Preventive Medicine 118 (2019) 286–294

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Maternal adverse childhood experiences, mental health, and child behaviour at age 3: The all our families community cohort study

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ARTICLE INFO

Keywords:
Adverse childhood experiences
Birth cohort
Population-based
Maternal mental health
Parenting
Child behaviour
Child temperament

ABSTRACT

Links between adverse childhood experiences (ACEs) and threats to health and well-being later in life are well established. The current study extends those findings into younger populations of pregnant women and their children; investigating how ACEs relates to maternal postpartum well-being, coping, and parenting, as well as child outcomes. Participants included 1994 mothers and children from the All Our Families community-based cohort in Alberta, Canada, followed from pregnancy (from 2008 to 2011) until child age 3 years. The sample is representative of the pregnant population in an urban Canadian centre. Mothers completed questionnaires on ACEs, postpartum mental health, as well as parenting morale, efficacy, coping, and personality. Child outcomes included internalizing and externalizing behavior, as well as temperament. Approximately 62% of participants experienced at least one ACE; 25% experienced 3 or more ACEs. The presence of 3 or more ACEs was associated with postpartum smoking, binge drinking, depressive and anxiety symptoms, lower optimism and higher neuroticism, and lower reported parenting morale. In children, 3 or more maternal ACEs was associated with higher levels of internalizing (e.g., anxiety) and externalizing difficulties (aggression and hyperactivity), as well as temperament (surgency and negative affectivity). Cumulative maternal ACEs are associated with postpartum mental health and parenting morale, as well as maladaptive coping strategies. The demonstrated downstream consequences of maternal ACEs for child outcomes suggests that early intervention strategies and community resources to improve life course outcomes for parents and children are critical for breaking intergenerational continuities of risk.

1. Background

Links between early adversity and threats to health and well-being later in life are well described (Shonkoff and Garner, 2012; Bellis et al., 2014; Kalmakis and Chandler, 2015; Hughes et al., 2017). A large body of evidence suggests that adverse childhood experiences (ACEs) can increase the risk for stress-induced changes in a child's neurobiological systems with long lasting effects (Anda et al., 2006). The past decade has seen increasing research attention devoted to the underlying mechanisms of early adversity and poor health outcomes, with enhanced focus on neuroendocrine and neurobiological changes, and the role of genetics and epigenetic effects associated with vulnerability and resilience (McCrory et al., 2010; Buss et al., 2017). A number of studies, including the seminal ACE study (N = ~17,000), have shown that approximately two-thirds of adults have experienced at least one ACE and one out of 10 have experienced four or more (Felitti et al., 1998). Replication of these findings have been demonstrated in several community samples in North America (Gilbert et al., 2006; McDonald et al., 2015). ACEs have consistently been found to be associated with unhealthy lifestyles, poor physical (e.g., heart disease, obesity) and mental health (e.g., suicide, addictions), and low educational achievement and economic productivity in adulthood (Felitti et al., 1998; McDonald et al., 2015; Edwards, 2004; Middlebrooks and A.N, 2008). A notable gap in this field of research, however, is an understanding of how ACEs are associated with parenting and early child development.

Adults with a history of physical, sexual, or emotional abuse, who become parents themselves, have been shown to be at higher risk of parenting difficulties, which include impaired parenting skills, diminished confidence, more negative self-appraisal, harsher parenting styles, and lack of emotional control during parenting (Lomanowska

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https://doi.org/10.1016/j.ypmed.2018.11.013
Received 16 February 2018; Received in revised form 1 November 2018; Accepted 19 November 2018
Available online 22 November 2018

et al., 2015; Bailey et al., 2012; Fuchs et al., 2015; Schuetze and Eiden, 2005; Julian et al., 2017). These challenges may influence the ability to build stable, supportive homes that in turn can influence child development and family well-being (Collins et al., 2000). An emerging focus in the literature is the intergenerational transmission of the influence of the accumulation of maternal ACEs, and the potential of underlying biological and/or environmental mechanisms. Recent research has shown that a maternal history of ACEs is indirectly associated with infant outcomes through prenatal biological risk (Madigan et al., 2017; Racine et al., in press) and perinatal psychosocial health (Madigan et al., 2017; Racine et al., in press; McDonnell and Valentino, 2016; Collishaw et al., 2007; Roberts et al., 2004; Sun et al., 2017). Research in this area is scarce due to the lack of large longitudinal cohorts that collect both biological and psychosocial information (McDonnell and Valentino, 2016). However, this research is essential, as enhanced understanding of intergenerational transmission can substantially influence the development of early intervention strategies to improve life course outcomes for parents and children who are most at risk (Doyle et al., 2009). Although mechanisms of the intergenerational transmission of adversity may be through maternal behaviour (i.e. maternal emotional availability and sensitivity (Fuchs et al., 2015) (Pereira et al., 2012)), there is a need to explore additional factors. For example, recent research suggests that maternal anxiety and depression in pregnancy and the postpartum period mediate the association between maternal ACEs and child internalizing and externalizing behavior at age 2, and that this pathway is differentiated by child sex (Letourneau et al., 2018). Furthermore, measures that use intensive behavioral observations or coding are often not feasible for use in community-base settings, indicating the importance of identifying self-report questionnaires that could better identify dyads at-risk. A better understanding of maternal postpartum outcomes, including mental health, parenting efficacy and morale, and coping mechanisms among new parents with a history of ACEs can help inform strategies to mitigate lingering ACE-related effects, prevent intergenerational transmission of adversity, and build parenting capacity to optimize child development. This study uses a life course approach, specifically the sensitive period model of risk with later life risk factors (Ben-Shlomo and Kuh, 2002), to determine the intergenerational effects of maternal childhood adversity and child outcomes in a community sample of maternal-infant dyads from Alberta, Canada. The sensitive period model of risk with later life risk factors aims to examine the influence of maternal ACEs as well as additional proximal risk factors in the postnatal period on child behavior and temperament outcomes at age 3.

