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Research article

Prenatal substance exposure diagnosed at birth and infant involvement with child protective services

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ABSTRACT

Infants have the highest rates of maltreatment reporting and entries to foster care. Prenatal substance exposure is thought to contribute to early involvement with child protective services (CPS), yet there have been limited data with which to examine this relationship or variations by substance type. Using linked birth, hospital discharge, and CPS records from California, we estimated the population prevalence of medically diagnosed substance exposure and neonatal withdrawal disorders at birth. We then explored the corresponding rates of CPS involvement during the first year of life by substance type after adjusting for sociodemographic and health factors. Among 551,232 infants born alive in 2006, 1.45% (n = 7994) were diagnosed with prenatal substance exposure at birth; 61.2% of those diagnosed were reported to CPS before age 1 and nearly one third (29.9%) were placed in foster care. Medically diagnosed prenatal substance exposure was strongly associated with an infant's likelihood of being reported to CPS, yet significant variation in the likelihood and level of CPS involvement was observed by substance type. Although these data undoubtedly understate the prevalence of prenatal illicit drug and alcohol use, this study provides a population-based characterization of a common pathway to CPS involvement during infancy. Future research is needed to explicate the longer-term trajectories of infants diagnosed with prenatal substance exposure, including the role of CPS.

1. Introduction

In 2014, more than 3.6 million referrals for child abuse or neglect were made in the United States (U.S. Department of Health and Human Services, 2016). Infants had the highest rate of maltreatment referrals and substantiated victimization (24.4 per 1000; U.S. Department of Health and Human Services, 2016). Parental substance abuse is believed to be an important contributor to the risk of maltreatment and involvement of child protective services (CPS) (Barth, 2001; O'Donnell et al., 2009; Olsen, 2015; Walsh, MacMillan, & Jamieson, 2003; Smith & Testa, 2002). Worldwide, studies have suggested that parental substance abuse is a concern in approximately 11% to 40% of investigated reports of child maltreatment (Dolan, Casanueva, Smith, Lloyd, & Ringeisen 2012; Sun, Shillington, Hohman, & Jones, 2001; Testa & Smith, 2009). Among children placed in the US foster care system, estimates range from 16 to 79% (Anthony, Austin, & Cormier, 2010; Taplin & Mattick, 2015 Murphy et al., 1991; U.S. General Accounting Office, 1994), although many of these findings are decades old and relied on inconsistent measurements of parental substance abuse.

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1.1. Consequences of prenatal substance exposure

Research on the effects of prenatal exposure to illicit drugs and alcohol has produced mixed results, yet has suggested that maternal substance use during pregnancy can cause direct health concerns, such as low birth weight (Anthony et al., 2010; Kelly et al., 2002; Pan & Yi, 2013; Patrick et al., 2012), preterm birth (Barth, 2001; Kelly et al., 2002; O'Donnell et al., 2009), hypoxia due to maternal malnutrition or drug-affected placental functioning (Behnke & Smith, 2013), congenital and neurological abnormalities (Behnke & Smith, 2013; Burns, Mattick, & Cooke, 2006; Pan & Yi, 2013), heart problems, and seizures resulting from neonatal abstinence or withdrawal (Burns et al., 2006; Pan & Yi, 2013). Maternal substance abuse has also been shown to pose indirect threats to a child's well-being in utero and throughout infancy through exposure to domestic violence (Choenni, Hammink & Van de Mheen, 2017; O'Shea, Collins, Allis, & Daly, 2016), tobacco and other toxic drug exposure through the air or skin-to-skin contact (Olsen, 2015; Boomgaarden-Brandes et al., 2011), unsafe postnatal home environment (Burke, 2007), and co-occurring maternal mental illness (Canfield, Radcliffe, & Marlow, 2017; O'Donnell et al., 2009).

