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Emergency Department Utilization for Substance Use Disorder During Pregnancy and Postpartum in the United States (2006–2016)

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A B S T R A C T

Objectives: We aimed to better understand emergency department (ED) use, admission patterns, and demographics for substance use disorder in pregnancy and postpartum (SUDPP).
Methods: In this longitudinal study, the United States Nationwide Emergency Department Sample was queried for all ED visits by 15- to 50-year-old women with a primary diagnosis defined by International Classification of Diseases, 9th or 10th edition Clinical Modification, codes of SUDPP between 2006 and 2016. Patterns of ED visit counts, rates, admissions, and ED charges were analyzed.
Results: Annual national estimated ED visits for SUDPP increased from 2,919 to 9,497 between 2006 and 2016 (a 12.4% annual average percentage change), whereas admission rates decreased (from 41.9% to 32.0%). ED visits were more frequent among women who were 20–29 years old, using Medicaid insurance, in the lowest income quartile, living in the South, and in metropolitan areas. Compared with the proportion of ED visits, 15- to 19-year-olds had significantly lower admission rates, whereas women with Medicaid and in the lowest income quartile had higher admission rates ($p < .001$). Opioid use, tobacco use, and mental health disorders were most commonly associated with SUDPP. The ED average inflation-adjusted charges for SUDPP increased from $1,486 to $3,085 between 2006 and 2016 (7.1% annual average percentage change; $p < .001$), yielding total annual charges of $4.02 million and $28.53 million.
Conclusions: Despite the decrease in admissions, the number and charges for ED visits for SUDPP increased substantially between 2006 and 2016. These increasing numbers suggest a continuous need to implement preventive public health measures and provide adequate outpatient care for this condition in this population specifically.

The use of illicit substances in the United States has increased substantially in the last decade and represents a critical public health concern (National Institute on Drug Abuse, 2015). According to the latest federal reports, approximately 24.6 million Americans aged 12 or older currently have a substance use disorder (SUD), and these conditions produce an annual cost of $740 billion including expenses related to health care, loss of work productivity, and crime (National Institute on Drug Abuse, 2015). The recent significant increase in substance use is partially caused by the misuse of and subsequent dependence on opioids such as prescription pain relievers, heroin, and synthetic opioids (National Institute on Drug

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Abuse, 2015). In the last decade, approximately 21%–29% of patients who were prescribed opioids for chronic pain misused them and between 8% and 12% developed an opioid use disorder, resulting in an estimated 1.7 million affected people in the United States (Florence, Zhou, Luo, & Xu, 2016; Substance Abuse and Mental Health Services Administration, 2019).

Women are at highest risk of developing a SUD during their reproductive years, especially during pregnancy and the postpartum period (Qato, Zhang, Gandhi, Simoni-Wastila, & Coleman-Cowger, 2019). Between 2004 and 2014, the number of pregnant women with a SUD (most frequently opioids, cannabinoids, cocaine, and amphetamines) quadrupled, resulting in more than 380,000 exposed neonates (Salameh, Hall, Crawford, Staten, & Hall, 2019). Similar trends were seen outside of the United States in Europe and Australia (El Marroun et al., 2008). Substance use in pregnancy can result in detrimental effects on both the mother and fetus, including higher rates of miscarriages, preterm births, fetal growth restriction, gestational hypertension, congenital anomalies, stillbirths, sudden infant death syndrome, and long-term cognitive and behavioral disorders in offspring (Alati et al., 2006; Epstain et al., 2013; Froen et al., 2001; MacDorman, Cnattingius, Hoffman, Kramer, & Haglund, 1997; Mitchell et al., 1993).

Additionally, SUDs create a significant health care burden related to emergency department (ED) use charges. According to the National Survey on Drug Use and Health, 500,000 of all ED visits are related to substance use (Salameh et al., 2019). Although it is known that women with SUDs use ED services 57% more frequently and are hospitalized at more than double the rate of women who do not have SUDs (Kotelchuck et al., 2017), our knowledge regarding national trends of ED use for substance use by women during pregnancy and postpartum is limited (Moyer, Johnson, Klug, & Burd, 2018). Women with SUDs in pregnancy and postpartum are more commonly seen in the ED for the management of substance intoxication and withdrawal, concomitant alcohol use disorders, or pregnancy complications associated with SUDs (Moyer et al., 2018).

Therefore, the specific objectives of these analyses were to explore trends in ED use for SUD in pregnancy and postpartum (SUDPP), to characterize this population, and to assess how related ED charges have changed between 2006 and 2016.

