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Numeracy and literacy attainment of children exposed to maternal incarceration and other adversities: A linked data study

Megan F. Bell^{a,*}, Leonie Segal^b, Susan Dennison^{c,d}, Stuart A. Kinner^{d,e,f,g,h,1}, Sharon Daweⁱ, Matthew J. Spittal^e, David B. Preen^a

^a School of Population and Global Health, University of Western Australia, Crawley, Western Australia, Australia

^b Australian Centre for Precision Health, University of South Australia, Adelaide, South Australia, Australia

^c School of Criminology and Criminal Justice, Griffith University, Mt Gravatt, Queensland, Australia

^d Griffith Criminology Institute, Griffith University, Mt Gravatt, Queensland, Australia

^e Justice Health Unit, Melbourne School of Population and Global Health, University of Melbourne, Parkville, Victoria, Australia

^f Centre for Adolescent Health, Murdoch Children's Research Institute, Royal Children's Hospital, Parkville, New South Wales, Australia

^g Mater Research Institute-UQ, University of Queensland, South Brisbane, Queensland, Australia

^h School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia

ⁱ School of Psychology, Griffith University, Mt Gravatt, Queensland, Australia

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ABSTRACT

Parental incarceration has been associated with educational disadvantages for children, such as lower educational attainment, increased grade retention, and truancy and suspensions. However, children exposed to parental incarceration often experience other adversities that are also associated with educational disadvantage; the contribution of these co-occurring adversities has not been considered in previous research. This study aimed to investigate the educational outcomes of children exposed to (a) maternal incarceration alone and (b) maternal incarceration plus other adversities (i.e., maternal mental illness and/or child protective services [CPS] contact). We used linked administrative data for a sample of children whose mothers were incarcerated during the children's childhood (i.e., from the time of mother's pregnancy through the child's 18th birthday; $n = 3828$) and a comparison group of children whose mothers had not been incarcerated ($n = 9570$). Multivariate multinomial logistic regressions examined the association between exposure to the three adversities (i.e., maternal incarceration, maternal mental illness, and child CPS contact) and above or below average reading and numeracy attainment in Grades 3, 5, 7 and 9. At all grade levels, children exposed to maternal incarceration alone and those exposed to maternal incarceration plus other adversities had increased odds of below average numeracy and reading attainment and decreased odds of above average numeracy and reading attainment compared to children without any of the recorded exposures. Children exposed to maternal incarceration and CPS contact and those exposed to all three adversities had increased odds of below average reading and numeracy attainment compared to children exposed to maternal incarceration alone. The findings highlight the complex needs of children of incarcerated mothers that must be considered when designing and delivering educational support programs. These children would benefit from the implementation of multi-tiered, trauma-informed educational and clinical services.

* Corresponding author at: School of Population & Global Health (M431), University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009, Australia.

E-mail addresses: megan.bell@uwa.edu.au (M.F. Bell), leonie.segal@unisa.edu.au (L. Segal), susan.dennison@griffith.edu.au (S. Dennison), stuart.kinner@curtin.edu.au (S.A. Kinner), s.dawe@griffith.edu.au (S. Dawe), m.spittal@unimelb.edu.au (M.J. Spittal), david.preen@uwa.edu.au (D.B. Preen).

¹ Present address: Curtin University, Perth, Western Australia

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1. Introduction

Education is widely recognized as a means of improving life opportunities, especially for groups who are socially and economically disadvantaged. Although individual differences in academic abilities strongly predict educational attainment, these abilities can be constrained by environmental adversities that limit children's opportunities for successful development (Sameroff et al., 1993). Children of incarcerated parents are one such group whose academic potential may be negatively impacted by multiple developmental challenges. These children often experience high levels of pre-existing social and economic disadvantage (Arditti, 2015; Australian Institute of Health and Welfare, 2013; Geller et al., 2012; Poehlmann, 2005) that can be compounded by the trauma and hardship of having an incarcerated parent (Arditti, 2012, 2015; Kahya & Ekinci, 2018; Minson, 2019; Turney & Wildeman, 2018).

There is a growing body of evidence linking parental incarceration with poor school outcomes for children, including reduced school readiness, lower attainment and school completion rates, increased grade retention, truancy and suspensions, and decreased college attendance (Andersen, 2016; Brown, 2017; Gifford et al., 2015; Hagan & Foster, 2012; Huynh-Hohnbaum et al., 2015; McCauley, 2020; Nichols et al., 2016; Testa & Jackson, 2021; Turney & Haskins, 2014). However, children with incarcerated parents are often also exposed to other adversities, such as parental mental illness and child protection system (CPS) contact (Arditti, 2015; Giordano et al., 2019; Johnson & Waldfogel, 2004; Murphey & Cooper, 2015; Sheehan, 2010; Turney, 2018), and these factors are also associated with poor school outcomes for children (Berger et al., 2015; Laurens et al., 2020; Raby et al., 2019; Shen et al., 2016). Although previous research with children of incarcerated parents has accounted for socio-economic disadvantage, it has not investigated the impact of co-occurring adversities on educational attainment. It therefore is unclear if the association between parental incarceration and children's school outcomes, as reported in the literature, is confounded by exposure to other adversities.

1.1. Theoretical framework

Bioecological theories posit that development is influenced by the characteristics of the individual and their family, other developmental settings such as their community or school, and the nature of the interactions children have with the people and objects within these settings (Bronfenbrenner, 1974; Bronfenbrenner & Ceci, 1994; Bronfenbrenner & Morris, 2007). Adversity factors within developmental settings, such as separation from a parent due to incarceration, are postulated to constrain a child's individual abilities so that their academic potential is not realized (Bronfenbrenner & Morris, 2007; Sameroff et al., 1993). Parental incarceration is associated with adversities such as social stigma, financial and housing instability, trauma, shame, and attachment disruption (Arditti, 2005), which can all negatively affect a child's ability to engage in learning via impacts on attention, motivation, attendance, behavior, and cognitive development (Guinasso et al., 2016; Smith & Pollak, 2021; Stempel et al., 2017). A child's experience of parental incarceration is also influenced by broader systemic factors, including sentencing practices, institutional policies around family visitation, social beliefs regarding culpability of non-incarcerated family members, and availability of practical, financial, social, and emotional supports for children and their non-incarcerated caregivers (Arditti, 2005; Hagan & Dinovitzer, 1999). These factors can determine whether a child has opportunities to use and develop their academic competencies (Sameroff, 2010). In addition, children of incarcerated parents are often exposed to other adversities such as child maltreatment, homelessness, domestic violence, and/or parental mental illness (Casey et al., 2015; Dallaire, 2007; Dowell et al., 2018). Experience of multiple adversities during development is associated with lower educational achievement during both elementary school and secondary school (Crouch et al., 2019; Gutman et al., 2003; Herbers et al., 2012; Laurens et al., 2020; Tan et al., 2017). Consequently, it is reasonable to hypothesize that children exposed to parental incarceration along with other co-occurring adversities will have poorer educational attainment than those who are exposed to parental incarceration alone and those who are not exposed to adversities.

