigated by universally insured pop.	Delivery with PAMCs (defined by Laditka) African-American women had higher odds of PAMCs compared to White women. This effect was somewhat mitigated by universal health coverage.	Age, marital status, system of care, direct care, active duty, dependents, census region, delivery mode	Delivery	Identity and Discrimination
Batra 2017[92] California KQ2 29016513	1,071,232 Retro cross-sectional. Cohort in California 2009-2011 data pulled from California Office of Statewide Health Planning and Development	90 days pp in California	Race/ethnicity, income, insurance payer	Emergency department visits Associated with race, insurance, income	Age, race/ethnicity, income, length of stay, antepartum complications, mode of delivery, SMM	90 days postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Brown 2007[93] Duke Univ. Medical Center, Durham, NC KQ2 17689648	10, 755 women, Duke University delivery database (hospital admin data), cross-sectional	African American, Hispanic, and White women Medicaid recipients	Race/ethnicity insurance status (Medicaid recipients)	Adverse outcomes by ICD-9 codes (abruption, preeclampsia, maternal death) Hospital length of stay, hospital charges Black more likely than Hispanic to experience preeclampsia, but no difference in gestational diabetes mellitus	Maternal age, employment status, residence, medical comorbidity, substance abuse, psychological comorbidity, length of hospital stay, and total hospital charges	Delivery hospitalization	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Ross 2020[94] Washington DC, Maryland, California, Illinois, North Carolina KQ2 29962223	1717; CCHN study data collected at home visits 6 & 12 months postpartum	Low-income women of African American, Latina, non-Hispanic White race/ethnicity was recruited immediately after a birth, 18-40 age	Race/ethnicity, poverty status (household income FPL)	Cardio-metabolic disorders (Resting blood pressure, waist and hip circumference, and dried blood spot-derived cholesterol and glycosylated hemoglobin) African American women had higher risk of cardio-metabolic disorders than white or Latina women.	Age, medical chart-obtained parity, pre-pregnancy BMI, health behaviors, breastfeeding, employment status, change in household income over the follow-up	<1 year postpartum	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Debbink 2022[95] National (41 sites) KQ 2 34856577	5,759; secondary RCT data	ARRIVE 41 center RCT of induction of labor compared with expended management	Race/Ethnicity	Maternal morbidity and cesarean birth Non-Hispanic Black and Hispanic people experienced higher relative risk of cesarean birth compared to non-Hispanic White people, which explained a portion of the excess maternal morbidity experienced by non-Hispanic Black and Hispanic people	Clinical chorioamnionitis (as noted in study), study treatment group, relationship/marital status, employment status, insurance, maternal age, BMI, and modified Bishop score at admission.	Delivery	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Leonard 2022[96] California KQ2 35358492	1,483,119 birthing mother w father partner, 2572 birthing mother w mother partner; 498 birthing father w any partner; California hospital records	All live births in CA 2016-2019	Likely sexual and/or gender minority delivery hospitalizations (Hospital discharge records)	Postpartum hemorrhage, SMM (hospital discharge records) Birthing patients in mother-mother partnerships experienced significantly higher rates of several adverse outcomes than birthing patients in mother-father partnerships, including postpartum hemorrhage (8.6% vs 4.4%) and severe morbidity (3.5% vs 1.7%). No outcome differences existed between father birthing patients in any partnerships and mother-father partnerships.	Age, expected method of payment for the delivery hospitalization, educational attainment, race-ethnicity (as a social characteristic), parity, prepregnancy BMI, obstetrical history, and obstetrical comorbidity score.	Delivery	Identity and Discrimination