Methods

Nationwide Emergency Department Sample Database

In this retrospective longitudinal study, de-identified data were derived from the Nationwide Emergency Department Sample (NEDS) of the Healthcare Cost and Utilization Project (HCUP) sponsored by the Agency for Healthcare Research and Quality (Sun, Karaca, & Wong, 2006; Finer & Zolna, 2011; HCUP, 2019; Agency for Healthcare Research and Quality, 2021). NEDS is the largest all-payer stratified single-cluster sample of ED data in the nation. It includes information collected from approximately 20% of community-based hospital EDs located in 34 states in the United States (Finer & Zolna, 2011), which is weighted to calculate national estimates (HCUP, 2019). This study was considered exempt by the University of Michigan Institutional Review Board.

Sample Population

International Classification of Diseases (ninth [ICD-9] and tenth [ICD-10] revisions) diagnosis codes were used to identify ED visits in which the primary diagnosis was a SUD in pregnancy or postpartum women aged 15–50 years old between 2006 and 2016. The ICD-9-CM coding system was used for ED visits before October 1, 2015, and the ICD-10-CM coding system was used thereafter. Up to 15 ICD diagnostic codes could be entered by ED physicians and were available for ED visits occurring between 2006 and 2013, and up to 30 diagnostic codes for visits between 2014 and 2016. We included patients with a primary diagnosis of SUDPP. The primary diagnosis, as defined by the HCUP, is the first-listed diagnosis on a medical record and is considered to be the principal indication for the ED visit. The remaining codes were considered secondary diagnoses. ICD-9 and 10-CM codes for ED visits with SUDPP in this study were included in Table 1.

Variables Analyzed

NEDS variables of interest included estimated number of ED visits, inflation-adjusted ED average and total charges, disposition after the ED visit (admission to the same hospital, admission to the observation unit, transfer to another hospital, or discharge home), patient's demographic information, hospital geographic location, and primary payer. Age was grouped into seven categories: 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, and 45–50 years. Health insurance categories included Medicare, Medicaid, private insurances, self-pay, no charge, or other. Hospital geographic location and setting were divided into Northeast, Midwest, South, or West. Population-based characteristics included metropolitan areas with populations of 1 million or more, metropolitan areas with populations of 50,000–999,999, or rural areas. Income quartile was a categorical variable that provides a quartile classification of the estimated median household income of residents in the patient's ZIP code. The quartiles are identified by values of 1–4,

Table 1
ICD-9 and 10-CM Codes Used to Identify ED Visits for SUDPP

ICD-9 Code Diagnosis Description	ICD-10 Code Diagnosis Description
648.30 Drug dependence of mother, unspecified as to episode of care or not applicable	O99.320 Drug use complicating pregnancy, unspecified trimester
648.31 Drug dependence of mother, delivered, with or without mention of antepartum condition	O99.321 Drug use complicating pregnancy, first trimester O99.322 Drug use complicating pregnancy, second trimester O99.323 Drug use complicating pregnancy, third trimester O99.324 Drug use complicating childbirth
648.32 Drug dependence of mother, delivered, with mention of postpartum complication	O99.325 Drug use complicating the puerperium
648.33 Drug dependence of mother, antepartum condition or complication	O99.321 Drug use complicating pregnancy, first trimester O99.322 Drug use complicating pregnancy, second trimester O99.323 Drug use complicating pregnancy, third trimester
648.34 Drug dependence of mother, postpartum condition or complication	O99.325 Drug use complicating the puerperium

Abbreviations: ED, emergency department; ICD-9-CM, International Classification of Diseases, 9th revision, Clinical Modification; ICD-10-CM, International Classification of Diseases, 10th revision, Clinical Modification; SUDPP, substance use disorder in pregnancy and postpartum.

indicating the poorest to wealthiest populations, respectively, and are calculated by HCUP.

Statistical Analyses

Data were reported as estimated counts or percentages with interval ranges where appropriate. Average annual percentage changes (AAPC) were estimated for counts and ED charges by fitting trend data into a log-linear model using Joinpoint software version 4.6.0.0 (National Cancer Institute, Bethesda, MD) (Clegg, Hankey, Tiwari, Feuer, & Edwards, 2009; HCUP, 2019; U.S. DHHS, 2018).

We used χ^2 tests to compare the percentages of total ED visits versus ED visits that ended in admission stratified by age, primary payer, and income quartile. Charges were adjusted for U.S. dollar inflation in 2016 using the Consumer Price Index for All Urban Consumers relative (CPIAUCSL) (FRED, 2018). Zero charges and those excessively low or high were recorded as missing by NEDS. Missing charge values were treated as missing at random and imputed for the calculation of total charges (SURVEYMEANS and SURVEYREG procedures). A test for trend was performed for admissions, age, income quartile, and insurance status. Age, region, income, and the presence of a SUD diagnosis were included as covariates for the imputation analysis. A p value of less than .05 was considered statistically significant.