1.2. Reporting of prenatal substance exposure

Prenatal substance exposure can be detected through toxicology screening during pregnancy or at birth (Gray & Huestis, 2007; Wexelblatt et al., 2015). In a majority of US states, positive toxicology results lead to a child maltreatment report (Drescher-Burke & Price, 2005), and in some, such as Tennessee, laws allow for criminal charges to be brought against substance abusing pregnant women (Olsen, 2015). Yet in other states, including California, there is no legal mandate to make a report to CPS based on evidence of maternal prenatal alcohol or substance use absent other safety concerns (Child Abuse, 2000). Variability in CPS reporting following positive toxicology results has been attributed to the stigma associated with illicit, so-called 'hard' drugs, and cultural assumptions about more mainstream substances, including alcohol and marijuana (Chasnoff, 2017; Choenni et al., 2017; Olsen, 2015). Indeed, alcohol and other illicit substances are known to have differential physiological and behavioral consequences for children, yet to date, few studies have assessed differences in child outcomes by substance type (Chasnoff, 2017; Choenni et al., 2017).

1.3. Impact of prenatal substance exposure on CPS involvement

Prenatal use of illicit drugs and alcohol during pregnancy may be noted in CPS case records, and many states have standard fields for recording this information (Barth, 2001). Local data-entry practices and policies, however, vary greatly (Testa & Smith, 2009; U.S. Department of Health and Human Services, 2013). Retrospective evaluations using CPS records alone provide a crude measure of population-level incidence rates of prenatal substance exposure. Research on prenatal substance use based on self-reports (Ebrahim & Gfroerer 2003; O'Donnell et al., 2009; Substance Abuse and Mental Health Administration, 2012), toxicology screens (Azadi and Diggy, 2008), and medical billing records (Kelly et al., 2002; O'Donnell et al., 2009) have produced widely varying prevalence rates. Very few studies have examined the rate of prenatal substance exposure among infants reported to CPS (Burns et al., 2006; O'Donnell et al., 2009; Smith & Testa, 2002). Only a small number of U.S. studies have examined CPS involvement following medically diagnosed prenatal substance exposure and have tended to be based on small samples from which it is challenging to make broader generalizations (Chasnoff, Landress, & Barrett, 1990; Leventhal et al., 1997; Qi et al., 1997; Smith & Testa, 2002). Internationally, several recent studies have documented the association between parental maternal substance abuse and poor child welfare outcomes, though most are restricted to populations already known to CPS (Forrester & Harwin, 2008; Laslett, Dietze, & Room, 2013). A 2017 study from Finland used substance abuse ICD-10 codes and other administrative data to prospectively follow full birth cohorts and evaluate the effects of maternal substance abuse on child health outcomes (Raitasalo & Holmila, 2017). CPS involvement, however, was not included as a measure of child health or wellbeing. It is currently unknown how many infants diagnosed with prenatal substance exposure become involved with CPS, or how involvement may vary by substance type.

1.4. Goals of current study

In the present analysis, we examined prenatal substance exposure and CPS involvement in California by linking maternal and infant hospital discharge records to infant CPS records. The objectives of this population-based California birth cohort study were to: (a) generate information concerning the prevalence of medically diagnosed prenatal substance exposure at birth; (b) characterize the population distribution of substance-related diagnoses across sociodemographic and pregnancy-related attributes; and (c) examine the relationship between substance type and an infant's likelihood of varying degrees of CPS involvement during the first 12 months of life, after adjusting for other factors.

2. Methods

2.1. Data

This analysis is based on a linked file of three administrative sources of data: (a) vital birth records from the California Department of Public Health; (b) maternal and infant hospital discharge records from California's Office of Statewide Health Planning and Development; and (c) CPS records from the California Department of Social Services. Birth and hospital discharge records are

from the 2006 cohort; CPS records cover the 12-month period following each infant's birth. Hospital discharge records were probabilistically linked to vital birth records as part of the California Vital Stats to Care Delivery Linkage project (Herrchen, Gould, & Nesbitt, 1997). A total of 97% of hospital discharge records were successfully linked to a birth record. Excluded from the dataset were births that occurred in military hospitals, at home, or in small birthing centers. Accounting for these exclusions, the data used in the present study include maternal and infant hospital discharge records concerning approximately 95% of all live births in California in 2006.