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Howell 2017[97] New York City KQ2 28079772	353,773 deliveries NYC Vital Statistics	Hispanic and non-Hispanic white deliveries	Race/ethnicity; hospital quality (SPARCS) Dominican, Mexican, Puerto Rican subgroups	SMM composite(ICD-9-CM diagnosis and procedure and DRG delivery codes) Hispanic contributes 37% of ethnic disparity in NYC Hispanic more likely to deliver at hospitals with higher risk-adjusted SMM rates	Adjusted for maternal socio demographics, clinical covariates, hospital fixed effects	Delivery	Hospital factors
Reid 2018[98] Maryland KQ2 29593355	364,113; hospital discharge records Population-based observational study	Hospital discharge records during 2010–2015 from the Maryland Health Services Cost Review Commission (HSCRC)	Hospital quality of care (obtained from linked state hospital discharge records, birth certificates, and Centers for Medicare and Medicaid Services (CMS) Hospital Compare databases)	SMM (ICD-9-CM) Lower clinical care quality associated with higher risk	Residence, race, ethnicity, age, marital status, first payer source (HSCRC)	Delivery	Hospital factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
McKinley 2020[99] Nationwide KQ2 32369860	2010-2014 Nationwide Readmissions Database (NRD) Retrospective cohort study	Delivery-hospitalizations (ICD-9-CM) 60 days after delivery	Hospital safety-net burden (high, medium, low based on proportions of Medicaid or uninsured patients	SMM, postpartum readmissions High-burden status associated with higher risk	Hospital factors: bed size, teaching status Patient factors: age, payer status, median income quartile by zip code	<60 days postpartum	Hospital factors
Mujahid 2021[100] California KQ2 32798461	3,020,525; Hospital discharge data (CA OSHPD) Cohort study	All births >20 weeks gestation in CA	Birth hospital: teaching affiliation, level of neonatal care (AAP quality & care guidelines), delivery volume & ownership type	SMM (CDC Prevention Index) SMM (CDC Prevention Index) Teaching hospital associated with higher risk excess odds among racially and ethnically minoritized women	Age, race/ethnicity, education, payer status, trimester prenatal care	Delivery	Hospital factors
Morong James J 2017[101] Louisiana KQ2 28087902	16; data collected via medical records	In-hospital maternal deaths within Ochsner Health System in Louisiana	Late entry to prenatal care, race, insurance (OHS)	Preventable death (OHS) Late entry, transfer, and insurance associated with higher risk	Maternal age, race, BMI at death, insurance	With 42 days of pregnancy termination	Healthcare use

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Liu 2021[102] New York KQ2 33855649	335; Hospital discharge records	Women who have birth at Kings County Hospital 4/10/20-6/10/20, predominately Black and underserved population	SARS-CoV-2 infection (PCR test)	Postpartum hemorrhage In this predominantly Black population in Brooklyn, SARS-CoV-2 infection did not confer increased risk of adverse obstetric outcomes	Age, race, ethnicity, parity, gestational age at delivery, comorbidities (electronic medical records)	Delivery	Comorbidities
Snowden 2020[103] Minnesota KQ2 32677043	Medicaid claims data	Black & white women in MN compared to 6 control states	Minnesota's blended payment policy	Maternal morbidity - postpartum hemorrhage, chorioamnionitis, cesarean (IC9 codes) Increases in postpartum hemorrhage signal potential unintended consequences of policy-related cesarean reduction	Clinical covariates (IC9 codes)	Delivery	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Howell 2020[104] New York City KQ2 31923076	591,455; deliveries NYC Vital Statistics	Medicaid vs. commercially insured deliveries	Within-hospital racial & ethnic disparities, insurance type (SPARCS)	SMM Composite (ICD-9-CM diagnosis and procedure and DRG delivery codes) Within-hospital risk for SMM higher for Black and Latina, not explained by insurance type	Adjusted for sociodemographic, obstetric factors	Delivery	Structural/ Institutional Factors
Ona 2021[105] nationwide KQ2 33798475	965,202; deliveries from 430 hospitals retrospective cross sectional, NIS and AHAAS databases	Delivery hospitalizations in the NIS	Characteristics of black-serving hospitals (NIS and AHA Survey) and Medicaid burden	SMM (ICD-9) 1st Black-serving hospital quartile associated with lower SMM; 2nd-4th quartiles no association	Adjusted for patient-level comorbidity and payer (table 4)	Delivery	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Burris 2021[106] KQ2 California, Missouri, Pennsylvania 33453183	5,679,044; birth certificates and hospital discharge data retrospective cohort	Black and white patients in CA, MO, & PA	Hospital types (Teaching status, black serving status), and race	Maternal mortality Teaching hospital mortality similar for Black-serving and non-Black-serving hospitals. Higher mortality in Black-serving non-teaching hospitals. Black women had greater risk of maternal mortality than White women across hospital types.	Age, gestational age, insurance status, mode of delivery, rurality, year, pregnancy comorbid conditions, state of delivery	Delivery	Structural/ Institutional Factors
Garg 2021[107] WA KQ2 33775201	407,808; hospital discharge data, Retrospective	Non-Hispanic Black compared to non-Hispanic white women	Race, Black serving hospitals	SMM (defined by CDC) Level of Black-serving hospitals associated with SMM, odds higher for Black women adjusting for hospital level	Race and indicator variable for black serving hospital (low, med. or high)	Delivery	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Howell 2016[108] Nationwide KQ2 26283457	4,609,291; deliveries Nationwide Inpatient Sample HCUP	Nationwide deliveries	Race/ethnicity; hospitals with low, med. or high black deliveries	SMM composite Black women delivering at high Black-serving hospitals had worst outcomes	Cesarean delivery, hospital of delivery	Delivery	Structural/ Institutional Factors
Howell 2016[109] New York City KQ2 27179441	353,773; deliveries NYC Vital Statistics	New York city	race/ethnicity; black-serving hospitals (SPARCS)	SMM composite (ICD-9-CM diagnosis and procedure and DRG delivery codes) Black/white differences in delivery location may contribute as much as 47.7% of the racial disparity in severe maternal morbidity rates in New York City	maternal age, self-identified race and ethnicity, parity, education, prenatal care visits, and clinical and obstetric factors (multiple pregnancy, history of previous cesarean delivery, body mass index)	Delivery	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Sullivan 2021[110] North Carolina KQ2 149572163	4,065; birth certificate data included in the NC Vital Statistics Reporting System Retrospective cohort study	Women in 5 rural areas of NC with L/D unit closures in rural counties between 2013 and 2017	Closures of labor and delivery units in rural counties (RUCC)	Maternal morbidity, neonatal outcomes (NC birth certificate data) College educated, commercially insured more likely to deliver out-of-area. No association between closures and maternal morbidity	Age, race, education, primary payer	Delivery	Structural/ Institutional Factors
Janevic 2020[111] NYC KQ2 32364858	316,600; NYC birth and hospitalization data	women in low-income neighborhoods who delivered in forty hospitals	Racial and economic spatial polarization (ICE Race-Income)	SMM (CDC algorithm) For combined race and income segregation associated with increased SMM, contributions were: comorbidity 50%, hospital 35%	Risk adjustment were maternal sociodemographic factors, comorbidities, and obstetric factors t	<1 year postpartum	Structural/ Institutional Factors