1.2. Maternal incarceration and children's educational outcomes

Compared to research conducted with children of incarcerated fathers, there has been little evaluation of the association between maternal incarceration and child educational attainment. This is primarily because there are fewer female prisoners as compared to male prisoners and obtaining large enough study samples through opt-in recruitment is problematic due to the sensitive nature of the information requested. However, there are increasing numbers of women being imprisoned in Australia (Australian Bureau of Statistics, 2018) and elsewhere (Walmsley, 2017), and children of incarcerated women are more likely to be cared for outside of the family home than children of incarcerated men (Black, 1992; Makariev & Shaver, 2010). Thus, greater attention to the outcomes of children of incarcerated mothers is needed.

Previous findings on the association between maternal incarceration and children's educational outcomes have been mixed. Hagan and Foster (2012), in an American study, found that children of incarcerated mothers had an increased risk of poor educational achievement. Cho (2009) found no association. Conducted in Colombia, Arteaga (2018) found that maternal incarceration was associated with an increase in children's educational attainment over time. However, none of these studies identified co-occurring adversities or estimated their impact on educational attainment. It is possible that unobserved heterogeneity influences the associations found between maternal incarceration and children's educational outcomes. If studies do not account for the co-occurring adversities present in the lives of children exposed to maternal incarceration, erroneous conclusions may be drawn about the scale of the impact of maternal incarceration on children's outcomes. Related research has found that the co-occurring adversities present in the lives of children whose mothers have been incarcerated have a stronger association with children's health, behavioral, and social outcomes than the incarceration itself (Turney, 2014; Wildeman et al., 2013; Wildeman & Wakefield, 2014). Therefore, it is possible

that once the effects of other adversities such as maternal mental illness and child CPS contact have been considered, the effect of maternal incarceration on children's educational attainment is null.

Issues of unobserved heterogeneity through non-inclusion of important explanatory variables can be addressed, in part, by use of multi-sector administrative data. Population-level incarceration data capture information on all incarcerated women while maintaining their anonymity (Eddy et al., 2001; Geller et al., 2016). These data can be merged with other administrative data sets including child maltreatment reports and maternal mental health contacts, as well as with children's school records. In this study, we used population-level administrative data to investigate the relationship between maternal incarceration and children's educational outcomes while accounting for co-occurring adversities.

1.3. The Australian context

Across Australia, the female prison population rate is 13.6 per 100,000 population, compared with 65.7 per 100,000 in the United States, 7.7 per 100,000 in Canada, and 6.7 per 100,000 in the United Kingdom (Walmsley, 2017). The present study was conducted in Western Australia (WA), which has the second highest female incarceration rate of all Australian states and territories, ranging from a low of 26.2 per 100,000 adult female population in 2002, to a high of 48.2 per 100,000 adult female population in 2012 (Australian Bureau of Statistics, 2002, 2012). However, these statistics do not reveal the stark difference in incarceration rates between Aboriginal and non-Aboriginal Australians. In 2012, Aboriginal and/or Torres Strait Islander women across Australia were imprisoned at 24 times the rate of non-Indigenous women (405.4 per 100,000 adult population versus 16.5 per 100,000 adult population; Australian Bureau of Statistics, 2012). Incarceration of Aboriginal and/or Torres Strait Islander women can intensify the impacts of intergenerational trauma associated with forced family separation (Krieg, 2006). Aboriginal and/or Torres Strait Islander people are also more likely to experience stigmatizing and discriminatory practices within the criminal justice system (Krieg, 2006; Roettger et al., 2019) and the education system (Gray & Beresford, 2008). There are significant discrepancies between learning outcomes for non-Aboriginal and Aboriginal students in Australia, contributed to by the lasting effects of colonization and intergenerational educational disadvantage (Gray & Beresford, 2008). Interpretation of the educational outcomes of children of incarcerated mothers in Australia must therefore be understood within this context.

1.4. The present study

The aim of this study was to examine the association between maternal incarceration and educational attainment (defined as attainment on standardized tests of numeracy and reading) in the context of CPS contact and maternal mental illness, which are two major co-occurring adversities. These co-occurring adversities were selected because of the significant overlap with maternal incarceration exposure (Dowell et al., 2018; Johnson & Waldfogel, 2002; Phillips et al., 2006; Swann & Sylvester, 2006) and evidence of an association between these exposures and poor educational attainment for children (Laurens et al., 2020; Maclean et al., 2016; Ranning et al., 2018; Shen et al., 2016). We used administrative data from a linked population cohort to investigate these associations for both above and below average educational attainment, relative to average levels of attainment. Based on evidence that adversity factors can have a constraining effect on children's outcomes, we hypothesized that children exposed to maternal incarceration would be more likely than children unexposed to maternal incarceration to have below average attainment and less likely to have above average attainment. Furthermore, we hypothesized that children exposed to maternal incarceration plus maternal mental illness and/or CPS contact would have the poorest outcomes overall. We also expected differences in the strength of association depending on the age of the child at which adversity exposure and educational attainment are measured given evidence of a change in influence of adversity factors as children's independence develops (Sameroff, 2010). Therefore, associations were examined at four different time points during schooling to identify age-specific variations.

2. Method

2.1. Study design

The original retrospective cohort study on which the present study was based comprised all children born in Western Australia (WA) from 1985 to 2011 whose biological mother was incarcerated during pregnancy or before the child's 18th birthday (or before the child's death; $N = 9471$) and a matched (3:1 sampling [where possible] based on Aboriginal and/or Torres Strait Islander status, year of birth, and sex) comparison group of children whose mothers had no record of contact with the WA Department of Justice ($N = 22,716$). Data for children and their mothers were linked through the WA Data Linkage System (WADLS) via the Family Connections System (Glasson et al., 2008) and were based on details recorded on the child's birth registration. Exclusion criteria were applied to the original study population to obtain the sample for this study (see further details below); the study period was revised from April 1993 to May 2013 based on availability of data on numeracy and reading attainment.

This study used prospectively collected administrative data linked by the WADLS. Records from disparate datasets were linked by matching identifiers (e.g., name, address) common to the sets of records, using a best-practice probabilistic matching approach and clerical review (Holman et al., 2008). Identifying information was removed from records and replaced with an encrypted key unique to each individual by the WA Data Linkage Branch prior to data being provided to the research team. Researchers used the encrypted keys to merge the datasets.

2.2. Study setting

This study was conducted in WA where prisoners are either sentenced (those who have faced trial and been found guilty) or are remandees (those who are awaiting trial or the outcome of their court case). Remandees and sentenced prisoners are housed within the same prisons, which are classified as minimum-, medium-, or maximum-security based on the individual's risk of escape and threat to the safety of the public (Office of the Inspector of Custodial Services, 2012). Prisons are likewise classified as minimum-security, medium-security, maximum-security, or multipurpose. Multipurpose and maximum-security prisons house individuals of all security types, often without regime differentiation (Office of the Inspector of Custodial Services, 2012). WA's largest female-only prison (i.e., Bandyup) is a maximum-security prison. During the study period, the median aggregate sentence length for all sentenced individuals (male and female) in WA ranged from a high of 4 years in 2002, to a low of 2.5 years in 2012 (figures disaggregated by gender and security type are not available; Australian Bureau of Statistics, 2012). Around a third of all female prisoners are remandees and have a median length of stay of 19 days (Office of the Inspector of Custodial Services, 2015).

