Maternal substance use in pregnancy: Differential prediction by childhood adversity subtypes

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A B S T R A C T

Substance use in pregnancy, including alcohol use, drug use, or smoking, is associated with poor health outcomes for both the mother and her unborn child. Building on previous research that has examined the cumulative impact of Adverse Childhood Experiences (ACEs) on maternal binge drinking and alcohol use in pregnancy, the current study sought to examine the association between maternal ACEs and substance use in pregnancy more broadly, including alcohol use, binge drinking, smoking, and drug use. Furthermore, we also examined how different adversity subtypes, including sexual abuse, family violence (physical abuse, emotional abuse), and household dysfunction, differentially predict maternal substance use behavior. A sample of 1994 women were recruited between 2008 and 2011 from a community-based pregnancy cohort in Calgary, Canada. Self-reported information on exposure to ACEs prior to the age of 18 years and maternal substance usewere collected. Examining ACE subtypes, medium effects were observed for the role of household-dysfunction on binge drinking, drug use, and smoking in pregnancy, while only small effects were observed for family violence on binge drinking, drug use, and smoking. There were no significant effects for sexual abuse after controlling for covariates. A dose-response association between the number of ACEs and substance use in pregnancy was also demonstrated. Increased support prior to, and in pregnancy, particularly for women with a history of childhood adversity, is needed to reduce substance use behaviors in pregnancy.

1. Introduction

Substance use in pregnancy, including alcohol use, drug use, or smoking, is a critical public health concern as it is associated with pregnancy complications (Kennare et al., 2005), birth complications (e. g., prematurity, low birth weight (Kennare et al., 2005; Smith et al., 2016)), as well as postpartum mental health difficulties, such as post-partum depression (Ross and Dennis, 2009). Maternal substance use in pregnancy is also associated with poor perinatal outcomes as well as long-term behavioral and emotional difficulties for children who are exposed (Ruisch et al., 2018). Elucidating the understanding of early precursors of substance use in pregnancy is paramount for identifying mothers at potential risk. Equipped with this information, health professionals can provide support and preventive interventions to mitigate risk to mothers and their unborn children.

1.1. Adverse childhood experiences and substance use in pregnancy

Several risk factors for substance use in pregnancy have been

identified, including low maternal education, substance use habits prior to pregnancy, and an unplanned pregnancy (McDonald et al., 2014). Recently, one risk factor that has received particular attention is exposure to adverse childhood experiences (ACEs), including abuse, neglect, and household dysfunction (Frankenberger et al., 2015). Exposure to abuse in childhood can lead to alterations in brain development and be linked to the development of mental health difficulties, such as depression or post-traumatic stress disorder (Atzl et al., 2019; Seng et al., 2014). Women with post-traumatic stress disorder have been shown to be at risk of increased substance use in pregnancy, conceptualized as a coping behavior for managing the mental health sequalae of childhood trauma (Seng et al., 2008). Given that pregnancy is a time of increased emotional, physical, and biological change (Slade and Sadler, 2018), women who struggle to manage and regulate their emotional states may use substances to cope with stress (Latuskie et al., 2019). Considered together, exposure to ACEs can trigger a cascade of negative events that lead to substance use in pregnancy and ultimately poor health and mental health outcomes.

Previous research has shown that women who experienced a greater

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number of ACEs in childhood are at increased risk for binge drinking (Currie et al., 2020), alcohol use (Frankenberger et al., 2015; Hicks et al., 2014), and drug use in pregnancy (Chung et al., 2010). Specifically, studies of community-based samplesin North America have shown that women who had 4 or more ACEs were nearly three times more likely to binge drink and five times more likely to drink alcohol in pregnancy, as compared to women who did not experience any adversities (Currie et al., 2020; Frankenberger et al., 2015). While the association between ACEs and alcohol use in pregnancy has been well-established, considerably less research has examined the association between ACEs and other forms of substance use such as smoking or drug use. Thus, the first goal of the current study was to examine whether ACEs were associated with smoking and drug use in pregnancy, as well as binge drinking and alcohol use in a community-based pregnancy cohort recruited between 2008 and 2011.

