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Opioid Overdose Associations in the United States Among Pregnant and Postpartum Women During 2019-2023

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Walden University

College of Health Sciences and Public Policy

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Permecia Dixon

has been found to be complete and satisfactory in all respects,
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the review committee have been made.

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Walden University

2026

Abstract

Opioid Overdose Associations in the United States Among Pregnant and Postpartum

Women During 2019-2023

by

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MPH, New York Medical College, 2015

BS, Valdosta State University, 2006

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Public Health

Walden University

May 2026

Abstract

The rising trend of opioid-involved overdose deaths among pregnant and postpartum women in the United States from 2019 to 2023 represents a pressing public health issue. This population faces increasing risk due to opioid use and co-occurring mental health conditions, yet remains underrepresented in research. The purpose of this quantitative study was to examine the association between opioid involvement among pregnancy-associated overdose deaths, while controlling for pandemic periods (pre-COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023). Grounded in the syndemic theory, this study addressed two research questions Grounded in syndemic theory, this study addressed two research questions focused on opioid-involved pregnancy-associated mortality and its relationship with pandemic period, geographic region, age group, and diagnosed mental health conditions. Using secondary data from the Centers for Disease Control and Prevention’s National Center for Health Statistics, logistic regression was applied to assess associations between selected risk factors and opioid involvement among maternal overdose deaths. Results indicated that opioid involvement accounted for approximately 71% of pregnancy-associated overdose deaths from 2019–2023; however, pandemic period was not significantly associated with opioid involvement when controlling for other factors. Significant associations were observed by geographic region and age group, while diagnosed mental health conditions were not significantly associated with opioid involvement. These findings may inform clinical practice and policy efforts to reduce substance use and mental health-related maternal mortality and support more equitable, evidence-based care for pregnant and postpartum women.

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Dedication

To my children, Harper and Winston, may you always pursue your dreams with courage and curiosity. Never stop believing in your potential and never stop reaching for what inspires you. You are my greatest motivation and my proudest achievement.

To my dad, your love lives on through me. I will carry your strength, your lessons, and your unwavering belief in me into every room I enter. I will continue to make you proud.

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This journey would not have been possible without the unwavering love and support of my parents and family. You offered encouragement, patience, and belief in me even when I struggled to find it myself. Your support was a constant source of strength, and I am deeply grateful for all that you sacrificed to help me reach this milestone.

To my children, Harper and Winston, you are my greatest motivation and my greatest joy. Thank you for your patience during long days, late nights, and moments when my attention was divided. Your love grounded me, your laughter sustained me, and your presence reminded me why perseverance matters. Everything I do is, and always will be, for you.

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Section 1: Foundation of the Study and Literature Review

Introduction

This chapter provides an overview of pregnancy-associated overdose deaths among pregnant and postpartum women in the United States between 2019 and 2023. The study focuses on three distinct COVID-19 periods: pre-pandemic (2019), peak pandemic (2020-2021) and post-pandemic (2022-2023). Given the rising rates of opioid-involved deaths among reproductive-aged women, particularly due to synthetic opioids like fentanyl, this research was needed to explore how opioid involvement, mental health challenges, and structural inequities have converged to exacerbate overdose risk and fatal maternal overdose outcomes during and after the pandemic.

By examining opioid-involved maternal deaths across pandemic periods, geographic regions, age groups, and mental health conditions, the study aims to address critical knowledge gaps and inform data-driven interventions. The implications for positive social change include the potential to improve maternal health policies, advance health equity, and reduce opioid-involved mortality through age-specific and regionally tailored strategies.

The chapter begins with an overview of opioid use and maternal health, followed by a discussion of maternal health risks and the impact of the COVID-19 pandemic amongst pregnant and postpartum women. It then examines demographic and geographic patterns of opioid use before and during the pandemic, along with mental health challenges. The study applies a syndemic framework to highlight the interconnectedness of these issues concluding with a synthesis of key findings, identification of research

gaps, and a discussion of how these gaps will guide the study's methodology.

Background

Existing research has established a strong association between opioid use and adverse maternal health outcomes, including neonatal abstinence syndrome (NAS), overdose, and maternal mortality, particularly among pregnant and postpartum women. While recent work has examined maternal opioid use before and during the COVID-19 pandemic, fewer studies have investigated how opioid-involvement among pregnancy associated overdose deaths shifted across the pandemic. Even fewer have applied a syndemic framework to explore how opioid use, mental health comorbidities, and structural inequities interact over time. This study addresses these critical gaps by analyzing national pregnancy associated overdose deaths with and without opioid involvement from 2019 to 2023, offering insights into pandemic-era trends and to inform more equitable public health strategies. As maternal opioid deaths continue to rise, timely research is needed to support targeted interventions and policy reforms that reduce preventable deaths and promote health equity.

Problem Statement

This study addresses the growing public health crisis of pregnant-associated overdose deaths among pregnant and postpartum women in the United States, and the increasing role of opioid involvement in these deaths across the COVID-19 pandemic period. Although opioid overdose is now a leading cause of pregnancy-associated death, limited research has explored how mortality patterns differ by age, geographic region, and mental health status across distinct pandemic periods. Public health experts and

national surveillance data sources have identified this issue as a critical and escalating threat to maternal health. The Centers for Disease Control and Prevention (CDC) and other researchers have documented a sharp rise in opioid-involved deaths among pregnant and postpartum women, emphasizing the need for deeper investigation. Broad consensus within the field confirms that this problem is urgent, relevant, and essential to address through targeted research, policy development, and public health intervention.

Purpose of Study

This study builds on prior research by analyzing the most recent data (2019–2023), to examine pregnancy-associated overdose deaths among pregnant and postpartum women and to assess factors associated with opioid involvement within these overdose deaths across the pre-COVID (2019), peak COVID (2020–2021), and post-peak (2022–2023) periods. While past studies examined opioid use and maternal mortality (Collier & Molina, 2019; Schiff et al., 2018), they lacked a breakdown of pandemic-related shifts. Using the syndemic framework, I explored how mental health conditions, geographic disparities, and COVID-19 disruptions impacted opioid-involved mortality amongst pregnant and postpartum women. This quantitative study uses CDC’s NCHS data to compare maternal overdose patterns across pre-COVID, peak-COVID, and post-COVID periods. The dependent variable is opioid involvement in a maternal overdose death, while opioid type, age group, and mental health conditions serve as independent variables. The pandemic period is treated as a contextual factor, and geographic region is included as a covariate. By addressing the gap in current research on COVID-19’s specific impact, this study will generate insights to inform more targeted interventions

and public health policies.

The field-based products resulting from this study will provide insights into opioid-involved mortality trends among pregnant and postpartum women by age, geography, and COVID-19 period. For policymakers, these findings can inform legislation and funding priorities that address maternal health and substance use treatment gaps. Public health practitioners may utilize this data to tailor prevention and intervention strategies to regions or populations at highest risk. For pregnant and postpartum women, the study's results can help improve access to timely, equitable care and support efforts to reduce stigma and structural barriers in maternal opioid use disorder treatment.

Research Questions and Hypotheses

This study was guided by the following two primary research questions that examine the likelihood of opioid involvement among pregnancy-associated overdose in relation to demographic characteristics, especially during different phases of the COVID-19 pandemic.

- RQ 1: What is the association between the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women when controlling for pandemic period (pre-COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023)?
 - H_0 1: There is no significant association between the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women when controlling for pandemic period.

- H_{a1} : There is a significant association between the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women when controlling for pandemic period.
- RQ 2: What is the association between geographic region, age group, and diagnosed mental health conditions and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women when controlling for pandemic period (pre-COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023)?
 - H_{02} : There is no significant association between geographic region and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre-COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023).
 - H_{a2} : There is a significant association with geographic regions and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre- COVID: 2019, peak COVID: 2020–2021, post- peak COVID: 2022–2023).
 - H_{03} : There is no significant association between age group and the likelihood that maternal overdose deaths are opioid

involved among pregnant and postpartum women across pandemic periods (pre- COVID: 2019, peak COVID: 2020–2021, post- peak COVID: 2022–2023).

- H_{a3} : There is a significant association with age and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre- COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023).
- H_{04} : There is no significant association between diagnosed mental health conditions (e.g., anxiety, depression, PTSD) and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre- COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023).
- H_{a4} : There is a significant association with diagnosed mental health conditions (e.g., anxiety, depression, PTSD) and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre- COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023).

To address RQ 2, logistic regression models were used to examine the associations between the likelihood that maternal overdose deaths are opioid involved

and the independent variables: age group, and the presence of diagnosed mental health conditions, geographic region (confounding), while controlling for the COVID-19 pandemic period. I also reviewed how these associations, including opioid involvement, shifted across the pandemic periods.

Theoretical Framework

The study is grounded in syndemic theory, which posits that co-occurring and interacting epidemics such as opioid use disorders, mental health conditions, and COVID-19 produce synergistic effects that exacerbate vulnerability and adverse health outcomes, particularly in marginalized populations. This theory allows for a deeper exploration of possible challenges faced by this population and is relevant for understanding opioid involved maternal overdose mortality, as it highlights the associations of biological, psychological, and social factors that influence perinatal health outcomes.

While awareness of the syndemic theory has increased, it remains underutilized in research on maternal overdose mortality (Singer et al., 2021). Most studies have not fully examined how opioid use disorder, mental health conditions, and structural inequities combine to increase health risks for pregnant and postpartum individuals (Austin et al., 2024; Lang et al., 2023). Syndemic theory was introduced in 1996 by Merrill Singer to explain how co-occurring epidemics driven by social and structural inequities interact synergistically to worsen health outcomes in vulnerable populations (Singer et al., 2021). Singer et al. (2021) also described major propositions of syndemic theory as: (a) two or more health conditions cluster within specific populations; (b) these conditions interact

synergistically to produce worse outcomes than would be expected in isolation; and (c) their interactions are driven by and embedded in broader social and structural contexts such as poverty, racism, and unequal healthcare access. These assumptions are particularly relevant to maternal health, where opioid use, psychiatric comorbidities, and access disparities often coexist and compound one another.

This theoretical framework aligns with the study's focus on identifying associations among opioid type, mental health diagnoses, maternal age, and geographic region across the pre-COVID, peak-COVID, and post-COVID periods. The research questions were developed to explore how these interrelated factors shift over time and across populations, enabling a multi-level analysis that reflects the complexity of maternal opioid-involved mortality. Lang et al. (2023) used syndemic theory to examine opioid-involved maternal overdose mortality by analyzing how mental health conditions and structural inequities co-occurred in overdose trends. However, no known studies have applied this framework specifically to maternal overdose mortality data particularly in the context of the COVID-19 pandemic, making this study both timely and novel.

A syndemic framework offers an understanding to address these intersecting drivers of opioid involved maternal overdose mortality. By integrating this approach, future studies can more effectively inform policies and interventions that reduce overdose deaths, promote health equity, and improve maternal outcomes across diverse populations. This theoretical framework also aligns with Section 4 of this study's public health intervention plan, which calls for comprehensive responses such as expanding integrated care models, enhancing behavioral health access, and addressing region-

specific treatment disparities for pregnant and postpartum individuals.

This syndemic interplay of OUD, mental health decline, and structural marginalization highlights the urgent need for public health interventions that address opioid use, mental health, and social determinants of health. A syndemic approach may also inform policies and interventions aimed at reducing opioid-involved maternal mortality. Despite the growing recognition of this framework, few studies have applied it to maternal overdose mortality during COVID-19. The research questions in this study are designed to reflect this theoretical framework by assessing how these intersecting factors vary across pandemic periods and demographic groups, thereby supporting a more comprehensive and equity-focused understanding of maternal opioid-involved deaths.

While it addresses intersecting factors, one limitation of applying syndemic theory is the challenge of measuring synergistic interactions using secondary, cross-sectional data. Additionally, variables such as stigma, discrimination, or informal barriers to care are often underreported, making it difficult to capture the full scope of syndemic effects. Furthermore, cross-sectional data precludes causal inference, limiting the ability to fully disentangle temporality in syndemic interactions. The constructs of syndemic theory, including co-occurring health conditions, structural factors, and their synergistic interactions, align with the study's research questions and its intervention plan, ensuring that findings are actionable in informing policies that address maternal opioid mortality through a health equity lens. This theoretical framework also aligns with the public health intervention plan in Section 4, which emphasizes addressing the intersecting drivers of maternal opioid involved overdose mortality. Constructs such as structural

marginalization and limited behavioral health access are directly tied to proposed strategies including targeting region-specific disparities in maternal health services.

Nature of Study

This study uses a retrospective cross-sectional quantitative research design to examine pregnancy-associated overdose deaths. This study is grounded in the positivist paradigm to examine associations using individual level mortality data. This design supports analysis of temporal and demographic patterns in maternal overdose mortality across the COVID-19 pandemic while enabling objective measurement and hypothesis testing using large-scale epidemiologic data. The dependent variable is opioid involvement in a maternal overdose death, operationalized through ICD-10 codes capturing unintentional or undetermined opioid-involved fatalities occurring during pregnancy or up to one year postpartum. Independent variables include opioid type, maternal age, and the presence of diagnosed mental health conditions. Geographic region, based on the U.S. Health and Human Services (HHS) regional definitions and the pandemic period serve as a critical contextual factor.

Data are drawn from the CDC's National Center for Health Statistics (NCHS) platform, specifically from the National Vital Statistics System (NVSS) mortality data, encompassing all pregnancy-associated overdose deaths nationwide during the study period. Rather than sampling, the study uses a full population enumeration to maximize statistical power and minimize bias. Data were analyzed using logistic regression models in SAS to assess associations between opioid involvement in maternal overdose deaths and the independent variables while controlling for the pandemic period. Findings are

reported through adjusted odds ratios and corresponding *p* values.

Literature Search Strategy

This study was conducted using multiple academic libraries and digital research tools, including the Walden University Library, PubMed, MEDLINE, the National Library of Medicine, the Centers for Disease Control (CDC) Library, as well as search engines such as Google Scholar and EBSCOhost. Key search terms included *opioid use disorder, opioid overdose, maternal overdose mortality, drug poisoning, pregnancy, postpartum women, COVID-19 pandemic, substance use disorders, mental health conditions, and healthcare interventions*. Broader terms such as *maternal mortality and maternal morbidity* were also included to contextualize overdose-related deaths within the wider maternal health literature. Combinations of these terms (e.g., *opioid overdose AND maternal mortality AND COVID-19*) were strategically employed to maximize relevance and retrieval of empirical sources.

The scope of the literature review spanned from foundational studies through the most recent peer-reviewed articles published between 2018 and 2024, prioritizing current research. Sources included peer-reviewed journal articles, government health surveillance reports (e.g., from CDC and NIH), and scholarly reviews addressing overdose mortality, substance use, and maternal health. Where recent literature was limited, especially regarding post-2020 maternal opioid overdose trends, supplemental sources were incorporated to ensure a thorough and balanced understanding of the research landscape.