2.3. Participants

Participants included all children from the original cohort who were eligible to sit the National Assessment Program–Literacy and Numeracy (NAPLAN) between 2008 and 2013, which corresponds to dates of birth between January 1994 and June 2005 (see Fig. 1). The NAPLAN (ACARA, 2019) is an annual assessment of the academic skills of children in Grades 3, 5, 7, and 9 conducted in all Australian government and non-government schools. Children who died prior to sitting for their first NAPLAN test were excluded from the sample ($n = 132$), as were children who had no NAPLAN records at any time during the study years ($n = 1614$). Children with no NAPLAN records at any time were assumed to be attending non-government schools (as only government school NAPLAN data can be linked in WA) and/or to have migrated out of WA before sitting for a NAPLAN test.

An additional 930 children had a NAPLAN record but did not have any assessment data in the record. Of these children, the majority (77%) were recorded as absent on the day of testing. The remaining 23% were exempt (i.e., for reasons of disability or limited English language proficiency) or officially withdrawn from testing by their parents. The majority (76%) of children with missing test data were Aboriginal and/or Torres Strait Islander (compared to ~48% of the participants with test data), 59% lived in the most socioeconomically disadvantaged areas (compared to ~46%), and 60% lived outside of the metropolitan area (compared to ~42%). Furthermore, around 50% of children with missing NAPLAN test data had been exposed to maternal incarceration as compared to 28% of children who had NAPLAN test data.

All children who had data for at least one numeracy or reading test were retained for analyses ($N = 13,398$; 93.5% of the eligible sample). The final sample was comprised of 3828 children whose mothers had an incarceration record at some point during the study period and 9570 children whose mothers had neither a record of being incarcerated nor a community-based correctional order during the study period (Fig. 1).

NAPLAN was conducted in Grades 3, 5, 7, and 9 when the mean child age in the study sample was 8.5 ($SD = 0.31$), 10.5 ($SD = 0.31$), 12.4 ($SD = 0.35$), and 14.2 ($SD = 0.38$) years, respectively. At each grade, approximately 48% of participants were female,

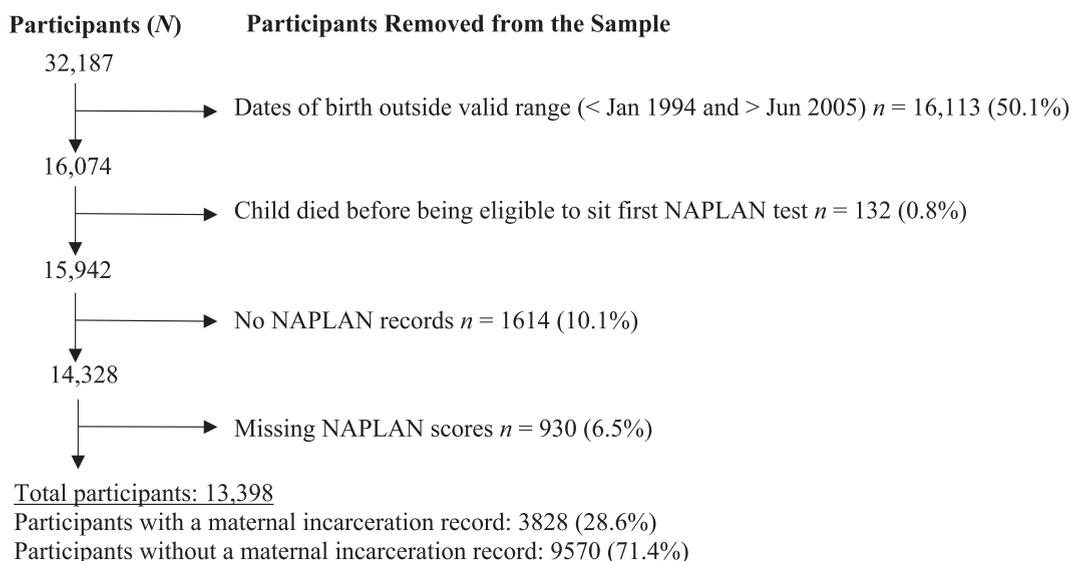


Fig. 1. Selection of Participants.

approximately 48% were Aboriginal and/or Torres Strait Islander, and approximately 46% lived in the most socioeconomically disadvantaged areas (see [Table 1](#) for detailed breakdown of child sex, Aboriginal status, and area-level socioeconomic status).

2.4. Outcome variables

Information on numeracy and reading attainment was sourced from the WA Department of Education as measured by the NAPLAN ([ACARA, 2019](#)). The outcome variables were numeracy and reading attainment during Grades 3, 5, 7, and/or 9. Attainment was based on scores on the NAPLAN numeracy and reading tests completed by students in government schools between 2008 and 2013. The school year in Australia runs from January to December; NAPLAN is conducted in schools over multiple days in May. During the study period, Grades 3, 5, and 7 were in elementary/primary school and Grade 9 was in secondary school.

NAPLAN scores were categorized into six achievement bands for each grade level and calendar year using the benchmark tables included in the annual NAPLAN reports ([ACARA, 2019](#)). For this study, NAPLAN scores on each test were further classified according to whether they fell within the bottom two bands (i.e., below average attainment), the middle two bands (i.e., average attainment), or the top two bands (i.e., above average attainment).

2.5. Exposure variables

Exposure variables included (a) maternal incarceration (sentenced or remand/pre-trial), sourced from the WA Department of Justice adult and juvenile custodial records; (b) child maltreatment notifications (substantiated or unsubstantiated) and out-of-home care placements, sourced from the WA Department of Communities Child Protection System; and (c) maternal mental illness (including substance use disorders), sourced from the Hospital Morbidity Data Collection (HMDC), the Emergency Department Data Collection (EDDC), and the Mental Health Information System (MHIS), provided by the WA Department of Health. The HMDC and EDDC contain records of all public and private hospital separations and emergency department presentations in WA, respectively. The MHIS contains records of all ambulatory mental health contacts in WA. EDDC data are available from 2002 onwards, but HMDC and MHIS data used in this study were from 1993 onwards. In all three data systems, diagnoses were coded using the International Classification of Diseases, 9th Edition (ICD-9 for years 1993–1998; [World Health Organization, 1990](#)) or 10th Edition, Australian Modification (ICD-10-AM for years 1999–2013; [National Centre for Classification in Health, 2004](#)). A full list of ICD-9 and ICD-10-AM codes used to identify maternal mental illness is provided in [Appendix A](#).

Exposure was defined as any record of maternal incarceration, maternal mental illness, and/or CPS contact recorded from 9 months prior to the child's month of birth (to cover pregnancy) until May 31 of the year in which the child sat for each NAPLAN test. Exposures during pregnancy were included given evidence of transmission of stress experiences between mother and fetus ([Dowell et al., 2019](#); [Lewinn et al., 2009](#); [Li et al., 2013](#)). There could be a maximum of four nested exposure periods per child, covering the period from "conception" to Grades 3, 5, 7, and 9. Children with test data at multiple grades were included in all relevant groups.