1.2. Differential prediction by childhood adversity subtypes

An important contribution of the ACEs literature has been the emphasis on both the cumulative influence of ACEs as well as the dose-response relationship that has been demonstrated with various outcomes (Hughes et al., 2017). Stemming from a well-established literature on cumulative risk and allostatic load (Evans et al., 2013; Rutter, 1978), recent research on ACEs has demonstrated that compounding exposure to stressful and negative experiences, particularly in childhood, exert a physiological "wear and tear" on the body that can lead to poor physical and mental health later in life (Felitti et al., 1998). Although the cumulative impact of ACEs has been well-documented, an emerging literature has pointed to the importance of considering how different types of adversity may influence health outcomes. Specifically, different types of adversity may differentially impact brain development, thereby leading to different health and mental health outcomes. For example, previous work has demonstrated differential associations with maternal mental health for tmaltreatment (e.g., physical or sexual abuse) iversus household dysfunction in childhood (e.g., parent with a mental health or substance use problem) (Atzl et al., 2019). Furthermore, previous research has demonstrated that sexual abuse may be a particularly salient predictor of mental health difficulties in pregnancy (Seng et al., 2014; Seng and Sperlich, 2008), which may contribute to an increased need for using coping behaviors such as substance use. Thus, a second goal of the current study was to examine how different types of maternal ACEs (Ford et al., 2014) predict maternal substance use behaviors, including alcohol use, binge drinking, smoking, and drug use, in a community-based pregnancy cohort.

1.3. The current study

Building on previous research that has examined the cumulative impact of ACEs on maternal binge drinking and alcohol use in pregnancy, as well as the dose-response relation between ACEs and alcohol use in pregnancy, the current study sought to examine the association between maternal ACEs and substance use in pregnancy more broadly, including alcohol use, binge drinking, smoking, and drug use. Furthermore, we also examined how different adversity subtypes (Ford et al., 2014), including sexual abuse, family violence (physical abuse, emotional abuse), and household dysfunction, may convey risk for maternal substance use in pregnancy. Based on previous research (Currie et al., 2020; Frankenberger et al., 2015), it was hypothesized that maternal ACEs would be positively associated with maternal substance use in pregnancy. It was also hypothesized that childhood experiences of maltreatment, such as physical and sexual abuse, as well as household dysfunction, would be positively associated with substance use in pregnancy. Findings from the current study have the potential to inform public health initiatives, such as education and screening prior to conception, that aim to reduce maternal substance use in pregnancy and optimize the health and development of offspring.

2. Material and methods

2.1. Participants and procedures

Women included in the current study were part of a community-based, longitudinal pregnancy cohort of women, the All Our Families (AOF) Study, conducted in Calgary, Alberta, Canada (McDonald et al., 2013; Tough et al., 2017). Data from this cohort are available for use from Policy Wise, SAGE Metadata Catalog (Policy Wise, 2020). Participants were recruited from medical laboratories and primary health-care clinics. Baseline questionnaire data were collected between 2008 and 2011. Women included in the current study were enrolled prior to 25 weeks of pregnancy, were over the age of 18 years, were able to complete a written questionnaire in English, and provided a report of their adverse childhood experiences when their child was 36 months of age. Women provided informed consent to participate and ethics approval was obtained from the Conjoint Health Research Ethics Board at the University of Calgary. Additional information on the cohort is reported elsewhere (McDonald et al., 2013; Tough et al., 2017). When compared to women in Alberta and Canada more broadly, women in the AOF study are more likely to have annual family incomes above $60,000 and to be married (Tough et al., 2017). Women in the AOF study are comparable to women in the province of Alberta and Canada with regards to education and likelihood of being born outside of Canada (Tough et al., 2017).

2.2. Measures

2.2.1. Demographic variables

Women completed a demographic questionnaire that measured age (in years), ethnicity, income, education, and reproductive history. Annual household family income was self-reported using an 11-item scale ranging from less than $10,000 to over $100,000 in increments of $10,000. Maternal education was self-reported using a 6-item scale ranging from "some elementary school or high school" to "completed graduate school".