Literature Review Related to Key Variables

Opioid Versus Non-Opioid Use and Health Outcomes

Women manage pain during pregnancy in various ways, including opioid-based treatments and non-opioid approaches for common pregnancy-related conditions such as lower back pain, pelvic girdle pain, and musculoskeletal discomfort, using supportive care and alternative pharmacologic strategies, such as clonidine. Non-opioid approaches have demonstrated potential benefits in reducing prolonged opioid exposure during pregnancy while maintaining clinical efficacy (Sithisarn et al., 2022). Non-opioid strategies, when combined with supportive interventions such as breastfeeding, are associated with improved maternal and neonatal health outcomes. Breastfeeding can serve as a therapeutic intervention by helping to reduce the severity of neonatal withdrawal symptoms and supporting maternal–infant bonding and physiologic regulation. For example, Sithisarn et al. (2022) compared opioid-based and non-opioid treatments for neonatal abstinence syndrome and found that, although opioid-based therapies are effective for symptom management, they may prolong infant hospitalization and dependency. Opioid overdose has become a leading cause of pregnancy-associated deaths in the United States, and the opioid crisis continues to have profound implications for maternal health (Han et al., 2024). Various findings have reported that opioid-involved maternal overdose mortality has surged in recent years, with fentanyl and synthetic opioids contributing to a substantial proportion of fatalities (Han et al., 2024; Kountanis et al., 2023). Research has also found that postpartum women face an elevated risk of overdose-related mortality, particularly within the first year following delivery

(Horn et al., 2024).

The impact of opioid use during pregnancy extends beyond the mother, affecting the developing fetus as well. Studies find opioid use during pregnancy to be associated with a range of adverse neonatal outcomes. For example, opioid exposure in utero can lead to neonatal abstinence syndrome (NAS), a condition characterized by withdrawal symptoms that may require prolonged hospitalization and medical intervention.

Additional research by Sithisarn et al. (2022) found that while opioid-based treatments can effectively manage NAS symptoms, they may also extend infants' dependency and length of hospital stay. In contrast, non-opioid strategies, including breastfeeding and rooming-in practices, have been linked to improved health outcomes and shorter recovery times for both mothers and infants (Eaves et al., 2021; Kelty et al., 2023). On average, NAS-related hospitalizations last more than twice as long as those for non-exposed infants, emphasizing the cost burden of care (Austin et al., 2022). In light of the growing economic strain and increasing burden of care, post-pandemic research may lend insight into long-term implications for healthcare systems that address maternal opioid health risks.

Addressing Maternal Opioid Health Risk

Maternal pain and mental health conditions can be considered comorbidities if they occur simultaneously within the same person. In the context of opioid use, this kind of co-occurrence is especially relevant, as unmanaged pain and mental health disorders are both strong predictors of opioid use and misuse and may increase vulnerability to opioid involved overdose. Maternal opioid use during pregnancy has been linked to

increased rates of severe maternal morbidity, infectious disease exposure, and co-occurring mental health disorders, all of which compound the risk of adverse maternal health outcomes (Jarlenski et al., 2022). Untreated or co-occurring mental health disorders, such as anxiety, depression, or post-traumatic stress disorder (PTSD), can influence the efficacy and uptake of non-opioid approaches and may further elevate overdose risk during pregnancy and postpartum period. To address opioid health risks among mothers, researchers suggest that upstream investments in maternal health services, including harm reduction, housing, and trauma-informed care, are crucial to reducing fatalities by preventing opioid-involved overdose deaths among pregnant and postpartum women. Such upstream investments require a deeper understanding of opioid-involved health disparities and co-occurring conditions, particularly as post-pandemic data may reveal new areas of concern.

Given the complexities of healthcare access, recognizing the challenges faced by women in obtaining non-opioid options is key to advancing equitable care. Age plays a critical role in shaping both risk and access, with younger and older reproductive-aged women potentially facing different barriers that influence overdose vulnerability. The increase in opioid-involved maternal deaths among women ages 10-44 exposed age-related disparities, necessitating targeted interventions (Han et al., 2024; Park et al, 2024).

While national overdose mortality data have historically highlighted elevated risks among older postpartum women, recent findings reveal a concerning rise in opioid-involved overdose deaths among adolescents and young adults, particularly during the

COVID-19 pandemic (Shiels et al., 2022). Shiels et al. (2022) reported that opioid overdose became a leading cause of death among U.S. adolescents during 2020–2021, highlighting a shift that challenges previous assumptions about age-related vulnerability. This emerging pattern may suggest a need to reassess how maternal age is conceptualized in overdose prevention frameworks, as risk is no longer concentrated among older cohorts alone.

Overdose risk among reproductive-aged women during the pandemic period exhibits variations by age. Mejia et al. (2024) reported a surge in treatment admissions and opioid involved overdose deaths among women under 25 and those aged 25–34, citing the mental health strain, economic disruption, and healthcare barriers induced by the pandemic as contributors. These disparities display the importance of understanding how systemic barriers and access to care may affect age groups. Simeon et al. (2021) suggested that older adults experience greater barriers to digital and harm reduction services while younger women were more likely to engage with harm reduction services and virtual prenatal programs, while older women faced more limited access, increasing their vulnerability to fatal overdose. Despite these increases, evidence from Jarlenski et al. (2022) and Smid et al. (2022) reveals that older postpartum women, particularly those over 35, continued to face heightened mortality risk due to delayed treatment initiation, postpartum care discontinuity, and limited behavioral health resources. These findings indicate a bifurcated risk landscape, with overdose deaths rising among younger women and persistent vulnerabilities among older women, demonstrating the need for additional research on mental health and structural barriers to examine the association between

maternal age and opioid involved overdose mortality. Addressing mental health and structural barriers may enable the development of age-specific interventions to reduce overdose mortality among reproductive-aged women while highlighting the need for a policy shift that accounts for age-specific vulnerabilities in overdose prevention.

The literature highlights a gap in maternal health policies and overdose prevention strategies, which often overlook the age-specific needs of pregnant and postpartum women. Moreover, the intersection of age with structural inequities, such as healthcare access, geographic location, and socioeconomic stressors, exacerbates these disparities in opioid involved maternal overdose deaths, necessitating a more targeted response. Further research is needed to understand how pandemic-related policy changes, such as telehealth expansion and Medicaid extensions, may have unevenly affected maternal overdose risk across age groups. Considering opioid-involved morbidity and mortality impacts such a broad group of women, understanding age-based differences in opioid use during pregnancy may serve as a foundation for informing efforts to improve access and reduce treatment barriers associated with overdose mortality.

Geographic variation can further complicate access, as rural and underserved regions may lack providers trained in non-opioid pain management or integrated care models. Higher overdose rates observed in rural areas of the United States and in regions with limited access to opioid use treatment services suggest that geographic variation may lend insight to opioid involved maternal overdose outcomes (Leech et al., 2023). Other structural inequities, including racial and socioeconomic disparities, impact maternal health outcomes, with Black and Indigenous women experiencing

disproportionately higher opioid-involved maternal mortality rates (Collier & Molina, 2019). These disparities reflect intersecting structural factors, including systemic racism in healthcare, limited access to high-quality prenatal and behavioral health services, heightened exposure to chronic stress and economic instability, and greater likelihood of undertreatment or delayed treatment for pain and substance use disorders. Together, demographic and geographic factors reflect the multifaceted nature of opioid-involved maternal health disparities. Examining differences across time periods can provide insight into how these intersecting factors have evolved, revealing areas where inequities have been exacerbated or alleviated in relation to overdose mortality.

A comparative study across pandemic periods would help identify how shifting healthcare landscapes affected maternal access to non-opioid treatments and the subsequent outcomes, providing a richer understanding of the broader impact on maternal health and overdose mortality. Research that disaggregates outcomes across these dimensions is critical to developing equitable, targeted interventions that reduce opioid-involved maternal overdose mortality while addressing structural barriers to care.

Pregnancy-Related and Pregnancy-Associated Overdose Deaths

Pregnancy-associated overdose deaths represent a critical and preventable contributor to maternal mortality in the United States, particularly during the postpartum period, where overdose mortality ratios have been shown to increase substantially compared with earlier in pregnancy. National data indicate that drug overdose is a leading cause of death for pregnant and postpartum women, with overdose mortality ratios more than tripling from 2018 to 2021 in some age groups (NIDA, 2023). Unlike traditional

obstetric causes of death, which occur primarily in the hospital setting, most pregnancy-associated overdose deaths occur outside healthcare settings, pointing to gaps in continuity of care and access to services (Han et al., 2024).

Maternal mortality reviews and public health analyses have consistently identified substance use, especially substance use disorders and overdose, as major contributing factors to pregnancy-associated deaths, emphasizing the need for integrated substance use and maternal health strategies (Duggal et al., 2025). The findings of this study highlight how opioid involvement compounds these vulnerabilities, reinforcing the need for maternal health strategies that extend beyond delivery and explicitly address substance use and mental health risk across the full perinatal continuum.

Maternal Health across Pandemic Periods

Few studies have examined opioid-involved maternal overdose mortality amid the COVID-19 pandemic and evolving healthcare policies. Evidence links prenatal opioid exposure to elevated infant mortality rates, particularly among populations with limited access to integrated maternal and behavioral health services (Grossarth et al., 2023). These findings emphasize the importance of sustained, coordinated care beyond delivery to reduce both maternal overdose risk and adverse infant outcomes. Grossarth et al. extends the literature by demonstrating that disparities in healthcare access, not just opioid exposure, play a pivotal role in infant outcomes. This emphasizes the importance of healthcare access, which may exacerbate the effects of opioid exposure on neonatal health and contribute to elevated maternal overdose vulnerability during the postpartum period. These intersecting influences highlight the need for policy-driven solutions such

as Medicaid expansion to improve maternal and infant health outcomes and reduce overdose related mortality.

Medicaid is a source of maternal health coverage that assists in ensuring access to perinatal care, including treatment for opioid use disorder (OUD). The expansion of Medicaid postpartum coverage to 12 months, now adopted by the majority of U.S. states, provides an opportunity to ensure continuity of care for women with opioid use disorder (OUD) and their infants during this high-risk period (KFF, 2024). Despite the policy advances, gaps remain in understanding how maternal age, opioid exposure, and pandemic-related policy shifts impact maternal overdose risk and mortality, highlighting the need for further research.

The surge in opioid-involved maternal overdose deaths from 2019 to 2023, exacerbated by the COVID-19 pandemic, reflects shifting opioid use patterns, increased overdose risk, and disparities in healthcare access (Frankeberger et al., 2023). While recent studies have highlighted the rise in opioid-involved maternal deaths during pregnancy and the postpartum period, other analyses have noted a lack of comprehensive data spanning the full perinatal continuum, particularly in the context of evolving drug trends and healthcare disruptions (West & Terplan, 2023). To inform targeted and equitable interventions, additional research is needed to align national efforts for maternal health advancement and the reduction of opioid involved overdose deaths among reproductive-aged women.

Opioid Use Patterns (Demographic & Geographic) Before the Pandemic

Prior to the onset of the COVID-19 pandemic, opioid use among pregnant and

postpartum women in the United States demonstrated geographic and demographic disparities, highlighting inequities in both exposure and access to treatment that contributed to differential risk for opioid involved overdose mortality. Women residing in rural populations, defined as less urbanized counties with lower population density and more limited access to healthcare services, faced heightened vulnerability due to limited access to comprehensive opioid use disorder (OUD) services and fewer providers to administer medication-assisted treatment (Bryan et al., 2020; Nguemeni Tiako et al., 2020). Simultaneously, racial and ethnic minorities experienced elevated rates of opioid use stigma, further complicating engagement with prenatal care and behavioral health support (Cleveland et al., 2020; Crawford et al., 2022).

Research shows the rising prevalence of polysubstance use, particularly the co-use of opioids with stimulants or alcohol, increases the risk of overdose and adverse maternal and neonatal outcomes (Qato et al., 2020; Guille et al., 2020). Polysubstance use has been identified as a key driver of opioid-involved overdose mortality, amplifying overdose risk among pregnant and postpartum women. While telehealth and integrated care models emerged as promising solutions, pre-pandemic research indicates they did not consistently reach underserved communities, raising concerns about their long-term effectiveness in addressing maternal health disparities and preventing overdose deaths (Coffey et al., 2024; Guille et al., 2020).

The shifting landscape of drug availability, public health policies, and healthcare delivery systems since 2020 exhibits a critical need to revisit and contextualize these patterns. Focusing on opioid type and intersecting geographic, demographic, and mental

health factors, this research addresses a gap in the literature seeking to inform more equitable, data-driven interventions for reducing maternal overdose deaths. These pre-pandemic disparities set the stage for exacerbated inequities during the pandemic. However, post-pandemic patterns remain underexplored.

Opioid Use Patterns (Demographic & Geographic) During the Pandemic

Before the COVID-19 pandemic, patterns of opioid use reflected disparities impacted by demographic and geographic factors. Research confirms that individuals with preexisting opioid use disorders in lower socioeconomic groups, including racial and ethnic minorities, were disproportionately affected, which deepened during the pandemic (Christy et al., 2022, Spencer et al., 2022, West et al., 2023). Some studies link this increase to pandemic-related economic instability, whereas others describe health disparities as the more influential driver. Bryan et al. (2020) found that rural pregnant and postpartum women with OUD faced compounded challenges due to both economic instability and limited access to care. These barriers resulted in delayed or inadequate treatment, further exacerbating disparities in opioid use outcomes. Similarly, Nielsen et al. (2020) highlighted that racial and ethnic minority women with opioid use disorder were less likely to receive medication-assisted treatment (MAT), reinforcing the role of pre-existing health disparities in driving opioid use trends during the pandemic.

Geographic patterns reveal an increase in fentanyl-related fatalities in urban areas, where synthetic opioids accounted for most overdose deaths (West et al., 2023), especially among reproductive-aged women. Rural communities faced limited access to treatment, though studies differ on whether opioid use increased simultaneously in urban

areas (Christy et al., 2022; Spencer et al., 2022). Beyond geography, pandemic-related stressors, such as social isolation and economic hardship, job loss, and financial strain, further contributed to increased opioid use among vulnerable populations (Spencer et al., 2022). Varied findings reveal the need for additional maternal health research to examine how pandemic-related stressors have shaped opioid use patterns and outcomes related to maternal overdose mortality among pregnant and postpartum women.

Mental Health Pre- and Post-Pandemic

Mental health issues were prevalent before the pandemic, exposing deepened vulnerabilities in the behavioral health system. These effects were especially pronounced among pregnant and postpartum individuals, whose risks were amplified by limited access to coordinated mental health and addiction services. As the crisis progressed, anxiety, depression, and opioid use disorders (OUDs) surged, driven by social isolation, economic precarity, and systemic healthcare gaps (McDonald et al., 2020; Pfefferbaum & North, 2020). Longitudinal data reveal that suicide and overdose fatalities reached historic highs, with perinatal individuals experiencing uniquely elevated risks exhibiting a demand for integrated mental health and addiction services (Austin et al., 2024; Czeisler et al., 2021; Kountanis et al., 2023). These risks were compounded by widening disparities in access to behavioral health services, particularly for pregnant and postpartum women living in underserved areas. In Appalachia, medication-assisted treatment (MAT) access declined by 28% during lockdowns, exacerbating barriers for pregnant individuals with opioid use disorder (OUD). Broader patterns across the United States revealed that women, racial/ethnic minorities, low-income populations, and

frontline workers faced compounded stressors, exacerbating pre-existing inequities in mental health care (Margerison et al., 2022; Thomeer et al., 2023). These disparities reflect the influence of structural determinants such as poverty, racism, and geographic isolation on both mental health and opioid use outcomes. Cross-national studies further emphasize that marginalized groups not only had fewer coping resources during the pandemic but also experienced higher rates of untreated psychiatric symptoms thereafter (Xiong et al., 2023; WHO, 2022). In response, programs like California’s Perinatal MAT Expansion Project, which led to a 22% reduction in overdoses, demonstrate the potential of targeted, perinatal-focused interventions.