2. Methods

2.1. Study design and population

The All Our Families (AOF) cohort is a pregnancy cohort of approximately 3000 maternal-infant pairs who completed questionnaires during the perinatal period at 4-months and were followed up at 12, 24, and 36 months postpartum (McDonald et al., 2013; Tough et al., 2017). Pregnant women were recruited from various sources including low risk maternity clinics (14%), posters and word of mouth (17%) and through Calgary lab services (69%). The city of Calgary uses a centralized lab services system and all pregnant women go through the central lab services for pregnancy-related blood work. This resulted in recruitment of a representative sample of the pregnant population in an urban center in Canada. In order to be included in the study, women had to be less than 24wks gestation, at least 18 years of age, speak English well enough to answer written questionnaires and be receiving prenatal care in Calgary. Recruitment began in May 2008 and was completed in December 2010. Extensive demographic, mental health, lifestyle and health service utilization data were obtained on each woman, using standardized tools and investigator/stakeholder-driven items. There were 2909 families eligible for the 36-month follow-up time point, of which 1994 participated. Consistent with other large Canadian epidemiological samples, the response rate for completed data collections at annual follow-up waves range from 81% at 12 months to 69% at 36 months (Tough et al., 2017).

2.2. Study variables

Our main exposure variable was ACEs, collected at one point in time, retrospectively at the 36-month data collection time point. Mothers were asked 11 questions, based on the original ACE checklist (Centers for Disease Control and Prevention, 2006) that referred to adverse experiences during her own childhood (before 18 years of age). The questions covered past experiences of physical, verbal, and sexual abuse, as well as witnessing violence in the home, experiencing parental separation or divorce, and living with a mentally ill or substance addicted adult/parent. A total ACE score was calculated for 8 categories with a range of 0 to 8. For the bivariate and multivariable analysis, the ACE score was operationalized as a dichotomous category ACE variable with a cut-off at 3 ACEs or more indicating exposure to ACEs. Although a number of studies define 4 or more ACEs as the at-risk category, we used 3 or more as our cut-off since we had 8 ACEs (compared to 10 or 11 in other studies). In addition, this cut-off has been used in previous ACE studies (Whitaker et al., 2014), including an ACE study in Albertan adults (McDonald et al., 2015). Test-retest reliability of childhood trauma information collected retrospectively has been shown to be satisfactory, indicating consistent reporting (Cammack et al., 2016).

The outcomes of interest were child behaviour and child temperament at child age 3 years. Child behaviour was measured using the behaviour scales drawn from the National Longitudinal Survey of Children and Youth (Statistics Canada and Human Resources Development Canada, 1994–1995), which uses adapted questions from the Child Behaviour Checklist (Achenbach and Rescorla, 2000). Four sub-optimal domains of child behaviour were assessed at 36 months: Hyperactivity/Inattention; Physical Aggression; Emotional Disorder/Anxiety; and Separation Anxiety. The former two subscales comprise externalizing behaviours and the latter two comprise internalizing behaviours. Chronbach alphas in our sample for these subscales range from 0.58 (Separation Anxiety) to 0.80 (Hyperactivity/Inattention). Child Temperament was measured using the Children's Behaviour Questionnaire (CBQ) (Rothbart et al., 2001), a 36-item tool that assessed three broad sub-optimal domains of child temperament: Extraversion/Surgency; Negative Affectivity; and Effortful Control. The general consensus is that child temperament is a relatively stable trait (Shiner et al., 2012), and recent research has shown that early child temperament is associated with later behavioral and developmental challenges (Abulizi et al., 2017). The child behaviour and child temperament measurement subscales were dichotomised using a cut-point based on the mean and falling above/below 1sd of mean (depending on scoring) to determine at risk status as per previous studies using AOF data (Hetherington et al., 2018), and this is consistent with the scoring algorithm of the full CBCL that uses a cut-off of the 84th percentile for standardized scores.

