

Research

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Pregnancy and Postpartum Drug Overdose Deaths in the US Before and During the COVID-19 Pandemic

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IMPORTANCE Knowledge about characteristics of US pregnancy-associated decedents is needed to guide responses.

OBJECTIVE To examine individual sociodemographic characteristics and residing county's health care resources and socioeconomic factors among pregnancy-associated overdose decedents in comparison with obstetric decedents and overdose decedents who were not pregnant in the past year.

DESIGN, SETTING, AND PARTICIPANTS This cross-sectional, exploratory study included 1457 pregnant and postpartum overdose decedents, 4796 obstetric decedents, and 11 205 nonpregnant overdose decedents aged 10 to 44 years from 2018 to 2021. Data were analyzed August 2023.

EXPOSURES Decedents from the 2018-2021 Multiple Cause of Death Files linked to the 2021 Area Health Resources Files and the 2018-2021 County Health Rankings data at the county level.

MAIN OUTCOMES AND MEASURES Pregnancy-associated deaths were defined as deaths during pregnancy or within 1 year of pregnancy termination. This study focused on unintentional drug overdoses or drug overdoses with undetermined intent involving the most common psychotropic drugs of misuse.

RESULTS From 2018 to 2021, across the pregnancy-postpartum continuum, pregnancy-associated overdose mortality ratios consistently increased among women aged 10 to 44 years. Mortality ratio more than tripled among pregnant and postpartum women aged 35 to 44 years from 4.9 (95% CI, 3.0-8.0) per 100 000 mothers aged 35 to 44 years with a live birth in January to June 2018 to 15.8 (95% CI, 12.3-20.4) in July to December 2021 (average semiannual percentage changes, 15.9; 95% CI, 8.7-23.6; $P < .001$). Compared with pregnant obstetric decedents, pregnant overdose decedents had increased odds of being aged 10 to 34 years (75.4% vs 59.5%; range of odds ratios [ORs], 1.8 [95% CI, 1.3-2.5] for ages 10 to 24 years to 2.2 [95% CI, 1.7-2.8] for ages 25 to 34 years), being non-college graduates (72.1% vs 59.4%; range of ORs, 2.7 [95% CI, 1.7-4.3] for those with some college education to 3.9 [95% CI, 2.4-6.1] for those with less than high school education), being unmarried (88.0% vs 62.1%; OR, 4.5; 95% CI, 3.7-6.0), and dying in nonhome, non-health care settings (25.9% vs 4.5%; OR, 2.5; 95% CI, 1.8-3.6) and were associated with decreased odds of dying in health care settings (34.7% vs 77.6%; range of ORs, 0.1 [95% CI, 0.1-0.1] for those who died in hospital inpatient settings to 0.4 [95% CI, 0.3-0.6] for those who died in hospital outpatient/emergency room settings).

CONCLUSIONS AND RELEVANCE From 2018 to 2021, the mortality ratio more than tripled among pregnant and postpartum women aged 35 to 44 years, consistent with increases in overdose mortality across US populations. Most pregnancy-associated overdose deaths occurred outside health care settings, indicating the need for strengthening community outreach and maternal medical support. To reduce pregnancy-associated overdose mortality, evidence-based interventions are urgently needed at individual, health care, local, and national levels, along with nonpunitive approaches incentivizing pregnant and postpartum women to seek substance use disorder treatments.

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Research has reported increases in pregnancy-associated drug overdose mortality.¹⁻⁴ To inform substance use policy and practice, it is important to understand trends in unintentional or undetermined-intent pregnancy-associated overdose mortality caused by common psychotropic drugs of misuse. Considering that overall drug overdose mortality has increased significantly from 2018 through the COVID-19 pandemic,⁵ an examination of trends in pregnancy-associated mortality from drug overdoses by pregnancy timing, age, race and ethnicity, educational attainment, and marital status during this time frame is warranted.

Furthermore, the implementation of evidence-based interventions to address pregnancy-associated mortality would benefit from a better understanding of sociodemographic characteristics, place of death, and timing relevant to pregnancy. Although a study reported trends in pregnancy-related mortality by age, race and ethnicity, and place of death from 2003 to 2016,⁶ little is known about specific characteristics of pregnant and postpartum drug overdose decedents during more recent years.

Notably, living in socioeconomically deprived neighborhoods and communities is associated with overall higher morbidity and mortality, including during pregnancy and post partum.^{7,8} According to the Association of American Medical Colleges, half of US counties lack a single obstetrician-gynecologist.⁹ Similarly, drug overdose mortality is associated with living in poverty¹⁰ and rises with increasing county-level income inequality.¹¹ Yet characteristics at the county level of residence among pregnancy-associated overdose decedents are unclear.

Importantly, little is known about how individual sociodemographic characteristics, place of death, and relevant health care resources at the county and state levels of pregnant and postpartum overdose decedents differ from decedents from obstetric causes and female overdose decedents of reproductive age who had no past-year pregnancy. Yet this information could help inform the implementation of prevention and intervention strategies to reduce pregnancy-associated overdose mortality and advance substance use policy and practice. Using recently available data from 2018 to 2021, this exploratory study was conducted to understand these knowledge gaps.

Methods

Data Sources and Measures

The 2018-2021 deidentified US individual-level Multiple Cause of Death Files and semiannual numbers of mothers aged 10 to 44 years with a live birth, overall and by mother's age, race and ethnicity, educational attainment, and marital status, were obtained from the National Center for Health Statistics. To control for birth plurality,¹² pregnancy-associated mortality ratios were defined as deaths during pregnancy or within 1 year of termination of pregnancy per 100 000 mothers with a live birth during each period. To reduce reporting errors in pregnancy checkboxes in older decedents,¹³ we focused on 3 groups aged 10 to 44 years: pregnant and postpartum decedents from overdose (n = 1457) or obstetric causes (n = 4796) and female

Key Points

Questions How did pregnant and postpartum overdose decedents aged 10 to 44 years differ from obstetric decedents in the US?

Findings In this cross-sectional study including 17 458 decedents, from 2018 to 2021, drug overdose mortality ratios rose (more than 3-fold in pregnant and postpartum individuals aged 35 to 44 years) across the pregnancy-postpartum continuum (the highest during late postpartum period since July 2020). Overdose decedents differed from obstetric decedents in sociodemographic characteristics (younger, less education, unmarried), place of death (outside health care settings), and available health care resources.

Meaning To reduce pregnancy-associated mortality, evidence-based interventions are needed at the individual, health care, community, state, and national levels along with nonpunitive approaches that incentivize pregnant and postpartum women to seek treatments for their substance use disorder.

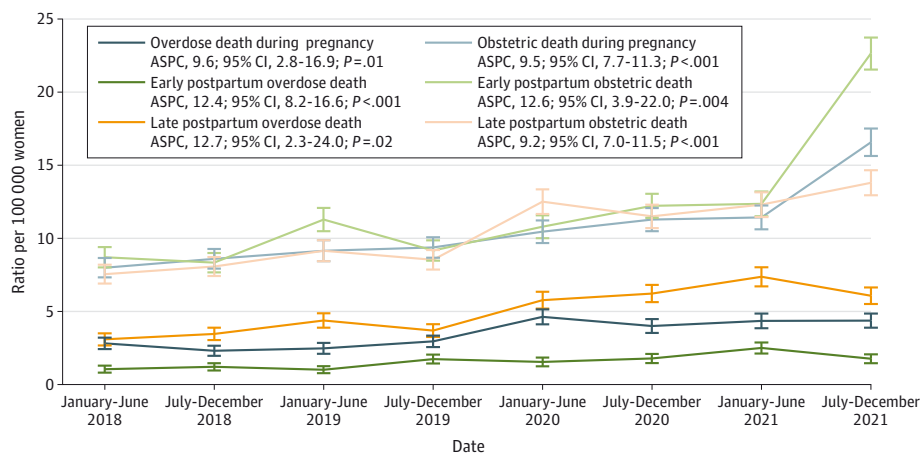
nonpregnant overdose decedents (n = 11 205). Race and ethnicity data and other demographic data were collected directly from death certificates. This study used deidentified data and was exempt from the National Institutes of Health's Institutional Review Board review by regulation. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Drug overdose with unintentional or undetermined intent decedents were those with *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)* codes X40-44 or Y10-14 as underlying causes, involving the most common psychotropic drugs of misuse (ie, *ICD-10* codes T400, T401, T402, T403, T404, T405, T406, T407, T408, T409, T423, T424, T436, T438, or T439). Obstetric decedents were those with *ICD-10* codes A34 and O00-O99 as underlying causes.