While such programs signal progress, additional research is needed to evaluate the long-term impact and scalability, requiring coordinated investments in mental health infrastructure and policy reforms that address the root causes of psychological distress, particularly among pregnant and postpartum populations.

Definitions

Age Group: Stratified by maternal age ranges (e.g., ages 10-54) used in CDC mortality data (Shiels et al., 2023).

Diagnosed Mental Health Conditions: Mental and behavioral health disorders documented on the death certificate as contributing conditions and classified under ICD-10 codes F01–F99. This variable reflects only conditions recorded at death and does not capture undiagnosed or untreated mental health disorders. (Jarlenski et al., 2022; Lang et al., 2023).

HHS Regions: The United States Department of Health and Human Services divides states into ten administrative regions. Region 1 (CT, ME, MA, NH, RI, VT); Region 2 (NJ, NY); Region 3 (DE, DC, MD, PA, VA, WV); Region 4 (AL, FL, GA, KY, MS, NC, SC, TN); Region 5 (IL, IN, MI, MN, OH, WI); Region 6 (AR, LA, NM, OK, TX); Region 7 (IA, KS, MO, NE); Region 8 (CO, MT, ND, SD, UT, WY); Region 9 (AZ, CA, HI, NV); Region 10 (AK, ID, OR, WA).

Mental Health Condition: Diagnosed psychiatric disorders such as depression (F32–F33), anxiety (F41), or PTSD (F43.1) (Jarlenski et al., 2022; Lang et al., 2023).

Opioid Use / Opioid Type: Categorized based on ICD-10 multiple cause of death codes (e.g., T40.0–T40.4 and T40.6) for opioid-involved maternal deaths in CDC NCHS (Han et al., 2024; Schiff et al., 2018).

Pandemic Period: Time-based context variable defined as pre-COVID (2019), peak COVID (2020–2021), and post-peak COVID (2022–2023) (Han et al., 2024).

Geographic Region: Grouped into 10 U.S. Department of Health and Human Services (HHS) regions (Leech et al., 2023; West & Terplan, 2023).

Pregnancy-Associated Death: Death during pregnancy or within one year postpartum, regardless of cause (Horon & Cheng, 2007; Collier & Molina, 2019).

Pregnancy-associated overdose death: A death resulting from drug poisoning (ICD-10 X40–X44; Y10–Y14) occurring during pregnancy or within one year postpartum.

Pregnant and Postpartum Women: Women who are pregnant or within one year postpartum at the time of death (Schiff et al., 2018; Han et al., 2024).

Rural: Defined using the National Center for Health Statistics (NCHS) Urban–Rural Classification Scheme for Counties and refers to living in a less urbanized county with lower population density and more limited access to healthcare services.

Syndemic: The co-occurrence and interaction of multiple health conditions (e.g., substance use, mental illness, social inequities) that amplify harm and contribute to increased risk of opioid-involved maternal overdose mortality (Singer et al., 2021; Lang et al., 2023).

Assumptions

This study assumes that the cause-of-death data captured in the CDC’s NCHS data database is accurate, consistent across states, and sufficiently detailed to identify opioid-involved maternal overdose deaths. It is also assumed that the ICD-10 codes used to classify drug poisoning and opioid-involvement are reliably assigned and reflect true substance involvement, despite known limitations in toxicology reporting and death certificate accuracy. Another critical assumption is that pandemic-related disruptions temporally align with the designated COVID-19 periods used in the analysis, pre-pandemic, peak pandemic, and post-peak pandemic, and meaningfully reflect shifts in maternal overdose risk. These assumptions are necessary to ensure the feasibility of conducting a national-level trend analysis using existing surveillance data and to support valid interpretation of observed associations specific to opioid-involved maternal overdose mortality despite constraints in available information.

Scope and Delimitations

The specific focus on these variables enhances internal validity by narrowing the

analysis to temporal and demographic factors most likely to affect opioid involved maternal overdose mortality outcomes. By structuring the study around clearly defined categories and periods, the research isolates the effects of the pandemic and geographic disparities from other potential confounders relevant to overdose mortality. This design limits alternative explanations and supports associational inference within the study's observational framework.

The boundaries of the study are defined by its population and theoretical scope. The study includes pregnant-associated overdose deaths among pregnant and postpartum women. The analysis evaluates opioid involvement within this overdose-death population with the use of CDC's NCHS data. It excludes non-maternal populations, men, and individuals who died of causes unrelated to drug overdose or opioid involvement. The study also focuses solely on U.S. data, excluding global or cross-national comparisons. While syndemic theory is used as the guiding theoretical framework, other relevant frameworks, such as the Health Belief Model, are not applied in this study, although they may offer complementary insights. This theoretical narrowing contributes to external validity by acknowledging which lenses were not used to interpret the data. Generalizability is limited by the exclusion of data on non-fatal overdoses and reliance on mortality data, which may underreport certain cases due to stigma, misclassification, or inconsistent cause-of-death reporting across jurisdictions for opioid-involved maternal overdose deaths.

Limitations

Despite these limitations, the study offers valuable, targeted insights into a high-

risk population experiencing opioid-involved maternal overdose mortality and lays the foundation for more comprehensive, multisectoral intervention strategies. Reliance on death certificate data may lead to misclassification of maternal status or opioid involvement, limiting construct validity. External validity is constrained by the focus on U.S.-based opioid-involved maternal overdose deaths and the exclusion of non-fatal overdoses or individual-level socioeconomic factors. Unmeasured confounders like race, income, or healthcare access may also influence findings.

Misclassification and reporting biases may arise from inconsistencies in documenting pregnancy status or opioid involvement on death certificates, which can lead to undercounting or misidentification of maternal opioid-involved deaths. To reduce these risks, the study uses standardized ICD-10 codes and CDC NCHS criteria to ensure consistency across states. The use of population-level data minimizes selection bias by including all eligible cases. Geographic region and pandemic period serve as proxies for unmeasured factors like race and income. These limitations are acknowledged, with future research recommended use of linked datasets or mixed methods to provide deeper context. To address study limitations, standardized ICD-10 codes and national surveillance data are used to improve consistency and minimize misclassification. Acknowledging data gaps, the study recommends future research using linked datasets and mixed methods for deeper insights. These strategies may enhance validity and support a better understanding of maternal opioid-involved overdose mortality across diverse populations.

Significance

This study advances knowledge by providing a syndemic-informed, population-level analysis of pregnancy-associated overdose deaths, with particular attention to opioid involvement, across distinct COVID-19 time periods in the United States. By examining associations by age, geographic region, and opioid type, this research addresses a critical gap in the literature where pregnancy-associated maternal mortality and substance related overdose deaths are not often integrated. Pregnancy-associated overdose deaths represent a preventable and increasingly prominent contributor to maternal mortality, particularly during the postpartum period, emphasizing the need for targeted investigation beyond traditional obstetric causes of death. The findings may inform more equitable public health responses, guide policy reforms in maternal health and substance use treatment and support targeted interventions that address structural and temporal drivers of pregnancy-associated overdose deaths with opioid involvement. This research may advance public health practice and policy by identifying high-risk subpopulations, such as younger or geographically isolated pregnant and postpartum women, for targeted intervention.

The findings can inform maternal health programs, guide the expansion of integrated perinatal care models, and support policies that extend postpartum care coverage and strengthen overdose surveillance. Given the disproportionate contribution of opioids to pregnancy-associated overdose mortality, these findings emphasize the importance of integrating substance use and mental health services into routine perinatal and postpartum care. Additionally, the syndemic approach can help policymakers and

practitioners prioritize structural interventions that address the intersecting drivers of opioid-involved pregnancy-associated overdose deaths, such as health care access, mental health support, and harm reduction services.

Findings may support positive social change by highlighting systemic gaps in maternal care for women affected by opioid use during and after pregnancy. By identifying when and where maternal opioid-involved deaths are most likely to occur, the research can help communities and health systems develop more responsive, equitable support services. It also reinforces the importance of addressing structural barriers such as limited access to postpartum care, mental health services, and harm reduction to reduce preventable maternal deaths. These insights can empower stakeholders to advocate for policies and practices that improve outcomes for vulnerable women and their families.

Summary and Conclusions

This chapter synthesizes existing research on opioid use and its impact on maternal health, particularly across three distinct COVID-19 periods: pre-pandemic, during the pandemic, and post-pandemic. Key findings highlight the effects of opioid use during pregnancy, linking it to a range of adverse maternal and neonatal outcomes, including opioid overdose, neonatal abstinence syndrome (NAS), and prolonged hospitalization. Pregnancy-associated overdose deaths have emerged as a leading cause of maternal mortality in the United States, particularly during the first year postpartum, reflecting gaps in continuity of care and behavioral health support. Rising opioid involvement, particularly from fentanyl and other synthetic opioids, has further

intensified these risks during the postpartum period. Concurrent mental health disorders have compounded the risks of opioid misuse, contributing to elevated maternal morbidity and mortality. Structural inequities in healthcare access, geography, and race have disproportionately affected vulnerable populations, exacerbating opioid-involved maternal morbidity and mortality.

Despite advancements, few studies have fully integrated a syndemic framework to examine the intersection of opioid use disorder, mental health decline, and structural marginalization in pregnancy-associated overdose mortality. Limited research has examined how these intersecting factors have shaped opioid-involved outcomes across COVID-19 periods and demographic groups. Moreover, while some studies highlight regional disparities, especially in rural and underserved communities, there is a lack of comprehensive data that spans the full perinatal continuum, including the post-pandemic period. Further research is needed to explore these gaps and how the pandemic and its resulting healthcare policies have influenced opioid-involved maternal health outcomes. By applying a syndemic approach, this research aims to build on previous studies and expand the understanding of pregnancy-associated overdose deaths and the disproportionate role of opioid involvement, particularly in the post-pandemic context, to promote health equity and improve maternal health outcomes in vulnerable populations.

Section 2: Research Design and Data Collection

Introduction

This study examined opioid involvement among pregnancy associated overdose deaths in the United States from 2019-2023, with an emphasis on how these patterns may have changed during the COVID-19 pandemic. Using quantitative methods, this study investigated how opioid involvement intersects with pregnancy associated overdose mortality during the COVID-19 pandemic. The timeframe is divided into three distinct periods: pre-pandemic (2019), peak pandemic (2020-2021), and post-peak pandemic (2022-2023) periods to assess how mortality outcomes may have shifted over time. This section provides an overview of the research design and rationale guiding the study, followed by a detailed description of the methodology, including the operationalization of key constructs. It also addresses potential threats to validity, outlines the ethical considerations relevant to the study, and concludes with a summary that synthesizes the key components of the research design and data collection approach.

Research Design and Rationale

This study explores key variables central to understanding opioid involvement among pregnancy associated overdose deaths within the context of the syndemic theoretical framework. The primary dependent variable is opioid involvement in a maternal overdose death, defined using ICD-10 codes for drug poisoning deaths with opioid involvement occurring during pregnancy or within one year postpartum. Independent variables include opioid type, maternal age group, and the presence of diagnosed mental health conditions. Geographic region is a confounding variable used to

assess structural differences in healthcare access across the United States. The pandemic period, categorized into pre-COVID (2019), peak COVID (2020 to 2021), and post-peak COVID (2022 to 2023), serves as a moderating variable to understand temporal comparisons and potential shifts in opioid-involvement among maternal overdose deaths across the COVID-19 pandemic. The interaction of these variables allows for an exploration of how opioid-involved maternal overdose mortality varies by demographic.

A retrospective cross-sectional design is consistent with the time and resource constraints inherent to public health research that relies on national-level surveillance data. The selection of a retrospective design using CDC NCHS data reflects both practical and methodological considerations. Collecting primary data on maternal mortality would be time prohibitive and ethically complex, particularly given the sensitive nature of pregnancy-associated overdose deaths. The use of publicly available, de-identified surveillance data mitigates these challenges and ensures timely, cost-effective access to nationally representative data. Additionally, the design supports full population enumeration rather than sampling, which enhances the statistical power and generalizability of findings without requiring additional resource-intensive procedures.

By analyzing pregnancy-associated overdose deaths identified within national mortality surveillance data across multiple years, the study can detect population-level patterns and regional disparities in opioid involvement essential for informing evidence-based interventions and policy decisions. Integrating the syndemic framework further enables a comprehensive analysis of comorbidities—such as opioid use and mental health disorders—within the context of structural inequities. Together, these elements support

the development of targeted, equitable strategies to reduce opioid-involved maternal overdose mortality and advance maternal health research.

Methodology

The target population for this study comprises pregnant and postpartum women (up to 1 year after delivery) in the United States who experienced pregnancy-associated overdose deaths between 2019 and 2023. Rather than employing sampling techniques, this study analyzes the entire population of cases meeting the inclusion criteria, representing a complete enumeration of relevant mortality events across the United States and the District of Columbia. This comprehensive approach ensures maximum statistical power and eliminates sampling bias that might otherwise affect the reliability of findings. The estimated population of interest includes several hundred pregnancy associated opioid involved overdose deaths between 2019 and 2023, as recorded in the CDC NCHS database. This analytic sample represents a subset of pregnancy-associated maternal deaths occurring in the United States and the District of Columbia between 2019 and 2023.

The data for this study were obtained from the Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics (NCHS) system, specifically leveraging the National Vital Statistics System (NVSS). The dataset includes all pregnancy-associated overdose deaths with opioid involvement occurring in the United States from 2019 through 2023, providing a complete enumeration rather than a sampled subset. Thus, the sampling strategy employed was a full population census, not a probabilistic or non-probabilistic sampling method such as random, stratified, or

convenience sampling. The dataset encompasses all cases meeting the inclusion criteria, thereby enhancing statistical power and minimizing selection bias inherent in sampling approaches. The procedures used to generate the data were standardized and conducted through state and local vital statistics offices, which collect and submit death certificate data to the NVSS. Each record includes ICD-10 coded information regarding cause of death, decedent characteristics (e.g., age, pregnancy status), and contextual factors. For this study, opioid-involved overdose deaths were defined as a subset of pregnancy-associated overdose deaths occurring during pregnancy or within one year postpartum and were identified using ICD-10 underlying cause-of-death codes for drug poisoning (X40–X44, Y10–Y14) with evidence of opioid involvement based on multiple-cause-of-death codes (T40.0–T40.4, T40.6). Opioid involvement was assessed within this population using opioid-specific multiple-cause-of-death codes (T40.0–T40.4, T40.6) and served as the primary outcome variable. Inclusion criteria were defined as women aged 10–54 years whose deaths occurred in the United States during pregnancy or within one year postpartum and were classified as opioid-involved overdose deaths based on ICD-10 codes. Exclusion criteria included non-maternal deaths, male decedents, and individuals outside the defined age range. These parameters ensured that only cases relevant to the research questions were retained for analysis.