2.3. Covariates

Baseline demographic and obstetric covariates were drawn from the pregnancy time points (maternal education, ethnicity, maternal age, marital status) or reflected status at birth (preterm status, child gender). These baseline covariates are standard covariates controlled for in multivariable models in pregnancy, postpartum, and early child development studies. Sociodemographics and obstetric variables are known to be associated with child behaviour (Bradley and Corwyn, 2002). Maternal postpartum characteristics were drawn from postpartum data collection points. These analyses were designed to understand the role that parenting morale, parenting efficacy, postpartum mental health, and coping tendencies play in influencing child

outcomes in addition to maternal ACEs. Parenting factors were operationalized using the Parenting Morale Index (PMI) (Trute and Hiebert-Murphy, 2005) at 4 months and Parenting Sense of Competence Efficacy Subscale (PSOC) (Johnston and Marsh, 1989) at 24 months to measure parenting enthusiasm and psychological energy, and competence in the parenting role, respectively. We operationalized postpartum mental health as symptoms of depression or anxiety as measured using the Edinburgh Postnatal Depression scale (EPDS) (Cox et al., 1987) at 4 and 12 months, the Centre for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977) at 24 months, and the State Anxiety Inventory (SAI) (Spielberger et al., 1970) at 4, 12, and 24 months. Previous research has shown links between maladaptive coping strategies in the face of stress and both lower optimism and higher neuroticism (Connor-Smith and Flachsbart, 2007; Nes and Segerstrom, 2006). Postpartum coping was operationalized as scores on the Life Orientation Test-Revised (LOT-R) (Scheier et al., 1994) during pregnancy, and the Neuroticism subscale of the Eysenck Personality Questionnaire short form (EPQ) (Eysenck et al., 1985), which was assessed at 36 months of age. Internal consistency coefficients for the maternal postnatal scales using AOF data range from 0.81–0.92. All study variables were treated as categorical for ease of interpretation from a population health perspective. Where available, validated cut-points were used to dichotomize continuous covariates. If a validated cut-point was not available, we used the mean plus or minus 1 standard deviation to determine 'at risk' status as per the outcome variables.

2.4. Statistical analysis

Descriptive data were generated to describe sample characteristics, maternal measures, and child development outcomes as frequencies and percentages. We used bivariate analysis to examine the association between ACEs and sociodemographic, postpartum lifestyle and mental health, and child outcome variables. Chi-square analysis was used to examine these associations and an alpha level of < 0.05 was considered statistically significant.

Using nested multivariable models, we examined the extent to which parenting morale, parenting efficacy, postpartum mental health, and coping influenced child outcomes, in addition to maternal ACEs and baseline demographic covariates. For these analyses, we compared baseline models containing only the ACE variable and baseline covariates (maternal education, ethnicity, maternal age, marital status, preterm delivery, child gender) to fully adjusted models containing the ACE variable, baseline covariates, and maternal postpartum measures. Comparison of nested models allowed for examining the influence of maternal postpartum factors on child outcomes in the presence of ACEs and also to assess whether the ACE effect remained after additional predictors were considered. These models tested the 'sensitive period with later life risk factors' lifecourse model of risk, such that the sensitive period of maternal early childhood and additional risk factors in the postnatal period were examined in relation to offspring behavior and temperament outcomes. Multivariable logistic regression results are presented as odds ratios (ORs) and 95% confidence intervals (CIs). All analyses were performed using STATA (Version 14).

3. Results

3.1. Sample characteristics

Of the 1994 participants, most were married or living common-law (95.6%), had completed post-secondary education (79.5%), and had household incomes over $80,000 (82%). Approximately 86% of mothers were Caucasian and 82% were born in Canada. 77% of women were < 35 years of age at delivery and 50% were primiparous. Child gender was 52% male and 48% female. Approximately 7% of children were preterm (36 weeks or less) at birth. (Table 1).

The prevalence of individual maternal ACEs ranged from 3% for criminal behavior in the household to a high of 36% for emotional abuse (Table 2). Nearly half of participants in the study experienced at least one form of either household dysfunction (48.3%) or abuse (44.6%). With respect to household dysfunction, the most common ACEs reported were mental illness in the household (24.7%) and having experienced a parental divorce or separation (23.5%). Almost 18% of women reported experiencing childhood physical abuse and over 13% reported experiencing sexual abuse as children. The distribution of the ACE score was skewed with the majority reporting none or just one ACE (cumulative percent, 61.1%). Among mothers in the present study, 37.6% reported 0 ACEs, 23.5% reported 1 ACE, 13.8% reported 2 ACEs; and approximately 25% reported 3 or more ACEs.

Table 1
Sample characteristics (N = 1994)[a].