Pregnancy-associated deaths were considered if pregnancy status was coded as pregnant at time of death; not pregnant, but pregnant within 42 days of death (early postpartum period); or not pregnant, but pregnant 43 days to 1 year before death (late postpartum period). If pregnancy status was coded as not on the certificate or unknown if pregnant within last year, methods from Margerison and colleagues¹ were followed for classifying pregnancy timing of decedents with underlying or contributing obstetric causes. Nonpregnant decedents were female decedents aged 10 to 44 years whose pregnancy status was reported as not pregnant in the past year. Time, age, race and ethnicity, education, marital status, being born outside the US, residing in a Medicaid expansion state (yes/no, time-dependent variable), county of residence, place of death, region, and metropolitan statistical area were examined.

Using Federal Information Processing Standard state and county codes, we linked the 2018-2021 Multiple Cause of Death files to the 2021 Area Health Resources Files (including earlier years of data)¹⁴ and the 2018-2021 County Health Rankings data¹⁵ at the aggregate county level. We examined proportions of county residents in deep poverty; numbers of

Figure. US Trends in Pregnancy-Associated Drug Overdose or Obstetric Mortality Ratio Among Women Aged 10 to 44 Years by Pregnancy Timing



Data were collected from the National Vital Statistics System, including 2018-2021 final mortality data and 2018-2021 final birth data. Mortality ratio was calculated as the number of deaths among pregnant or recently pregnant women aged 10 to 44 years by causes divided by the number of women aged 10 to 44 years who gave live birth during the corresponding time period (per 100 000 mothers). Error bars indicate 95% CIs. ASPC indicates average semiannual percentage change.

physicians practicing in obstetrics and gynecological medicine, emergency medicine, and psychiatry per 100 000 county residents; and numbers of general hospitals with substance use treatment services, psychiatric care, obstetric care, and medical and surgical care from the 2021 Area Health Resources data. We assessed county income equality from the 2018-2021 County Health Rankings data.

Statistical Analysis

First, we estimated US trends in mortality ratios from drug overdose and obstetric causes among women aged 10 to 44 years by timing relative to pregnancy, age, race and ethnicity, educational attainment, and marital status in 50 states and Washington, DC, and 95% CIs were estimated using the Wilson-Score method.¹⁶ We also examined trends in overdose mortality rates among US women aged 10 to 44 years. Joinpoint Regression Program version 4.8.01 (National Cancer Institute) was used to test for significant changes in nonlinear trends in pregnancy-associated mortality ratios using the bayesian information criterion.

Second, we conducted bivariable multinomial logistic regression analyses to explore how sociodemographic characteristics and place of death at the individual decedent level and socioeconomic characteristics and health care resources at the county level of pregnancy-associated overdose decedents differed from obstetric decedents and female nonpregnant overdose decedents. Significance was calculated using 2-sided *t* tests, and the level of statistical significance was set at *P* < .05. All the other analyses were conducted using SAS version 9.4 (SAS Institute).

Results

Trends in Drug Overdose and Obstetric Mortality Ratios by Timing Relative to Pregnancy

From 2018 to 2021 (Figure), across the pregnancy-postpartum continuum, US pregnancy-associated mortality ratios in-

creased from unintentional or undetermined-intent drug overdose involving the most common psychotropic drugs of misuse and from obstetric causes among women aged 10 to 44 years. Late postpartum overdose mortality ratios almost doubled from 3.1 (95% CI, 2.3-3.9) per 100 000 mothers aged 10 to 44 years with a live birth in January to June 2018 to 6.1 (95% CI, 5.0-7.2) in July to December 2021 (average semiannual percentage change, 12.7; 95% CI, 2.3-24.0; *P* = .02). Across all periods, overdose mortality ratios during the late postpartum period and during pregnancy were consistently higher than early postpartum overdose mortality ratios. During July 2020 to December 2021, late postpartum overdose mortality ratios were consistently higher than overdose mortality ratios during pregnancy. Between January to June 2020 and July to December 2021, pregnancy obstetric mortality ratios increased from 10.5 (95% CI, 8.9-12.0) per 100 000 mothers aged 10 to 44 years with a live birth to 16.6 (95% CI, 14.7-18.4), and early postpartum obstetric mortality ratios increased from 10.8 (95% CI, 9.3-12.3) per 100 000 mothers aged 10 to 44 years with a live birth to 22.7 (95% CI, 20.5-24.8).

Trends in Overdose and Obstetric Mortality Ratios Overall and by Sociodemographic Characteristics

Pregnancy-associated drug overdose mortality ratios increased among pregnant and postpartum women aged 10 to 44 years overall, those aged 35 to 44 years, non-Hispanic Black women, non-Hispanic White women, Hispanic women, and women at each examined education and marital status level (Table 1). The mortality ratio more than tripled among pregnant and postpartum women aged 35 to 44 years from 4.9 (95% CI, 3.0-8.0) per 100 000 mothers with a live birth in January to June 2018 to 15.8 (95% CI, 12.3-20.4) in July to December 2021 (average semiannual percentage change, 15.9; 95% CI, 8.7-23.6; *P* < .001). The mortality ratio was notably high for non-Hispanic American Indian or Alaska Native mothers in 2018 to 2019 and 2020 to 2021.

Pregnancy-associated obstetric mortality ratios increased among pregnant and postpartum women aged 10 to 44 years

Table 1. Pregnancy-Associated Mortality Ratios and Average Semiannual Percentage Changes (ASPC) Among Women Aged 10 to 44 Years Who Died From a Drug Overdose, 2018-2021