Access to the dataset was granted through a formal application process to obtain restricted-use, individual-level mortality data from the NCHS via CDC. Although the CDC NCHS platform offers publicly available, aggregated data, this study required access to more detailed, individual-level records not accessible through the standard

public interface. Approval was obtained through submission of a research proposal and data use agreement in accordance with NCHS research protocols. As the dataset consists of de-identified individual-level records, the study was determined exempt from the Institutional Review Board therefore strict adherence to CDC data security protocols and confidentiality guidelines was maintained throughout the research process.

The CDC NCHS system is a reputable and widely used epidemiologic database that supports rigorous public health research. It adheres to standardized data collection protocols and quality assurance procedures across jurisdictions, ensuring data integrity and comparability. The NVSS is the nation's most comprehensive source of mortality data and is considered the gold standard for analyzing cause-specific death trends. This dataset represents the most appropriate and robust source for examining opioid-involved maternal overdose mortality in the United States. Its national scope, standardized coding, inclusion of all relevant cases, and stratification capabilities by time, geography, and demographic characteristics make it uniquely suited for the study's objectives. It enables a comprehensive and generalizable analysis of maternal opioid mortality patterns across the pre-pandemic, peak pandemic, and post-pandemic periods, thereby informing timely public health interventions and advancing evidence-based policy efforts.

Because this study uses secondary, population-level data from the CDC's NCHS Vital Statistics System, the analytic sample represents a full enumeration of all relevant pregnancy associated opioid-involved overdose deaths from 2019–2023. A traditional a priori power analysis is not applicable; however, a G*Power calculation confirmed that the available sample size far exceeds the minimum threshold required to detect small

effect sizes (Cohen's $w = 0.2$) with 80% power at $\alpha = 0.05$. This verification demonstrates sufficient statistical precision for logistic regression analyses and supports the reliability of observed associations.

Operationalization

The theoretical framework guiding this study has been operationalized through carefully defined variables that capture the multidimensional nature of opioid involvement among pregnancy-associated overdose deaths. The dependent variable in this study is pregnancy-associated overdose death, defined as a drug poisoning death occurring during pregnancy or within one year postpartum. For analytic consistency, pregnancy-associated overdose deaths were restricted to unintentional and undetermined intent drug poisonings, identified using ICD-10 underlying cause-of-death codes X40–X44 and Y10–Y14; intentional overdose deaths (X60–X64, X85) were excluded from all analyses. Within this analytic sample of pregnancy-associated overdose deaths, opioid involvement is operationalized as a dichotomous exposure variable, measured as 1 = opioid-involved overdose death and 0 = non-opioid-involved overdose death, based on the presence of opioid-specific multiple-cause-of-death codes (T40.0–T40.4, T40.6). Opioid involvement serves as the primary outcome of interest in the logistic regression analyses examining factors associated with opioid involvement among overdose deaths. An additional analytic variable, opioid type, is operationalized using opioid-specific ICD-10 T-codes to categorize the substances involved in the overdose (e.g., natural and semi-synthetic opioids, methadone, synthetic opioids other than methadone). This variable supports descriptive and stratified analyses and supports examination of shifts in

substance involvement across pandemic periods. The variables have been structured to address the research questions:

- **Opioid Type:** This independent variable captures the specific opioid substance(s) involved in pregnancy-associated overdose deaths. Opioid involvement is identified using ICD-10 multiple cause-of-death T-codes (T40.0–T40.4 and T40.6), including heroin (T40.1), natural and semi-synthetic opioids (T40.2), methadone (T40.3), and synthetic opioids other than methadone (T40.4, e.g., fentanyl). Drug overdose deaths are identified using ICD-10 underlying cause-of-death codes for drug poisoning (X40–X44 and Y10–Y14), consistent with NVSS definitions. Intentional overdose codes (X60–X64, X85) are excluded to align with the analytic dataset. Each opioid type is coded as a binary variable (1 = present, 0 = not present) to allow for logistic regression analyses. Scores reflect the presence or absence of a specific opioid type listed on the death certificate.
Example: A case coded with T40.4 indicates pregnancy associated overdose death involving synthetic opioids.
- **Pandemic Period:** This moderating variable captures the time period in which the pregnancy associated death occurred. It is operationalized as a three-level categorical variable: pre-COVID (2019), peak COVID (2020–2021), and post-peak COVID (2022–2023). This classification allows for analysis of temporal shifts in opioid involvement among maternal overdose deaths across the COVID-19 pandemic.
Example: A death occurring in May 2020 is coded as occurring during the peak

COVID period.

- **Pregnancy Status:** This variable identifies whether the decedent was pregnant at the time of death or within one year postpartum. It is determined based on pregnancy checkbox indicators rather than ICD-10 codes alone and is coded as binary (1 = pregnant/postpartum, 0 = not). Only cases meeting the pregnancy associated criteria are included in the analytic sample.

Example: A death certificate indicating death withing 12 months postpartum is classified as pregnancy associated.

- **Geographic Region:** This confounding variable captures regional variation based on the ten U.S. Department of Health and Human Services (HHS)-defined regions. Each descendant is assigned to a region based on their state of residence at the time of death. This operationalization facilitates the identification of region-specific mortality patterns I opioid involved maternal overdose mortality while maintaining statistical power for subgroup analysis.

Example: A death in Alabama would be assigned to HHS Region 4 (Southeast).

- **Age Group:** Age at the time of death is operationalized as an independent variable using collapsed age categories derived from CDC mortality reporting. For analytic purposes, age is grouped into under 25 years, 25–34 years, and 35 years or older. These groupings reflect standard maternal health research classifications and allow for age-specific analysis. For regression analyses, age categories were combined to ensure sufficient observations and model stability, more detailed age groupings are presented in descriptive analyses to illustrate distributional patterns.

Example item: A 22-year-old woman who died postpartum would be classified as under 25 years.

- **Diagnosed Mental Health Conditions:** This independent variable captures the presence of mental and behavioral health disorders, identified using ICD-10 codes F01-F99. Common diagnoses include depression (F32–F33), anxiety (F41.0), and post-traumatic stress disorder (F43.1). Each condition is recorded as a binary variable (1 = condition present, 0 = condition not present), allowing for analysis of their potential association with opioid involvement among maternal overdose deaths.

Example: A death certificate listing F33.1 would indicate a diagnosis of recurrent depressive disorder.

Together, these variables support a comprehensive, syndemic-informed analysis of opioid involvement among pregnancy-associated overdose deaths, enabling the exploration of how opioid type, mental health status, age, and geography interact with pandemic-period context to influence maternal overdose mortality outcomes.

Data Analysis Plan

Maternal mortality data were uploaded to the CDC Virtual Data Enclave (VDE) platform and analyzed using SAS® version 9.4 software. This study utilized secondary data extracted from national mortality records. Data cleaning involved several steps to ensure analytic readiness and followed the NCHS provided codebook. Variables were restricted to those relevant to the research questions, including age (AGEREC27), geographic region (HHS_region), opioid involvement among overdose deaths

(any_opioid), underlying cause of death (icd10_3), pandemic period (YEAR), and diagnosed mental health condition (Any_MH). All categorical variables were labeled consistently, frequencies were verified, and records with missing data were removed prior to analysis. The analytic sample was restricted to pregnancy-associated overdose deaths occurring during pregnancy or within one year postpartum.

RQ1: What is the relationship between the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women when controlling for pandemic period (pre-COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023)?

- H_1 : There is no significant association between the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women when controlling for pandemic period.
- H_{a1} : There is a significant association between the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women when controlling for pandemic period.

RQ2: What is the association between geographic region, age group, and diagnosed mental health conditions and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women when controlling for pandemic period (pre-COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023)?

- H_2 : There is no significant association between geographic region and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre-COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023).

- H_{a2} : There is a significant association with geographic regions and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre- COVID: 2019, peak COVID: 2020–2021, post- peak COVID: 2022–2023).
- H_3 : There is no significant association between age group and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre- COVID: 2019, peak COVID: 2020–2021, post- peak COVID: 2022–2023).
- H_{a3} : There is a significant association with age and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre- COVID: 2019, peak COVID: 2020–2021, post- peak COVID: 2022–2023).
- H_4 : There is no significant association between diagnosed mental health conditions (e.g., anxiety, depression, PTSD) and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre- COVID: 2019, peak COVID: 2020–2021, post- peak COVID: 2022–2023).
- H_{a4} : There is a significant association with diagnosed mental health conditions (e.g., anxiety, depression, PTSD) and the likelihood that maternal overdose deaths are opioid involved among pregnant and postpartum women across pandemic periods (pre- COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023).

Descriptive statistics, including frequencies and percentages, will be used to summarize categorical variables such as geographic region, opioid involvement, age group, presence of diagnosed mental health conditions, opioid type, and COVID-19 pandemic period. The first model (RQ1) will examine the association between pandemic period and the likelihood that a pregnancy-associated overdose death involved opioids, with pandemic period (pre-COVID, peak COVID, post-peak COVID) serving as an independent variable to account for temporal shifts in overdose patterns associated with the COVID-19 pandemic. The second model (RQ2) will expand upon this by incorporating geographic region, age group, and presence of diagnosed mental conditions, while controlling for the pandemic period. Age group and diagnosed mental health conditions were specified as independent variables, and geographic region was included as a confounding variable to account for structural and regional variation in healthcare access, drug supply, and overdose risk.

Results will be interpreted using odds ratios (ORs), 95% confidence intervals (CIs), and p-values. Odds ratios greater than one will indicate increased odds that a pregnancy-associated overdose death involved opioids, whereas odds ratios less than one will indicate reduced odds relative to the reference group. Statistical significance will be determined at $\alpha = 0.05$, and findings will be contextualized in relation to maternal overdose risk factors, geographic variation, and the influence of the COVID-19 pandemic.

Threats to Validity

This study employs secondary analysis of de-identified public health surveillance

data, which minimizes traditional ethical concerns associated with primary research involving human subjects. A data use agreement (DUA) was executed with the National Center for Health Statistics (NCHS) at the Centers for Disease Control and Prevention (CDC), ensuring compliance with all security protocols. In accordance with this agreement, all data will be used solely for the approved research purposes and securely destroyed upon the conclusion of the study.

Several potential threats to validity have been identified and addressed in the research design. External validity considerations include the generalizability of findings to pregnancy-associated overdose deaths across all U.S. regions and potential underreporting in the surveillance system, particularly for maternal deaths where pregnancy status may not be consistently recorded. Internal validity challenges include the limitations inherent in death certificate data accuracy, potential misclassification of cause of death, and inconsistent reporting of pregnancy status across jurisdictions. Statistical conclusion validity concerns are addressed through appropriate sample size determination, consideration of multiple testing issues, and careful interpretation of statistical findings.

Despite these limitations, the comprehensive nature of the NCHS data, combined with the robust analytical approach, positions this study to make significant contributions to understanding opioid-involved maternal overdose mortality patterns during a critical period in public health history. The findings will provide valuable insights to inform targeted intervention strategies and policy recommendations aimed at reducing opioid-involved maternal overdose deaths in the post-pandemic context.

Ethical Procedures

This study utilizes restricted, deidentified individual-level mortality data from the Centers for Disease Control and Prevention (CDC) National Vital Statistics System (NVSS), accessed through the CDC Virtual Data Enclave (VDE) under a formal Data Use Agreement (DUA) between the researcher and the National Center for Health Statistics (NCHS). The DUA outlines the provisions for data access, analysis, and secure destruction following completion of the approved research project. The dataset was analyzed through the VDE and fully de-identified prior to researcher access; direct identifiers (e.g., names, addresses, Social Security numbers) were never included in the analytic files. All analyses occurred within the secure CDC VDE environment, which prohibits data exportation, downloading, or external sharing of record-level data. Data access is restricted to the principal investigator and NCHS-approved users as specified in the DUA. Upon completion of the study and final approval of analytic outputs, access to the VDE will be terminated, and all related data materials will be securely destroyed in compliance with the DUA and CDC confidentiality standards.

Two ethical considerations were identified and addressed: (1) the risk of stigmatizing vulnerable subgroups (e.g., younger women or those with mental health diagnoses) will be mitigated through neutral, respectful language and evidence-based interpretation of findings; and (2) although the data are deidentified, ethical stewardship is required when using mortality records, particularly in pregnancy-associated deaths. This concern will be addressed by adhering to public health principles of beneficence while avoiding speculative conclusions in the presentation of results.

Summary

This study utilized an individual level, quantitative approach to analyze opioid-involvement among pregnancy-associated overdose deaths in the United States from 2019 to 2023, with particular attention to variations across pre-pandemic, peak pandemic, and post-peak pandemic periods. Grounded in the syndemic theoretical framework, the research design explores the interactions of opioid involvement, maternal age, mental health conditions, and geographic regions. The study variables were defined using ICD-10 underlying and multiple coding standards within the National Vital Statistics System, ensuring consistent classification of pregnancy associated overdose deaths and opioid-involvement. These standardized definitions facilitated reliable data categorization and supported the use of multivariate analyses to examine associations across demographic, temporal, and contextual factors. The ethical use of deidentified mortality data was reinforced by formal approval through the National Center for Health Statistics, ensuring alignment with research governance standards.

Overall, the design and methods for this study provide a strong foundation for understanding how opioid involved pregnancy -associated patterns shifted across the COVID-19 pandemic. The results and findings may offer additional insight into the associations among opioid involvement, maternal overdose mortality, and demographic factors throughout the COVID-19 pandemic.

Section 3: Presentation of the Results and Findings

Introduction

The analytic dataset included 38,843 women of reproductive age with documented pregnancy or postpartum status in the NVSS mortality file; however, all figures and regression analyses are based on the restricted analytic sample of 2,315 pregnancy-associated overdose deaths. Of these records, 2,315 deaths met the definition of pregnancy-associated overdose deaths and comprised the analytic sample for all descriptive analyses. All analyses were restricted to this subset; comparisons reflect opioid-involved versus non-opioid overdose deaths within this defined subset and do not represent all-cause maternal mortality. The purpose of this quantitative, retrospective cross-sectional study was to examine the association between opioid involvement among pregnancy-associated overdose deaths among pregnant and postpartum women in the United States from 2019 to 2023. Specifically, this study compared pregnancy-associated overdose deaths involving opioids to pregnancy-associated overdose deaths without opioid involvement to describe variation across demographic and contextual characteristics, including age group, geographic region, the presence of a mental health condition and COVID-19 period. The study addressed two research questions:

1. What is the association between the likelihood that a pregnancy-associated overdose death involved opioids when controlling for the pandemic period (pre-COVID: 2019, peak COVID: 2020–2021, post-peak COVID: 2022–2023)?
2. What is the association between geographic region, age group, and diagnosed

mental health conditions and the likelihood that a pregnancy-associated overdose death involved opioids when controlling for the pandemic period?