Characteristic	n (%)
Socio-demographics	
Child sex	
Boy	1022 (52.3)
Girl	932 (47.7)
Maternal age (delivery)	
< 35 years	1480 (77.1)
≥ 35 years	440 (22.9)
Marital status	
Married/common-law	1895 (95.6)
Single	88 (4.4)
Ethnicity	
Other	352 (17.8)
Caucasian	1631 (82.3)
Born in Canada	
Born in Canada	1627 (81.6)
Not born in Canada	358 (18.0)
Household income	
Less than $80,000 annually	378 (31.6)
$80,000 or greater annually	819 (68.4)
Education, post-secondary	
Some HS/graduated HS/some post-sec	407 (20.5)
Graduated post-sec/some grad/completed	1576 (79.5)
Obstetrics	
Preterm birth	
37 or more weeks GA at birth	1816 (93.5)
36 weeks or less GA at birth	126 (6.5)
Parity	
No previous birth	994 (50.4)
Previous birth	979 (49.6)

With the exception of income,missingness was $< 4\%$.
[a] Denominator varies due to missing data for some variables.

3.2. Maternal ACEs and sociodemographic, pregnancy and postpartum factors

The bivariate association between ACEs and subgroups of the sample according to socio-demographic, pregnancy, and postpartum variables are presented in Tables 3 and 4. A higher maternal ACE score was significantly associated with single marital status, and lower household income and education. A higher maternal ACE score was associated with both postpartum smoking and binge drinking. In addition, mothers who experienced three or more adverse experiences in their own childhood were more likely to have lower optimism and higher neuroticism, have experienced postpartum depression and anxiety, and report lower parenting morale.

Maternal ACEs and sub-optimal child behaviour and temperament at 36 Months.

Bivariate crude associations between maternal ACEs and children's behaviour and temperament are summarized in Table 5. For all but one child outcome, the highest proportion of sub-optimal behaviour was seen in children whose mothers reported 3 or more ACEs. Children in families where mothers experienced 3 or more ACEs were more likely to have higher levels of hyperactivity/inattention, physical aggression,

Table 2
Definition and prevalence of each category of maternal adverse childhood experiences and the ACE score (N = 1987[a]).

Category and indicator	n (%)
Childhood abuse	
Emotional abuse	
How often did a parent or adult in your home ever swear at you, insult you, or put you down?	
Once or more	722 (36.3)
Never	1266 (63.7)
Physical abuse	
Before the age of 18, how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? (please do not include spanking)	
Once or more	352 (17.7)
Never	1638 (82.3)
Sexual abuse	
How often did anyone at least 5 years older than you or an adult ever touch you sexually, make you touch them sexually, or force you to have sex?	
Once or more	267 (13.4)
Never	1722 (86.6)
Household dysfunction	
Domestic violence	
How often did your parents or adults in your household ever slap, hit, kick, punch or beat each other up?	
Once or more	302 (15.2)
Never	1687 (84.8)
Household substance abuse	
Did you live with anyone who was a problem drinker or alcoholic, used illegal street drugs, or live with somehow who abused prescription medications?	
Yes	421 (21.2)
No	1569 (78.8)
Mental illness in household	
Did you live with anyone who was depressed, mentally ill, or suicidal?	
Yes	492 (24.7)
No	1498 (75.3)
Criminal behaviour	
Did you live with anyone who served time or was sentenced to serve time in prison, jail or other correctional facility?	
Yes	59 (3.0)
No	1931 (97.0)
Parental separation or divorce	
Were your parents separated or divorced?	
Yes	468 (23.5)
No	1522 (76.5)
ACE score (dichotomous)	
Not high (fewer than 3 ACEs)	1488 (74.9)
High (3 or more ACEs)	499 (25.1)

[a] Provided a valid response for all ACE questions.

anxiety/emotional disorders, separation anxiety, surgency/extraversion, and negative affectivity.

3.3. Multivariable models

Comparison of nested models (baseline to baseline plus maternal postpartum factors) showed that there were additional maternal factors that influenced child outcomes in addition to maternal ACEs. In fully adjusted models, an independent maternal ACE effect was seen for all child outcomes excluding separation anxiety and one dimension of temperament, namely effortful control (Tables 6 and 7).

4. Discussion

Drawing data from the All Our Families community-based, pregnancy cohort, this study examined the prevalence of maternal ACEs, the association between ACEs and postpartum characteristics and experiences, and the relationship between maternal ACEs and dimensions of child behaviour and temperament at age 3 years. AOF participants are generally representative of the parenting and pregnancy population in an urban centre (McDonald et al., 2013; Tough et al., 2017). The proportion of mothers reporting at least one ACE (62%) aligns with proportions seen in previous research, including the seminal ACE study (Felitti et al., 1998) and more recently in the Behavioral Risk Factor Surveillance System (Gilbert et al., 2006).