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
McGregor 2021[112] New Jersey KQ2 34496307	227,412; delivery hospitalizations discharge data	All deliveries in NJ for 9 years	SMM measured using a composite variable for severe illness during hospitalizations	Obstetrical unit closures (zip code tabulation), Race (white, Black, Hispanic) Black and Hispanic women had higher rates of SMM compared to White women	Race, individual SES, age, pre-existing conditions	Delivery	Structural/ Institutional Factors
Sastow 2021[113] 5 states (NY, FL, CA, MD, KY) KQ1 33931312	6,879,332; delivery hospitalizations, individual inpatient discharge records, SID HCUP	women delivering in high black serving delivery units	race/ethnicity primary: 1) hospital factors (High Black-serving delivery units and 2) high hospital safety-net burden), race/ethnicity	Severe maternal morbidity Black women in Black-serving delivery units higher odds than white women in low Black-serving units	Unclear, controlling for pre-existing conditions and patient-level characteristics	Delivery	Structural/ Institutional Factors
Luke 2021[114] KQ2 Nationwide 33216678	4,494,089; discharge data from the National Inpatient Sample Retrospective cohort study	Delivery hospitalizations (ICD-9)	Patient locality (NIS 6 categories of size)	SMM (ICD-9) Black, Hispanic, and Native American women had higher odds of SMM&M than White women.	Race, age, insurance, zip code, comorbidities	Delivery	Rural/Urban

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Kozhimanni 2020[115] Nationwide KQ2 31923072	1,416,000; National Inpatient Sample; HCUP	Indigenous and white patients who gave birth	Race/ethnicity rural/urban	SMM (ICD-9-CM diagnosis and procedure codes) Indigenous women experienced higher incidence of SMM compared to white women Among indigenous and white women, higher incidence of SMM was observed in rural vs urban	Age, insurance payer, income, and hospital region	<1 year postpartum	Rural/Urban