The hypotheses corresponding to these questions are outlined in Section 2. This section presents the results of these analyses and addresses the research questions of the study.

Accessing the Data Set for Secondary Analysis

The dataset included all recorded pregnancy-associated overdose deaths among pregnant and postpartum women in the United States for 2019-2023. Data were first analyzed to summarize pregnancy-associated overdose deaths by opioid involvement and subsequent analysis analyzed associations by geographic region, age group, and mental health conditions across Pre- COVID (2019), Peak COVID (2020-2021), Post-peak COVID (2022-2023) using bivariate and multivariate regression modeling to test the stated hypotheses.

All variables outlined in Section 2 were retained and operationalized as intended; no deviations or substitutions occurred. The dependent variable, opioid involvement among pregnancy-associated overdose deaths, was identified using ICD-10 underlying cause-of-death codes for unintentional and undetermined drug poisoning (X40–X44, Y10–Y14) in combination with opioid-specific multiple-cause codes (T40.0–T40.4, T40.6), consistent with the analytic approach described in Section 2. Opioid type and diagnosed mental health conditions were defined using ICD-10 multiple cause of death codes while remaining independent variables were derived from demographic information reported in NVSS.

Data were accessed through the CDC Virtual Data Enclave (VDE) under a formal

Data Use Agreement with the National Center for Health Statistics (NCHS). Records with incomplete information were excluded to ensure analytic precision and validity. Because the National Vital Statistics System (NVSS) captures all registered deaths in the United States, the dataset provides complete national coverage of pregnancy-associated overdose mortality, ensuring strong external validity and generalizability of the findings to the broader U.S. maternal population.

Results

As presented in Table 1, the final analytic dataset included 2,315 pregnancy-associated overdose deaths among women aged 10-54 years in the United States from 2019 through 2023. The total $N = 38,843$ represents all women of reproductive age with documented pregnancy or postpartum in the NVSS mortality file prior to restriction to pregnancy-associated overdose deaths. Of these pregnancy-associated overdose deaths, 2,315 were classified as opioid-involved or non-opioid involved and compromised the analytic sample for multivariable regression models examining predictors of opioid involvement. Descriptive analyses summarized pregnancy-associated overdose deaths by opioid involvement across geographic region, age group, presence of a mental health condition, and COVID-19 pandemic period. Table 1 shows that pregnancy-associated overdose deaths were not evenly distributed across HHS regions, therefore, geographic region was included as a covariate to account for regional variation in overdose mortality.

As shown in Figure 1, within the analytic sample of pregnancy-associated overdose deaths, opioid-involved deaths were observed more frequently within the sample of pregnancy-associated overdose deaths than non-opioid involved deaths in the

United States between 2019-2023. Figures 2 through 5 further disaggregate these proportions to illustrate variation across demographic and contextual factors. Figure 2 shows that opioid involvement was more frequently observed within the analytic sample across all HHS regions, although the distribution of non-opioid deaths varied geographically. Some regions (e.g., Regions 6 and 9) show higher proportions of non-opioid deaths compared with other regions, while opioid involvement remains predominant overall. Figure 3 indicates that opioid-involvement was observed more frequently within the analytic sample of pregnancy-associated overdose deaths across all age groups, with the highest proportions observed among women aged 20-24 and 25-29 years. While relatively lower, but still predominant, opioid involvement among women aged 40 years and older. Figure 4 illustrates opioid-involved deaths were observed among pregnancy-associated overdose deaths both with and without a documented mental health condition, with a higher proportion observed among those with a documented condition. Documented mental health conditions were infrequently recorded in the NVSS mortality file; therefore, findings related to mental health reflect only diagnoses noted on death certificates and should be interpreted as indicators of documentation rather than prevalence. Figure 5 demonstrates that opioid-involved overdose deaths were observed across all COVID-19 pandemic periods, with higher proportions observed during the peak and post-peak periods relative to the pre-COVID period. Across all periods, opioid-involved deaths consistently exceeded non-opioid deaths, with the highest proportions observed during the post-peak period.

Descriptive analyses indicate that, within the analytic sample of pregnancy-

associated overdose deaths, opioid-involved deaths occurred more frequently than non-opioid overdose deaths across regions, age groups, and pandemic periods. Higher proportions of opioid involvement were observed among women aged 20–39 years and during the peak and post-peak COVID-19 periods. Figures 1–5 present unadjusted distributions and should be interpreted as descriptive patterns rather than causal or inferential findings. Multivariable logistic regression results presented later in this chapter provide statistical assessment of these associations while controlling for confounding factors.

Table 1

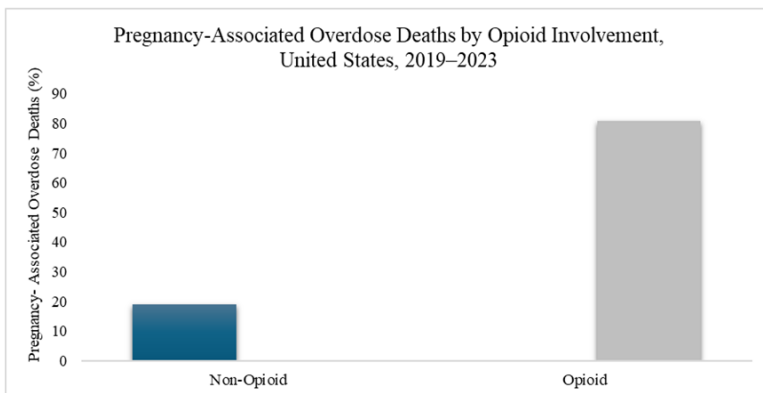
Descriptive Characteristics of Pregnancy- Associated Overdose Deaths, United States (2019–2023)

Variable	<i>N</i>	% of Pregnancy Associated Overdose Deaths
HHS Region		
Region 1	80	3.46
Region 2	229	9.89
Region 3	302	13.05
Region 4	629	27.17
Region 5	472	20.39
Region 6	186	8.03
Region 7	108	4.67
Region 8	84	3.63
Region 9	152	6.57
Region 10	73	3.15
Age Group (years)		
15–19	56	2.42
20–24	345	14.9
25–29	651	28.12
30–34	680	29.37
35–39	427	18.44
40+	156	6.74
Presence of Diagnosed Mental Health Condition		
No	2283	98.62
Yes	32	1.38
COVID Period		
Pre-COVID (2019)	350	15.12
Peak COVID (2020-2021)	998	43.11
Post-peak COVID (2022-2023)	967	41.77

Note. Percentages are calculated among pregnancy-associated overdose deaths ($N = 2,315$). Documented mental health conditions reflect diagnoses recorded on death certificates and are subject to underreporting in NVSS mortality data.

Figure 1

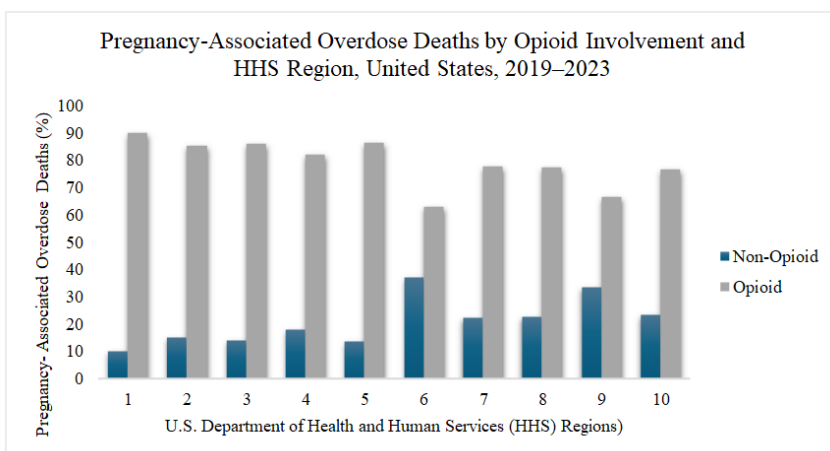
Distribution of Pregnancy-Associated Overdose Deaths by Opioid Involvement, United States, 2019–2023



Note. Percentages represent the distribution of pregnancy-associated overdose deaths by opioid involvement (opioid-involved vs. non-opioid-involved). Data derived from the CDC National Vital Statistics System (2019–2023).

Figure 2

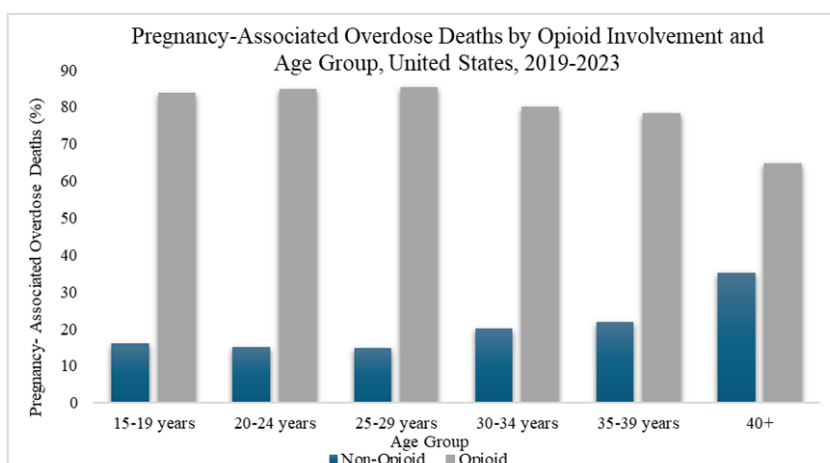
Distribution of Pregnancy-Associated Overdose Deaths by Opioid Involvement and HHS Region, United States, 2019–2023



Note. Percentages represent the distribution of pregnancy-associated overdose deaths by opioid involvement (opioid-involved vs. non-opioid-involved) across U.S. Department of Health and Human Services (HHS) regions. Data are derived from the CDC National Vital Statistics System, 2019–2023.

Figure 3

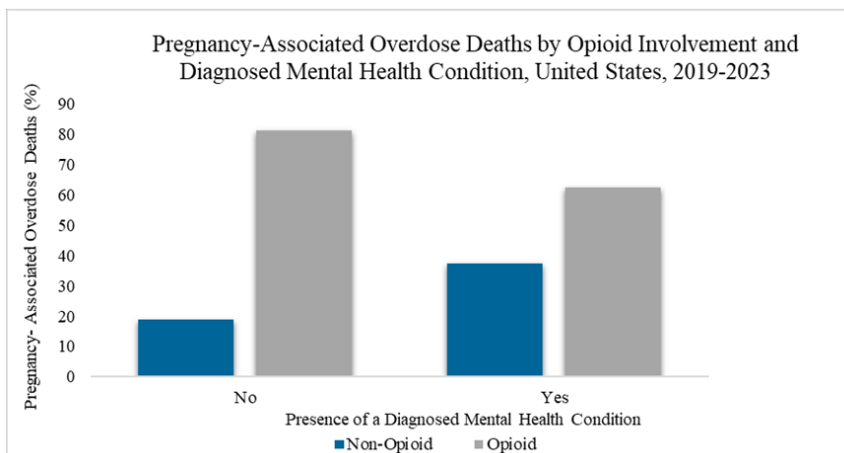
Distribution of Pregnancy-Associated Overdose Deaths by Opioid Involvement and Age Group, United States, 2019–2023



Note. Percentages represent the distribution of pregnancy-associated overdose deaths by opioid involvement (opioid-involved vs. non-opioid-involved) across maternal age groups. Data are derived from the CDC National Vital Statistics System, 2019–2023.

Figure 4

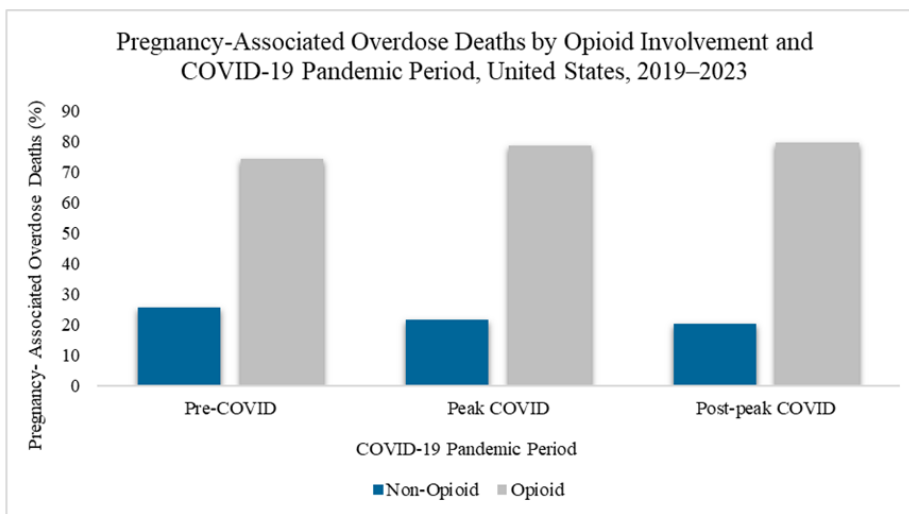
Distribution of Pregnancy-Associated Overdose Deaths by Opioid Involvement and Diagnosed Mental Health Condition, United States, 2019–2023



Note. Percentages represent the distribution of pregnancy-associated overdose deaths by opioid involvement (opioid-involved vs. non-opioid-involved) stratified by the presence of a documented mental health condition. Data are derived from the CDC National Vital Statistics System, 2019–2023.

Figure 5

Distribution of Pregnancy-Associated Overdose Deaths by Opioid Involvement and COVID-19 Pandemic Period, United States, 2019–2023



Note. Percentages represent the distribution of pregnancy-associated overdose deaths by opioid involvement (opioid-involved vs. non-opioid-involved) across COVID-19 pandemic periods. Data are derived from the CDC National Vital Statistics System, 2019–2023.

Prior to conducting logistic regression analyses, assumptions were evaluated to ensure suitability for binary logistic regression. The dependent variable, opioid involvement among pregnancy-associated overdose deaths, was binary and coded to distinguish between opioid-involved and non-opioid-involved overdose deaths. All observations were independent, as each record represented an individual-level mortality case. Collinearity diagnostics were examined among the independent variables, moderating variable (pandemic period), and covariate (geographic region), and no evidence of problematic multicollinearity was identified. Binary logistic regression

analyses were then conducted to examine associations between the predictors and the likelihood that a pregnancy-associated overdose death involved opioids.

For Research Question 1, a binary logistic regression analysis was conducted to examine the association between pandemic period and the likelihood that a pregnancy-associated overdose death was opioid involved, using opioid involvement as the dependent variable, while controlling for the pandemic period (pre-COVID, peak COVID, and post-peak COVID). The overall model demonstrated that pandemic period did not significantly contribute to distinguishing opioid-involved from non-opioid-involved pregnancy-associated overdose deaths. Opioid involvement served as the outcome variable in this model, and pandemic period was examined for its association with variation in opioid involvement among pregnancy-associated overdose deaths. Results indicated that opioid involvement did not differ significantly by pandemic period. Neither the peak COVID period (OR = 1.04, 95% CI [0.92, 1.18], $p = .51$) nor the post-peak COVID period (OR = 0.99, 95% CI [0.87, 1.13], $p = .90$) was associated with significantly different odds of opioid involvement compared with the pre-COVID period. Overall, these findings fail to reject the null hypothesis (H_0) and indicate that pandemic period was not independently associated with opioid involvement among pregnancy-associated overdose deaths.