Characteristic	Mortality ratio per 100 000 mothers with a live birth (95% CI)												P value
	2018			2019			2020			2021			
	January-June	July-December	ASPC (95% CI)	January-June	July-December	ASPC (95% CI)	January-June	July-December	ASPC (95% CI)	January-June	July-December	ASPC (95% CI)	
Overall	6.9 (5.8-8.3)	7.0 (5.9-8.3)	7.9 (6.7-9.3)	8.4 (7.2-9.8)	11.9 (10.4-13.7)	12.0 (10.5-13.7)	14.2 (12.5-16.1)	12.2 (10.7-13.9)	11.4 (1.5-22.4)	.02			
Age, y													
10-24	6.4 (4.6-8.8)	3.7 (2.4-5.6)	5.7 (3.9-8.2)	4.4 (3.0-6.6)	8.2 (5.9-11.6)	11.6 (8.7-15.3)	10.3 (7.8-13.7)	6.7 (4.8-9.4)	11.4 (-0.4 to 24.6)	.06			
25-34	7.1 (5.7-9.0)	7.7 (6.2-9.5)	8.0 (6.5-9.9)	8.3 (6.8-10.2)	12.7 (10.7-15.1)	11.9 (10.0-14.2)	10.8 (9.2-12.7)	9.1 (7.7-10.8)	6.0 (-0.4 to 12.9)	.06			
35-44	4.9 (3.0-8.0)	7.8 (5.4-11.4)	8.9 (6.2-12.8)	12.5 (9.3-16.8)	14.2 (10.7-18.9)	12.9 (9.6-17.3)	14.2 (10.7-18.8)	15.8 (12.3-20.4)	15.9 (8.7-23.6)	<.001			
Race and ethnicity ^d													
Non-Hispanic American Indian or Alaska Native	31.7 (20.1-50.1)				49.8 (34.0-73.0)				18.1 (-6.0 to 42.2) ^a	.14			
Non-Hispanic Black	4.6 (2.6-8.0)	4.0 (2.2-7.1)	4.3 (2.4-7.7)	10.7 (7.5-15.3)	13.8 (9.9-19.2)	17.4 (13.1-23.3)	19.5 (14.7-26.0)	10.2 (7.0-14.8)	21.6 (2.0-44.8)	.03			
Hispanic	2.9 (1.6-5.0)	1.5 (0.7-3.2)	2.4 (1.3-4.4)	2.4 (1.3-4.3)	4.1 (2.6-6.6)	3.2 (1.9-5.3)	6.2 (4.2-9.1)	4.7 (3.1-7.1)	14.6 (3.0-27.6)	.02			
Non-Hispanic multiple races	7.5 (5.1-11.1)								NA	NA			
Non-Hispanic White	10.3 (8.4-12.6)	11.1 (9.2-13.4)	12.0 (9.9-14.4)	11.2 (9.2-13.5)	16.7 (14.2-19.6)	15.9 (13.6-18.8)	17.0 (14.5-19.9)	17.7 (15.2-20.5)	8.8 (5.0-12.8)	.001			
Education (ages ≥25 y) ^b													
<High school	16.3 (10.7-25.0)	14.6 (9.5-22.6)	17.3 (11.3-26.4)	20.5 (14.1-29.8)	30.7 (22.2-42.5)	29.1 (20.9-40.4)	33.9 (24.5-47.0)	30.1 (21.8-41.7)	13.7 (8.1-19.6)	.001			
High school	16.5 (12.3-22.1)	18.3 (14.0-23.9)	20.5 (15.7-26.6)	20.1 (15.6-25.9)	31.3 (25.3-38.7)	30.4 (24.7-37.5)	34.6 (28.2-42.4)	35.9 (29.7-43.3)	13.2 (10.1-16.3)	<.001			
Some college or college graduates	1.8 (1.2-2.7)	2.8 (2.0-3.8)	2.7 (2.0-3.8)	3.3 (2.5-4.4)	4.0 (3.1-5.3)	3.4 (2.5-4.5)	5.1 (4.0-6.5)	3.7 (2.9-4.9)	11.9 (2.5-22.2)	.01			
Marital status ^c													
Unmarried	16.9 (14.0-20.5)	15.1 (12.4-18.3)	17.2 (14.3-20.8)	19.5 (16.4-23.0)	26.9 (23.2-31.3)	27.1 (23.4-31.4)	32.1 (27.9-37.0)	26.6 (22.9-30.8)	11.4 (6.5-16.4)	.001			
Married	1.6 (0.9-2.6)	2.3 (1.5-3.5)	2.8 (1.9-4.0)	1.9 (1.2-3.0)	3.6 (2.5-5.0)	2.9 (2.0-4.2)	3.8 (2.7-5.3)	4.0 (3.0-5.5)	11.5 (7.9-15.2)	<.001			

Abbreviation: NA, not applicable.

^a Difference in mortality ratios per 100 000 American Indian or Alaska Native mothers with a live birth between 2018-2019 and 2020-2021.

^b We limit to mothers 25 years or older because educational attainment is often presented among mothers 25 years or older with a live birth during the corresponding period.

^c Limited to US pregnancy-associated overdose deaths outside of California since California did not collect the marital status of women with a live birth at the record level during this study period.

^d Race and ethnicity data were collected directly from death certificates. Per the US Centers for Disease Control and Prevention reporting rules, mortality rates were suppressed for non-Hispanic Asian mothers or Native Hawaiian or Other Pacific Islander mothers due to the number smaller than 10 from 2018 to 2021.

overall and almost all examined age, race and ethnicity, education, and marital status groups (eTable 1 in Supplement 1).

Trends in Drug Overdose Mortality Rates Overall and by Age

From 2018 to 2021, drug overdose mortality rates increased overall among women aged 10 to 44 years and each examined age group (eTable 2 in Supplement 1). Women aged 35 to 44 years consistently had higher mortality rates than younger age groups.

Comparing Pregnant and Postpartum Overdose Decedents With Obstetric Counterparts and Nonpregnant Overdose Counterparts

Individual Sociodemographic Characteristics and Place of Death

Compared with pregnant obstetric decedents (Table 2), pregnant overdose decedents were associated with increased odds of being aged 10 to 34 years (75.4% vs 59.5%; range of odds ratios [ORs], 1.8 [95% CI, 1.3-2.5] for ages 10 to 24 years to 2.2 [95% CI, 1.7-2.8] for ages 25 to 34 years), being non-college graduates (72.1% vs 59.4%; range of ORs, 2.7 [95% CI, 1.7-4.3] for those with some college education to 3.9 [95% CI, 2.4-6.1] for those with less than high school education), being unmarried (88.0% vs 62.1%; OR, 4.5; 95% CI, 3.7-6.0), dying in non-home, non-health care settings (25.9% vs 4.5%; OR, 2.5; 95% CI, 1.8-3.6), and residing in Medicaid expansion states (65.4% vs 52.3%; OR, 1.7; 95% CI, 1.4-2.1). However, compared with pregnant obstetric decedents, pregnant overdose decedents were associated with decreased odds of being born outside the US (3.4% vs 12.2%; OR, 0.3; 95% CI, 0.3-0.4), dying in health care settings (34.7% vs 77.6%; range of ORs, 0.1 [95% CI, 0.1-0.1] for those who died in hospital inpatient settings to 0.4 [95% CI, 0.3-0.6] for those who died in hospital outpatient/emergency room settings), and being certified by neither medical examiners nor coroners (33.5% vs 73.4%; range of ORs, 0.01 [95% CI, 0.003-0.03] for those certified by pronouncing and/or certifying physicians to 0.3 [95% CI, 0.2-0.3] for those certified by others).

Compared with nonpregnant overdose decedents (Table 2), pregnant overdose decedents were associated with increased odds of being aged 10 to 34 years (75.4% vs 48.3%; range of ORs, 3.2 [95% CI, 1.7-4.1] for ages 25 to 34 years to 3.3 [95% CI, 2.5-4.4] for ages 10 to 24 years), American Indian or Alaska Native (3.2% vs 1.4%; OR, 2.3; 95% CI, 1.4-4.0), and unmarried (88.0% vs 80.0%; OR, 1.8; 95% CI, 1.4-2.4), and dying in health care settings or other nonhome places (60.6% vs 49.7%; range of ORs, 1.4 [95% CI, 1.1-1.7] for those who died in other places to 2.0 [95% CI, 1.5-2.5] for those who died in hospital outpatient/emergency room settings). These differences are similar to differences between early/late postpartum overdose and obstetric decedents and between early/late postpartum overdose and nonpregnant decedents (Table 3 and Table 4).