In a separate set of probabilistic linkages, the records of all children born in 2006 and reported to CPS as alleged victims of maltreatment before age 1 were linked to birth records using a combination of unique (i.e., maternal Social Security number) and non-unique (e.g., infant's first and last name) personal identifiers. A total of 92% of reported infants were successfully matched to a birth record. Unmatched CPS records included infants born outside of California and infants for whom the accuracy or completeness of the data prevented a successful record match. A de-identified analytic dataset was then constructed using the unique, state-generated file numbers assigned to each birth record to integrate information across the two linked files. This study received human subjects approval from both state and university institutional review boards. The proposed research was additionally reviewed by all agencies from which data were obtained.

2.2. Dependent variable

Three levels of CPS involvement were chosen as outcomes for each infant in our birth cohort: (a) report of alleged maltreatment, (b) substantiation as a victim of maltreatment, and (c) placement in foster care. Maltreatment reports included any allegation of abuse or neglect during infancy, regardless of whether there was an investigation or substantiation by CPS. Substantiation was based on whether there was any substantiated allegation of maltreatment before age 1. In California, substantiation refers to an allegation determined by a CPS investigator to constitute child abuse or neglect based on evidence suggesting that more likely than not, child abuse or neglect occurred (CA Penal Code § 11165.12; 11165.6, 2011). Foster care placement was defined as any placement of the infant in a CPS-supervised, out-of-home placement before age 1. Given that these three CPS outcomes were modeled separately, they were not coded as mutually exclusive events (e.g., an infant who entered foster care was also coded as substantiated and reported).

2.3. Independent variable

Prenatal substance exposure diagnoses were coded based on International Classification of Diseases, 9th Revision, Clinical Modification diagnostic codes (World Health Organization, 1977). Up to 25 codes are recorded on maternal and infant discharge records corresponding to a hospitalized delivery. We categorized all births based on the presence of medically diagnosed maternal substance abuse or infant substance exposure disorder. Maternal substance abuse diagnoses were defined based on diagnostic categories for maternal alcohol and nondependent and dependent substance abuse disorders. We classified in utero substance exposure among infants by using codes designated for drug withdrawal syndrome; narcotic, hallucinogenic, or cocaine exposure via placenta or breast milk; and suspected damage to the fetus from drugs affecting management of the mother. We additionally included a general obstetrical diagnostic category for substance use disorder of pregnancy. A full listing of codes specified in this analysis is available in Appendix A.

2.4. Covariates

We coded and explored several covariates to examine the distribution of diagnosed prenatal substance exposure across sociodemographic and pregnancy-related characteristics. These included maternal age at the time of first birth ($\leq$ *19 years*, *20–24 years*, *25–29 years*, $\geq$ *30 years*); maternal race and ethnicity (*White*, *Black*, *Hispanic*, *Asian or Pacific Islander*, *Native American*), birth payment method as a measure of socioeconomic status (*private insurance*, *public insurance*), the initiation of prenatal care (*first trimester*, *second trimester*, *third trimester*, *no care or missing*), paternity establishment (*established*, *missing*), birth order (*first birth*, *other birth*), and infant birth weight ($\geq$*2500 g*, $<$ *2500 g*; i.e., normal vs. low, respectively). Linked hospital discharge records provided information concerning maternal age at first birth. The decision was made to rely on this coding given research indicating that maternal age at first birth (rather than age at current birth) is a key predictor of subsequent children's developmental, educational, and other outcomes (Gibbs, Wendt, Peters, & Hogue, 2012; Kozuki, Lee, & Silveira, 2013). In California, parents are retroactively enrolled in the state's public health insurance program if they have no insurance coverage at birth. Paternity establishment was coded based on whether a father was named on the birth record.