The highest proportion of a single ACE was 36% for emotional abuse. In an affluent sample of mothers living in an urban centre, this finding aligns with previous reports that ACEs cut across diverse samples and population characteristics. As such, a public health approach is warranted to address ACEs, including upstream and multisectoral approaches to support both children and adults alike (Black et al., 2017), given the potential for maternal ACEs to influence child development in the next generation (Madigan et al., 2017; Sun et al., 2017).

Our results showed that mothers who reported 3 or more ACEs were more likely to have mental health and parenting morale concerns, and potentially maladaptive strategies for coping in times of stress. These findings align with a growing body of research examining outcomes specific to parents with a history of early adversity. For example, in a community sample of mother-infant dyads in Ontario, Canada, Madigan and colleagues found that a maternal history of ACEs was associated with a 5-fold increased risk of experiencing postnatal psychosocial risk (Madigan et al., 2017). Other studies have documented associations between maternal maltreatment history and increased parenting hostility, maternal emotional unavailability, and decreased maternal sensitivity (Bailey et al., 2012; Fuchs et al., 2015; Pereira et al., 2012). Research has linked both lower levels of optimism and higher levels of neurotic traits with difficulty coping and adoption of maladaptive strategies (Connor-Smith and Flachsbart, 2007; Nes and Segerstrom, 2006; Frolund Pedersen et al., 2016; Schou et al., 2005). That a history of at least three ACEs was associated with maladaptive coping aligns with previous research on the robust association between increasing number of early adversities and health risk behaviours (Dube et al., 2003), including coping (Karmakar et al., 2017). Indeed, a recent systematic review of interventions for adults in primary care with a history of ACEs found robust evidence for cognitive behavioral interventions,

Table 3
Demographic, obstetric and postpartum lifestyle characteristics by maternal ACEs.

Characteristic	Low ACE (< 3 ACEs) (N = 1486) n (%)	High ACE (≥3 ACEs) (N = 499) n (%)
Socio-demographics		
Child sex		
Boy	766 (52.7)	253 (51.6)
Girl	689 (47.4)	237 (48.4)
Maternal age (delivery)		
< 35 years	1106 (77.4)	369 (76.6)
≥35 years	323 (22.6)	113 (23.4)
Marital status		
Married/common-law	1441 (97.4)	449 (90.9)
Single	39 (2.6)	45 (9.1)
Ethnicity		
Other	262 (17.7)	90 (18.2)
Caucasian	1217 (82.3)	405 (81.8)
Born in Canada		
Born in Canada	1206 (81.4)	413 (83.4)
Not born in Canada	275 (18.6)	82 (16.6)
Household income		
Less than $80,000 annually	263 (29.3)	114 (38.8)
$80,000 or greater annually	634 (70.7)	180 (61.2)
Education, post-secondary		
Some HS/graduated HS/some post-sec	240 (16.2)	164 (33.1)
Graduated post-sec/some grad/completed	1238 (83.8)	332 (66.9)
Obstetrics		
Preterm birth		
37 or more weeks GA at birth	1348 (93.2)	460 (94.3)
36 weeks or less GA at birth	98 (6.8)	28 (5.7)
Parity		
No previous birth	742 (50.4)	246 (49.9)
Previous birth	729 (49.6)	247 (50.1)
Postpartum lifestyle		
Postpartum smoking since baby was 4 months old		
Yes	45 (5.0)	39 (13.1)
No	860 (95.0)	258 (86.9)
Postpartum binge drinking since baby was 4 months (5+ drinks on one occasion)		
Yes	152 (22.3)	67 (29.9)
No	529 (77.7)	157 (70.1)

Table 4
Psychosocial and parenting characteristics by maternal ACEs.

Characteristic	Low ACE (< 3 ACEs) (N = 1486) n (%)	High ACE (≥3 ACEs) (N = 499) n (%)
Maternal personality		
Low maternal optimism		
Yes (LOTR ≤ 13)	206(14.7)	114(25.0)
No (LOTR > 13)	1195(85.3)	343(75.1)
High maternal neuroticism		
Yes (EPQ ≥ 7)	193(13.0)	125(25.1)
No (EPQ < 7)	1290(87.0)	373(74.9)
Postpartum maternal mental health		
Depression, (4, 12, or 24 months)		
Yes (EPDS ≥ 10 or CES-D ≥ 16)	238 (26.3)	147 (46.4)
No (EPDS < 10 or CES-D < 16)	688 (73.7)	170 (53.6)
Anxiety - state, (4, 12, or 24 months)		
Yes (SAI ≥ 40)	307 (34.7)	162 (52.6)
No (SAI < 40)	578 (65.3)	146 (47.4)
Parenting		
Low parenting morale (PMI score)		
Yes (PMI ≤ 33)	195 (13.9)	107 (23.5)
No (PMI > 33)	1213 (86.2)	348 (76.5)
Low parenting efficacy (PSOC) – 5-item		
Yes (PSOC ≤ 21)	175 (17.7)	69 (22.0)
No (PSOC > 21)	816 (82.3)	245 (78.0)