As a sensitivity analysis to test the robustness of our results, we used a sample of ED visits in which SUDPP was either the primary or secondary diagnosis.

Results

National Number of ED Visits and Admission Patterns

The national estimated number of ED visits for SUDPP significantly increased from 2,919 in 2006 to 9,497 in 2016 (12.4% AAPC; $p < .01$) (Figure 1). When we looked more specifically at antepartum versus postpartum SUDs, the number of ED visits for antepartum SUDs accounted for more than 92% of all ED visits for SUD included in this analysis. In our sensitivity analysis using a sample of ED visits over the same timeframe for which SUDPP was the primary or secondary diagnosis, we found similar ED use trends.

The percentage of ED visits for SUDPP that ended in admission decreased from 41.9% in 2006 to 32.0% in 2016, with a low of 28.2% in 2014. However, these admission rates remained four times higher than those seen in age-matched women who sought ED care for all other diagnoses during the same time period (admission SUDPP, 36.8% vs. admission non-SUDPP, 7.5%; $p < .01$). The characteristics of the women with SUDPP presenting to the ED compared with age-matched women with all other diagnoses can be found in Table 2. Notably, Medicaid insurance coverage was more common among women presenting to the ED with SUDPP than for all other primary diagnoses (SUDPP with Medicaid insurance, 66% vs. non-SUDPP with Medicaid insurance, 34.4%; $p < .01$).

Cumulatively, during the 11 years analyzed, the percentages of total ED visits compared with the ED visits that ended in admission in women with SUDPP stratified by age showed a significantly lower proportion of ED admissions in 15- to 19-year-olds ($p < .01$) (Figure 2a). The percentage of admissions for SUDPP was significantly higher for women with Medicaid insurance, but significantly lower for those with private insurance or self-pay (Figure 2b). A significantly higher proportion of ED visits by women in the lowest income quartile ended in admission, whereas a significantly lower proportion of admissions was seen in women belonging to the highest income quartile ($p < .01$) (Figure 2c).

When analyzing trends over time, 15- to 19-year-olds and those who self-paid for care had a significant decrease in ED visits (AAPC = −0.30 [$p = .02$] and AAPC = −1.04 [$p = .01$], respectively) and ED visits with admissions (AAPC = −0.22 [$p = .03$] and AAPC = −1.39 [$p < .01$], respectively). Additionally, during the study period women with Medicaid insurance had a significant increase in ED visits (AAPC = 1.11; $p = .03$) and women in the lowest income quartile had a significant increase in ED visits with admission (AAPC = 1.69; $p = .02$).

Demographics and Hospital Characteristics

A summary of the estimated ED visit counts and percentages of ED visits for SUDPP between 2006 and 2016 stratified by demographic and hospital characteristics is reported in Table 3. More than 60% of all ED visits for SUDPP were in those aged 20–29 years old, with the 25–29-year-old category showing the highest frequencies across all the years analyzed.

After stratifying ED visits for SUDPP by hospital geographic location, we found the largest increase from 2006 to 2016 in the South compared with other areas (range, 949–3,795, a 299.8%

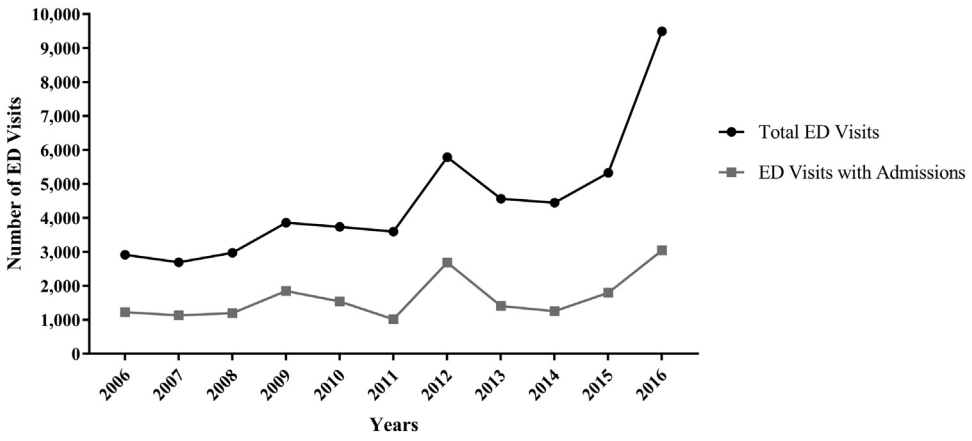

Figure 1. Number of emergency department (ED) visits and admissions for substance use disorder in pregnancy and postpartum (SUDPP) between 2006 and 2016.