2.5. Analysis

The distribution of diagnosed prenatal substance exposure was assessed across sociodemographic and pregnancy-related characteristics using χ^2, with $p < 0.001$ denoting statistically significant differences. To assess the relationship between a substance exposure diagnosis and the likelihood an infant was reported to CPS before age 1, we specified a series of multivariable generalized linear models based on a Poisson distribution and log link and with a robust standard error adjustment (Zou, 2004). In Model 1, we examined the relationship between diagnosed substance exposure and the likelihood an infant was reported to CPS. In Models 2 and 3, we examined the relationship between substance exposure and an infant's substantiation as a victim of maltreatment and placement in foster care, respectively. Findings are reported as adjusted risk ratios (RRs) with corresponding 95% confidence intervals

Table 1
Sociodemographic and Pregnancy Characteristics of Live Births in California in 2006.

	No Diagnosis		Diagnosis			Alcohol		Amphetamine		Cannabis		Cocaine		Opioids		Neonatal Withdrawal	
	(*n* = 543,238)		(*n* = 7,994)			(*n* = 628)		(*n* = 3,305)		(*n* = 2,502)		(*n* = 950)		(*n* = 1,343)		(*n* = 571)	
	n	%	*n*	%	*p*	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Age at first birth					< 0.001												
≤19	107,944	19.9	2,123	26.6		156	24.8	896	27.1	812	32.5	187	19.9	278	20.7	83	14.6
20–24	127,256	23.4	2,251	28.2		136	21.7	964	29.2	781	31.2	196	20.9	368	27.4	150	26.3
25–29	132,098	24.3	1,776	22.3		125	19.9	773	23.4	515	20.6	214	22.8	315	23.5	142	24.9
≥30	175,908	32.4	1,831	22.9		211	33.6	671	20.3	393	15.7	343	36.5	381	28.4	195	34.2
Race and ethnicity					< 0.001												
White	149,079	27.9	3,160	40.3		228	37.0	1,316	40.6	1,112	45.1	202	22.0	564	42.8	290	52.3
Black	29,616	5.5	1,269	16.2		104	16.9	182	5.6	591	24.0	387	42.2	145	11.0	46	8.3
Hispanic	287,948	53.8	2,999	38.2		238	38.6	1,539	47.4	656	26.6	292	31.8	545	41.3	190	34.2
Asian or Pacific Islander	66,057	12.3	262	3.3		36	5.8	132	4.1	49	2.0	–	2.9	39	3.0	–	3.8
Native American	2,221	0.4	152	1.9		11	1.8	76	2.3	57	2.3	–	1.1	26	2.0	–	1.4
Birth payment method					< 0.001												
Private	281,429	51.9	2,154	27.3		217	35.2	730	22.5	856	34.6	201	21.8	321	24.2	158	28.1
Public	260,887	48.1	5,731	72.7		400	64.8	2,519	77.5	1,620	65.4	720	78.2	1,004	75.8	404	71.9
Paternity					< 0.001												
Established	495,439	91.2	4,722	59.1		392	62.4	1,687	51.0	1,644	65.7	450	47.4	830	61.8	351	61.5
Missing	47,799	8.8	3,272	40.9		236	37.6	1,618	49.0	858	34.3	500	52.6	513	38.2	220	38.5
Prenatal care					< 0.001												
First trimester	465,797	85.7	4,377	54.8		383	61.0	1,418	42.9	1,592	63.6	473	49.8	710	52.9	326	57.1
Second trimester	59,640	11.0	1,888	23.6		113	18.0	908	27.5	540	21.6	199	21.0	309	23.0	120	21.0
Third trimester	11,265	2.1	578	7.2		53	8.4	297	9.0	136	5.4	81	8.5	107	8.0	40	7.0
No care or missing	6,536	1.2	1,151	14.4		79	12.6	682	20.6	234	9.4	197	20.7	217	16.2	85	14.9
Parity					< 0.001												
First birth	211,994	39.0	2,506	31.3		249	39.7	838	25.4	1,076	43.0	243	25.6	334	24.9	163	28.6
Other birth	331,244	61.0	5,488	68.7		379	60.4	2467	74.6	1,426	57.0	707	74.4	1,009	75.1	408	71.5
Infant birth weight					< 0.001												
≥2,500 g	507,021	93.3	6,644	83.1		518	82.5	2765	83.7	2,151	86.0	682	71.8	1,064	79.2	444	77.8
< 2,500 g	36,217	6.7	1,350	16.9		110	17.5	540	16.3	351	14.0	268	28.2	279	20.8	127	22.2

Note: Values for cocaine use and neonatal withdrawal in Asian or Pacific Islander and Native American subgroups are masked due to small cell sizes.