Socioeconomic Characteristics and Health Care Resources at the Residing County Levels

Compared with pregnant obstetric decedents (Table 2), pregnant overdose decedents were associated with increased odds of residing in counties at the second quartile of income inequality (27.7% vs 18.0%; OR, 1.9; 95% CI, 1.5-2.5) and at the

first to third quartiles of the proportion of county residents in deep poverty (85.7% vs 76.4%; range of ORs, 1.5 [95% CI, 1.1-2.0] for those in the third quartile to 2.2 [95% CI, 1.6-3.1] for those in the first quartile), residing in counties with the number of physicians practicing obstetrics and gynecology medicine within the 48th to 75th percentile (32.9% vs 25.5%; OR, 1.4; 95% CI, 1.1-1.7), and residing in counties with 1 general hospital with substance use services (23.8% vs 20.7%; OR, 1.4; 95% CI, 1.1-2.0), 1 general hospital with obstetric care (31.9% vs 25.9%; OR, 1.3; 95% CI, 1.1-1.7), and 1 general hospital with adult medical and surgical care (31.1% vs 25.8%; OR, 1.3; 95% CI, 1.0-1.6). However, compared with pregnant obstetric decedents, pregnant overdose decedents were associated with decreased odds of residing in a county with no physicians practicing emergency medicine (7.3% vs 10.6%; OR, 0.6; 95% CI, 0.4-0.9) and with no psychiatrists for patient care (11.3% vs 15.7%; OR, 0.7; 95% CI, 0.5-0.9). These differences are consistent with differences between early/late postpartum overdoses and obstetric decedents (Table 3 and Table 4).

Compared with nonpregnant overdose decedents (Table 2 and Table 3), pregnant overdose decedents were associated with increased odds of residing in a county with the lowest quartile of the proportion of residents in deep poverty (24.6% vs 19.2%; OR, 1.6; 95% CI, 1.2-2.1), but early postpartum overdose decedents were associated with increased odds of residing in a county with no general hospital with adult medical and surgical care (15.8% vs 11.3%; OR, 1.5; 95% CI, 1.1-2.2) and were associated with decreased odds of residing in a county with fewer than 2 general hospitals with substance use services (78.5% vs 84.5%; range of ORs, 0.6 [95% CI, 0.4-0.9] for 1 general hospital with substance use services to 0.7 [95% CI, 0.4-0.9] for no general hospital with substance use services). Compared with nonpregnant overdose decedents (Table 4), late postpartum overdose decedents were associated with decreased odds of residing in a county with the number of physicians practicing emergency medicine under 86th percentile among US counties (57.3% vs 64.4%; range of ORs, 0.6 [95% CI, 0.4-0.8] for the 44th percentile to 0.8 [95% CI, 0.7-0.9] for between the 65th and 86th percentile) and residing in a county with fewer than 2 general hospitals with substance use services (77.1% vs 84.5%; range of ORs, 0.6 [95% CI, 0.5-0.7] for no general hospital with substance use services to 0.7 [95% CI, 0.5-0.8] for 1 general hospital with substance use services).

Discussion

From 2018 to 2021, pregnancy-associated overdose mortality ratios increased among women aged 10 to 44 years consistently across the pregnancy-postpartum continuum and more than tripled among pregnant and postpartum women aged 35 to 44 years. Throughout the COVID-19 pandemic, pregnancy-associated overdose mortality ratios increased among most race and ethnicity groups and each examined educational and marital status group. These increases are consistent with increases in overall overdose mortality rates among women aged 10 to 44 years, especially women aged 35 to 44 years, who had the highest overdose mortality rates. Our results suggest that

Table 2. Comparing Pregnant Overdose Decedents (POD) With Pregnant Obstetric Decedents (POBD) and Female Overdose Decedents With No Past-Year Pregnancy (NPOD): Differences in Individual Sociodemographic and County-Level Characteristics

Characteristic	Distribution, %			OR (95% CI)	
	POD (n = 505)	POBD (n = 1544)	NPOD (n = 11 205)	POD vs POBD	POD vs NPOD
Age					
10-24 y	16.4	14.7	10.4	1.8 (1.3-2.5) ^a	3.3 (2.5-4.4) ^a
25-34 y	59.0	44.8	37.9	2.2 (1.7-2.8) ^a	3.2 (1.7-4.1) ^a
35-44 y	24.6	40.5	51.7	1 [Reference]	1 [Reference]
Race and ethnicity^d					
Non-Hispanic American Indian or Alaska Native	3.2	2.3	1.4	0.9 (0.5-1.6)	2.3 (1.4-4.0) ^a
Non-Hispanic Asian, Native Hawaiian, or Other Pacific Islander	0.4	2.7	0.5	0.1 (0.02-0.4) ^a	0.8 (0.2-3.3)
Non-Hispanic Black	11.9	30.3	11.0	0.2 (0.2-0.3) ^a	1.1 (0.8-1.5)
Hispanic	6.4	17.0	8.1	0.2 (0.2-0.3) ^a	0.8 (0.6-1.1)
Non-Hispanic multiple races	2.0	1.2	1.5	1.0 (0.5-2.2)	1.4 (0.7-2.6)
Non-Hispanic White	76.2	46.5	77.5	1 [Reference]	1 [Reference]
Education (in those 18-44 y)					
<High school	21.9	17.1	20.0	3.9 (2.4-6.1) ^a	1.3 (0.8-2.0)
High school	50.2	42.3	48.4	3.6 (2.3-5.5) ^a	1.2 (0.8-1.9)
Some college	22.7	25.0	25.4	2.7 (1.7-4.3) ^a	1.1 (0.7-1.6)
College or more	5.2	15.6	6.1	1 [Reference]	1 [Reference]
Marital status (in those 18-44 y)					
Unmarried	88.0	62.1	80.0	4.5 (3.7-6.0) ^a	1.8 (1.4-2.4) ^a
Married	12.0	37.9	20.0	1 [Reference]	1 [Reference]
Being born outside the US					
Yes	3.4	12.2	2.8	0.3 (0.2-0.4) ^a	1.2 (0.7-2.0)
No	96.6	87.8	97.2	1 [Reference]	1 [Reference]
Place of death					
Hospital inpatient setting	12.7	55.8	10.9	0.1 (0.1-0.1) ^a	1.5 (1.1-2.0) ^a
Hospital outpatient/emergency department setting	22.0	21.8	14.3	0.4 (0.3-0.6) ^a	2.0 (1.5-2.5) ^a
Dead on arrival at hospital/clinic	0.8	0.7	0.9	0.5 (0.2-1.8)	1.2 (0.4-3.2)
Other	25.9 ^b	4.5	24.5	2.5 (1.8-3.6) ^a	1.4 (1.1-1.7) ^a
Home	38.6	17.2	49.4	1 [Reference]	1 [Reference]
Certifier					
Pronouncing and/or certifying physician	0.6	24.6	0.7	0.01 (0.003-0.03) ^a	0.9 (0.3-2.9)
Other	32.9	48.8	28.0	0.3 (0.2-0.3) ^a	1.3 (1.04-1.5) ^a
Medical examiner or coroner	66.5	26.6	71.3	1 [Reference]	1 [Reference]
Metropolitan area					
Large metropolitan	49.5	48.1	43.4	1.1 (0.8-1.4)	1.2 (1.0-1.6)
Small metropolitan	32.5	32.6	37.5	1.1 (0.8-1.4)	0.9 (0.7-1.2)
Nonmetropolitan	18.0	19.2	19.2	1 [Reference]	1 [Reference]
Resided in a Medicaid expansion state					
Yes	65.4	52.3	64.9	1.7 (1.4-2.1) ^a	1.0 (0.8-1.2)
No	34.6	47.7	35.1	1 [Reference]	1 [Reference]
Income inequality, quartile^c					
Lowest (≤4.010)	14.9	15.2	15.0	1.2 (0.9-1.7)	1.0 (0.7-1.3)
Second (>4.010-≤4.406)	27.7	18.0	22.2	1.9 (1.5-2.5) ^a	1.2 (1.0-1.5)
Third (>4.406-≤4.873)	28.9	31.5	35.0	1.1 (0.9-1.5)	0.8 (0.6-1.0)
Highest (>4.873)	28.5	35.3	27.8	1 [Reference]	1 [Reference]