Table 2
Characteristics of ED Visits Among Women Aged 15–50 Years by Primary Diagnosis (2006–2016)

Characteristic	Primary Diagnosis of SUDPP (*n*)	Primary Diagnosis of SUDPP (%)	All Other Primary Diagnoses (*n*)	All Other Primary Diagnoses (%)	Primary Diagnosis of SUDPP with Admission (*n*)	Primary Diagnosis of SUDPP with Admission (%)	All Other Primary Diagnoses with Admission (*n*)	All Other Primary Diagnoses with Admission (%)	Admission Rate of Primary Diagnosis of SUDPP (%)	Admission Rate of All Other Primary Diagnoses (%)
Total	49,413	100.0	424,167,546	100.0	18160	100.0	31,823,658	100.0	36.8	7.5
Age group, years										
15–19	2,088	4.2	52,770,467	12.4	602	3.3	2,340,518	7.4	28.8	4.4
20–24	14,443	29.2	76,069,941	17.9	5392	29.7	3,892,562	12.2	37.3	5.1
25–29	17,952	36.3	70,810,246	16.7	6611	36.4	4,288,449	13.5	36.8	6.1
30–34	10,131	20.5	60,492,806	14.3	3825	21.1	4,318,545	13.6	37.8	7.1
≥35	4,800	9.7	164,024,086	38.7	1730	9.5	16,983,584	53.4	36.0	10.4
Region										
Northeast	12,328	24.9	78,597,148	18.5	5278	29.1	6,940,047	21.8	42.8	8.8
Midwest	10,542	21.3	99,313,544	23.4	3093	17.0	6,563,888	20.6	29.3	6.6
South	20,083	40.6	17,5134,237	41.3	8639	47.6	12,900,456	40.5	43.0	7.4
West	6,461	13.1	71,122,617	16.8	1150	6.3	5,419,267	17.0	17.8	7.6
Urban/rural										
Metro, ≥1 million	24,121	48.8	205,913,319	48.5	9518	52.4	18,402,514	57.8	39.5	8.9
Metro, 50,000–<1 million	16,543	33.5	137,626,906	32.4	5426	29.9	9,037,445	28.4	32.8	6.6
Nonmetro	8,200	16.6	78,530,763	18.5	2955	16.3	4,156,554	13.1	36.0	5.3
Primary payer										
Medicare	1,519	3.1	23,522,379	5.5	569	3.1	3,667,957	11.5	37.4	15.6
Medicaid	32,596	66.0	145,834,660	34.4	13173	72.5	11,392,133	35.8	40.4	7.8
Private	6,636	13.4	146,574,528	34.6	1979	10.9	11,558,478	36.3	29.8	7.9
Self-pay	6,135	12.4	82,824,206	19.5	1502	8.3	3,603,422	11.3	24.5	4.4
No charge	278	0.6	3,634,779	0.9	77	0.4	361,019	1.1	27.6	9.9
Other	2,106	4.3	20,356,979	4.8	785	4.3	1,187,570	3.7	37.3	5.8
Income quartile by zip code										
Lowest	17,096	34.6	148,130,030	34.9	6609	36.4	10,362,543	32.6	38.7	7.0
Second	13,651	27.6	116,079,534	27.4	4921	27.1	8,068,503	25.4	36.0	7.0
Third	10,712	21.7	90,234,734	21.3	3787	20.9	6,913,147	21.7	35.3	7.7
Highest	6,509	13.2	61,355,524	14.5	2110	11.6	5,398,595	17.0	32.4	8.8

Abbreviations: ED, emergency department; Metro, metropolitan; SUDPP, substance use disorder in pregnancy and postpartum.
Frequencies of <10 were not reported per Nationwide Emergency Department Sample policy.