(CIs). All analyses were conducted using Stata/MP, version 14.

3. Results

3.1. Birth cohort characteristics

Table 1 presents the sociodemographic and pregnancy characteristics of 551,232 infants born in California in 2006, stratified by a diagnosis of prenatal substance exposure. Overall, a diagnosis was documented for 1.45% ($n = 7994$) of live births in our cohort. Characteristic differences by a substance exposure diagnosis were observed for all covariates examined ($p < 0.001$). Among births with a diagnosis, more than a quarter were born to current or former teen mothers (26.6%), whereas 22.9% were to mothers whose first birth occurred at or after age 30. Among births with no substance diagnosis, 19.9% were to women who first gave birth during their teens, whereas 32.4% were to mothers aged 30 or older. Births to White, Black, and Native American mothers were more frequently observed in the prenatal substance exposure group, whereas births to Hispanic and Asian or Pacific Islander mothers were underrepresented.

Nearly three quarters of births with a diagnosis of prenatal substance exposure were covered by public health insurance (72.7%). Paternity was missing for 40.9% of births in which prenatal substance exposure was diagnosed, compared to only 8.8% of births with no diagnosis. Notable differences also emerged by the initiation of prenatal care. Among births in which substance exposure was diagnosed, 14.4% had no indication of prenatal care, compared to 1.2% of births without a diagnosis. Finally, low birth weight occurred in 16.9% of births with a substance exposure diagnosis, compared to 6.7% of births without a diagnosis.

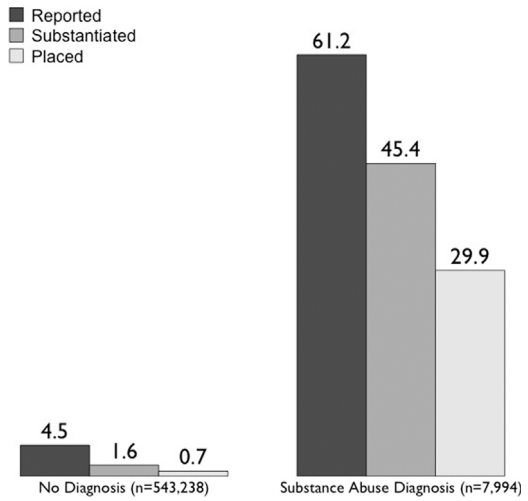

Fig. 1. Percentage of infants born in California in 2006 and reported to CPS, substantiated as victims, and placed in foster care by medically diagnosed substance exposure at birth.

3.2. Involvement with CPS

Substance exposure at birth was strongly associated with increased rates of CPS involvement, as documented in Fig. 1. Among infants without a substance exposure diagnosis at birth, 4.5% were reported to CPS, 1.6% were substantiated for maltreatment, and 0.7% were placed in foster care during infancy. Among those with a substance exposure diagnosis, 61.2% were reported, 45.4% were substantiated, and 29.9% were placed in foster care.

Fig. 2 depicts several of the most commonly diagnosed substance exposure types and the proportion of infants in each diagnostic group who were reported to CPS, substantiated as victims, and placed in foster care. Diagnoses reflecting maternal cocaine abuse and infant cocaine exposure were associated with the highest share of infants reported to CPS (76.8%), followed by amphetamines (74.6%) and opioids (69.0%). When the outcome of a substantiated CPS report was examined, a similar sorting by substance type was observed, with the largest share of infants with a diagnosis of cocaine (67.7%), amphetamines (60.8%), and opioids (54.6%) being substantiated. The proportion of diagnosed infants placed in foster care produced a slightly different pattern, with modestly more infants diagnosed with neonatal withdrawal placed in foster care (41.3%) than those diagnosed with amphetamine (39.4%) or opioid (37.2%) exposure. Notably lower shares of infants with alcohol and cannabis exposure experienced all levels of CPS involvement.