First Author Year Region Key Question Study (PMID)	Sample Size, Data Source (Administrative, Medical Records, Prospective Data Collection)	Population	Exposure/ Independent Variables	Outcome Variables	Covariates	Timing	Domain
Laditka 2005[116] Nationwide KQ2 15859053	276,347; deliveries in the sample of mothers insured by Medicaid, NIS HCUP data from 28 states	Mothers insured by Medicaid	Access to care, race/ethnicity rural vs. urban hospitals Hospitals in Metropolitan Statistical Areas (MSAs)	Potentially avoidable maternity complications PAMCs (defined by expert team) Rural hospitals associated with high risk. Compared with non-Hispanic White, Black risk higher in rural but not urban hospitals. Hispanic and Asian risk lower in urban hospitals.	Maternal age; comorbidities median income of the mother's ZIP code of residence; hospital ownership, size, and teaching status; annual hospital delivery volume; and US region	Delivery	Rural/urban

Abbreviations: A-PNCU index= Adequacy of Prenatal Care Utilization; AAmC -attraction to American cultureAAP-American Academy of Pediatrics quality and standard of care guidelines; AArC -American Arabic cultureAAS -Abuse Assessment Screen; ACES -Adverse Childhood Experiences; AHA -American Hospital Association; AHAAS -American Hospital Association Annual Survey Databases; ARSMA-II -Acculturation Rating Scale for Mexican Americans; IICCHN -Community Child and Health Network cohort; CDI -Children's Depression Inventory; CDC PRMM -Centers for Disease Control and Prevention Retrospective Maternal Mortality Study; CES-D -Center for Epidemiologic Depression Scale; CHARS -Comprehensive Hospital Discharge Reporting System; CIDI-SF -Composite International Diagnostic Interview –Short Form; CTS2 -Revised Conflict Tactics Scale physical and sexual coercion subscales; DAST-10 -Drug Abuse Screening; DSM-IV -Diagnostic and Statistical Manual of Mental Disorders; DVISQ -Dysfunctional Voiding and Incontinence Symptom Questionnaire; EDS -Everyday Discrimination Scale; EOD= Experiences of Discrimination scale; EPDS -Edinburgh Postnatal Depression Scale; FPL -Federal Poverty Line; GAD-7 -General Anxiety Disorder -7; HCUP -HealthCare Utilization Project; HITS -Hurt, Insult, Threaten, Scream, IPV screening tool; HSCL-Hopkins Symptom Checklist-Depression Scale; ICE -Index of Concentration at the Extremes; JHP -Jackson, Hogue, Phillips contextualized stress measure; LUM -entropy-based land use mix index; LSCS -Link stigma scale; LUR -Land Use Regression models to estimate exposure to air pollution; NCHS -National Center for Health Statistics; NHDS -National Hospital Discharge Survey; NIS -Nationwide Inpatient Sample; NMRS -Negative Mood Regulation Scale, 15 item short version; NSSQ -Norbeck Social Support Questionnaire; NUPDQ -Revised Prenatal Distress Questionnaire; nuMoM2b -Nulliparous Pregnancy Outcomes Study; NYBPM -New York Best Practice Model for activity-based travel demand; OSHPD -CA -Office of Statewide Health Planning & Development; PAMCs -Potentially avoidable maternity complications; PAS -Psychological Acculturation Scale; PCL-C -PTSD Checklist -Civilian Version; PDQ -Perceived Deficits Questionnaire; PDSS -Postpartum Depression Screening Scale; PMSS -Pregnancy Mortality Surveillance System; PRAMS -Pregnancy Risk Assessment Monitoring System; PRMR Pregnancy-related Mortality Ratio; PSQI -Pittsburgh Sleep Quality Index; PSS -

Perceived Stress Scale; RBC -red blood cellsRetFAR-retail floor area ratio, street connectivity, and sidewalk availability; RUCC -Rural-Urban Continuum Codes; SAS -Short Acculturation ScaleSID -State Inpatient Databases; SIP -Stress in Pregnancy Study; SNOMED -Systematized Nomenclature of Medicine; SPAH -Stress, Pregnancy, and Health Study; SPARCS=Statewide Planning and Research Cooperative System; STAI -State Anxiety Inventory; SVAWS -Severity of Violence Against Women Scales; TWEAK -Tolerance, Worried, Eye-opener, Amnesia, K-Cut Down; VKT -Vehicle kilometer traveled; WAPT -Weighted Average Poverty Thresholds

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