Notes. LOTR: Life Orientation Test-Revised; EPQ: Esyenk Personality Questionnaire; EPDS: Edinburgh Postnatal Depression scale; SAI: State Anxiety Inventory; PMI: Parenting Morale Index; PSOC: Parenting Sense of Competence Efficacy Subscale.

and suggested that promising targets for intervention included addressing modifiable factors such as emotional dysregulation, coping, and health-risk behaviours (Korotana et al., 2016). Overall, these findings point to the need for increased intervention and support for women who have experienced adversity in childhood as it relates to their parenting role.

There is a growing body of research on the intergenerational transmission of parental ACEs and child outcomes. Some recent studies have found that early maternal adversity is associated with infant physical and emotional health (Madigan et al., 2017; McDonnell and Valentino, 2016) through biological and psychosocial pathways. Letourneau and colleagues showed that maternal ACEs indirectly influenced child behavior at age 2 through prenatal and postpartum depression and anxiety (Letourneau et al., 2018) To our knowledge, the current study is one of few that describe child behaviour outcomes in the context of a history of maternal ACEs as a cumulative score beyond the infancy period; with the exception of Letourneau et al. (Letourneau et al., 2018), most of the previous work that has addressed early childhood outcomeshas focused on single adversities, such as sexual abuse (Collishaw et al., 2007; Roberts et al., 2004). Three or more maternal ACEs was an independent risk factor for 5 out of the 7 early childhood outcomes examined, controlling for additional factors that influenced child development. This finding suggests that maternal early experiences of adversity can have lasting influences on not only adult health but also the next generation; mechanisms of association could include both biological (i.e., epigenetic) and environmental pathways (Repetti et al., 2002). Given the associations between maternal ACEs and postpartum challenges including parenting, mental health, and coping, exploration of these factors as potential mediators is warranted and would contribute to the growing body of evidence on mechanisms that underlie intergenerational transmission of risk ((Madigan et al., 2017; Racine et al., in press; McDonnell and Valentino, 2016; Sun et al., 2017; Letourneau et al., 2018). Finally, identification of subgroups of mothers for whom the association is greater would inform targeted intervention strategies, as would identification of buffering factors among those with high ACE scores, such as social support and community engagement.

As seen in the fully adjusted models, there were other independent predictors of child behaviour and temperament in addition to maternal ACEs. These additional predictors in turn could partially explain the maternal ACE effect to some extent, but were also independent predictors of child outcomes. Due to the number of outcomes assessed, we report on only those predictors that were significant at $p < 0.01$ to avoid the potential for type 1 error. In terms of socio-demographic and socioeconomic factors, non-Caucasian and less educated mothers were more likely to report higher separation anxiety symptoms in their children, and mothers with less education were more likely to report that their child exhibited decreased effortful control. These findings align with those found in the literature (Afifi et al., 2014; Ng-Knight and Schoon, 2017) and suggest the need for early identification and more strategic interventions using a social determinants of health lens. Policies that address these social determinants of health have the potential to improve population health over the long-term (Letourneau et al., 2018). Examples include high quality, affordable child care, and professional training, wages and benefits for early childhood educators. Furthermore, using cohort data, like All Our Families, to examine

Table 5
Child behavior and temperament at 36 months by maternal ACEs.

Child behaviour/temperament	Low ACE (< 3 ACEs) (N = 1486) n (%)	High ACE (≥ 3 ACEs) (N = 499) n (%)	OR (95% CI)
Externalizing behaviour			
Higher level of hyperactivity/inattention			
No	1255 (84.7)	391 (78.7)	1.50 (1.16–1.94)
Yes	227 (15.3)	106 (21.3)	
Higher level of physical aggression			
No	1307 (88.4)	409 (82.6)	1.61 (1.21–2.13)
Yes	171 (11.6)	86 (17.4)	
Internalizing behaviour			
Possible anxiety/emotional disorder			
No	1355 (91.3)	438 (87.8)	1.46 (1.06–2.02)
Yes	129 (8.7)	61 (12.2)	
Higher level of separation anxiety			
No	1220 (82.2)	388 (77.8)	1.32 (1.03–1.70)
Yes	264 (17.8)	111 (22.2)	
Temperament			
Surgency/extraversion			
No	1242 (83.6)	397 (79.6)	1.31 (1.01–1.69)
Yes	244 (16.4)	102 (20.4)	
Negative affectivity			
No	1266 (85.2)	386 (77.4)	1.68 (1.31–2.17)
Yes	220 (14.8)	113 (22.7)	
Effortful control			
No	1274 (85.7)	412 (82.6)	1.27 (0.97–1.67)
Yes	212 (14.3)	87 (17.4)	

policy-relevant inventions is an underused resource to inform population health inventions (Edwards and Plotnikoff, 2018).