(continued)

Table 2. Comparing Pregnant Overdose Decedents (POD) With Pregnant Obstetric Decedents (POBD) and Female Overdose Decedents With No Past-Year Pregnancy (NPOD): Differences in Individual Sociodemographic and County-Level Characteristics (continued)

Characteristic	Distribution, %			OR (95% CI)	
	POD (n = 505)	POBD (n = 1544)	NPOD (n = 11 205)	POD vs POBD	POD vs NPOD
County residents in deep poverty, quartile among US counties					
Lowest (≤4.182)	24.6	18.3	19.2	2.2 (1.6-3.1) ^a	1.6 (1.2-2.1) ^a
Second (>4.182-≤5.736)	27.9	21.4	30.1	2.2 (1.6-3.0) ^a	1.1 (0.8-1.5)
Third (>5.736-≤7.698)	33.3	36.6	33.3	1.5 (1.1-2.0) ^a	1.2 (0.9-1.6)
Highest (>7.698)	14.3	23.6	17.3	1 [Reference]	1 [Reference]
Physicians practicing in OBGYN medicine per 100 000 county residents					
48th Percentile among US counties (0)	7.7	10.7	8.3	0.8 (0.5-1.1)	0.9 (0.7-1.3)
>48th-≤75th Percentile among US counties (>0-≤8.189)	32.9	25.5	33.3	1.4 (1.1-1.7) ^a	1.0 (0.8-1.2)
>75th Percentile among US counties (>8.189)	59.4	63.8	58.4	1 [Reference]	1 [Reference]
Physicians practicing in emergency medicine per 100 000 county residents					
44th Percentile among US counties (0)	7.3	10.6	7.0	0.6 (0.4-0.9) ^a	0.9 (0.7-1.3)
>44th-≤65th Percentile among US counties (>0-≤6.0)	20.4	19.8	23.0	0.9 (0.7-1.2)	0.8 (0.6-1.0)
>65th-≤86th Percentile among US counties (>6.0-≤14.0)	32.9	34.8	34.4	0.8 (0.7-1.1)	0.9 (0.7-1.1)
>86th Percentile among US counties (>14.0)	39.4	34.7	35.6	1 [Reference]	1 [Reference]
Psychiatrists for patient care per 100 000 county residents					
55th Percentile among US counties (0)	11.3	15.7	11.9	0.7 (0.5-0.9) ^a	0.9 (0.7-1.2)
55th-75th Percentile among US counties (>0-≤5)	25.0	21.1	27.9	1.2 (0.9-1.5)	0.8 (0.7-1.0)
>75th Percentile among US counties (>5)	63.8	63.2	60.2	1 [Reference]	1 [Reference]
General hospitals with substance use services					
0 (89th Percentile among US counties)	57.6	55.8	58.6	1.3 (1.0-1.7)	0.8 (0.6-1.0)
1 (98th Percentile among US counties)	23.8	20.7	25.9	1.4 (1.1-2.0) ^a	0.8 (0.6-1.0)
≥2 (99th Percentile among US counties)	18.6	23.5	15.5	1 [Reference]	1 [Reference]
General hospitals with psychiatric care in the county					
0 (78th Percentile among US counties)	36.2	34.6	33.9	1.1 (0.9-1.4)	1.1 (0.9-1.4)
1 (95th Percentile among US counties)	29.5	28.1	30.3	1.1 (0.9-1.5)	1.0 (0.8-1.3)
≥2 (98th Percentile among US counties)	34.3	37.3	35.8	1 [Reference]	1 [Reference]
General hospitals with obstetric care in the county					
0 (59th Percentile among US counties)	17.6	18.9	19.5	1.0 (0.8-1.3)	0.9 (0.7-1.2)
1 (89th Percentile among US counties)	31.9	25.9	28.7	1.3 (1.1-1.7) ^a	1.1 (0.9-1.4)
≥2 (95th Percentile among US counties)	50.5	55.3	51.8	1 [Reference]	1 [Reference]
General hospitals with adult medical and surgical care					
0 (39th Percentile among US counties)	10.5	12.2	11.3	0.9 (0.7-1.3)	1.0 (0.7-1.3)
1 (82th Percentile among US counties)	31.1	25.8	28.4	1.3 (1.02-1.6) ^a	1.1 (0.9-1.4)
≥2 (92th Percentile among US counties)	58.4	62.0	60.3	1 [Reference]	1 [Reference]

Abbreviations: OBGYN, obstetrics and gynecology; OR, odds ratio.

^a P < .05.

^b For pregnant women who died from unintentional or undermined-intent overdose, 25.9% died at other places, including none in a hospice, none at a nursing home or a long-term care facility, none at an unknown place, but

25.9% at "other" places (a reporting category on a death certificate not specifying any further location).

^c Income inequality was defined as the ratio of household income at the 80th percentile to income at the 20th percentile.

^d Race and ethnicity data were collected directly from death certificates.

increases in pregnancy-associated overdose mortality reflect the persistent US overdose crisis, especially during the COVID-19 pandemic.

We further found that pregnant and postpartum overdose decedents differed from obstetric decedents and nonpregnant overdose decedents in sociodemographic characteristics and

Table 3. Comparing Early Postpartum Overdose Decedents (EPOD) With Early Postpartum Obstetric Decedents (EPOBD) and Female Overdose Decedents With No Past-Year Pregnancy (NPOD): Differences in Individual Sociodemographic and County-Level Characteristics