3.3. Multivariable models

Table 2 highlights the relationship between diagnosed prenatal substance exposure at the time of birth and CPS involvement during the first year of life. As reflected in Model A, and after adjusting for sociodemographic and health covariates reported in

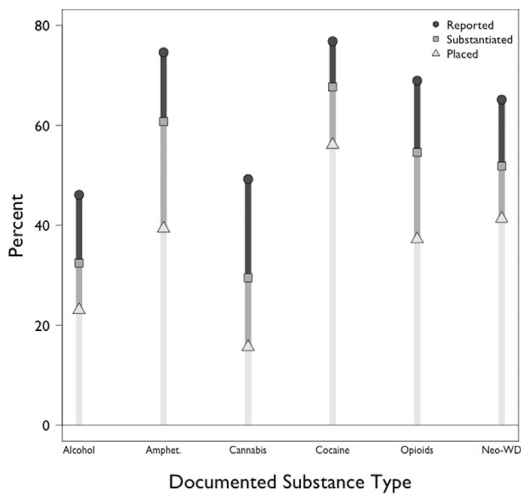

Fig. 2. Percentage of infants born in California in 2006 and reported to CPS, substantiated as victims, and placed in foster care before age 1 by medically diagnosed substance exposure type at birth.

Table 2
Adjusted Relative Risk Estimates for Reported Exposure Leading to CPS Contact.

	Reported		Substantiated			Placed in Foster Care
	(n = 29,146)		(n = 12,477)			(n = 6,429)
	Adj. RR	95% CI	Adj. RR	95% CI	Adj. RR	95% CI
Substance exposure diagnosis at birth[a]	5.25	5.09, 5.42	9.32	8.88, 9.77	11.15	10.39, 11.97
Risk by substance (vs Other Substances)[b]						
Cocaine	1.20	1.14, 1.25	1.46	1.37, 1.54	1.86	1.72, 2.01
Amphetamine	1.32	1.28, 1.37	1.55	1.47, 1.63	1.46	1.36, 1.57
Opioids	1.12	1.07, 1.16	1.20	1.13, 1.27	1.28	1.18, 1.38
Alcohol	0.78	0.71, 0.85	0.73	0.65, 0.81	0.78	0.67, 0.90
Cannabis	0.84	0.80, 0.88	0.67	0.62, 0.71	0.52	0.47, 0.58
Neonatal withdrawal	1.06	0.99, 1.12	1.14	1.05, 1.24	1.41	1.27, 1.56
Risk by Polysubstance (vs Monosubstance)[c]						
Cocaine	0.95	0.88, 1.02	0.97	0.88, 1.06	0.97	0.86, 1.10
Amphetamine	1.04	1.00, 1.09	1.10	1.04, 1.16	1.18	1.08, 1.28
Opioids	1.27	1.18, 1.37	1.45	1.31, 1.61	1.62	1.40, 1.89
Alcohol	1.60	1.32, 1.94	2.13	1.61, 2.82	2.31	1.58, 3.40
Cannabis	1.38	1.27, 1.49	2.28	1.99, 2.60	3.78	3.00, 4.76
Neonatal withdrawal	1.36	1.18, 1.57	1.67	1.37, 2.02	1.76	1.38, 2.25

Note: Adj. RR = adjusted rate ratio; CI = confidence interval. Rate ratios adjusted for demographics (age at first birth, race and ethnicity, insurance type, paternity establishment, prenatal care, parity, infant birth weight, and maternal mental health.

[a] Reference category was no substance exposure diagnosis at birth.

[b] Reference category was any substance identified at birth. Risk ratios identify additional risk when a specific substance type is identified.

[c] Reference category was only focal substance identified at birth. Risk Ratios identify additional risk when additional substances are found with focal substance.

Table 1, infants with medically diagnosed substance exposure were reported to CPS at 5 times the rate (RR = 5.25; 95% CI = 5.09, 5.42; $p < 0.001$), substantiated as victims of maltreatment at 9 times the rate (RR = 9.32; 95% CI = 8.88, 9.77; $p < 0.001$), and placed in foster care at 11 times the rate (RR = 11.15; 95% CI = 10.39, 11.97; $p < 0.001$) of those without a diagnosis.