2.2.2. Outcomes: maternal substance use in pregnancy

Women were asked to self-report on their substance use behaviors during pregnancy when they were between 34 and 36 weeks pregnant. Binge drinking during pregnancy was assessed by the question "Since becoming pregnant, including before you knew you were pregnant, did you ever drink 5 or more drinks on any one occasion?". Drinking any alcohol in pregnancy was operationalized using the question "Since becoming pregnant, including before you knew you were pregnant, did you drink any alcohol?". Use of drugs during pregnancy was operationalized using the question "Since becoming pregnant, including before you knew you were pregnant, have you used street drugs?". Smoking during pregnancy was operationalized using the question "Since becoming pregnant, including before you knew you were pregnant, have you smoked cigarettes?". All self-report questions were answered using yes (1) or no (0) responses. Self-report of substance use in pregnancy has been deemed to be more accurate than retrospective report and has shown predictive validity with child neurobehavioral outcomes (Jacobson et al., 2002).

2.3. Exposure: adverse childhood experiences (ACEs)

2.3.1. Individual maternal ACE types

The ACEs modules used in the current study to assess maternal adversity in childhood included 11 questions that assessed 8 areas of abuse and household dysfunction prior to the age of 18 years, based on the original ACE checklist (Center for Disease Control and Prevention, 2020). The questionnaire used in the current study has been published elsewhere (McDonald et al., 2019; Racine et al., 2018b). Measures of maternal maltreatment in childhood included physical abuse (1

variable), emotional abuse (1 variable), exposure to domestic violence (1 variable), and sexual abuse (3 variables). Measures of household dysfunction included living with someone who abused substances (alcohol: 1 variable, drugs: 1 variable), living with someone with a mental health problem (1 variable), having an incarcerated family member (1 variable), and parental separation or divorce (1 variable). The sexual abuse items were combined to obtain a dichotomous variable of whether or not sexual abuse had occurred. To examine individual ACEs subtypes, all variables were coded as either 0-no or 1-yes.

2.3.2. ACE subtypes

Based on previous research using confirmatory factor analysis based on a general population sample (Ford et al., 2014), as well as research with a prenatal sample (Racine et al., 2018b), three adversity subtype variables were created: family violence (physical abuse, emotional abuse, and exposure to domestic violence), sexual abuse (i.e., being touched sexually, being forced to touch someone sexually, or forced sex), and household dysfunction (i.e., parent mental illness, parent alcohol problem, parent drug problem, parent incarceration, divorce/separation). Mean scores for each of these subtypes were calculated. For the physical/emotional abuse and sexual/abuse subtypes, the items were scores as 1-never, 2-once, and 3-more than once and thus mean scores ranged from 1 to 3. The household dysfunction items were coded as 0-no and 1-yes and therefore the mean ranged from 0 to 1.

2.3.3. Cumulative ACEs

A sum of the 8 adversity types was created (ranging from 0 to 8) and participants were categorized as having exposure to 0, 1, 2, 3, or 4 or more adversities, which has been done in previous research (Currie et al., 2020; Frankenberger et al., 2015; Racine et al., 2020). In the current study, 37.5% had experienced no ACEs, 23.3% had experienced one ACE, 13.7% had experienced 2 ACEs, 10.3% had experienced 3 ACEs, and 14.7% had experienced 4 or more ACEs.

3. Statistical analyses

All statistical analyses were conducted in SPSS Version 25. The prevalence of substance use behaviors in pregnancy were calculated by examining the number of women who endorsed a given substance use behavior. To examine the association between individual ACE variables and maternal substance use in pregnancy, odds-ratios (ORs) were computed. Using multivariable logistic regression, unadjusted (OR) and adjusted odds ratios (AORs), as well as 95% confidence intervals, were calculated to quantify the association of different ACEs subtypes (entered as means) with maternal substance use in pregnancy (dichotomous). Adjusted models were assessed for confounding by maternal age, income, and education, when the confounding variable had a significant association with the outcome. Finally, to examine the dose response relationship between maternal cumulative ACEs and substance use in pregnancy, logistic regression with ACEs as a categorical variable was used to assess the odds of substance use in pregnancy as a function of a 5-category ACEs score (no ACEs, 1 ACE, 2 ACEs, 3 ACEs, and 4+ ACEs), where each category of maternal ACEs was compared to the reference group (no ACEs exposure). Based on guidelines for interpreting the magnitude of effect size of an odds ratio (Chen et al., 2010), ORs of 1.68, 3.47, and 6.71 were considered to be equivalent to small, medium, and large effect sizes, respectively.