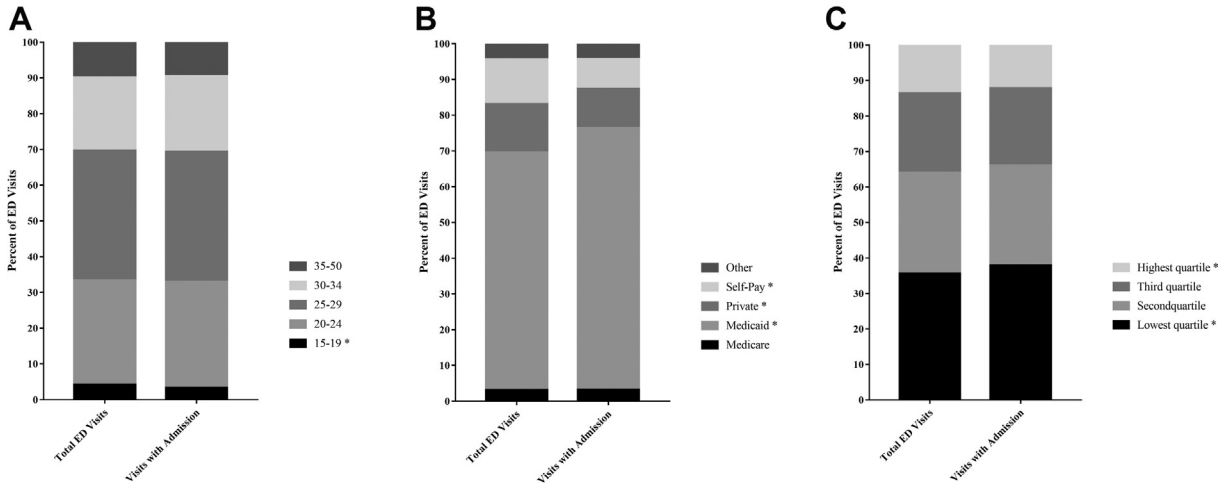

Figure 2. Comparisons between percentage of total emergency department (ED) visits and ED visits that ended in admission for substance use disorder in pregnancy and postpartum (SUDPP) stratified by (a) age, (b) primary payer, and (c) income quartile based on zip code. *A X^2 test between total ED visits and ED visits with admission ($p < .05$).

increase). The South also had the highest counts in all years except for 2006, when more visits were registered in the Northeast (1,233). Additionally, ED visits for SUDPP were higher and increased the most in metropolitan areas with a population of more than 1 million (range, 1,787–4,500, a 151.8% increase) and in metropolitan teaching hospitals (range, 1,800–6,237, a 246.5% increase). When ED visits for SUDPP were stratified based on primary payer, rates were higher and increased the most in women with Medicaid insurance (range, 1,406–6,731, a 378.7% increase) compared with women with Medicare insurance, private insurance, self-pay, or no charge. ED visits for SUDPP were also higher among women in the lowest income quartile through the years analyzed, with the exception of 2006 and 2011, when higher rates were registered among women belonging to the second-lowest income quartile. Women in the lowest quartile for household income showed the largest increase (468.7%) in ED visits for SUDPP, from 671 in 2006 to 3,816 in 2016.

Secondary Diagnoses

The distribution and frequency of the top twenty secondary diagnoses when SUDPP was the primary diagnosis are reported in Table 4. The most commonly associated secondary diagnoses were opioid dependence, tobacco use disorder, drug withdrawal, and maternal mental disorders. When we combined all ICD codes with similar diagnosis descriptions, a secondary diagnosis of any opioid use disorder was present in more than 60% of all ED visits with a primary diagnosis of SUDPP. Overall, any tobacco use disorder and maternal mood disorders such as depression, anxiety, and bipolar disorder were documented in approximately 35% and 37% of ED visits for SUDPP, respectively.

ED Charges

The average inflation-adjusted charges per visit for SUDPP significantly increased by 108%, from $1,486 in 2006 to $3,085 in 2016 (7.1% AAPC; $p < .04 \times 10^{-5}$), yielding total annual charges of $4.02 million and $28.53 million, respectively. In our sample, the percent of records with missing charges in each year ranged from a high of 27.7% in 2006 to a low of 18.4% in 2016.

Discussion

The widespread substance use among individuals with the capacity for pregnancy, especially during the antepartum and postpartum periods, has negative effects on pregnancy, maternal, and neonatal outcomes and represents a major multigenerational health care burden to society (Krans & Patrick, 2016; Weiss, Barrett, Heslin, & Stocks, 2020). By analyzing trends in ED use for SUDPP, we attempted to better understand the magnitude, charges, and characteristics of this phenomenon in the hope of generating novel ideas for preventive public health services and care options specifically tailored toward this population.

When looking at a substantial interval of time (2006–2016), we found that despite an approximate 10% decrease in admission rates, the overall national estimates of ED visits for SUDPP more than tripled. These results are consistent with those of Patrick et al.'s study, which described a nearly fivefold increase in antepartum opioid use between 2000 and 2009 when looking at hospital discharge data from the Nationwide Inpatient Sample (Patrick et al., 2012). The significant rise of SUDs in women during pregnancy and postpartum described by our study was even higher than the increased rate of national ED visits by all adult women (aged ≥15 years) for any substance use related issue seen by Weiss et al. between 2006 and 2013 (rate per 100,000 women, 1,248–1,733; cumulative percentage change, 38.9%) (Weiss et al., 2020). These alarming numbers suggest a need to better address prenatal substance use, implement preventive public health measures, and provide adequate outpatient care for people with a SUD who have the capacity for pregnancy (Malik et al., 2017).