At each grade level, children were classified into one of five mutually exclusive and collectively exhaustive groups based on their history of exposures: (a) no exposures (i.e., reference group), (b) maternal incarceration alone, (c) maternal incarceration plus CPS contact, (d) maternal incarceration plus maternal mental illness, (e) maternal incarceration plus CPS contact and maternal mental illness, or (f) CPS contact and/or maternal mental illness (i.e., no maternal incarceration). These groups were created to permit identification of any differences in magnitude of effect on numeracy and reading attainment for children exposed to maternal incarceration alone versus children exposed to multiple adversities.

2.6. Covariates

In addition to the exposure variable of interest, we included several covariates in regression models to account for possible confounding. The definitions and data sources for these covariates are provided in [Appendix B](#). Covariates measured at the child's birth included sex (male/female), whether the child was Aboriginal and/or Torres Strait Islander (yes/no), geographic location of home address (metropolitan, regional, remote), area-based socioeconomic index for home address (in quintiles, from 1 = *most disadvantaged* to 5 = *least disadvantaged*), and mother's age. Aboriginal and/or Torres Strait Islander status was included as a proxy for the far-reaching impacts of racism, structural discrimination, intergenerational disadvantage, and trauma that Aboriginal and/or Torres Strait Islander people have experienced in Australia and that can significantly impede the educational progress of Aboriginal and/or Torres Strait Islander children ([Gray & Beresford, 2008](#)). Any associations found in this study between Aboriginal and/or Torres Strait Islander status and educational attainment should therefore be viewed as social rather than racial determinants. The socioeconomic index was obtained from the Index of Relative Social Disadvantage, calculated by the Australian Bureau of Statistics and derived from census information reflecting area-level income, education, and employment characteristics ([Australian Bureau of Statistics, 2011](#)).

Parent education level was also included as a covariate and was sourced from the NAPLAN dataset. This dataset does not specify the gender of the parent for whom education level is reported and does not require information to be recorded for both parents. When education level was reported for both 'Parent 1' and 'Parent 2', the overall highest education level of either parent was taken. Parent education level was measured at each grade (to account for changes in values over time) and was defined as the highest level of education (i.e., tertiary, vocational, or high school) reported for one or both parents.

Table 1
Descriptive Statistics for Children with and without Maternal Incarceration Exposure by Grade Level.

	Grade 3, N = 6161		Grade 5, N = 6836		Grade 7, N = 6415		Grade 9, N = 5826	
	No maternal incarceration, n = 4571 (74%)	Maternal incarceration, n = 1590 (26%)	No maternal incarceration, n = 5035 (74%)	Maternal incarceration, n = 1801 (26%)	No maternal incarceration, n = 4763 (74%)	Maternal incarceration, n = 1652 (26%)	No maternal incarceration, n = 4497 (77%)	Maternal incarceration, n = 1329 (23%)
<i>Sociodemographic factors</i>								
Non-Aboriginal*	2659 (58.2)	673 (42.3)	2984 (59.3)	762 (42.3)	2813 (59.1)	712 (43.1)	2790 (62.0)	646 (48.6)
Aboriginal	1912 (41.8)	917 (57.7)	2051 (40.7)	1039 (57.7)	1950 (40.9)	940 (56.9)	1707 (38.0)	683 (51.4)
Female*	2249 (49.2)	808 (50.8)	2399 (47.6)	888 (49.3)	2187 (45.9)	777 (47.0)	2081 (46.3)	645 (48.5)
Male	2322 (50.8)	782 (49.2)	2636 (52.4)	913 (50.7)	2576 (54.1)	875 (53.0)	2416 (53.7)	684 (51.5)
Year of birth	1998–2005		1996–2003		1995–2002		1992–1999	
Mother age ^a								
≤ 19 years	589 (12.9)	336 (21.1)	600 (11.9)	399 (22.1)	574 (12.1)	407 (24.6)	517 (11.5)	359 (27.0)
20–25 years	1350 (29.5)	614 (38.6)	1473 (29.3)	720 (40.0)	1446 (30.3)	705 (42.7)	1322 (29.4)	601 (45.2)
26–30 years*	1246 (27.3)	391 (24.6)	1413 (28.0)	441 (24.5)	1346 (28.3)	351 (21.3)	1344 (29.9)	237 (17.8)
≥ 31 years	1386 (30.3)	249 (15.7)	1549 (30.8)	241 (13.4)	1397 (29.3)	189 (11.4)	1314 (28.2)	132 (10.0)
Parent highest education level ^b								
University*	227 (5.0)	29 (1.8)	219 (4.3)	27 (1.5)	174 (3.6)	20 (1.2)	127 (2.8)	8 (0.6)
Vocational	806 (17.6)	164 (10.3)	854 (17.0)	170 (9.4)	666 (14.0)	141 (8.6)	524 (11.7)	95 (7.2)
High school	1275 (27.9)	576 (36.2)	1267 (25.2)	619 (34.4)	1095 (23.0)	559 (33.8)	889 (19.8)	388 (29.2)
Not reported	2263 (49.5)	821 (51.6)	2695 (53.5)	985 (54.7)	2828 (59.4)	932 (56.4)	2957 (65.7)	838 (63.0)
Geographic remoteness ^a								
Metropolitan*	2554 (55.9)	998 (62.8)	2729 (54.2)	1134 (63.0)	2537 (53.3)	1022 (61.9)	2478 (55.1)	815 (61.4)
Regional	1073 (23.5)	332 (20.9)	1216 (24.1)	369 (20.5)	1131 (23.7)	351 (21.2)	1068 (23.8)	307 (23.1)
Remote	942 (20.6)	259 (16.3)	1087 (21.6)	297 (16.5)	1093 (23.0)	279 (16.9)	948 (21.1)	206 (15.5)
Index of relative socioeconomic disadvantage (quintiles) ^a								
Most	1733 (37.9)	918 (57.8)	1871 (37.2)	1036 (57.6)	1703 (35.8)	928 (56.2)	1504 (33.5)	684 (51.5)
2	1066 (23.3)	327 (20.6)	1170 (23.3)	372 (20.7)	1120 (23.5)	378 (22.9)	1048 (23.3)	335 (25.2)
3	660 (14.5)	198 (12.4)	813 (16.2)	237 (13.2)	838 (17.6)	207 (12.5)	874 (19.5)	176 (13.3)
4	635 (13.9)	105 (6.6)	659 (13.1)	114 (6.3)	638 (13.4)	96 (5.8)	589 (13.1)	88 (6.6)
Least*	474 (10.4)	41 (2.6)	516 (10.2)	40 (2.2)	460 (9.7)	42 (2.6)	477 (10.6)	44 (3.4)
Other exposures ^b								
None*	3501 (76.6)	236 (14.8)	3850 (76.5)	258 (14.3)	3627 (76.1)	259 (15.7)	3501 (77.9)	238 (17.9)
CPS contact	443 (9.7)	517 (32.5)	460 (9.1)	557 (30.9)	441 (9.3)	465 (28.2)	363 (8.1)	344 (25.9)
Maternal mental illness	392 (8.6)	158 (10.0)	464 (9.2)	175 (9.7)	447 (9.4)	184 (11.1)	426 (9.5)	169 (12.7)
CPS contact & maternal mental illness	235 (5.1)	679 (42.7)	261 (5.2)	811 (45.0)	248 (5.2)	744 (45.0)	207 (4.6)	578 (43.5)

Note. CPS = Child Protective Services. Statistics reported are for all children with a reading and/or numeracy test score at each grade level. Children with test data at multiple grade levels are included in all relevant groups.