Table 2

Binary Logistic Regression Predicting Opioid Involvement Among Pregnancy-Associated Overdose Deaths

Variable	Adjusted OR	95% CI	<i>p</i>
Pandemic Period			
Peak (2020–2021) vs. Pre-COVID (2019)	1.04	0.92-1.18	.51
Post Peak COVID (2022-2023) vs. Pre-COVID (2019)	0.99	0.87-1.13	.90
Geographic Region (HHS)			
Region 1 vs Region 4	1.99	1.53-2.58	< .001
Region 2 vs Region 4	1.78	1.50-2.10	< .001
Region 3 vs Region 4	1.24	1.07-1.43	.005
Region 5 vs. Region 4	0.88	0.77-1.00	.046
Region 6 vs Region 4	1.12	0.94-1.33	.23
Region 7 vs Region 4	0.98	0.78-1.21	.82
Region 8 vs Region 4	1.00	0.78-1.28	.99
Region 9 vs Region 4	0.84	0.70-1.02	.07
Region 10 vs Region 4	1.05	0.81-1.36	.70
Age Group			
< 25 vs. 20-24	0.47	0.35-0.63	< .001
25-29 vs. 20-24	1.07	0.93-1.24	.34
30-34 vs. 20-24	0.75	0.65-0.87	< .001
35-39 vs. 20-24	0.41	0.35-0.48	< .001
40+ vs. 20-24	0.04	0.03-0.05	< .001
Diagnosed Mental Health Condition			
Yes vs. No	0.75	0.52-1.08	.12

Note. Adjusted odds ratios (AORs) were estimated using a multivariable logistic

regression model examining the likelihood that a pregnancy-associated overdose death was opioid-involved among pregnant and postpartum women in the United States from

2019–2023 ($N = 2,315$). The model adjusted for pandemic period, geographic region (HHS), maternal age group, and presence of a documented mental health condition. Reference categories were pre-COVID period (2019), HHS Region 4, age 20–24 years, and no diagnosed mental health condition. Statistically significant associations ($p < .05$) are bolded.

For Research Question 2, a binary logistic regression analysis was conducted to examine the associations between geographic region, age group, diagnosed mental health conditions and the likelihood that maternal overdose deaths occurred among pregnant and postpartum women, while controlling for pandemic period. The overall model was statistically significant, $\chi^2 (18, N = 38,843) = 3,051.64, p < .001$, indicating that the variables contributed to variation in maternal overdose mortality.

Geographic region was a significant predictor of maternal overdose deaths. Using HHS Region 4 as the reference category, women residing in Region 1 (OR = 1.99, 95% CI [1.53, 2.58], $p < .001$), Region 2 (OR = 1.78, 95% CI [1.50, 2.10], $p < .001$), and Region 3 (OR = 1.24, 95% CI [1.07, 1.43], $p = .005$) had significantly higher odds of maternal overdose death. In contrast, women in Region 5 had significantly lower odds compared with Region 4 (OR = 0.88, 95% CI [0.77, 1.00], $p = .046$). No statistically significant differences were observed for Regions 6, 7, 8, 9, or 10.

Maternal age group was also a significant predictor. Compared with women aged 20–24 years, women aged 15–19 years had lower odds that the overdose death was opioid-involved (OR = 0.47, 95% CI [0.35, 0.63], $p < .001$). Similarly, women aged 30–34 years (OR = 0.75, 95% CI [0.65, 0.87], $p < .001$), 35–39 years (OR = 0.41, 95% CI

[0.35, 0.48], $p < .001$), and 40 years or older (OR = 0.04, 95% CI [0.03, 0.05], $p < .001$) had significantly lower odds of maternal overdose death compared with the reference group. No significant difference was observed for women aged 25–29 years.

Diagnosed mental health conditions were not significantly associated with opioid involvement among pregnancy-associated overdose deaths in the adjusted model (OR = 0.75, 95% CI [0.52, 1.08], $p = .12$). Pandemic period was also not a significant predictor, with neither the peak COVID nor post-peak COVID periods differing significantly from the pre-COVID period.

Overall, these findings partially support the alternative hypotheses for Research Question 2. Geographic region and maternal age were significantly associated with maternal overdose mortality among pregnant and postpartum women, whereas diagnosed mental health conditions and pandemic period were not significant predictors after adjustment for covariates. Tables and figures presented in this chapter summarize the descriptive patterns and regression results related to opioid involvement among pregnancy-associated overdose deaths.

Summary

Overall, the findings indicate that opioid involvement was a significant predictor of maternal overdose mortality among pregnant and postpartum women, independent of pandemic period. The COVID-19 pandemic period was not a statistically significant predictor, suggesting that elevated maternal overdose risk was not driven solely by temporal pandemic effects. Geographic region and maternal age were significant predictors, with elevated odds observed in HHS Regions 1–3 and among women aged

20–24 years relative to older age groups.

Diagnosed mental health conditions were not significantly associated with maternal overdose mortality in the adjusted analyses. These findings highlight the persistent influence of opioid involvement and structural determinants, including geographic variation and age-related differences, in shaping patterns of maternal overdose mortality. Rather than reflecting a uniform pandemic effect, the findings suggest that preexisting vulnerabilities and regional disparities continued to influence maternal outcomes throughout the COVID-19 period.

Collectively, this study provides a foundation for data-driven public health interventions and policies that prioritize opioid overdose prevention among pregnant and postpartum women. Identification of high-risk populations across geographic regions supports the development of targeted prevention strategies, expansion of integrated maternal and behavioral health services, and equitable allocation of resources. The following section discusses these findings in greater depth, emphasizing their implications for professional practice and public health policy. The discussion also explores how evidence-based interventions informed by this analysis may advance positive social change by strengthening surveillance systems, enhancing community-level prevention efforts, and reducing opioid-involved maternal overdose mortality.

Section 4: Application to Professional Practice and Implications for Social Change

Introduction

This study examined opioid-involved pregnancy-associated overdose mortality in the United States from 2019–2023 with a focus on opioid involvement and its association with pandemic period (pre-COVID, peak, post-peak), geographic region, age group, and documented mental-health conditions among pregnant and postpartum women. Using national mortality data, the study sought to identify demographic and contextual factors associated with opioid involvement among pregnancy-associated overdose deaths. This analysis addresses maternal mortality, a critical public health concern that has increased in recent years and was further exacerbated by longstanding structural inequities in healthcare access, substance use treatment, and social support systems. Findings indicated that opioid involvement was a significant predictor of pregnancy-associated overdose mortality. Pandemic period was not a statistically significant predictor in the adjusted models, suggesting that differences observed across pre-, peak-, and post-COVID phases were not attributable to temporal pandemic effects alone.

Geographic region and maternal age also emerged as important factors, with elevated odds observed in specific HHS regions relative to the reference region and among women in the reference age group compared with older age categories. Documented mental health conditions were not significantly associated with opioid involvement among pregnancy-associated overdose deaths in adjusted analyses. The low prevalence of documented mental health conditions likely reflects underreporting in death certificate data rather than an absence of psychiatric comorbidity among pregnant and

postpartum women who died from overdose. Collectively, these results indicate that opioid-involved pregnancy-associated overdose mortality during 2019–2023 was shaped primarily by opioid involvement and persistent structural and demographic factors, rather than by pandemic timing alone.

Interpretation of Findings

Consistent with prior research, opioid involvement emerged as a central factor associated with pregnancy-associated overdose mortality among pregnant and postpartum women, reinforcing patterns documented by Han et al. (2024), Metz et al. (2016), and Bagley et al. (2018). After adjustment for key covariates, opioid involvement remained a significant predictor, suggesting its influence on the likelihood that a pregnancy-associated overdose death involved opioids, independent of temporal context. Pandemic period was not a statistically significant predictor in the adjusted models, indicating that differences observed across pre-, peak-, and post-COVID phases were not attributable to temporal pandemic effects alone.

Rather than reflecting a uniform pandemic-driven shift, the findings suggest that patterns of opioid-involved pregnancy-associated overdose mortality continued to be shaped by preexisting structural and demographic vulnerabilities throughout the COVID-19 period. Geographic region and maternal age were particularly noticeable, highlighting persistent regional disparities and age-related differences in risk. Elevated odds observed in specific regions align with prior literature emphasizing the influence of structural conditions, including healthcare access, resource availability, and regional variation in substance use treatment infrastructure (Collier & Molina, 2019; Morton et al., 2017).

These patterns are consistent with findings by Horon and Cheng (2024) and Bryan et al. (2020), who documented higher maternal mortality in rural and resource-limited settings.

Diagnosed mental health conditions were not a significant predictor in the adjusted analyses; however, descriptive patterns suggest complexity in the relationship between documented mental health conditions and opioid involvement among pregnancy-associated overdose deaths. The inverse association observed descriptively between recorded mental health diagnoses and overdose deaths may reflect limitations in the identification and documentation of mental health conditions within mortality records, rather than a true absence of comorbidity. Consistent with prior research, underdiagnosis and incomplete reporting of mental health conditions in death certificate data may obscure the full burden of mental health–related risk among pregnant and postpartum women (Goodman et al., 2020). These findings suggest the need for enhanced mental health surveillance and improved integration of behavioral health information in maternal mortality data systems.

Guided by the syndemic framework, the results illustrate how opioid use, structural inequities, and demographic factors intersect to shape opioid-involved pregnancy-associated overdose mortality risk. Although the COVID-19 pandemic introduced widespread social and healthcare disruptions, the adjusted findings indicate that these stressors likely interacted with, rather than supplanted, longstanding vulnerabilities. Consistent with Singer’s syndemic theory, overlapping conditions such as substance use, structural disadvantage, and demographic risk appear to operate synergistically, reinforcing the likelihood of opioid involvement among pregnancy-

associated overdose deaths over time. Importantly, interpretations remain grounded in observed associations and do not imply causality beyond the scope of the data. The findings emphasize the need for interventions that extend beyond substance use treatment to address structural and systemic inequities influencing maternal health outcomes.

Limitations of Study

Several limitations affect generalizability and internal validity. As a secondary analysis, the study relied on death certificate data subject to coding inaccuracies, misclassification of opioid involvement, underreporting of mental health conditions, and inconsistencies in cause-of-death classification across jurisdictions. Age groupings were modified from the original proposal due to small cell sizes, which may limit comparability with studies using alternate maternal age categorizations. The absence of individual-level variables such as race, socioeconomic status, or access to treatment limits the ability to assess all potential confounders and to fully evaluate structural inequities influencing opioid-involved pregnancy-associated overdose deaths. Missing data may introduce bias if data were not missing completely at random. Furthermore, the cross-sectional design precluded causal inference, and the findings may not generalize beyond the U.S. population or to non-pandemic contexts.

Recommendations for Future Research

Future research should build on these findings by integrating linked datasets that combine mortality, hospital, and behavioral health records to provide a more comprehensive understanding of factors associated with opioid involvement among pregnancy-associated overdose deaths. Studies should further disaggregate opioid types,

particularly synthetic opioids such as fentanyl, to assess substance-specific risks identified in recent literature (Han et al., 2024). Region-specific qualitative or mixed-methods research is also warranted to explore contextual factors influencing overdose mortality in underserved and rural areas, as noted by Camden et al. (2021) and Horn et al. (2024). Evaluations of pandemic-era policy adaptations such as telehealth expansion and harm reduction initiatives may clarify which interventions most effectively reduce opioid involvement among pregnancy-associated overdose deaths. Grounded in this study's limitations and supported by the literature, these recommendations highlight the need for longitudinal, intersectional, and policy-focused approaches that address both clinical and structural drivers of opioid-involved maternal overdose mortality. Continued investigation of these factors can strengthen the evidence base for public health action and guide equitable, data-informed interventions to prevent opioid-involved pregnancy-associated overdose deaths in future crises.

Public Health Practice and Field-Based Products

The results of this study highlight critical opportunities for public health action to address opioid-involved pregnancy-associated overdose mortality. Strengthening coordination between maternal health, behavioral health, and substance use prevention systems is essential to reducing preventable deaths among pregnant and postpartum women. Improved data integration across mortality surveillance, clinical care, and behavioral health systems may enhance identification of high-risk populations and support more timely, targeted interventions.

Findings from this analysis emphasize the importance of prioritizing equitable

access to evidence-based treatment, harm reduction services, and postpartum continuity of care in high-burden geographic regions and age groups identified in the study. These results provide a population-level evidence base to inform field-based products, including policy briefs, surveillance summaries, and practice-oriented guidance for public health agencies, healthcare systems, and maternal health programs. Collectively, these products may support data-driven decision-making, guide allocation of prevention resources, and inform policies aimed at reducing opioid-involved maternal overdose deaths and improving outcomes for women and families nationwide.

Positive Social Change

Pregnancy-associated opioid overdose mortality among pregnant and postpartum women represents a critical public health challenge in the United States, particularly among populations experiencing structural and socioeconomic disadvantage. This challenge is shaped by a complex interplay of individual vulnerability, family context, organizational capacity, and broader societal and policy environments. Addressing maternal overdose mortality therefore requires a multilevel, systems-oriented approach that strengthens prevention, improves continuity of care, and advances equity across the perinatal continuum. The findings from this study contribute to positive social change by identifying population-level patterns in opioid involvement across demographic, geographic, and temporal contexts. Although the study does not evaluate interventions, the results provide evidence that may inform coordinated action at the individual, family, organizational, and societal/policy levels. By identifying population-level patterns in the distribution of opioid-involved pregnancy-associated overdose deaths, this research

supports the development of targeted, equity-centered strategies that enhance maternal health and reduce preventable mortality without exceeding the study's analytic scope.

Individual Level

At the individual level, the findings of this study may indirectly support improved identification of pregnant and postpartum women who are at elevated risk for opioid-involved overdose mortality based on age group, geographic region, and documented mental health conditions. Although this study does not assess individual behaviors or clinical outcomes, increased awareness of risk patterns may inform screening, referral, and follow-up practices within prenatal and postpartum care settings. By framing opioid use disorder as a public health condition influenced by structural and contextual factors, the findings may also contribute to stigma reduction and support patient-centered approaches to care.

Family Level

The prevention of pregnancy-associated opioid overdose deaths has implications for family stability, caregivers, and child well-being. Maternal overdose mortality represents a significant disruption to family systems which exhibits a need to enhance family awareness and support related to maternal mental health and substance use challenges, which may contribute to improved caregiving environments. By highlighting the concentration of risk during the postpartum period, the findings emphasize the importance of sustained maternal support beyond delivery to reduce preventable maternal deaths and mitigate family trauma. There is a need to lessen the emotional and social burden experienced by families affected by pregnancy-associated overdose deaths

through improved access to supportive services and resources. In addition, reinforcing family resilience during the high-risk postpartum period and increasing the engagement of partners and family members in maternal support may strengthen caregiving continuity and shared responsibility, promoting healthier environments for infants and children.