4. Results

4.1. Demographic characteristics

The sociodemographic characteristics of women included in the current study are reported in Table 1.

Table 1

Distribution of demographic characteristics of the sample (*N* = 1994).

Characteristic	n (%)	Mean (SD)
Ethnicity		
Other	352 (17.7)	
White	1631 (81.8)	
Missing	11 (0.6)	
Marital status		
Married/common law	1895 (95.0)	
Single	88 (4.4)	
Missing	11 (0.6)	
Born in Canada		
Born in Canada	1627 (81.6)	
Not born in Canada	358 (18.0)	
Missing	9 (0.5)	
Household income		
Less than $60,000 annually	264 (13.2)	
More than $60,000 annually	1653 (82.9)	
Missing	77 (3.9)	
Education, post-secondary		
Some high-school, high school, some post-secondary	162 (8.1)	
Completed post-secondary or graduate school	1821 (91.3)	
Missing	11 (0.6)	
Maternal age		30.87 (4.40)
<35 years	1552 (77.8)	
>35 years	389 (19.5)	
Missing	53 (2.7)	
Parity		
No previous births	994 (49.8)	
Previous birth	979 (49.1)	
Missing	21 (1.1)	
ACEs subtypes		
Family violence	845 (42.4)	
Sexual abuse	267 (13.3)	
Household dysfunction	881 (44.2)	

4.2. ACEs subtypes and substance use in pregnancy

4.2.1. Alcohol use in pregnancy

The risk of using any alcohol in pregnancy by ACE type is reported in Table 2. Nearly half of women in the AOF sample reported using alcohol in pregnancy (45.3%) with the majority reporting low consumption (i.e. 40% reported having one drink at any given time or at a special occasion or prior to pregnancy recognition). Only childhood experiences of household dysfunction significantly predicted alcohol use in pregnancy after adjusting for covariates (OR = 3.06, 95%CI = 1.94, 4.81).

4.2.2. Moderate to high alcohol use prior to pregnancy recognition

Only 2.6% of women reported using moderate to high alcohol consumption after pregnancy recognition (See Table 2). No ACE subtypes predicted moderate to high use of alcohol after pregnancy recognition once covariates were included in the model (See Table 3).

4.2.3. Binge drinking in pregnancy

Approximately 10% of women in the current study reported drinking 5 or more alcoholic beverages on any one occasion during pregnancy (See Table 2). Family violence and household dysfunction significantly predicted binge drinking in pregnancy after controlling for covariates.

4.2.4. Drug use in pregnancy

Only 3% of women in the AOF sample reported illicit drug use in pregnancy (See Table 2). Family violence and household dysfunction subtypes significantly predicted drug use in pregnancy.

Table 2
Percentage of women who engaged in substance use by whether they had or had not experienced an ACE subtype.

	Any alcohol % (N)	Moderate/high alcohol after recognition % (N)	Binge drinking % (N)	Drug use % (N)	Smoking % (N)
Overall					
Yes	45.3 (904)	2.6 (52)	9.2 (184)	3.1 (62)	8.4 (168)
No	49.0 (977)	87.9 (1752)	84.3 (1680)	95.9 (1912)	85.9 (1713)
Missing	5.7 (113)	9.5 (190)	6.5 (130)	1.0 (20)	5.7 (113)
Physical abuse					
Yes	48.3 (156)	2.6 (8)	14.7 (47)	4.4 (15)	14.9 (48)
No	47.9 (745)	3.0 (44)	8.9 (137)	2.9 (47)	7.7 (119)
Sexual abuse					
Yes	50.8 (127)	3.4 (8)	12.4 (31)	6.5 (17)	14.0 (35)
No	47.5 (772)	2.8 (44)	9.4 (151)	2.6 (45)	8.1 (131)
Emotional abuse					
Yes	50.9 (344)	3.1 (20)	14.0 (94)	5.2 (37)	15.2 (103)
No	46.3 (556)	2.8 (32)	7.5 (89)	2.0 (25)	5.3 (63)
Parent mental illness					
Yes	56.8 (259)	4.1 (18)	15.0 (68)	4.7 (23)	14.9 (68)
No	45.1 (642)	2.5 (34)	8.2 (116)	2.6 (39)	7.0 (99)
Parent alcohol problem					
Yes	56.4 (193)	3.6 (12)	14.5 (49)	6.2 (22)	17.3 (59)
No	46.1 (708)	2.7 (40)	8.9 (135)	2.5 (40)	7.0 (108)
Parent drug problem					
Yes	53.6 (82)	5.3 (8)	20.4 (31)	7.5 (12)	20.9 (32)
No	47.5 (819)	2.7 (44)	9.0 (153)	2.8 (50)	7.8 (135)
Parent incarceration					
Yes	59.3 (32)	1.9 (1)	18.5 (10)	5.4 (3)	29.6 (16)
No	47.6 (869)	2.9 (51)	9.6 (174)	3.1 (59)	8.3 (151)
Parent separation/divorce					
Yes	55.6 (244)	4.1 (17)	16.5 (72)	6.1 (28)	16.4 (72)
No	45.7 (657)	2.5 (35)	7.9 (112)	2.3 (34)	6.6 (95)
Domestic violence					
Yes	51.1 (143)	3.4 (9)	15.9 (44)	5.1 (15)	16.1 (45)
No	47.4 (757)	2.8 (43)	8.8 (139)	2.8 (47)	7.6 (122)