^a Measured at birth.

^b Measured May 31 of the year that the child sat for the Grade 3, Grade 5, Grade 7, or Grade 9 test.

* Reference group for logistic regressions.

2.7. Missing data

There was a high proportion of missing information for parent education level for children with and without exposure to maternal incarceration. Missing values for highest parent education level at Grades 5, 7, and 9 were imputed from non-missing values from previous grades (where available). Despite imputation, the proportion of missing information for parent education remained high, at an average of 56.7% across all grades. Additional missing values were thus coded as 'not reported' in regression models to estimate the effect of missing parent education (see [Table 1](#)).

2.8. Statistical methods

Descriptive statistics were generated for all study variables. Separate multivariate multinomial logistic regression models were constructed for each NAPLAN test at each grade level to examine the association between combinations of adversities and above/below average educational attainment. Average attainment was used as the reference group in all models. Results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). For brevity, only the fully adjusted models are presented. Unadjusted effect estimates are provided in [Appendix C](#). Analyses were conducted in SAS Version 9.4 ([SAS Institute Inc, 2016](#)).

3. Results

3.1. Descriptive statistics

3.1.1. Sociodemographic factors and adversity exposures

[Table 1](#) summarizes the sociodemographic factors and exposures for children with and without maternal incarceration exposure at each grade level. Data for children with either/both reading and numeracy tests were pooled to create summary statistics. At all grade levels and compared to children without maternal incarceration exposure, there were higher proportions of children with maternal incarceration exposure who were Aboriginal, were born to mothers aged 25 years or younger, and who lived in the most socioeconomically disadvantaged areas ([Table 1](#)). Of children without exposure to maternal incarceration, around 23% had been exposed to CPS contact and/or maternal mental illness; of children with exposure to maternal incarceration, around 85% had been exposed to CPS contact and/or maternal mental illness ([Table 1](#)).

3.1.2. Numeracy and reading outcomes

At all grade levels, there were higher proportions of below average numeracy attainment in the group of children exposed to maternal incarceration (range = 55.6% at Grade 3 to 65.5% at Grade 9) compared to the group of children without exposure to maternal incarceration (range = 35.1% at Grade 3 to 41.0% at Grade 5). Results were similar for reading attainment, with higher proportions of children exposed to maternal incarceration scoring below average (range = 56.9% at Grade 3 to 64.0% at Grade 9) compared to children unexposed to maternal incarceration (range = 36.7% at Grade 7 to 41.9% at Grade 9).

These patterns were mirrored for above average numeracy and reading attainment. There were lower proportions of above average reading and numeracy attainment at all grades in the group of children with maternal incarceration exposure (range = 2.8% at Grade 9 to 6.4% at Grade 3 for numeracy; range = 3.5% at Grade 9 to 9.4% at Grade 3 for reading) compared to the group of children without maternal incarceration exposure (range = 12.8% at Grade 5 to 17.5% at Grade 3 for numeracy; range = 12.7% at Grade 9 to 25.9% at Grade 3 for reading). A full table of results is provided in [Appendix D](#).

3.2. Multinomial logistic regressions

[Tables 2–5](#) present the adjusted ORs (aORs) for above and below average numeracy and reading attainment at Grades 3, 5, 7, and 9. For brevity, only the aORs for the adversity exposures are presented; the full table of results (including covariates) is provided in [Appendix E](#).

3.2.1. Below average attainment

At all grades (see [Tables 2–5](#)) and compared to children without exposure to any of the observed adversities, there were increased odds of below average reading and numeracy attainment for children exposed to maternal incarceration alone (range = 37%–86%). Increased odds of below average reading and below average numeracy attainment were also observed for children exposed to maternal incarceration plus CPS contact (range = 101%–150%), children exposed to maternal incarceration plus maternal mental illness (range = 62%–98%), and children exposed to all three adversities (range = 74%–118%). The only exception was for children exposed to maternal incarceration plus maternal mental illness on the Grade 3 reading test, where odds were elevated but did not reach statistical significance (aOR = 1.30, 95% CI [0.90, 1.88], $p = .169$; see [Table 2](#)). Children exposed to maternal mental illness and/or CPS contact (but not maternal incarceration) also had increased odds of below average reading and numeracy attainment at all grade levels (range = 35%–66%) compared to children without exposure to any of the observed adversities.

At all grades, effect estimates were considerably higher for children exposed to maternal incarceration plus CPS contact and for children exposed to all three adversities, compared to children exposed to maternal incarceration alone. Although many of the differences were not statistically significant, there was a clear pattern of these two groups having the highest odds of below average and numeracy attainment. The aORs for three of the tests were statistically significant: on the numeracy tests at Grade 3 and Grade 5 (see

Table 2
Predictors of Grade 3 Reading and Numeracy Attainment (Relative to Average Attainment).

	Numeracy				Reading			
	Below average		Above average		Below average		Above average	
<i>Exposures at baseline</i> ^a	aOR ^b [95% CI]	<i>p</i>						
None	REF		REF		REF		REF	
Maternal incarceration	1.41 [1.05, 1.90]	0.025	0.51 [0.29, 0.87]	0.014	1.59 [1.17, 2.18]	0.003	0.67 [0.43, 1.04]	0.071
+ CPS contact	2.35 [1.89, 2.93]	< 0.001	0.59 [0.39, 0.89]	0.012	2.01 [1.61, 2.50]	< 0.001	0.35 [0.24, 0.52]	< 0.001
+ maternal mental illness	1.92 [1.34, 2.76]	< 0.001	0.78 [0.42, 1.46]	0.440	1.30 [0.90, 1.88]	0.169	0.57 [0.33, 0.97]	0.039
+ CPS contact & maternal mental illness	1.98 [1.63, 2.39]	< 0.001	0.59 [0.41, 0.85]	0.004	1.74 [1.42, 2.11]	< 0.001	0.54 [0.40, 0.74]	< 0.001
CPS contact and/or maternal mental illness (no maternal incarceration)	1.60 [1.37, 1.88]	< 0.001	0.61 [0.46, 0.79]	< 0.001	1.38 [1.17, 1.62]	< 0.001	0.61 [0.49, 0.76]	< 0.001

Note. CPS = Child Protective Services; aOR = adjusted Odds Ratio; CI = Confidence Interval; REF = Reference Category. Results significant at $p < .05$ indicated in **bold**.

^a Measured May 31 of the year the child was in Grade 3.