Our analysis found decreasing admission rates for SUDPP during the study period, which could reflect a lower acuity of cases seen in the ED for this condition or signal the successful implementation of interventions involving more outpatient resources. Many EDs are now functioning as a bridge to primary care offices by initiating medication for opioid use disorder (MOUD) with medications such as buprenorphine (D'Onofrio et al., 2015). This recent practice has resulted in a greater percentage of individuals engaged in treatment with fewer relapses

Table 3
Characteristics of ED Visits for SUDPP From 2006 to 2016

Characteristic	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Total	2,919	2,695	2,973	3,859	3,737	3,598	5,787	4,565	4,452	5,332	9,497
Age group (years)											
15–19	196 (6.7)	177 (6.6)	94 (3.2)	219 (5.7)	189 (5.1)	191 (5.3)	173 (3)	150 (3.3)	128 (2.9)	199 (3.7)	372 (3.9)
20–24	950 (32.5)	784 (29.1)	838 (28.2)	1,216 (31.5)	1,270 (34)	1,094 (30.4)	1,799 (31.1)	1,328 (29.1)	1,265 (28.4)	1,429 (26.8)	2,469 (26)
25–29	918 (31.5)	992 (36.8)	1,107 (37.2)	1,337 (34.7)	1,269 (34)	1,239 (34.4)	2,138 (36.9)	1,586 (34.7)	1,714 (38.5)	2,021 (37.9)	3,629 (38.2)
30–34	523 (17.9)	446 (16.5)	482 (16.2)	688 (17.8)	697 (18.7)	749 (20.8)	1,169 (20.2)	1,111 (24.3)	1,002 (22.5)	1,152 (21.6)	2,113 (22.2)
35–50	332 (11.4)	296 (11)	452 (15.2)	400 (10.4)	311 (8.3)	325 (9)	508 (8.8)	390 (8.5)	343 (7.7)	530 (9.9)	914 (9.6)
Region											
Northeast	1,233 (42.2)	835 (31)	863 (29)	805 (20.9)	800 (21.4)	729 (20.3)	1,760 (30.4)	1,172 (25.7)	895 (20.1)	1,338 (25.1)	1,898 (20)
Midwest	433 (14.8)	500 (18.6)	636 (21.4)	604 (15.6)	659 (17.6)	773 (21.5)	995 (17.2)	1,200 (26.3)	1,456 (32.7)	963 (18.1)	2,324 (24.5)
South	949 (32.5)	1,043 (38.7)	1,176 (39.6)	2,093 (54.3)	1841 (49.3)	1,578 (43.8)	2,307 (39.9)	1,698 (37.2)	1,444 (32.4)	2,158 (40.5)	3,795 (40)
West	303 (10.4)	317 (11.7)	299 (10)	357 (9.3)	438 (11.7)	518 (14.4)	724 (12.5)	496 (10.9)	657 (14.8)	872 (16.4)	1479 (15.6)
Urban/rural											
Metro, ≥1 million	1,787 (61.7)	1,386 (52.1)	1,446 (49.6)	1,778 (46.8)	1745 (47.4)	1,637 (46)	3,001 (52.3)	2,063 (45.7)	2,194 (49.5)	2,584 (49.1)	4,500 (47.8)
Metro, 50,00–<1 million	867 (29.9)	944 (35.4)	1,042 (35.7)	1,188 (31.3)	1,288 (35)	1287 (36.2)	1,859 (32.4)	1,586 (35.1)	1,515 (34.2)	1,631 (31)	3,335 (35.5)
Nonmetro	242 (8.4)	333 (12.5)	428 (14.7)	831 (21.9)	649 (17.6)	632 (17.8)	875 (15.3)	863 (19.1)	725 (16.3)	1,052 (20)	1,571 (16.7)
Primary payer											
Medicare	59 (2)	79 (2.9)	104 (3.5)	69 (1.8)	116 (3.1)	130 (3.6)	208 (3.6)	154 (3.4)	146 (3.3)	181 (3.4)	273 (2.9)
Medicaid	1,822 (62.5)	1,406 (52.6)	1,752 (59.4)	2,676 (69.5)	2,443 (65.5)	2,239 (62.3)	4,023 (69.7)	2,857 (62.7)	3,033 (68.2)	3,612 (67.8)	6,731 (71)
Private	347 (11.9)	426 (15.9)	393 (13.3)	450 (11.7)	463 (12.4)	495 (13.8)	690 (12)	650 (14.3)	641 (14.4)	850 (15.9)	1,233 (13)
Self-pay	466 (16)	600 (22.5)	591 (20)	432 (11.2)	509 (13.6)	537 (14.9)	531 (9.2)	640 (14.1)	401 (9)	497 (9.3)	933 (9.8)
No charge	86 (2.9)	37 (1.4)	23 (0.8)	50 (1.3)	-	-	11 (0.2)	33 (0.7)	19 (0.4)	-	18 (0.2)
Other	135 (4.6)	123 (4.6)	88 (3)	173 (4.5)	191 (5.1)	190 (5.3)	310 (5.4)	222 (4.9)	207 (4.7)	178 (3.3)	290 (3.1)
Income quartile by zip code											
Lowest	671 (23.4)	926 (35.8)	1,072 (38.1)	1,238 (33.4)	1318 (36.4)	914 (26.3)	1,845 (32.5)	1,525 (34.5)	1,517 (34.9)	2,256 (43.5)	3,816 (41.1)
Second	807 (28.1)	752 (29.1)	754 (26.8)	1,218 (32.9)	1023 (28.3)	1,157 (33.3)	1,538 (27.1)	1,321 (29.9)	1,271 (29.3)	1,216 (23.4)	2,593 (27.9)
Third	832 (29)	582 (22.5)	613 (21.8)	777 (21)	752 (20.8)	915 (26.3)	1,456 (25.7)	1,076 (24.3)	900 (20.7)	1,078 (20.8)	1,731 (18.6)
Highest	560 (19.5)	322 (12.5)	371 (13.2)	470 (12.7)	527 (14.6)	489 (14.1)	832 (14.7)	502 (11.3)	654 (15.1)	635 (12.2)	1,147 (12.4)