Table 3
Childhood adversity subtypes and maternal substance use in pregnancy.

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[a]
Any alcohol use in pregnancy		
Family violence	1.12 (0.95–1.32)	1.17 (0.99–1.39)
Sexual abuse	1.09 (0.84–1.42)	1.09 (0.84–1.47)
Household dysfunction	2.92 (1.91–4.47)	3.41 (2.18–5.35)
Moderate/high use after recognition		
Family violence	1.11 (0.69, 1.78)	1.04 (0.64, 1.68)
Sexual abuse	1.33 (0.67, 2.65)	1.20 (0.60, 2.40)
Household dysfunction	3.07 (1.05, 9.00)	-
Binge drinking in pregnancy		
Family violence	1.81 (1.43–2.28)	1.65 (1.29–2.10)
Sexual abuse	1.15 (0.76–1.74)	0.92 (0.59–1.43)
Household dysfunction	6.26 (3.48–11.25)	3.92 (2.10–7.33)
Drug use in pregnancy		
Family violence	1.87 (1.29–2.70)	1.50 (1.01–2.23)
Sexual abuse	2.25 (1.38–3.66)	1.68 (1.0–2.83)
Household dysfunction	8.18 (3.32–20.09)	3.47 (1.30–9.24)
Smoking in pregnancy		
Family violence	2.37 (1.88–3.00)	2.13 (1.65–2.73)
Sexual abuse	1.83 (1.28–2.61)	1.39 (0.94–2.07)
Household dysfunction	12.41 (6.86–22.44)	6.92 (3.59–13.37)

[a] ORs are adjusted for confounding variables including maternal age, income, and education, if variables were found to significantly predict the outcome.

4.2.5. Smoking in pregnancy

Only 8% of women in the AOF sample reported smoking in pregnancy (See Table 2). Family violence and household dysfunction subtypes significantly predicted smoking in pregnancy.

4.3. Cumulative ACEs and substance use in pregnancy

The associations between cumulative adversity exposure and maternal substance use in pregnancy are presented in Table 4.

Generally, a dose-response relation was observed, with the odds of engaging in risky health behaviors in pregnancy increasing with the cumulative exposure to ACEs.

5. Discussion

Maternal substance use in pregnancy is associated with increased morbidity for both the mother and her unborn child (Guille and Aujla, 2019). The current study builds on existing literature by demonstrating the association between ACEs and multiple types of substance use in pregnancy, including alcohol use, binge drinking, drug use, and smoking in a community-based cohort. Furthermore, in line with literature suggesting that adversity subtypes may have differential associations with maternal health and mental health outcomes (Racine et al., 2018b), we examined the associations between adversity subtypes in childhood (i.e., family violence, sexual abuse, and household dysfunction), as well as cumulative adversity, and maternal substance use in pregnancy. Results for each of these findings will be discussed in turn below.