^b Adjusted for child Aboriginal status, sex, and year of birth, maternal age, parent highest education level, geographic remoteness, and area-level socioeconomic disadvantage.

Table 3
Predictors of Grade 5 Reading and Numeracy Attainment (Relative to Average Attainment).

	Numeracy				Reading			
	Below average		Above average		Below average		Above average	
<i>Exposures at baseline</i> ^a	aOR ^b [95% CI]	<i>p</i>						
None	REF		REF		REF		REF	
Maternal incarceration	1.37 [1.02, 1.85]	0.036	0.49 [0.26, 0.91]	0.023	1.84 [1.36, 2.49]	<0.001	0.55 [0.33, 0.93]	0.026
+ CPS contact	2.35 [1.89, 2.92]	<0.001	0.41 [0.23, 0.72]	0.002	2.03 [1.63, 2.51]	<0.001	0.45 [0.29, 0.69]	<0.001
+ maternal mental illness	1.98 [1.38, 2.83]	<0.001	0.98 [0.51, 1.86]	0.945	1.93 [1.34, 2.78]	<0.001	1.01 [0.59, 1.73]	0.976
+ CPS contact & maternal mental illness	2.17 [1.80, 2.61]	<0.001	0.37 [0.23, 0.60]	<0.001	2.01 [1.67, 2.42]	<0.001	0.50 [0.35, 0.71]	<0.001
CPS contact and/or maternal mental illness (no maternal incarceration)	1.66 [1.42, 1.94]	<0.001	0.56 [0.41, 0.76]	<0.001	1.43 [1.22, 1.68]	<0.001	0.75 [0.59, 0.95]	0.017

Note. CPS = Child Protective Services; aOR = adjusted Odds Ratio; CI = Confidence Interval; REF = Reference Category. Results significant at $p < .05$ indicated in **bold**.

^a Measured May 31 of the year the child was in Grade 5.

^b Adjusted for child Aboriginal status, sex, and year of birth, maternal age, parent highest education level, geographic remoteness, and area-level socioeconomic disadvantage.

Table 4
Predictors of Grade 7 Reading and Numeracy Attainment (Relative to Average Attainment).

	Numeracy				Reading			
	Below average		Above average		Below average		Above average	
<i>Exposures at baseline</i> ^a	aOR ^b [95% CI]	<i>p</i>						
None	REF		REF		REF		REF	
Maternal incarceration	1.70 [1.26, 2.28]	0.001	0.49 [0.28, 0.85]	0.010	1.86 [1.38, 2.49]	<0.001	0.48 [0.27, 0.83]	0.009
+ CPS contact	2.41 [1.91, 3.04]	<0.001	0.31 [0.17, 0.56]	<0.001	2.50 [1.98, 3.17]	<0.001	0.36 [0.21, 0.62]	<0.001
+ maternal mental illness	1.62 [1.15, 2.28]	0.006	0.71 [0.39, 1.29]	0.265	1.86 [1.31, 2.65]	0.001	0.77 [0.43, 1.38]	0.384
+ CPS contact & maternal mental illness	2.18 [1.80, 2.64]	<0.001	0.56 [0.38, 0.82]	0.003	1.78 [1.47, 2.15]	<0.001	0.64 [0.46, 0.89]	0.009
CPS contact and/or maternal mental illness (no maternal incarceration)	1.42 [1.21, 1.67]	<0.001	0.68 [0.52, 0.89]	0.004	1.47 [1.25, 1.73]	<0.001	0.89 [0.70, 1.13]	0.320

Note. CPS = Child Protective Services; aOR = adjusted Odds Ratio; CI = Confidence Interval; REF = Reference Category. Results significant at $p < .05$ indicated in **bold**.

^a Measured May 31 of the year the child was in Grade 7.

^b Adjusted for child Aboriginal status, sex, and year of birth, maternal age, parent highest education level, geographic remoteness, and area-level socioeconomic disadvantage.

Table 5
Predictors of Grade 9 Reading and Numeracy Attainment (Relative to Average Attainment).

	Numeracy				Reading			
	Below average		Above average		Below average		Above average	
Exposures at baseline ^a	aOR ^b [95% CI]	<i>p</i>	aOR ^b [95% CI]	<i>p</i>	aOR ^b [95% CI]	<i>p</i>	aOR ^b [95% CI]	<i>p</i>
None	REF		REF		REF		REF	
Maternal incarceration	1.82 [1.31, 2.51]	< 0.001	0.56 [0.29, 1.08]	0.082	1.68 [1.23, 2.31]	0.001	0.40 [0.18, 0.87]	0.021
+ CPS contact	2.45 [1.86, 3.23]	< 0.001	0.18 [0.07, 0.49]	0.001	2.45 [1.85, 3.24]	< 0.001	0.28 [0.11, 0.70]	0.006
+ maternal mental illness	1.76 [1.23, 2.51]	0.002	0.13 [0.03, 0.55]	0.005	1.81 [1.25, 2.60]	0.002	0.27 [0.08, 0.88]	0.030
+ CPS contact & maternal mental illness	2.07 [1.66, 2.59]	< 0.001	0.45 [0.27, 0.77]	0.003	1.81 [1.45, 2.25]	< 0.001	0.83 [0.54, 1.27]	0.383
CPS contact and/or maternal mental illness (no maternal incarceration)	1.35 [1.13, 1.60]	0.001	0.67 [0.50, 0.91]	0.011	1.35 [1.14, 1.60]	0.001	0.74 [0.54, 1.01]	0.057

Note. CPS = Child Protective Services; aOR = adjusted Odds Ratio; CI = Confidence Interval; REF = Reference Category. Results significant at $p < .05$ indicated in **bold**.

^a Measured May 31 of the year the child was in Grade 9.

^b Adjusted for child Aboriginal status, sex, and year of birth, maternal age, parent highest education level, geographic remoteness, and area-level socioeconomic disadvantage.

Tables 2–3), children exposed to maternal incarceration plus CPS contact had greater odds of below average numeracy attainment (Grade 3 aOR = 2.35, 95% CI [1.89, 2.93]; Grade 5 aOR = 2.35, 95% CI [1.89, 2.92]) compared to children exposed to maternal incarceration alone (Grade 3 aOR = 1.41, 95% CI [1.05, 1.90]; Grade 5 aOR = 1.37, 95% CI [1.02, 1.85]), as evidenced by non-overlapping 95% CIs. Children with all three exposures also had greater odds of below average attainment on the Grade 5 numeracy test (aOR = 2.17, 95% CI [1.80, 2.61]) compared to children exposed to maternal incarceration alone (aOR = 1.37, 95% CI [1.02, 1.85]; see Table 3).