Organizational Level

At the organizational level, there is a need to strengthen the capacity of healthcare systems, public health agencies, and maternal health programs to address pregnancy-associated opioid overdose mortality. Findings from this study indicate opportunities for organizations to enhance coordination across obstetric care, behavioral health services, and substance use treatment, particularly within regions and age groups experiencing higher proportions of opioid-involved maternal overdose deaths. There is also a need to support workforce development through training that promotes evidence-based, trauma-informed, and culturally responsive care for pregnant and postpartum populations. Strengthening partnerships among healthcare providers, public health agencies, and community-based organizations may further expand access to prevention, treatment, and supportive services. Additionally, organizations should enhance surveillance and data-monitoring capacity to better identify emerging trends, guide resource allocation, and inform program planning in alignment with population-level risk patterns.

Societal/Policy Level

At the societal and policy level, policy actions are needed to address structural factors that contribute to pregnancy-associated opioid overdose mortality and related disparities in maternal health outcomes. The persistence of opioid involvement across

pandemic periods emphasizes the need for sustained policy responses that extend beyond short-term emergency measures. Findings from this study may inform maternal health policies that promote continuity of postpartum care, expand access to medication for opioid use disorder, and strengthen integration of mental health services within perinatal care systems. There is also a need to reduce healthcare disparities through policies that improve insurance coverage and access to care, including extended postpartum coverage. By addressing systemic barriers that influence maternal health, such as inequitable access to healthcare services, policy efforts informed by population-level surveillance data may contribute to more equitable maternal outcomes and support long-term improvements in public health infrastructure.

Conclusion

This study demonstrates that opioid involvement is a contributor to pregnancy-associated overdose mortality among pregnant and postpartum women in the United States from 2019 through 2023. Rather than reflecting a temporary disruption associated with the COVID-19 pandemic, opioid-involved maternal overdose deaths demonstrate enduring demographic, geographic, and structural inequities that extend across pre-pandemic, peak-pandemic, and post-pandemic periods. These findings highlight the need for sustained, systems-oriented approaches that strengthen postpartum care continuity and address structural drivers of opioid-involved maternal mortality. Population-level patterns by age, geography, and mental health documentation provide evidence to inform targeted, equity-centered strategies within the study's analytic scope.

This study was designed as a quantitative, retrospective cross-sectional analysis

using national mortality surveillance data from the CDC's National Vital Statistics System to address the public health problem of pregnancy-associated opioid overdose mortality. The application of multivariable logistic regression enabled examination of associations between opioid involvement and key demographic and contextual factors, including pandemic period, maternal age, geographic region, and documented mental health conditions. This rigorous analytic approach ensured population-level coverage, minimized selection bias, and produced findings relevant to public health practice and policy development.

The study applied syndemic theory to examine the co-occurrence and interaction of opioid use, mental health conditions, and structural inequities influencing maternal overdose mortality. The strength of this theoretical framework lies in its capacity to capture the complexity of overlapping epidemics and contextual vulnerabilities affecting pregnant and postpartum women. However, the study also acknowledged limitations in applying syndemic theory to secondary, cross-sectional mortality data, including constraints in measuring synergistic interactions and establishing causal pathways. Despite these limitations, the framework provided a robust lens for interpreting observed patterns with broader social and structural contexts of maternal overdose mortality.

Ethical considerations were integral to this study. The use of deidentified, restricted-use mortality data under a formal data use agreement ensured confidentiality and responsible data stewardship. Ethical rigor was further maintained through non-stigmatizing language, transparent acknowledgment of data limitations, and avoidance of causal claims beyond the data, consistent with core public health principles.

The findings and implications of this study were communicated to diverse stakeholders including policymakers, public health practitioners, healthcare providers, and community audiences using accessible formats appropriate for varying levels of health literacy. Field-based products, including a policy brief, intervention framework, and fact sheet, while translating complex epidemiologic evidence into clear, actionable insights to inform decision-making, guide program planning, and support maternal health policy development.

Based on the study's findings, policy-relevant strategies were proposed to support positive social change in communities affected by pregnancy-associated opioid overdose mortality. These strategies emphasize extended postpartum coverage, expanded access to medication for opioid use disorder, integration of mental health services within perinatal care, and strengthened overdose surveillance. Grounded in national surveillance data and population-level patterns, these recommendations aim to reduce preventable maternal deaths and promote health equity while remaining within the study's analytic scope.

Collectively, this study strengthens the evidence base for addressing pregnancy-associated opioid overdose mortality through data-driven, equity-centered public health strategies. The integration of quantitative methods, theory, ethics, communication, and supports sustained efforts to improve maternal health outcomes for pregnant and postpartum women in the United States.

References

- Austin, A. E., Di Bona, V., Cox, M. E., Proescholdbell, S. K., & Naumann, R. B. (2022). Differences in mortality among infants with neonatal opioid withdrawal syndrome. *American Journal of Preventive Medicine*, *63*(4), 619–623. <https://doi.org/10.1016/j.amepre.2022.03.018>
- Austin, A. E., Naumann, R. B., DiPrete, B. L., Geary, S., Proescholdbell, S. K., & Jones-Vessey, K. (2024). Pregnancy-associated homicide, suicide and unintentional opioid-involved overdose deaths, North Carolina 2018-2019. *Injury Prevention*, *30*(5), 393–399. <https://doi.org/https://dx.doi.org/10.1136/ip-2023-045112>
- Bagley, S. M., Cabral, H., Saia, K., Brown, A., Lloyd-Travaglini, C., Walley, A. Y., & Rose-Jacobs, R. Frequency and associated risk factors of non-fatal overdose reported by pregnant women with opioid use disorder. <https://doi.org/https://doi.org/10.1186/s13722-018-0126-0>
- Bruzelius, E., & Martins, S. S. (2022). US trends in drug overdose mortality among pregnant and postpartum persons, 2017-2020. *JAMA*, *328*(21), 2159–2161. <https://doi.org/10.1001/jama.2022.17045>
- Bryan, M. A., Smid, M. C., Cheng, M., Fortenberry, K. T., Kenney, A., Muniyappa, B., Pendergrass, D., Gordon, A. J., & Cochran, G. (2020). Addressing opioid use disorder among rural pregnant and postpartum women: a study protocol. *Addiction Science & Clinical Practice*, *15*(1), 33. <https://doi.org/10.1186/s13722-020-00206-6>
- Camden, A., Guttman, A., Li, W., Velez, M. P., & Brogly, S. B. (2021). Risk of

postpartum opioid use disorder or opioid overdose after prenatal opioid analgesic use. *Obstetrics and Gynecology*, 138(6), 891–893.

<https://doi.org/10.1097/AOG.0000000000004598>

Christy, K. S., Christine, E. G., Michael, L. D., John, C., & Robin, L. (2022). Availability of best practices for opioid use disorder in jails and related training and resource needs: findings from a national interview study of jails in heavily impacted counties in the U.S. *Health & Justice*, 10(1), 1–15.

<https://doi.org/10.1186/s40352-022-00197-3>

Cleveland, L. M., McGlothen-Bell, K., Scott, L. A., & Recto, P. (2020). A life-course theory exploration of opioid-involved maternal mortality in the United States. *Addiction*, 115(11), 2079–2088. <https://doi.org/10.1111/add.15054>

Coffey, M. J., Weng, M., Jimes, C., Brigham, S., & Lira, M. C. (2024). Telehealth Treatment for Opioid Use Disorder During Pregnancy. *JAMA Network Open*, 7(3), e242463. <https://doi.org/10.1001/jamanetworkopen.2024.2463>

Collier, A. Y., & Molina, R. L. (2019). Maternal mortality in the United States: Updates on trends, causes, and solutions. *Neoreviews*, 20(10), e561–e574.

<https://doi.org/10.1542/neo.20-10-e561>

Crawford, A. D., McGlothen-Bell, K., Recto, P., McGrath, J. M., Scott, L., Brownell, E. A., & Cleveland, L. M. (2022). Stigmatization of pregnant individuals with opioid use disorder. *Women's health reports*, 3(1), 172–179.

<https://doi.org/10.1089/whr.2021.0112>

Czeisler, M., Lane, R. I., Petrosky, E., Wiley, J. F., Christensen, A., Njai, R., Weaver, M.

- D., Robbins, R., Facer-Childs, E. R., Barger, L. K., Czeisler, C. A., Howard, M. E., & Rajaratnam, S. M. W. (2020). Mental Health, Substance Use, and Suicidal Ideation During the COVID-19 Pandemic - United States, June 24-30, 2020. *Morbidity Mortality Weekly Report*, 69(32), 1049–1057. <https://doi.org/10.15585/mmwr.mm6932a1>
- Duggal, R., Allshouse, A. A., Small, M., & Smid, M. C. (2025). Substance use disorder as a contributing factor to pregnancy-associated deaths. *O&G Open*, 2(2), e076. <https://doi.org/10.1097/OG9.0000000000000076>
- Eaves, E. R., Barber, J., Whealy, R., Clancey, S. A., Wright, R., Cocking, J. H., Spadafino, J., & Hepp, C. M. (2021). Characterization of neonatal opioid withdrawal syndrome in Arizona from 2010-2017. *PLoS ONE*, 16(6), e0248476. <https://doi.org/10.1371/journal.pone.0248476>
- Frankeberger, J., Jarlenski, M., Krans, E. E., Coulter, R. W. S., & Mair, C. (2023). Opioid use disorder and overdose in the first year postpartum: A rapid scoping review and implications for future research. *Maternal and Child Health Journal*, 27(7), 1140–1155. <https://doi.org/10.1007/s10995-023-03614-7>
- Goodman, D. J., Saunders, E. C., & Wolff, K. B. (2020). In their own words: A qualitative study of factors promoting resilience and recovery among postpartum women with opioid use disorders. *BMC Pregnancy & Childbirth*, 20(1), 178. <https://doi.org/10.1186/s12884-020-02872-5>
- Grossarth, S., Osmundson, S. S., Wiese, A., Phillips, S., Pham, A., Ashley, L., Patrick, S., Spieker, A., Grijalva, C., & Adgent, M. (2023). Prenatal opioid use disorder

- exposure and infant mortality. *American Journal of Obstetrics & Gynecology*, 228, S693–S694. <https://doi.org/10.1016/j.ajog.2022.11.1161>
- Guille, C., Simpson, A. N., Douglas, E., Boyars, L., Cristaldi, K., McElligott, J., Johnson, D., & Brady, K. (2020). Treatment of Opioid Use Disorder in Pregnant Women via Telemedicine: a Nonrandomized Controlled Trial. *JAMA Network Open*. <https://doi.org/10.1001/jamanetworkopen.2019.20177>
- Han, B., Compton, W. M., Einstein, E. B., Elder, E., & Volkow, N. D. (2024). Pregnancy and Postpartum Drug Overdose Deaths in the US before and during the COVID-19 Pandemic. *JAMA Psychiatry*, 81(3), 270-283. <https://doi.org/https://dx.doi.org/10.1001/jamapsychiatry.2023.4523>
- Horn, A., Adgent, M. A., Osmundson, S. S., Wiese, A. D., Phillips, S. E., Patrick, S. W., Griffin, M. R., & Grijalva, C. G. (2024). Risk of Death at 1 Year Following Postpartum Opioid Exposure. *American Journal of Perinatology*, 41(7), 949-960. <https://doi.org/https://dx.doi.org/10.1055/s-0042-1745848>
- Horon, I., & Cheng, D. (2007). Unintended pregnancy and associated perinatal behaviors and outcomes. *Contraception*, 76(2), 160. <https://doi.org/https://doi.org/10.1016/j.contraception.2007.05.013>
- Jarlenski, M., LoCiganic, W. H., Chen, Q., Pudasainy, S., Donohue, J. M., Cole, E. S., & Krans, E. E. (2025). Association between buprenorphine dose and outcomes among pregnant persons with opioid use disorder [In Press]. *American Journal of Obstetrics and Gynecology*. <https://doi.org/https://dx.doi.org/10.1016/j.ajog.2024.12.001>

- Karaye, I. M., Nasir, R., Infante, O., Ali, H., Tiwari, O., Marium, A., & Hackett, M. (2024). Racial, Age, and Regional Disparities in Maternal Mortality in the USA, 1999-2020. *Journal of Racial & Ethnic Health Disparities*, *11*(4), 2265-2270. <https://doi.org/https://dx.doi.org/10.1007/s40615-023-01694-3>
- Kelty, E., Terplan, M., Orr, C., & Preen, D. B. (2023). Neonatal outcomes associated with in utero exposure to oxycodone, overall and by trimester of exposure: A retrospective cohort study. *The Journal of Pain*, *24*(4), 617-626. <https://doi.org/10.1016/j.jpain.2022.11.007>
- Kountanis, J. A., Roberts, M., Admon, L. K., Smith, R., Cropsey, A., & Bauer, M. E. (2023). Maternal deaths due to suicide and overdose in the state of Michigan from 2008 to 2018 [Research Support, Non-U.S. Gov't]. *American Journal of Obstetrics & Gynecology MFM*, *5*(2), 100811. <https://doi.org/https://dx.doi.org/10.1016/j.ajogmf.2022.100811>
- Lang, J., Mendenhall, E., & Koon, A. D. (2023). Disentangling opioids-related overdose syndemics: a scoping review. *International Journal of Drug Policy*, *119*, 104152. <https://doi.org/https://doi.org/10.1016/j.drugpo.2023.104152>
- Leech, A. A., McNeer, E., Stein, B. D., Richards, M. R., McElroy, T., Dupont, W. D., & Patrick, S. W. (2023). County-level Factors and Treatment Access Among Insured Women With Opioid Use Disorder. *Medical Care*. <https://doi.org/10.1097/MLR.0000000000001867>
- Margerison, C. E., Roberts, M. H., Gemmill, A., & Goldman-Mellor, S. (2022). Pregnancy-Associated Deaths Due to Drugs, Suicide, and Homicide in the United

States, 2010-2019 [Research Support, N.I.H., Extramural]. *Obstetrics & Gynecology*, *139*(2), 172-180.

<https://doi.org/https://dx.doi.org/10.1097/AOG.0000000000004649>

Margerison, C. E., Wang, X., Gemmill, A., & Goldman-Mellor, S. (2023). Changes in Pregnancy-Associated Deaths in the US During the COVID-19 Pandemic in 2020. *JAMA Network Open*, *6*(2), E2254287.

<https://doi.org/https://dx.doi.org/10.1001/jamanetworkopen.2022.54287>

McDonald, L. R., Antoine, D. G., Liao, C., Lee, A., Wahab, M., & Coleman, J. S. (2020). Syndemic of Lifetime Mental Illness, Substance Use Disorders, and Trauma and Their Association With Adverse Perinatal Outcomes. *Journal of Interpersonal Violence*, *35*(1/2), 476-495. <https://doi.org/10.1177/0886260516685708>

Mejia, M. C., Kowalchuk, A., Gonzalez, S. J., Nair, M., Webb, L., & Scamp, N. (2024). Challenges and Implications for Substance Use and Mental Healthcare Among Under-Resourced Women in the COVID-19 Era. *Cureus*, *16*(6), e62452.