Characteristic	Distribution, %			OR (95% CI)	
	EPOD (n = 228)	EPOBD (n = 1739)	NPOD (n = 11 205)	EPOD vs EPOBD	EPOD vs NPOD
Age					
10-24 y	18.0	13.4	10.4	2.1 (1.3-3.2) ^a	3.7 (2.5-5.6) ^a
25-34 y	57.9	49.6	37.9	1.8 (1.3-2.5) ^a	3.3 (2.4-4.5) ^a
35-44 y	24.1	37.0	51.7	1 [Reference]	1 [Reference]
Race and ethnicity^c					
Non-Hispanic American Indian or Alaska Native	3.5	1.9	1.4	1.0 (0.5-2.2)	2.7 (1.3-5.5) ^a
Non-Hispanic Asian, Native Hawaiian, or Other Pacific Islander	0.9	5.5	0.5	0.1 (0.02-0.4) ^a	1.8 (0.4-7.5)
Non-Hispanic Black	13.7	32.1	11.0	0.2 (0.2-0.3) ^a	1.3 (0.9-1.9)
Hispanic	5.7	18.9	8.1	0.2 (0.1-0.3) ^a	0.7 (0.4-1.3)
Non-Hispanic multiple races	1.3	1.4	1.5	0.5 (0.2-1.7)	0.9 (0.3-2.9)
Non-Hispanic White	74.9	40.2	77.5	1 [Reference]	1 [Reference]
Education (in those 18-44 y)					
<High school	22.0	15.7	20.1	7.2 (3.5-14.8) ^a	1.7 (0.8-3.5)
High school	51.1	38.4	48.4	6.8 (3.4-13.6) ^a	1.6 (0.8-3.2)
Some college	22.9	25.6	25.4	4.6 (2.2-9.4) ^a	1.4 (0.7-2.8)
College or more	4.0	20.3	6.1	1 [Reference]	1 [Reference]
Marital status (in those 18-44 y)					
Unmarried	81.9	55.7	80.0	3.6 (2.5-5.1) ^a	1.1 (0.8-1.6)
Married	18.1	44.3	20.0	1 [Reference]	1 [Reference]
Being born outside the US					
Yes	2.2	18.5	2.8	0.1 (0.04-0.2) ^a	0.8 (0.3-1.9)
No	97.8	81.5	97.2	1 [Reference]	1 [Reference]
Place of death					
Hospital inpatient setting	18.4	74.0	10.9	0.04 (0.03-0.06) ^a	1.9 (1.3-2.7) ^a
Hospital outpatient/emergency department setting	20.2	14.6	14.3	0.2 (0.2-0.4) ^a	1.6 (1.1-2.2) ^a
Dead on arrival at hospital/clinic	0.9	0.6	0.9	0.3 (0.1-1.2)	1.1 (0.3-4.7)
Other	16.2	3.2	24.5	0.9 (0.5-1.4)	0.7 (0.5-1.1)
Home	43.3	7.7	49.4	1 [Reference]	1 [Reference]
Certifier					
Pronouncing and/or certifying physician	1.8	31.4	0.7	0.02 (0.01-0.04) ^a	2.9 (1.1-8.1) ^a
Other	36.8	50.7	28.0	0.2 (0.2-0.3) ^a	1.5 (1.2-2.0) ^a
Medical examiner or coroner	61.4	17.9	71.3	1 [Reference]	1 [Reference]
Metropolitan area					
Large metropolitan	50.0	51.6	43.4	0.9 (0.6-1.3)	1.2 (0.8-1.7)
Small metropolitan	31.1	30.4	37.5	1.0 (0.7-1.5)	0.8 (0.6-1.2)
Nonmetropolitan	18.9	18.0	19.2	1 [Reference]	1 [Reference]
Resided in a Medicaid expansion state					
Yes	68.0	53.6	64.9	1.8 (1.4-2.5) ^a	1.2 (0.9-1.5)
No	32.0	46.4	35.1	1 [Reference]	1 [Reference]
Income inequality, quartile^b					
Lowest (≤4.010)	13.2	13.2	15.0	1.2 (0.7-1.8)	0.8 (0.5-1.2)
Second (>4.010-≤4.406)	24.6	21.1	22.2	1.4 (0.9-2.0)	1.0 (0.7-1.5)
Third (>4.406-≤4.873)	32.0	30.4	35.0	1.2 (0.9-1.7)	0.8 (0.6-1.2)
Highest (>4.873)	30.3	35.3	27.8	1 [Reference]	1 [Reference]
County residents in deep poverty, quartile among US counties					
Lowest (≤4.182)	21.1	16.7	19.2	1.4 (0.9-2.1)	0.9 (0.6-1.4)

(continued)

Table 3. Comparing Early Postpartum Overdose Decedents (EPOD) With Early Postpartum Obstetric Decedents (EPOBD) and Female Overdose Decedents With No Past-Year Pregnancy (NPOD): Differences in Individual Sociodemographic and County-Level Characteristics (continued)

Characteristic	Distribution, %			OR (95% CI)	
	EPOD (n = 228)	EPOBD (n = 1739)	NPOD (n = 11 205)	EPOD vs EPOBD	EPOD vs NPOD
Second (>4.182-≤5.736)	21.5	23.4	30.1	1.0 (0.7-1.5)	0.6 (0.4-0.9) ^a
Third (>5.736-≤7.698)	37.3	37.6	33.3	1.1 (0.7-1.6)	1.0 (0.7-1.4)
Highest (>7.698)	20.2	22.2	17.3	1 [Reference]	1 [Reference]
Physicians practicing in OBGYN medicine per 100 000 county residents					
48th Percentile among US counties (0)	7.5	9.2	8.3	0.9 (0.5-1.6)	0.9 (0.6-1.5)
>48th-≤75th Percentile among US counties (>0-≤8.189)	36.0	26.0	33.3	1.6 (1.2-2.1) ^a	1.1 (0.8-1.5)
>75th Percentile among US counties (>8.189)	56.6	64.8	58.4	1 [Reference]	1 [Reference]
Physicians practicing in emergency medicine per 100 000 county residents					
44th Percentile among US counties (0)	7.9	10.4	7.0	0.8 (0.5-1.3)	1.1 (0.7-1.9)
>44th-≤65th Percentile among US counties (>0-≤6.0)	21.9	19.5	23.0	1.1 (0.8-1.7)	0.9 (0.7-1.3)
>65th-≤86th Percentile among US counties (>6.0-≤14.0)	34.2	33.4	34.4	1.0 (0.8-1.5)	1.0 (0.7-1.3)
>86th Percentile among US counties (>14.0)	36.0	36.7	35.6	1 [Reference]	1 [Reference]
Psychiatrists for patient care per 100 000 county residents					
55th Percentile among US counties (0)	13.2	12.4	11.9	1.2 (0.8-1.8)	1.1 (0.8-1.7)
55th-75th Percentile among US counties (>0-≤5)	28.5	22.6	27.9	1.4 (1.1-1.9) ^a	1.1 (0.8-1.4)
>75th Percentile among US counties (>5)	58.3	65.0	60.2	1 [Reference]	1 [Reference]
General hospitals with substance use services					
0 (89th Percentile among US counties)	57.9	54.2	58.6	1.3 (0.9-1.8)	0.7 (0.4-0.9) ^a
1 (98th Percentile among US counties)	20.6	20.0	25.9	1.2 (0.8-1.9)	0.6 (0.4-0.9) ^a
≥2 (99th Percentile among US counties)	21.5	25.8	15.5	1 [Reference]	1 [Reference]
General hospitals with psychiatric care in the county					
0 (78th Percentile among US counties)	37.3	33.8	33.9	1.3 (1.0-1.8)	1.1 (0.8-1.6)
1 (95th Percentile among US counties)	28.5	24.7	30.3	1.4 (1.0-2.0)	1.0 (0.7-1.4)
≥2 (98th Percentile among US counties)	34.2	41.4	35.8	1 [Reference]	1 [Reference]
General hospitals with obstetric care in the county					
0 (59th Percentile among US counties)	22.8	17.7	19.5	1.5 (1.1-2.1) ^a	1.2 (0.9-1.7)
1 (89th Percentile among US counties)	26.3	24.2	28.7	1.2 (0.9-1.7)	0.9 (0.7-1.3)
≥2 (95th Percentile among US counties)	50.9	58.2	51.8	1 [Reference]	1 [Reference]
General hospitals with adult medicine and surgical care					
0 (39th Percentile among US counties)	15.8	11.2	11.3	1.6 (1.1-2.4) ^a	1.5 (1.1-2.2) ^a
1 (82th Percentile among US counties)	27.6	24.4	28.4	1.3 (0.9-1.8)	1.0 (0.8-1.4)
≥2 (92th Percentile among US counties)	56.6	64.4	60.3	1 [Reference]	1 [Reference]

Abbreviations: OBGYN, obstetrics and gynecology; OR, odds ratio.

percentile to income at the 20th percentile.

^a P < .05.

^c Race and ethnicity data were collected directly from death certificates.