Model B estimated the relative likelihood of CPS involvement among infants with a diagnosis of substance exposure after adjusting for other sociodemographic and health factors. For example, we evaluated the likelihood of a CPS report, substantiation, or placement in foster care for an infant diagnosed with cocaine exposure versus infants diagnosed with all other substance types. Relative to other substance types and consistent with the descriptive data in Fig. 2, several substance types were associated with an elevated risk of CPS reporting: cocaine (RR = 1.20; 95% CI = 1.14, 1.25; $p < 0.001$), amphetamine (RR = 1.32; 95% CI = 1.28, 1.37; $p < 0.001$), and opioids (RR = 1.12; 95% CI = 1.07, 1.16; $p < 0.001$). Likewise, substances associated with a depressed risk of CPS reporting included alcohol (RR = 0.78; 95% CI = 0.71, 0.85; $p < 0.001$) and cannabis (RR = 0.84; 95% CI = 0.80, 0.88; $p < 0.001$). Neonatal drug withdrawal syndrome had no significant effect on risk (RR = 1.06; 95% CI = 0.99, 1.12; $p = 0.083$). In models examining substantiated maltreatment and placement in foster care as the dependent variables, the adjusted RR increased in magnitude for substance types shown to be associated with an elevated risk of CPS reporting and became smaller for substances associated with depressed risk of CPS reporting. Neonatal withdrawal syndrome was associated with an elevated risk in the substantiated and foster care placement models.

Model C identified the risk for CPS involvement associated with polysubstance exposure in the birth cohort. The severity of cocaine diagnoses was shown by the nonsignificant change in risk when additional substances are detected (RR = 0.95; 95% CI = 0.88, 1.02; $p > 0.05$). For all other substance types, there was an increase in risk when at least one other substance was detected in addition to the focal substance ($RR_{amphetamine} = 1.04$; 95% CI = 1.00, 1.09; $p = 0.05$; $RR_{opioids} = 1.27$; 95% CI = 1.18, 1.37; $p < 0.001$; $RR_{alcohol} = 1.60$; 95% CI = 1.32, 1.96; $p < 0.001$; $RR_{cannabis} = 1.38$; 95% CI = 1.27, 1.49; $p < 0.001$; $RR_{neonatalwithdrawal} = 1.36$; 95% CI = 1.18, 1.57; $p < 0.001$). These results were stable over substantiation and foster care placement models within focal substance type.

4. Discussion

The strong association between diagnosed prenatal substance exposure and CPS involvement may seem obvious–indeed maternal substance abuse is frequently cited as a risk factor for CPS involvement (Burke, 2007; Hafekost, Lawrence, & O'Leary, 2017; Leventhal et al., 1997)–yet there has been very little data to describe the nature or extent of this relationship at a population level. In light of the documented increase in prenatal substance exposure throughout the US over the last decade (Ohio Department of Health, 2016; Patrick, Davis, Lehmann, & Cooper, 2015), the results of the present study of California data underscore the potential to use linked data to monitor population-level incidence rates and the associated adversities experienced by children and families. At least three important findings emerged.

First, nearly 1 in 3 children diagnosed with prenatal substance exposure were placed in foster care during infancy–a rate 11 times that of other socio-demographically similar children with no such diagnosis. While many other children served by the CPS may also be exposed directly or indirectly to maternal substance abuse, this finding offers policy makers and service providers a conservative

reference point with which to track changes among a particularly vulnerable subset of the population. This finding also underscores the importance of interdisciplinary collaboration between the CPS system and other service providers, medical professionals, drug treatment providers, and developmental specialists.