3.2.2. Above average attainment

Compared to children without exposure to any of the observed adversities, children exposed to maternal incarceration alone had decreased odds of above average reading attainment at Grades 5, 7, and 9 (range = 45%–60%) and decreased odds of above average numeracy attainment at Grades 3, 5, and 7 (range = 49%–51%; see Tables 2–5). Children exposed to maternal incarceration plus CPS contact had decreased odds of above average reading and numeracy attainment at all grade levels (range = 41%–82%). Children exposed to maternal incarceration plus CPS contact and maternal mental illness also had decreased odds of above average reading and numeracy attainment at all grade levels (range = 36%–63%), except for the Grade 9 reading test (aOR = 0.83, 95% CI [0.51, 1.27], $p = .383$). Children exposed to maternal incarceration plus maternal mental illness had decreased odds of above average numeracy attainment at Grade 9 (87%) and decreased odds of above average reading attainment at Grades 3 and 9 (43% and 73%, respectively; see Table 2 and Table 5). Children exposed to maternal mental illness and/or CPS contact (but not maternal incarceration) had decreased odds of above average numeracy attainment at all grades (range = 32%–44%) and decreased odds of above average reading attainment at Grade 3 and Grade 5 (39% and 25%, respectively). There was no evidence that children exposed to maternal incarceration plus CPS contact and/or maternal mental illness had lower or higher odds of above average reading or numeracy attainment compared to children exposed to maternal incarceration alone.

4. Discussion

This study examined the reading and numeracy attainment of children of incarcerated mothers at four different timepoints. We investigated adversity factors associated with above and below average educational attainment, relative to average attainment, determined from national standardized testing. We hypothesized that children exposed to maternal incarceration, maternal mental illness, and/or CPS contact would have poorer attainment than children with no recorded exposure to such adversities, when controlling for other explanatory factors. Results supported this hypothesis, with increased odds of below average reading and numeracy attainment at all grade levels for children exposed to any of the three adversities compared to those without a record of exposure. We also hypothesized that children exposed to maternal incarceration plus maternal mental illness and/or CPS contact would have poorer educational attainment compared to children exposed to maternal incarceration alone. Consistent with this hypothesis, there was a clear pattern suggesting that children exposed to maternal incarceration plus CPS contact and children exposed to all three adversities had poorer numeracy and reading attainment compared to children exposed to maternal incarceration alone. However, a number of these differences did not reach statistical significance, potentially due to statistical imprecision, so additional research with larger samples is needed to confirm our findings. In general, our results indicate that children exposed to maternal incarceration with or without exposure to other adversities are at increased risk of below average educational attainment in both elementary and secondary school. This risk appears to be elevated for children exposed to maternal incarceration plus other adversities.

We also investigated the association of adversity with above average educational attainment. In general, children exposed to any of the included adversities had reduced odds of above average attainment compared to children without records of exposure to the observed adversities. Other research has found that children exposed to adversity have a decreased likelihood of above average educational attainment (Laurens et al., 2020), suggesting that a range of adversity factors can constrain individual abilities to the extent that academic potential is not realized. However, it is possible that there is large variability in the educational success of children exposed to adversity that is not evident when looking at average effects. For example, variations in maternal incarceration history by frequency, duration, or type of crime may differentially impact children's educational attainment. Additionally, children with alternative supports available to them outside of the home that buffer against the effects of adversity may still experience positive outcomes (Bronfenbrenner & Morris, 2007). Limitations of our data (i.e., only a quarter of children had attainment scores at two or more time points) meant that we were unable to perform more sophisticated analytical techniques such as growth curve analysis. Such techniques can reveal variability in educational trajectories for children experiencing adversity and highlight possible promotive or protective factors (Gutman et al., 2003). Future research should consider investigating the educational trajectories of children of incarcerated mothers to establish whether there are some children who do well, despite the challenges they face.

4.1. Multiple adversity

Our findings are consistent with the substantial literature documenting educational disadvantage for children exposed to multiple adversities (Crouch et al., 2019; Gutman et al., 2003; Herbers et al., 2012; Lanza et al., 2010; Laurens et al., 2020; Tan et al., 2017). In our study, it was common for children of incarcerated mothers to be exposed to other adversities, as has been documented elsewhere (Giordano et al., 2019; Murphey & Cooper, 2015; Phillips et al., 2006; Poehlmann, 2005; Sheehan, 2010; Turney, 2018). This highlights the importance of accounting for the contribution of co-occurring adversities when conducting research with children exposed to maternal incarceration, which has been lacking from the literature in this area to date. Our findings also draw attention to the complex needs of children of incarcerated mothers that must be addressed when designing and delivering educational support programs for this group.

4.2. Implications

Children with incarcerated mothers who also experience other adversities would likely benefit from better access to multi-tiered, trauma-informed services to address their educational and psychosocial needs. The growing acknowledgement of the impact of exposure to childhood adversity has led to significant system-wide approaches to supporting children in educational settings both in Australia and internationally. However, to date there has not been a consistent framework adopted uniformly within Australia; rather, training is delivered by a range of different providers (Howard, 2019). In WA, there are currently no formal trauma-specific policies or programs in place for government schools. There are several Australian and international trauma-informed models available that could be drawn on, but few of these consider the particular challenges experienced by Aboriginal and/or Torres Strait Islander children (Miller & Berger, 2020). This will be an important consideration for developing programs to assist children exposed to maternal incarceration.

The implementation of trauma-informed practices in WA schools would require the involvement of all school staff (Thomas et al., 2019). Raising awareness in the school community of the difficulties that children of incarcerated mothers may experience, and how school staff can best support them, is an essential component (McCrickard & Flynn, 2015; Morgan et al., 2013). This should include acknowledgement of the different stressors children may experience before and during their mother's incarceration and post-release, including trauma, stigma, anxiety, homelessness, financial instability, and family separation (Arditti, 2012; Dallaire & Wilson, 2010; Geller & Franklin, 2014; Morgan et al., 2014; Nesmith & Ruhland, 2008; Roettger et al., 2019; Saunders & Barry, 2013). Previous research has found that when school staff are aware that a parent has been incarcerated, modifications to academic tasks and expectations can be made, relieving the pressure on affected children (McCrickard & Flynn, 2015).

Although a general understanding of the challenges that children of incarcerated parents may face is important, supports should be tailored to individual children based on their experiences, abilities, strengths, and existing support networks (McCrickard & Flynn, 2015; Morgan et al., 2013; Thomas et al., 2019; Warren et al., 2019). Multi-tiered, trauma-informed services provided in the school context can offer universal, group, and individual interventions based on children's needs (Ormiston et al., 2021; Reinbergs & Fefer, 2018; Thomas et al., 2019). Some families may not wish to disclose the mother's incarceration to school staff due to fear of stigma. In the absence of disclosure, universal social and emotional learning programs that are delivered to all children can lead to improved academic performance, social and emotional skills, and behavior (Mahoney et al., 2018). However, policies should be established regarding safeguards for family privacy to increase the likelihood that disclosure of parental incarceration will occur. Working with incarcerated mothers to build trust and subsequently gain permission to work with children will be important for providing targeted supports.

Group and individual interventions could be provided to children requiring more intensive support, provided either within school or by external organizations, depending on family preference (Lopez & Bhat, 2007; Warren et al., 2019). Regular and comprehensive consultation both within schools and between schools and external support providers is a necessary component of providing support to children experiencing adversity (Berger, 2019; Chafouleas et al., 2016). This would ideally involve confidential communication

between the relevant statutory agencies and school staff, with parental consent, to ensure schools can appropriately support affected children during the mother's imprisonment and beyond (McCrickard & Flynn, 2015). However, more research is needed on what services are most beneficial for students whose mothers have been incarcerated and whether disclosure of maternal incarceration is necessary for supports to be effective.