Prior to a fuller discussion of study findings, it should be noted that the self-reported prevalence of binge drinking (9.2%), drug-use (3.1%), and smoking (8.4%) identified in the current study are consistent with previous large-scale population-based studies examining maternal substance use in pregnancy in North America (Public Health Aegency of Canada, 2008; Lange et al., 2018). However, there are two notable differences in the current study: 1) a higher proportion of women reported using alcohol prior to pregnancy recognition or during pregnancy (45.3%) and 2) higher household family income than the national average in Canada and in the United States. The higher prevalence of alcohol use in pregnancy in the current study may be attributed to the fact that pregnant women were queried as to *any* alcohol consumption, including prior to pregnancy recognition. In addition, response choices allowed for minimal (i.e., <1) amounts per occasion and per timeframe. Previous research has demonstrated that the majority of women significantly reduce their alcohol intake after pregnancy recognition (McDonald et al., 2014). In the current study, only 3% of women

Table 4
Cumulative adversity and risk of substance use in pregnancy.

ACEs	Alcohol use		Alcohol after pregnancy recognition		Binge drinking		Drug use		Smoking	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
0	1.0[(referent)]	1.0[(referent)]	1.0[(referent)]	1.0[(referent)]	1.0[(referent)]	1.0[(referent)]	1.0[(referent)]	1.0[(referent)]	1.0[(referent)]	1.0[(referent)]
1	1.41	1.11–1.79	1.08	0.51, 2.26	2.22	1.39, 3.54	1.32	0.54, 3.21	1.75	1.02–3.00
2	1.25	0.94–1.66	1.05	0.43, 2.55	2.89	1.74, 4.79	3.31	1.47, 7.48	3.10	1.80–5.35
3	1.48	1.07–2.04	0.84	0.28, 2.51	3.59	2.11, 6.11	3.13	1.28, 7.67	3.70	2.08–6.95
4+	1.73	1.31–2.30	1.62	0.76, 3.48	3.94	2.45, 6.33	4.96	2.35, 10.49	6.67	4.11–10.81

consumed moderate to high amounts of alcohol after pregnancy recognition. Women who do not reduce their alcohol consumption in pregnancy may have been engaging in higher levels of use prior to pregnancy (McDonald et al., 2014). Future research specifically addressing pregnancy intention and changes in substance use prior to pregnancy recognition may further help elucidate associations between maternal substance use and ACEs.

Although small odds ratios were generally observed for individual ACEs, a different pattern emerged when examining ACE's subtypes in childhood. Specifically, medium-sized odds ratios were observed for the role of household-dysfunction on binge drinking, drug use, and smoking in pregnancy, while only small odds ratios were observed for family violence. There were no significant odds ratios for sexual abuse, after controlling for covariates. It is interesting to consider why exposure to household dysfunction in childhood, including exposure to caregiver mental illness, caregiver substance use, parent incarceration, and separation/divorce, would be most strongly associated with substance use in pregnancy. First, there is some evidence for the intergenerational transmission of substance use across generations, particularly for smoking, both via genetic and environmental pathways (Knight, Menard, Simmons, 2013; Kendler, Chen, Dick, 2012). That is, children of parents with substance use difficulties are at higher risk of engaging in problematic use themselves and environmental influences can perpetuate these patterns. Second, and in regard to environmental influences in particular, previous research has found that experiences of threat (i.e. physical, sexual abuse, or witnessing domestic violence) and deprivation (i.e., neglect, incarcerated caregiver) differentially impact developing systems within the body (Sheridan et al., 2017). While threat experiences result in changes to fear and affective brain circuitry, experiences of deprivation, as would be commonly experienced with household dysfunction, have an impact on the development of cognitive skills, such as executive functions, which are used both in affect regulation and in problem solving (Sheridan and McLaughlin, 2014). Thus, exposure to the chaos and lack of supportive guidance associated with household dysfunction may lead to disruptions in the development of cognitive abilities to plan, organize, and adaptively deal with stress, putting an individual at increased risk of using maladaptive coping, such as substance use (DeBellis, 2002; Giancola and Mezzich, 2003). Third, substance use is often used as a coping strategy to reduce strong emotions and to deal with internal and external stressors, which may be increased during pregnancy (Latuskie et al., 2019; Lopez et al., 2011; Sheffler et al., 2020; Tull et al., 2015). Future research examining mechanisms by which adversity in childhood influences maternal health risk behavior in pregnancy are needed to inform when and for whom interventions may be most helpful.