Abbreviations: ED, emergency department; SUDPP, substance use disorder in pregnancy and postpartum.
Frequencies of <10 were not reported per Nationwide Emergency Department Sample policy.
Trend analysis by variable was performed and found to be significant for all variables except no charge, which was not per Nationwide Emergency Department Sample policy (frequencies of <10).

Table 4
Percentage of Top 20 Secondary Diagnoses Associated With ED Visits With a Primary Diagnosis of SUDPP

Diagnosis Description	Percent
Opioid dependence, uncomplicated	51.5
Smoking (tobacco) complicating pregnancy, first, second or third trimester	28.6
Other psychoactive substance use, unspecified with withdrawal, unspecified	28.2
Other mental disorders complicating pregnancy, first trimester	15.3
Malnutrition in pregnancy, first trimester	11.2
Cocaine dependence, uncomplicated	7.6
Major depressive disorder, single episode, unspecified	7.3
Single live birth	7.0
Anxiety disorder, unspecified	7.0
Nicotine dependence, unspecified, uncomplicated	6.7
Unspecified viral hepatitis C without hepatic coma	6.4%
Nicotine dependence, cigarettes, uncomplicated	6.0
Unspecified genitourinary tract infection in pregnancy, first trimester	5.9
Urinary tract infection, site not specified	5.3
Opioid dependence with withdrawal	4.8
Other viral diseases complicating pregnancy, first trimester	3.7
Unspecified asthma, uncomplicated	3.6
Other psychoactive substance dependence, uncomplicated	3.5
Sedative, hypnotic or anxiolytic dependence, uncomplicated	3.1
Opioid abuse, uncomplicated	3.0

Abbreviations: ED, emergency department; SUDPP, substance use disorder in pregnancy and postpartum.

and days of self-reported substance use (D'Onofrio et al., 2015) and has been extended to and considered safe in pregnant, postpartum, and breastfeeding women. Additional efforts are underway to increase the proportion of ED providers who can prescribe MOUD, implement MOUD protocols in EDs, disseminate MOUD prescribing tools, and add novel providers like peer recovery coaches in the ED setting. Our results may inform the continued adaptation and implementation of these programs for antepartum and postpartum individuals. Making outpatient services for SUDs more accessible and efficient for pregnant and postpartum patients could potentially relieve some of the burden on already overcrowded EDs (Morley, Unwin, Peterson, Stankovich, & Kinsman, 2018) and allow women to seek care in a known setting from trusted providers. Furthermore, considering the progressively more expensive ED services, shifting some of these visits to specialized outpatient clinics could decrease overall ED-related health costs.

When we looked at admission patterns within our SUDPP cohort, the proportion of ED visits that ended in admission were higher for women with Medicaid insurance and those in the lowest income quartile, but lower for teens (aged 15–19 years), those with private insurance or who were self-pay, and women in the highest income quartile. The higher percentage of Medicaid insured patients with SUDPP can be explained partially by the availability of Medicaid coverage for health services during pregnancy in the United States. However, these numbers correlate with the overall higher frequency of ED use by women with Medicaid insurance for all diagnoses in general (Brown, Dakkak, Gilliland, & Seabrook, 2019; Kim, McConnell, & Sun, 2017; Malik et al., 2017; Weiss et al., 2020). Other potential factors contributing to differences in ED admission patterns include the presence of barriers to accessing outpatient preventive and primary care providers, as well as implicit bias in screening practices. Studies have previously identified bias in drug screening practices among obstetric patients; the rates of screening are higher among those with young age, single status, Black race, Hispanic ethnicity, and addresses in the lowest income quartile by zip code, even though these groups have equivalent percentages of positive screening results as all other tested patients (Kunins, Bellin, Chazotte, Du, & Arnsten, 2007; Perlman, Cantonwine, & Smith, 2020).