<https://doi.org/10.7759/cureus.62452>

Metz, T. D., Rovner, P., Hoffman, M. C., Allshouse, A. A., Beckwith, K. M., & Binswanger, I. A. (2016). Maternal Deaths From Suicide and Overdose in Colorado, 2004–2012. *Obstetrics & Gynecology*, *128*(6), 1233-1240.

<https://doi.org/10.1097/aog.0000000000001695>

Morton, C., & Wells, M. (2017). Behavioral and Substance Use Outcomes for Older Youth Living With a Parental Opioid Misuse: A Literature Review to Inform Child Welfare Practice and Policy. *Journal of Public Child Welfare*, *11*(4-5), 546-

567. <https://doi.org/10.1080/15548732.2017.1355866>

Nguemeni Tiako, M. J., Culhane, J., South, E., Srinivas, S. K., & Meisel, Z. F. (2020). Prevalence and Geographic Distribution of Obstetrician-Gynecologists Who Treat Medicaid Enrollees and Are Trained to Prescribe Buprenorphine. *JAMA Network Open*, 3(12), e2029043-e2029043.

<https://doi.org/10.1001/jamanetworkopen.2020.29043>

Nielsen, T., Bernson, D., Terplan, M., Wakeman, S. E., Yule, A. M., Mehta, P. K., Bharel, M., Diop, H., Taveras, E. M., Wilens, T. E., & Schiff, D. M. (2020). Maternal and infant characteristics associated with maternal opioid overdose in the year following delivery [Research Support, N.I.H., Extramural Research Support, U.S. Gov't, P.H.S.]. *Addiction*, 115(2), 291-301.

<https://doi.org/https://dx.doi.org/10.1111/add.14825>

Pfefferbaum, B., & North, C. S. (2020). Mental Health and the Covid-19 Pandemic. *New England Journal of Medicine*, 383(6), 510-512.

<https://doi.org/doi:10.1056/NEJMp2008017>

Qato, D. M., Zhang, C., Gandhi, A. B., Simoni-Wastila, L., & Coleman-Cowger, V. H. (2020). Co-use of alcohol, tobacco, and licit and illicit controlled substances among pregnant and non-pregnant women in the United States: Findings from 2006 to 2014 National Survey on Drug Use and Health (NSDUH) data. *Drug and Alcohol Dependence*, 206. <https://doi.org/10.1016/j.drugalcdep.2019.107729>

Qato, D. M., Zhang, C., Gandhi, A. B., Simoni-Wastila, L., & Coleman-Cowger, V. H. (2020). Co-use of alcohol, tobacco, and licit and illicit controlled substances

among pregnant and non-pregnant women in the United States: Findings from 2006 to 2014 National Survey on Drug Use and Health (NSDUH) data. *Drug & Alcohol Dependence*, 206, 107729.

<https://doi.org/10.1016/j.drugalcdep.2019.107729>

Schiff, D. M., Nielsen, T., Terplan, M., Hood, M., Bernson, D., Diop, H., Bharel, M., Wilens, T. E., LaRochelle, M., Walley, A. Y., & Land, T. (2018). Fatal and Nonfatal Overdose Among Pregnant and Postpartum Women in Massachusetts. *Obstet Gynecol*, 132(2), 466-474. <https://doi.org/10.1097/aog.0000000000002734>

Schiff, D. M., Nielsen, T. C., Hoepfner, B. B., Terplan, M., Hadland, S. E., Bernson, D., Greenfield, S. F., Bernstein, J., Bharel, M., Reddy, J., Taveras, E. M., Kelly, J. F., & Wilens, T. E. (2021). Methadone and buprenorphine discontinuation among postpartum women with opioid use disorder [Research Support, N.I.H., Extramural]. *American Journal of Obstetrics & Gynecology*, 225(4), 424.e421-424.e412. <https://doi.org/https://dx.doi.org/10.1016/j.ajog.2021.04.210>

Shiels, M. S., Haque, A. T., Berrington de González, A., & Freedman, N. D. (2022). Leading Causes of Death in the US During the COVID-19 Pandemic, March 2020 to October 2021. *JAMA Internal Medicine*, 182(8), 883-886. <https://doi.org/10.1001/jamainternmed.2022.2476>

Simeon D. Kimmel, M., MA Corresponding Author; Jessie M. Gaeta, MD; Scott E. Hadland, MD, MPH, MS; Eliza Hallett, MS; Brandon D.L. Marshall, PhD, & Simeo, A. c. t. (2021). Principles of Harm Reduction for Young People Who Use Drugs. *Pediatrics (2021) 147 (Supplement 2): S240–S248*.

<https://doi.org/https://doi.org/10.1542/peds.2020-023523G>

Singer, M., Bulled, N., Ostrach, B., & Mendenhall, E. (2017). Syndemics and the biosocial conception of health. *The Lancet*, 389(10072), 941-950.

[https://doi.org/10.1016/S0140-6736\(17\)30003-X](https://doi.org/10.1016/S0140-6736(17)30003-X)

Sithisarn, T., Legan, S. J., Westgate, P. M., Bada, H. S., & Wilson, M. E. (2022).

Understanding the effects of opioids vs non-opioids in the treatment of neonatal abstinence syndrome, an in vitro model. *Frontiers in Pediatrics*, 10, 1068330.

<https://doi.org/10.3389/fped.2022.1068330>

Smid, M. C. M. S., Terplan, M., & Smid, M. C. (2022). What Obstetrician-Gynecologists Should Know About Substance Use Disorders in the Perinatal Period [Journal Article]. *Obstetrics & Gynecology*, 139(2), 317-337.

<https://doi.org/10.1097/AOG.0000000000004657>

Spencer MR, G. M., Miniño AM. (2020). Urban–rural differences in drug overdose death rates, 2020.

Tatyana Roberts, B. F., Heather Saunders, and Alina Salganicoff. (2023). Opioid Use Disorder and Treatment Among Pregnant and Postpartum Medicaid Enrollees.

<https://www.kff.org/medicaid/opioid-use-disorder-and-treatment-among-pregnant-and-postpartum-medicaid-enrollees/>

Thomeer, M. B., Moody, M. D., & Yahirun, J. (2023). Racial and Ethnic Disparities in Mental Health and Mental Health Care During The COVID-19 Pandemic.

Journal of Racial & Ethnic Health Disparities, 10(2), 961-976.

<https://doi.org/10.1007/s40615-022-01284-9>

West, B. S., Choi, S., & Terplan, M. (2023). In our responses to the overdose epidemic,

we cannot forget pregnant and postpartum people. *Int J Drug Policy*, *120*,

104153. <https://doi.org/10.1016/j.drugpo.2023.104153>

Xiong, J., Lipsitz, O., Nasri, F., Lui, L. M. W., Gill, H., Phan, L., Chen-Li, D., Iacobucci,

M., Ho, R., Majeed, A., & McIntyre, R. S. (2020). Impact of COVID-19

pandemic on mental health in the general population: A systematic review. *J*

Affect Disord, *277*, 55-64. <https://doi.org/10.1016/j.jad.2020.08.001>

Appendix A: Policy Brief Memo

Addressing the Maternal Opioid Crisis: Policy Priorities for Reducing Pregnancy-Associated Deaths

Introduction

Opioid overdose, especially from fentanyl, has become a leading cause of pregnancy-related deaths in the U.S., rising sharply since 2019 amid pandemic-driven healthcare and social inequities.

Scope of the Problem

Limited access to medication-assisted treatment (MAT), especially in rural areas, along with poverty, racial inequities, and fragmented care systems, fueled the maternal opioid crisis.

Current Approaches

Supportive policies like the SUPPORT Act and Medicaid expansions improved access but failed to close gaps in postpartum care, behavioral health, and stigma reduction.

Proposed Program or Policy

Federal priorities should include expanding postpartum Medicaid to 12 months, funding regional centers and rural telehealth, and reducing stigma through awareness, protections, and community support.

Major Constituencies

Stakeholders include women with opioid use, providers, public health agencies, and advocacy groups.

Conclusions

Adopting these reforms could reduce deaths and costs while improving treatment and establishing a sustainable, equitable maternal health model.

References

NIDA. 2023, November 22. Overdose deaths increased in pregnant and postpartum women from early 2018 to late 2021. Retrieved from <https://nida.nih.gov/news-events/news-releases/2023/11/overdose-deaths-increased-in-pregnant-and-postpartum-women-from-early-2018-to-late-2021> on 2025, October 11

Appendix B: Community Health Intervention Plan

Problem Definition

Rising opioid-involved maternal deaths (2019–2023) reflect restricted MAT access, stigma, and structural inequities, particularly in rural areas. With NAS hospitalizations exceeding \$1.5 billion annually, a coordinated, community-based integration of addiction, obstetric, and behavioral health care is imperative.

Goal Setting

Reduce opioid-involved maternal mortality and improve access to evidence-based treatment for pregnant and postpartum women.

Target Population

Focused on pregnant and postpartum women with OUD in regions of high maternal mortality and inadequate treatment capacity, the initiative also benefits infants with NAS, their families, and local care providers.

Intervention Strategies

This multi-level intervention integrates individual, interpersonal, organizational, community, and policy actions to reduce maternal opioid-involved deaths and promote equitable access to care.

- **Individual Level:** Expand access to medication-assisted treatment (MAT) and behavioral health services. Strengthen outreach and peer support to improve MAT acceptance and retention.
- **Interpersonal / Family Level:** Provide psychosocial education and support to families during pregnancy and postpartum. Facilitate peer-led recovery groups to enhance engagement and resilience among mothers with opioid use disorder (OUD).
- **Organizational / Institutional Level:** Implement routine screening for opioid use and mental health conditions in all prenatal settings. Integrate obstetric, addiction, and behavioral health services through co-located or referral-based care models.
- **Community Level:** Partner with community organizations to conduct educational campaigns that reduce stigma and increase awareness of maternal OUD. Engage trusted local leaders to promote treatment-seeking behaviors and community-based recovery supports.
- **Policy Level:** Mandate 12-month postpartum Medicaid coverage inclusive of addiction and mental health services. Expand federal and state funding for rural addiction treatment infrastructure and telehealth delivery.

Implementation Plan

Year 1: Form partnerships among health departments, community organizations, and healthcare systems; secure federal funding; initiate provider training.

Year 2: Launch integrated care hubs, mobile treatment units, and telehealth networks. Begin family and community education initiatives.

Year 3: Expand community outreach, evaluate outcomes, and refine program components for sustainability.

Resources

Supported by federal grants, local hospital partnerships, telehealth infrastructure funds, and community health workers to assist with outreach, case management, and follow-up.

Roles/Responsibilities

- State Health Departments: Oversight, funding allocation, and program evaluation.
- Community Health Centers: Service integration, data collection, and patient navigation.
- Local Organizations: Implementation of education campaigns, peer support networks, and stigma reduction initiatives.

Evaluation Plan

Evaluation will combine quantitative data (e.g., electronic health records, program metrics) with qualitative feedback from participants and providers. Findings will inform continuous quality improvement and long-term policy recommendations for maternal behavioral health systems.

Process Measures

- Number of pregnant and postpartum women screened, referred, and enrolled in MAT programs.
- Number of providers trained in addiction treatment and stigma reduction.

Outcome Measures

- Reduction of maternal opioid-involved deaths by 30% within three years.
- Increased treatment retention and postpartum follow-up rates.
- Improved patient satisfaction and reductions in reported stigma.

References

Centers for Disease Control and Prevention. (2023). *Pregnancy-related deaths and substance use disorders, 2019–2023*. U.S. Department of Health and Human Services.

<https://www.cdc.gov/reproductivehealth/maternalinfanthealth/pregnancy-relatedmortality.htm>

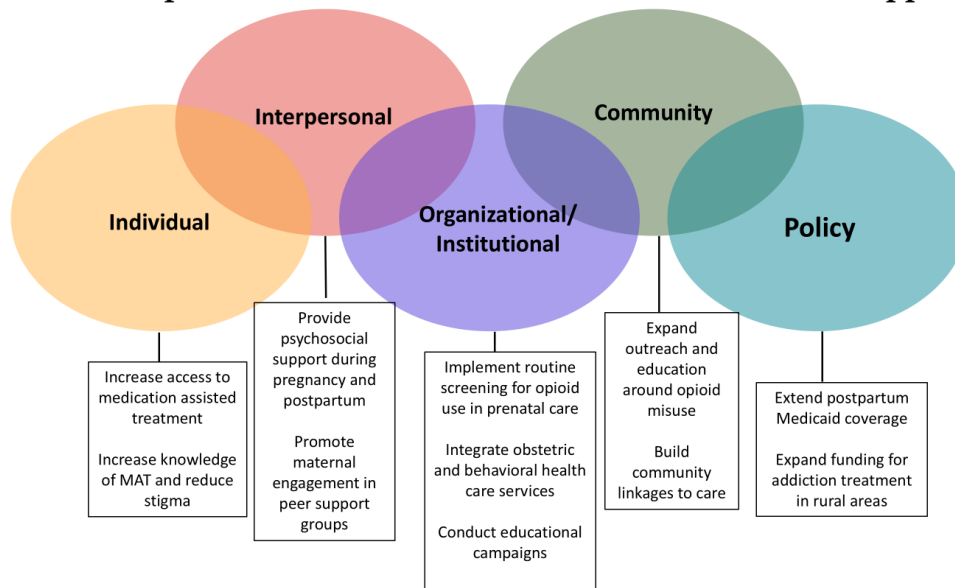
Substance Abuse and Mental Health Services Administration. (2022). *Medication-assisted treatment for pregnant women with opioid use disorder*. U.S. Department of Health and Human Services. <https://www.samhsa.gov/medication-assisted-treatment>

Health Resources and Services Administration. (2022). *Rural maternal health toolkit*. U.S. Department of Health and Human Services. <https://ruralhealthinfocenter.hrsa.gov/toolkits/maternal-health>

National Institute on Drug Abuse. (2023). *Overdose deaths increased in pregnant and postpartum women from early 2018 to late 2021*. National Institutes of Health. <https://nida.nih.gov/news-events/news-releases/2023/11/overdose-deaths-increased-in-pregnant-and-postpartum-women>

Appendix C: Maternal Opioid Use Disorder: A Multi-Level Intervention Approach

Maternal Opioid Use Disorder: A Multi-level Intervention Approach



Appendix D: Fact Sheet

OPIOID SAFETY FOR
PREGNANT &
POSTPARTUM WOMEN

KNOW the FACTS

WHY IT MATTERS

From 2019–2023, nearly 80% of maternal overdose deaths involved opioids, with risk highest during and after COVID-19. Pregnant and postpartum women face overlapping challenges including substance use, stress, and mental health needs that require coordinated care.



WHAT WORKS?

Integrated care connects medical, mental health, and social support for mothers and infants.



FACT

Medications to treat opioid use disorder, like methadone and buprenorphine, are administered or prescribed by medical providers to save people's lives. These medications help stabilize individuals and support their treatment so they can begin and sustain recovery.



OUR GOAL

Ensure every pregnant and postpartum woman has access to safe, stigma-free care. We are linking treatment, recovery, and community support for healthier families.

**You're not alone.
Hope, healing, and recovery start here.**