In the current study, sexual abuse was associated with drug use in pregnancy prior to controlling for maternal age, income, and education. However, this association dissipated after controlling for these confounders. This lack of association is in contrast to some previous literature indicating that women who have experienced childhood sexual abuse are more likely to use substances in pregnancy (Leeners et al., 2010). Our lack of findings may be attributed to a highly educated and high-income sample, where these factors may mitigate the mental health sequalae that are often associated with exposure to childhood sexual abuse, such as post-traumatic stress disorder. We would anticipate

finding this association among samples with greater prevalence of poverty and instability.

Consistent with previous research (Chung et al., 2010; Frankenberger et al., 2015), our findings demonstrated a dose-response association between the number of ACEs and risk for substance use in pregnancy, with medium associations for binge drinking, drug-use and smoking. These findings highlight the critical importance of considering cumulative exposure to adversity above and beyond any one individual predictor. Ultimately, cumulative risk provides an understanding of how multiple exposures compound to lead to poor physical and mental health outcomes. While individual adversity subtypes may have differential associations with different outcomes, cumulative risk has been hypothesized to contribute to a "central integrative factor" that increases the risk of poor outcomes (Atkinson et al., 2015). Identification of promotive and resilience factors that can disrupt these negative cascades are needed for the development of prevention and intervention strategies.

5.1. Study limitations

There are some limitations to the current study that should be considered. First, our findings apply to a community-based sample and are not representative of clinical samples or of women with substance use disorder. Women in the current study were also more likely to be married and had higher family incomes than women of young children in the province of Alberta and Canada, which may influence the generalizability of these findings to lower income samples. Second, as is common with most large-scale epidemiologic studies, we relied on maternal retrospective report of both adversity in childhood and substance use in pregnancy. Previous research has demonstrated that there may be bias in these reports (Hardt and Rutter, 2004; Reuben et al., 2016), and thus this must be considered in the interpretation of our findings. Specifically, pregnant women may be more inclined to under report both early adversity and substance use in pregnancy, indicating that the results we present here are conservative estimates. Lastly, maternal reports from the current study were obtained in the context of a research paradigm, not in clinical practice, and as such similar estimates or prevalence for both substance use and childhood adversity may not be obtained in a clinical setting.

6. Conclusion

The current findings point to the importance of broad public health initiatives to provide information about the importance of reducing substance use when women become pregnant (Cook et al., 2017; Wong et al., 2011), as well as discussing the risks associated with substance use in pregnancy during routine medical visits, preferably prior to conception or consideration of trying to get pregnant. Trauma-informed approaches to patient care have the potential to mitigate risk behaviors, address patient distress during a potentially turbulent transition to parenthood, and identify supports and healthy coping strategies for pregnant women, particularly for those who have a history of adversity (Racine et al., 2019). Identification of past and current protective factors, such as social support, may be helpful for (Racine et al., 2018a) reducing maternal stress and increasing coping strategies in pregnancy

(Narayan et al., 2018) and the postpartum (Hetherington et al., 2020; Madigan et al., 2016). Policies that promote reductions in family stress in the childbearing years as well as increasing the capacity for members of neighborhoods to provide support to individuals within it are needed.

Availability of data and materials

The datasets generated and analyzed during the current study are form the All Our Babies/Families Study (http://allourbabiesstudy.com) have been made available in the SAGE repository by the senior author (Dr. Tough) and are available at https://policywise.com/initiatives/sage/current-data-assets/

Author statement

Suzanne Tough is the lead investigator of the All Our Families study and contributed to conceptualization, data curation, funding acquisition, methodology, project administration, supervision, and review & editing of the draft. Sheri Madigan contributed to conceptualization, formal analysis, funding acquisition, supervision, writing of the original draft, and review/editing of the draft. Sheila McDonald is the lead scientist of the All Our Families study and contributed to conceptualization, data curation, funding acquisition, methodology, project administration, supervision, and review & editing of the draft. Nicole Racine contributed to conceptualization, formal analysis, funding acquisition, writing of the original draft, and reviewing/editing the draft. Kathleen Chaput contributed to conceptualization, formal analysis, and review/editing of the written draft.

Declaration of Competing Interest

None.

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