Fully adjusted models showed that maternal neuroticism was associated with a higher risk for both child hyperactivity and physical aggression. Mothers with high neuroticism, defined as low emotional stability and negative affect, are more likely to use maladaptive parenting strategies, such as discouraging their children's autonomy (McCabe, 2014), which may hinder the development of self-regulatory skills leading to behavior problems. The ability of a parent to encourage and support their child's autonomy is a strong predictor of self-regulation in young children (Bernier et al., 2010). In addition, mothers with high levels of negative affect and low emotional stability are more likely to use maladaptive coping mechanisms, such as avoidance and escape, in times of stress (Glidden et al., 2006). Limited research suggests that ineffective coping influences parent-child interaction and child behavior (Atlas and Rickel, 1988). Maternal neuroticism is a novel risk factor not commonly seen in the literature and could be a venue for further research in child development, informing innovative interventions for families.

Finally, maternal anxiety was associated with increased levels of child physical aggression at age 3, which aligns with previous studies that have found associations between maternal anxiety and child internalizing and externalizing behaviour (Yoo et al., 2009). The mechanism through which maternal anxiety influences child physical aggression may be through parenting behaviour and discipline strategies, but other mechanisms are possible such as difficulty coping for both the anxious mother and child that may in turn manifest in behaviour problems.

Strengths of this study include its population based recruitment strategy, longitudinal follow-up and the collection of a diverse array of maternal and child outcomes across time. Limitations include low representation of subgroups vulnerable to poor outcomes, given an overrepresentation of families with higher education and income, and lack of diagnostic parent-child interaction, parenting assessments, and schedules for child behavior (e. g., Structured Clinical Interview for DSM−V). However, given that our focus is population based approaches to intervention as well as the time intensive nature of many observational tools, we employed self-report standardized measures as seen in other population based birth cohorts (Golding et al., 2001; Jaddoe et al., 2006). We have previously reported that women who were included in at least one follow-up data collection up to 36 months were older, in a stable relationship, were Canadian born, and had higher income and education, compared to women who were recruited in pregnancy and participated in the perinatal period but were lost to follow-up in the early childhood period (Tough et al., 2017). As such, there may be potential for bias due to attrition, which may underestimate the associations seen in this study given known relationships between ACEs and lower SES (Metzler et al., 2017). In addition, we acknowledge that magnitudes of our estimates (odds ratios) are, for the most part, < 2, with the exception of maternal postpartum anxiety and maternal neuroticism for some, but not all child outcomes. As such, caution is warranted when extrapolating statistical significance according to 95% confidence intervals into clinical significance, and further research is encouraged. Finally, maternal ACEs were assessed at the same time-point as child outcomes, which, in turn could lead to potential reporting bias.

In summary, maternal ACEs can impact parenting behaviours and mental health, and potentially other pathways to influence the development of child behaviour problems and poor self-regulation. Intergenerational transmission of risk includes early maternal influences as well as concurrent environmental influences, including parenting esteem, mental health, and coping strategies. Further research could examine a latent construct of these proximal inputs as the mechanism through which distal factors influence child outcomes and link findings to evidence-based approaches to optimize family well-being. Sensitivity analyses examining ACEs as a continuous variable and examination of mitigating factors that foster resilience such as social support and community engagement would also be informative. Finally, despite the relative financial and education security of the cohort, it is important to recognize that over a third report emotional abuse in childhood and a quarter at least three ACEs, suggesting both universal and strategic approaches to supporting families with young children.

Table 6
Predictive multivariable logistic regression models for child behaviour outcomes.