While investigating the demographic and geographic characteristics of women who used the ED for SUDPP, ED visits were higher in younger reproductive-aged women (20–29 years old) compared with other age categories and among those in the Southern regions and in metropolitan areas compared with other geographic locations. These results align with previous reports that found women at highest risk of developing a SUD were between the ages of 18 and 29 and were living in large metropolitan areas (Compton, Thomas, Stinson, & Grant, 2007; Malik et al., 2017; Salameh et al., 2019); Weiss et al. (2020).

More than 60% of the SUDPP ED visits analyzed were associated with a secondary diagnosis of opioid use, confirming the alarming findings regarding the rise in illegal and prescribed opioid use in the United States in the last decade (Florence, Zhou, Luo, & Xu, 2016; Kim et al., 2017). Multiple initiatives have already been established to combat the opioid crisis, including safe prescribing practices and increased number and accessibility of MOUD treatment facilities (Kim et al., 2017). Furthermore, polysubstance use is common in pregnancy, with rates as high as 50% (Salameh et al., 2019). Tobacco use disorder along with another SUD is common, and our analyses found it to be frequently associated with SUDPP—an important finding given that tobacco use in pregnancy is associated with higher risks of preterm birth and other adverse outcomes (Qato et al., 2019; Salameh et al., 2019). A diagnosis of a mental health disorder was also commonly associated with SUDPP in the ED. This result was similar to previous reports where overall 25%–33% of pregnant women with opioid or any SUD were found to have at least one psychiatric comorbidity, with depression and anxiety being the most common (Ailes et al., 2015; Brown et al., 2019; Malik et al., 2017; Weiss et al., 2020). These concurrent substance use and mental health conditions suggest that preventive efforts should be multidisciplinary.

This novel study is the first to assess ED use for SUDs in pregnant and postpartum women and has many strengths. The main strength is the use of the largest ED visit dataset in the United States, which allows a nationally representative longitudinal assessment and increases the generalizability of our results. In addition, to the best of our knowledge, this is the largest analysis to date to provide U.S. national trends in ED use for substance use in both pregnancy and postpartum. The postpartum period, also known as the fourth trimester of pregnancy, is a time when women are at the highest risk of developing mood disorders and SUDs (Ailes et al., 2015; Brown et al., 2019). Additionally, by comparing ED visit trends with admission patterns, investigating SUDPP-associated diagnoses, and including demographic and geographic characteristics of women using the ED for SUDPP, we provided a broader understanding of the complexity surrounding substance use in pregnancy and the postpartum period, of the determinants of ED use, and potential disparities in health care administration. Furthermore, information regarding associated ED charges for SUDPP allowed us to investigate the burden of this condition on the national health system and the economic implications of SUDPP-related visits.

There are a few limitations to this study, mainly related to the nature of the NEDS database. One limitation is the potential variations in the way physicians from different hospitals use ICD codes, which could have affected how the diagnoses for the ED visits were entered. The introduction of the ICD-10 system in 2016 could introduce a source of coding bias. However, similar trends in ED visits have been described by several smaller studies (Malik et al., 2017; Weiss et al., 2020). NEDS is also limited in its ability to capture key demographic data including race/ethnicity, education status, parity, gravidity, reason for admission to the hospital after an ED visit, and other factors that deserve further investigation to better characterize the contributions of social determinants of health to these findings.

Our study highlights areas where future clinical research is needed. Because our sample included mainly ED visits for antepartum SUDs (92%), further studies are warranted to investigate this phenomenon during the critical postpartum period, which accounts for approximately one-third of SUDs in reproductive age women (Salameh et al., 2019). Additionally, as some hospitals might see a portion of antepartum women in different health care settings such as urgent care, obstetric triage, or labor and delivery, additional studies should include women who are seen for SUDPP in other departments or facilities.

Implications for Practice and/or Policy

Our multiyear population-based assessment of trends in ED use by women with SUDPP and associated admission patterns and charges found that ED visits for SUDPP increased and became more expensive from 2006 to 2016. We also found that although the admission rates decreased for this population overall, admission rates for those in the lowest income quartile and with Medicaid insurance increased. These findings suggest a need to explore alternative ways to provide outpatient, more accessible, less expensive, and ultimately more equitable health care for all birthing people.

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