Second, in the state of California, diagnosed in utero substance exposure appears to elicit different patterns of CPS reporting and responses based on substance type. Our findings align with those of a 1990 Florida study (Chasnoff et al., 1990), which found that cocaine-exposed infants were far more likely to be reported than those prenatally exposed to marijuana. Infants exposed to alcohol and marijuana were reported at comparatively lower rates, despite a plethora of empirical evidence documenting the harmful impact of both substances on child outcomes (Chasnoff, 2017; Pan & Yi, 2013). These results contrast with research conducted in Australia in 2009, which documented a strong association between CPS reporting and subsequent involvement and maternal alcohol and other drug abuse (Laslett et al., 2013). Variations in CPS responses based on substance type may be due in part to variations in perceptions of severity among drug types and the social stigma associated with use of specific substances (Burke, 2007; Olsen, 2015).

Third, even though a significantly larger share of births with a prenatal substance exposure diagnosis had absent or missing prenatal care, data from the present study indicate that most infants were born to mothers who received some prenatal care (85.6%). Our findings support earlier work indicating that medical professionals providing prenatal services have unique opportunities to educate women about the detrimental effects of in utero drug exposure, identify cases of prenatal substance use, and engage substance-abusing pregnant women in drug treatment services (Hall, Moreau, & Trussell, 2013).

4.1. Limitations

The estimates derived from these administrative records should be viewed cautiously given at least four important limitations: measurement error, surveillance, unobserved factors, and generalizability. First, our data indicate that only 1.45% of infants were medically diagnosed with substance exposure at birth. Estimates from community-based studies of self-reported illicit substance use or based on randomized statewide toxicology screenings in birthing hospitals and prenatal care clinics are much higher, ranging from 10% to 20% (Kelly et al., 2002; Noble, Vega, & Kolody, 1997). Although prevalence rates in this study undoubtedly represent an imperfect measure of the actual prevalence of prenatal substance abuse, by assessing the frequency of diagnosed prenatal substance exposure among multiple birth cohorts using consistent parameters, we can evaluate changes that occur over time.

Surveillance poses an additional threat to associations among diagnoses of substance exposure, maternal characteristics, and CPS involvement. Health care providers may be more likely to screen for prenatal substance exposure among mothers with absent or late prenatal care or low maternal age at first birth (Burke, 2007). Further, the common practice of discretionary testing following birth may over-represent prenatally exposed infants who experienced neonatal complications while undercounting substance-exposed babies with otherwise healthy births (Burke, 2007; Kelly et al., 2002).

It may also be that other unobserved factors correlated with both substance type and CPS decisions to substantiate maltreatment or place an infant in foster care, such as polysubstance use, domestic violence, co-occurring mental illness, and an unsafe home environment explain the differences in risk found (Chasnoff, 2017; Choenni, Hammink & Van de Mheen, 2017; Olsen, 2015). Presently, the impact of and CPS responses to prenatal cannabis exposure are most certainly in flux, given recent policy changes to legalize marijuana use in many states throughout the US. This initial analysis identifies main effects of substance exposure, controlling for maternal characteristics. Future work should be geared towards investigating how different maternal characteristics interact across substance types.

Finally, findings from the present study are not generalizable to births outside of California or children in other birth cohorts in California. The present analysis was limited to a single birth cohort of children born a decade ago, identifying a snapshot of conditions of substance exposure during this period. Notwithstanding these limitations, standardized diagnostic codes provide a foundation of existing data for the cost-effective and population-level generation of these estimates across states and countries and over time. The ability to track the prevalence of specific substance types and emergence of classes of substance exposure is critical for public health responses. With respect to current trends in opioid use, this methodology seems particularly salient.

5. Conclusion

In this study, we demonstrated how linked, population-level administrative data can be used to study prenatal substance exposure and assess the subsequent CPS service trajectories and outcomes of exposed newborns in California. Our results underscore the need for interagency collaboration, particularly among birthing hospitals, obstetrics healthcare providers, developmental specialists and CPS agencies for the purposes of offering prevention and targeted intervention services. Additionally, the field would benefit from future research examining variations in hospital screening procedures; federal, state, and local policies regarding mandated reporting; medical practitioners' decisions to act or report; and other biases that may influence the relationship between prenatal drug exposure and CPS responses.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.chiabu.2017.10.002.

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