Independent variables	Hyperactivity/inattention		Physical aggression		Emotional disorder/anxiety		Separation anxiety	
	Adjusted OR (baseline model[a])	Adjusted OR (baseline model plus mediators)	Adjusted OR (baseline model[a])	Adjusted OR (baseline model plus mediators)	Adjusted OR (baseline model[a])	Adjusted OR (baseline model plus mediators)	Adjusted OR (baseline model[a])	Adjusted OR (baseline model plus mediators)
Early maltreatment								
Maternal ACEs (high, ≥3 ACEs)	1.49 (1.14,1.94)	1.69 (1.15,2.48)	1.57 (1.17,2.10)	1.64 (1.07,2.52)	1.50 (1.07,2.10)	1.76 (1.08,2.88)	1.25 (0.97,1.63)	0.96 (0.64,1.43)
Socio-demographics								
Ethnicity (white/Caucasian)		1.33 (0.72,2.46)		1.53 (0.72,3.23)		0.90 (0.42,1.93)		0.48 (0.29,0.81)
Born in Canada (no)		1.20 (0.68,2.10)		0.79 (0.40,1.59)		0.96 (0.46,2.00)		1.27 (0.75,2.14)
Maternal education (did not complete post-secondary)		0.94 (0.60,1.49)		0.92 (0.56,1.53)		0.98 (0.55,1.76)		1.77 (1.17,2.66)
Child gender (male)		1.43 (1.00,2.03)		1.26 (0.85,1.87)		1.03 (0.65,1.63)		0.88 (0.63,1.24)
Obstetrics								
Parity (at least one previous birth)		0.70 (0.49,0.99)		1.66 (1.11,2.49)		0.68 (0.43,2.88)		0.97 (0.69,1.38)
Preterm birth (< 37 weeks gestation)		1.67 (0.75,3.72)		1.53 (0.65,3.65)		1.22 (0.46,3.24)		0.91 (0.47,1.77)
Parenting, mental health, coping								
Low parenting morale		0.56 (0.33,0.93)		1.28 (0.77,2.12)		1.11 (0.60,2.07)		1.01 (0.63,1.63)
Low parenting self-efficacy		1.57 (1.04,2.37)		1.08 (0.68,1.73)		0.93 (0.53,1.64)		0.89 (0.58,1.38)
Postpartum depression		1.44 (0.88,2.34)		1.02 (0.60,1.75)		1.01 (0.53,1.91)		1.79 (1.11,2.90)
Postpartum anxiety		1.41 (0.89,2.25)		2.19 (1.32,3.64)		1.54 (0.84,2.83)		0.97 (0.61,1.54)
Low optimism		1.16 (0.73,1.83)		1.53 (0.95,2.48)		1.43 (0.82,2.50)		1.60 (1.04,2.45)
High neuroticism		1.94 (1.23,3.06)		1.92 (1.18,3.11)		1.49 (0.83,2.69)		1.57 (0.99,2.49)

[a] Baseline models for adjusted odds ratio include ACEs plus socio-demographics (ethnicity, born in Canada, maternal education, child gender) and obstetrics (parity, preterm birth).

Table 7
Predictive multivariable logistic regression models for child temperament outcomes.

Independent variables	Surgency		Negative affect		Effortful control	
	Adjusted OR (baseline model[a])	Adjusted OR (baseline model plus mediators)	Adjusted OR (baseline model[a])	Adjusted OR (baseline model plus mediators)	Adjusted OR (baseline model[a])	Adjusted OR (baseline model plus mediators)
Early maltreatment						
Maternal ACEs (high, ≥3 ACEs)	1.27 (0.97,1.66)	1.55 (1.05,2.29)	1.65 (1.27,2.16)	1.74 (1.16,2.59)	1.28 (0.96,1.71)	1.48 (0.96,2.27)
Socio-demographics						
Ethnicity (white/Caucasian)		0.93 (0.53,1.63)		0.64 (0.37,1.13)		0.75 (0.41,1.36)
Born in Canada (no)		1.36 (0.80,2.32)		1.49 (0.86,2.58)		1.28 (0.72,2.27)
Maternal education (did not complete post-secondary)		0.96 (0.61,1.50)		0.83 (0.51,1.34)		1.80 (1.16,2.81)
Child gender (male)		1.45 (1.03,2.05)		0.67 (0.47,0.97)		0.61 (0.41,0.90)
Obstetrics						
Parity (at least one previous birth)		0.96 (0.68,1.36)		1.33 (0.92,1.93)		0.66 (0.45,0.97)
Preterm birth (< 37 weeks gestation)		0.93 (0.46,1.88)		1.38 (0.63,3.06)		0.72 (0.34,1.56)
Parenting, mental health, coping						
Low parenting morale		0.60 (0.36,1.03)		1.24 (0.76,2.02)		0.81 (0.44,1.48)
Low parenting self-efficacy		1.43 (0.94,2.18)		0.61 (0.37,0.99)		0.52 (0.29,0.93)
Postpartum depression		1.18 (0.72,1.95)		1.46 (0.88,2.41)		1.60 (0.90,2.85)
Postpartum anxiety		1.37 (0.86,2.18)		1.58 (0.98,2.56)		0.81 (0.47,1.40)
Low optimism		0.86 (0.53,1.40)		1.79 (1.15,2.79)		0.69 (0.39,1.23)
High neuroticism		0.74 (0.44,1.25)		1.33 (0.81,2.16)		0.84 (0.46,1.55)

[a] Baseline models for adjusted odds ratio include ACEs plus socio-demographics (ethnicity, born in Canada, maternal education, child gender) and pregnancy and birth characteristics (parity, preterm birth).

Acknowledgments

This work was supported by Alberta Innovates - Health Solutions (Interdisciplinary Team Grant #200700595), the Palix Foundation, the Alberta Children's Hospital Foundation, and the Women & Children's Health Research Institute.

Conflict of interest

The authors declare there is no conflict of interest.

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