^b Income inequality was defined as the ratio of household income at the 80th

Table 4. Comparing Late Postpartum Overdose Decedents (LPOD) With Late Postpartum Obstetric Decedents (LPOBD) and Female Overdose Decedents With No Past-Year Pregnancy (NPOD): Differences in Individual Sociodemographic and County-Level Characteristics

Characteristic	Distribution, %			OR (95% CI)	
	LPOD (n = 724)	LPOBD (n = 1513)	NPOD (n = 11 205)	LPOD vs LPOBD	LPOD vs NPOD
Age					
10-24 y	20.0	15.2	10.4	2.6 (1.0-3.5) ^a	5.3 (4.2-6.8) ^a
25-34 y	61.3	47.3	37.9	2.6 (2.1-3.3) ^a	4.5 (3.7-5.5) ^a
35-44	18.7	37.5	51.7	1 [Reference]	1 [Reference]
Race and ethnicity^c					
Non-Hispanic American Indian or Alaska Native	2.8	1.9	1.4	0.9 (0.5-1.6)	2.3 (1.4-3.7) ^a
Non-Hispanic Asian, Native Hawaiian, or Other Pacific Islander	0.7	4.1	0.5	0.1 (0.04-0.3) ^a	1.6 (0.6-4.0)
Non-Hispanic Black	17.8	30.8	11.0	0.4 (0.3-0.5) ^a	1.9 (1.5-2.3) ^a
Hispanic	10.1	19.7	8.1	0.3 (0.2-0.4) ^a	5.1 (4.5-5.8) ^a
Non-Hispanic multiple races	1.7	1.0	1.5	1.1 (0.5-2.2)	1.3 (0.7-2.4)
Non-Hispanic White	66.9	42.7	77.5	1 [Reference]	1 [Reference]
Education (in those 18-44 y)					
<High school	21.3	15.7	20.1	7.4 (4.6-11.8) ^a	2.0 (1.3-3.1) ^a
High school	49.9	39.3	48.4	6.9 (4.4-10.8) ^a	2.0 (1.3-3.0) ^a
Some college	25.5	27.6	25.4	5.0 (3.2-8.0) ^a	1.9 (1.2-3.0) ^a
College or more	3.2	17.5	6.1	1 [Reference]	1 [Reference]
Marital status (in those 18-44 y)					
Unmarried	81.7	55.7	80.0	3.6 (2.9-4.4) ^a	1.1 (0.9-1.4)
Married	18.3	44.3	20.0	1 [Reference]	1 [Reference]
Being born outside the US					
Yes	3.0	14.7	2.8	0.2 (0.1-0.3) ^a	1.1 (0.7-1.7)
No	97.0	85.3	97.2	1 [Reference]	1 [Reference]
Place of death					
Hospital inpatient setting	11.2	52.9	10.9	0.1 (0.07-0.1) ^a	1.0 (0.8-1.3)
Hospital outpatient/emergency department setting	15.5	16.4	14.3	0.4 (0.3-0.5) ^a	1.1 (0.9-1.3)
Dead on arrival at hospital/clinic	0.4	0.5	0.9	0.4 (0.1-1.5)	0.5 (0.2-1.5)
Other	23.3	9.0	24.5	1.1 (0.8-1.5)	0.9 (0.8-1.1)
Home	49.6	21.2	49.4	1 [Reference]	1 [Reference]
Certifier					
Pronouncing and/or certifying physician	0.4	24.0	0.7	0.01 (0.002-0.02) ^a	0.7 (0.2-2.3)
Other	40.9	52.2	28.0	0.3 (0.3-0.4)	1.8 (1.5-2.1) ^a
Medical examiner or coroner	58.7	23.9	71.3	1 [Reference]	1 [Reference]
Metropolitan area					
Large metropolitan	49.5	48.7	43.4	1.1 (0.8-1.4)	1.4 (1.1-1.7) ^a
Small metropolitan	34.4	34.0	37.5	1.1 (0.8-1.4)	1.1 (0.9-1.4)
Nonmetropolitan	16.2	17.3	19.2	1 [Reference]	1 [Reference]
Resided in a Medicaid expansion state					
Yes	63.0	58.6	64.9	1.2 (1.01-1.4) ^a	0.9 (0.8-1.1)
No	37.0	41.4	35.1	1 [Reference]	1 [Reference]
Income inequality, quartile^b					
Lowest (≤4.010)	15.1	13.3	15.0	1.6 (1.2-2.1) ^a	1.0 (0.8-1.3)
Second (>4.010-≤4.406)	22.7	17.0	22.2	1.9 (1.5-2.4) ^a	1.0 (0.8-1.3)
Third (>4.406-≤4.873)	34.2	30.7	35.0	1.6 (1.2-1.9) ^a	1.0 (0.8-1.2)
Highest (>4.873)	28.0	39.1	27.8	1 [Reference]	1 [Reference]
County residents in deep poverty, quartile among US counties					
Lowest (≤4.182)	21.1	16.7	19.2	1.7 (1.3-2.3) ^a	1.1 (0.9-1.5)

(continued)

Table 4. Comparing Late Postpartum Overdose Decedents (LPOD) With Late Postpartum Obstetric Decedents (LPOBD) and Female Overdose Decedents With No Past-Year Pregnancy (NPOD): Differences in Individual Sociodemographic and County-Level Characteristics (continued)

Characteristic	Distribution, %			OR (95% CI)	
	LPOD (n = 724)	LPOBD (n = 1513)	NPOD (n = 11 205)	LPOD vs LPOBD	LPOD vs NPOD
Second (>4.182-≤5.736)	21.5	23.4	30.1	1.5 (1.2-2.0) ^a	0.9 (0.7-1.1)
Third (>5.736-≤7.698)	37.3	37.6	33.3	1.5 (1.1-1.9) ^a	1.1 (0.9-1.4)
Highest (>7.698)	20.2	22.2	17.3	1 [Reference]	1 [Reference]
Physicians practicing in OBGYN medicine per 100 000 county residents					
48th Percentile among US counties (0)	7.8	8.3	8.3	1.1 (0.9-1.4)	0.9 (0.7-1.0)
>48th-≤75th Percentile among US counties (>0-≤8.189)	30.4	28.2	33.3	1.1 (0.9-1.3)	0.9 (0.8-1.1)
>75th Percentile among US counties (>8.189)	61.7	63.5	58.4	1 [Reference]	1 [Reference]
Physicians practicing in emergency medicine per 100 000 county residents					
44th Percentile among US counties (0)	5.0	9.5	7.0	0.4 (0.3-0.6) ^a	0.6 (0.4-0.8) ^a
>44th-≤65th Percentile among US counties (>0-≤6.0)	20.0	18.5	23.0	0.9 (0.7-1.1)	0.7 (0.6-0.9) ^a
>65th-≤86th Percentile among US counties (>6.0-≤14.0)	32.3	36.6	34.4	0.7 (0.6-0.9) ^a	0.8 (0.7-0.9) ^a
>86th Percentile among US counties (>14.0)	42.7	35.4	35.6	1 [Reference]	1 [Reference]
Psychiatrists for patient care per 100 000 county residents					
55th Percentile among US counties (0)	10.9	12.4	11.9	0.9 (0.7-1.2)	0.8 (0.7-1.1)
55th-75th Percentile among US counties (>0-≤5)	22.5	21.3	27.9	1.1 (0.8-1.3)	0.7 (0.6-0.9) ^a
>75th Percentile among US counties (>5)	66.5	66.3	60.2	1 [Reference]	1 [Reference]
General hospitals with substance use services					
0 (89th Percentile among US counties)	51.1	55.9	58.6	1.0 (0.8-1.3)	0.6 (0.5-0.7) ^a
1 (98th Percentile among US counties)	26.0	18.4	25.9	1.6 (1.2-2.0) ^a	0.7 (0.5-0.8) ^a
≥2 (99th Percentile among US counties)	22.9	25.6	15.5	1 [Reference]	1 [Reference]
General hospitals with psychiatric care in the county					
0 (78th Percentile among US counties)	30.3	35.3	33.9	1.0 (0.8-1.2)	0.9 (0.8-1.1)
1 (95th Percentile among US counties)	35.3	26.4	30.3	1.5 (1.2-1.8) ^a	1.2 (1.01-1.4) ^a
≥2 (98th Percentile among US counties)	34.4	38.3	35.8	1 [Reference]	1 [Reference]
General hospitals with obstetric care in the county					
0 (59th Percentile among US counties)	17.2	18.1	19.5	1.0 (0.8-1.2)	0.9 (0.7-1.1)
1 (89th Percentile among US counties)	29.6	27.4	28.7	1.1 (0.9-1.4)	1.0 (0.8-1.2)
≥2 (95th Percentile among US counties)	53.3	54.5	51.8	1 [Reference]	1 [Reference]
General hospitals with adult medical and surgical care					
0 (39th Percentile among US counties)	10.4	11.7	11.3	0.9 (0.7-1.2)	0.9 (0.7-1.2)
1 (82th Percentile among US counties)	29.5	25.8	28.4	1.2 (1.0-1.5)	1.0 (0.9-1.2)
≥2 (92th Percentile among US counties)	60.2	62.5	60.3	1 [Reference]	1 [Reference]

Abbreviations: OBGYN, obstetrics and gynecology; OR, odds ratio.

percentile to income at the 20th percentile.

^a P < .05.

^c Race and ethnicity data were collected directly from death certificates.

^b Income inequality was defined as the ratio of household income at the 80th

place of death at the individual level and relevant health care resources at the county and state levels. Throughout the pregnancy-postpartum continuum, unlike most obstetric decedents who died in a hospital inpatient setting, 60% to 73% of pregnant and 74% of nonpregnant overdose decedents died at home or other non-health care places. These findings are consistent with the phenomenon that overdose deaths occur frequently at drug-consumption locations. Access to naloxone (and other overdose medications) in the community has been an essential way to reduce overdose deaths.¹⁷ In 2023, the US Food and Drug Administration approved nonprescription naloxone nasal spray.¹⁸ Whether this new resource will help reduce overdose among pregnant and postpartum women needs to be assessed.

Moreover, 70% to 75% pregnant and nonpregnant overdose decedents resided in counties with the number of physicians practicing emergency medicine per 100 000 population ranking over the 65th percentile among US counties, suggesting that in many instances, emergency services may have been available but not accessed. Understanding factors that drive failure to access emergency medicine services is needed for tailored interventions. Even if women were successfully treated in emergency departments for an overdose, they may not have received appropriate treatment for their drug use. From 2019 to 2021, naloxone and buprenorphine were prescribed only in 1 of 12 emergency department visits for opioid overdose.¹⁹

Consistent with our results for pregnancy-related overdose decedents, most opioid overdose decedents in the US do not have a bystander present at the scene.²⁰ To help reduce overdose mortality, it is pivotal to increase use of evidence-based substance use treatments during the pregnancy and postpartum periods. We found that at the county level, among pregnant-associated overdose decedents, 34% resided in counties with no hospital with psychiatric care, and 51% to 58% resided in counties with no hospital with substance use treatment services. Yet use of medications for opioid use disorder,^{21,22} and timely overdose treatments are critical to prevent overdose mortality. These can be challenging because many women may conceal their drug use from clinicians during pregnancy and motherhood due to stigma and fear of prosecution and loss of custody.²³⁻²⁷

Recent research has highlighted the importance of taking harm-reduction approaches to address the multiplicity of stigma and related barriers for pregnant and postpartum women with drug use.²⁷⁻²⁹ Strategies to destigmatize pregnant and nonpregnant women with substance use disorders are necessary to improve their access to health care services, including substance use treatments. If states take harm-reduction approaches rather than implementing punitive measures, existing health care and social welfare resources may help reduce pregnancy-associated overdose mortality. For pregnancy-associated overdose decedents, our results show that in addition to the potential emergency medicine resources, 51% to 53% resided in counties with 2 or more general hospitals with obstetric care ranking at the 95th percentile among US counties, and 58% to 67% resided in counties with numbers of practicing psychiatrists per 100 000 county

residents ranking over the 75th percentile among US counties. Previous research highlights the importance of integrating perinatal addiction screening, assessment, and treatment into prenatal care and postpartum visits.³⁰ Another important component of care is offering highly effective forms of contraception to women with drug use disorders who do not desire pregnancy.³¹

To access these health care resources, women with drug use disorders need to have sufficient payment sources. In non-Medicaid expansion states, individuals with pregnancy-related Medicaid coverage typically lose their benefits 60 days after the end of pregnancy. Although the adoption of Medicaid expansion is associated with lower pregnancy-associated mortality,^{32,33} our results show that approximately one-third of overdose decedents resided in non-Medicaid expansion states. In 2022, a critical new policy was enacted to give states the option to extend pregnancy-only Medicaid coverage to 1-year post partum to help ensure that no one loses coverage just months after birth. Our finding that the highest overdose mortality occurred in the late postpartum period since July 2020 highlights the importance of interventions during this stage.

Although the field of perinatal addiction psychiatry is growing rapidly, too few addiction medicine specialists accept pregnant women or Medicaid beneficiaries as patients.³⁴ Among pregnant patients with Medicaid, non-Hispanic Black, Hispanic, and rural women have a lower likelihood of receiving medications for opioid use disorder than their non-Hispanic White and urban counterparts.³⁵ Moreover, being a non-college graduate and being unmarried during pregnancy and motherhood suggest limited socioeconomic resources and social support³⁶ and a lack of spousal health insurance benefits. Research is urgently needed to identify evidence-based strategies for policymakers, clinicians, and social service professionals to help promote treatment access and improve the quality of treatment for pregnant and postpartum women with drug use disorders.

Critical attention has been focused on reducing disparities in pregnancy-associated obstetric mortality.³⁶⁻³⁹ Yet our results show that most obstetric decedents, in contrast to overdose decedents, are disproportionately racial and ethnic minority group women. This result aligns with studies highlighting that non-Hispanic Black and American Indian or Alaska Native women have higher pregnancy-associated mortality ratios than non-Hispanic White women.³⁷⁻⁴⁰ Consistent with a recent finding that SARS-CoV-2 infection was associated with increased maternal mortality,⁴¹ our results show 1.6-fold to 2.1-fold increases in pregnancy and early postpartum obstetric mortality ratios between January to June 2020 and July to December 2021. We also found that 41% to 48% of pregnant and postpartum decedents from obstetric causes resided in non-Medicaid expansion states. Among obstetric decedents, 35% to 39% resided in counties ranking in the highest quartile of income inequality among US counties, 22% to 24% resided in counties with proportions of county residents in deep poverty ranking in the highest quartile among US counties, and 12% to 19% were born outside the US. Health insurance status, income inequality, poverty, mistrust in the health care sys-

tem, stigma, bias, and cultural and language issues may be barriers to health care access for pregnant and postpartum decedents from obstetric causes.⁴¹⁻⁴⁸ These social determinants of health need to be urgently addressed.

Limitations

This study has several limitations. First, the US mortality data do not have information on a decedent's health insurance status, family income, and employment status. Thus, our analyses cannot examine these important factors. Second, our study may underestimate or overestimate pregnancy-associated overdose mortality because of potential misclassification of drug overdose as causing the death, as well as underreporting and misclassifications of pregnancy status, postpartum stages,⁴⁹ and overdose intent (eg, undetermined intent could include intentional intent). Third, future research is needed to examine risk and protective factors of pregnancy-associated mortality (eg, in states with vs without punitive policies) at the multi-variable level among US pregnant women with and without

drug use (ie, studying the overall population of pregnant and postpartum women). Fourth, research is needed to examine whether overdose awareness may increase the likelihood of reporting overdose mortality.

Conclusions

From 2018 to 2021, average semiannual drug overdose mortality ratios more than tripled among pregnant and postpartum women aged 35 to 44 years, reaching unprecedented high levels. Most pregnancy-associated overdose deaths occurred outside health care settings, indicating the need for strengthening community outreach and maternal medical support. Research is required to identify evidence-based strategies for policymakers, clinicians, and social service professionals to help promote harm reduction approaches and treatment access and improve the treatment quality for pregnant and postpartum women with substance use disorders.

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