4.3. Mechanisms of risk transmission

Results were generally uniform across the four time points examined, suggesting that the mechanisms that underpin the observed associations are not specific to a particular developmental stage. These mechanisms are likely complex and multifactorial given the large range of adversities to which children with incarcerated mothers may be exposed. Our data do not permit analysis of these mechanisms, but previous research has found that children exposed to parental incarceration, maternal mental illness, and/or child maltreatment during early childhood are at increased risk of physical, social, emotional, communicative, and cognitive difficulties (Baker & Iruka, 2013; Bell et al., 2018a, 2018b, 2019; Kovan et al., 2014; Laurens et al., 2017). Poor educational attainment may therefore be a consequence of children with incarcerated mothers commencing school without the necessary foundation of skills and resources for academic success. Furthermore, teacher-student relationships significantly predict children's educational trajectories (Burchinal et al., 2002; McCormick et al., 2013), as do peer relationships and social acceptance (Ladd et al., 1997; Schwartz et al., 2005; Wentzel et al., 2018, 2021; Woodward & Ferguson, 2000). However, children with incarcerated parents and other adversities may experience stigma from peers and teachers (Comfort, 2007; Dallaire et al., 2010; McCrickard & Flynn, 2015; Nesmith & Ruhland, 2008; Wildeman et al., 2017), troubled peer relationships (Bocknek et al., 2009), and social isolation or exclusion (Anthonysamy & Zimmer-Gembeck, 2007; Besemer & Dennison, 2019; Bocknek et al., 2009; Bolger & Patterson, 2001; Graham et al., 2010). Difficulties in peer and teacher relationships at school may therefore contribute to poorer educational attainment for children with incarcerated mothers. The stressors associated with parental incarceration can also negatively affect a child's ability to concentrate in class and therefore reduce their engagement in learning (McCrickard & Flynn, 2015). There is a need for detailed research on the mechanisms of risk transmission as they relate to maternal incarceration and child outcomes (Poehlmann-Tynan & Turney, 2021). It would also be of interest to examine whether outcomes are moderated by gender of child given evidence of differences in educational attainment and transmission of maternal risk between boys and girls (Jahanshahi et al., 2023; Voyer & Voyer, 2014). Such information could guide the development of appropriate support programs tailored to individual children's needs.

4.4. Aboriginal and/or Torres Strait Islander children

Due to the sampling methodology employed for our study, both our exposed and comparison groups had higher proportions of Aboriginal and/or Torres Strait Islander children than the overall WA population (~56% of exposed and ~43% of comparison groups were Aboriginal and/or Torres Strait Islander, versus ~6% of the overall population of WA children and young people) (Australian Bureau of Statistics, 2011a). Our findings must therefore be understood within the context of the significant structural challenges experienced by Aboriginal and/or Torres Strait Islander people in both the education and criminal justice systems in Australia. The suitability of NAPLAN for assessing the educational attainment of Aboriginal and/or Torres Strait Islander children has previously been questioned given the construction of the tests in written English and a focus on non-Indigenous cultural concepts (Angelo, 2013; Macqueen et al., 2019; Wigglesworth et al., 2011). However, the NAPLAN tests are still useful for identifying group-level average effects at each grade; these findings can inform teaching and learning practices that are relevant to children who share similar characteristics with our exposure groups (Wu, 2015). It is critical that educational support programs for Aboriginal and/or Torres Strait Islander children with incarcerated mothers include Aboriginal and/or Torres Strait Islander community-led, -designed, and -implemented services that are culturally and linguistically appropriate and that acknowledge structural barriers to educational progress (Miller & Berger, 2020; Roettger et al., 2019; Thomas et al., 2019). These services could be integrated with Western trauma-informed models and would ideally incorporate support for the individual, their family and kinship systems, and their community (Dobia & Rourke, 2011; Miller & Berger, 2020; Milroy, 2014). Some such interventions currently exist, but evaluation of efficacy is required (Miller & Berger, 2020).

4.5. Strengths and limitations

Strengths of our study include the use of population-level administrative data on all mothers in WA who had been incarcerated during the study period. Genealogical linkage enabled the evaluation of the educational attainment of their children. This methodology maintains participant anonymity and limits the potential for sample and reporting bias (Eddy et al., 2001; Geller et al., 2016). The use of statutory multi-agency records enabled complete coverage and permitted the analysis of associations between multiple adversities and educational attainment at multiple time points.

There are some inherent limitations associated with the use of administrative data for research. Although we attempted to address issues of unobserved heterogeneity through inclusion of data on multiple adversities, there are likely to be additional unmeasured variables influencing the association between adversities and educational attainment that were not included due to lack of available

data. These variables may include family (rather than area-level) socioeconomic status, school-level characteristics, and other adversities children may have experienced, such as homelessness and domestic violence. We were also unable to determine if children were living with their mothers prior to or after her incarceration, and findings for children who do and do not normally reside with their mothers may differ (Johnson & Waldfogel, 2004). As stated in the Method, we only had NAPLAN data for children attending government schools and we do not know if our findings would be replicated with students in non-government schools. Furthermore, our data on some of the exposures were incomplete: we did not have mental health data from private psychiatrists/psychologists or general practitioners, and we only had data on maltreatment notifications, which may not capture all children experiencing maltreatment. However, despite the likely underestimation of maternal mental illness and child maltreatment, we found evidence of strong associations between these exposures and educational attainment. These associations would likely be larger if we were able to identify all exposures, so our estimates are conservative. Lastly, 6.5% of the sample did not have NAPLAN test data despite being eligible to sit the test; 50% of these children had been exposed to maternal incarceration, and the majority had other characteristics suggesting a high exposure to socioeconomic disadvantage. Other research has found that children who do not participate in NAPLAN testing are more likely to have experienced adversity (Wong et al., 2017). The omission of these children from our models may have resulted in an underestimate of the magnitude of effect between exposure to maternal incarceration and educational attainment.

5. Conclusions

This study found that children exposed to maternal incarceration with or without exposure to other adversities are at increased risk of below average educational attainment in both elementary and secondary school. These children are also less likely to achieve above average educational attainment. Our results reinforce the importance of considering the complex challenges that children of incarcerated mothers may experience and how this may impact their educational attainment. Multi-tiered systems of support within the education sector as well as the broader human services sector are needed to ensure that these children are given the best opportunities for educational success.

Ethics approval and data availability

Ethics approval for this study was granted by the WA Department of Health Human Research Ethics Committee (2013/72), the University of Western Australia Human Research Ethics Committee (RA/4/1/8111), the University of South Australia Human Research Ethics Committee (0000032609), and the WA Aboriginal Health Ethics Committee (543). Participant consent was not required for this study as permitted under national and state-based privacy legislation relating to secondary use of data for monitoring and research (National Health and Medical Research Council, 2000). The processes by which de-identified data are provided for research in WA ensure confidentiality and ethical practice by conserving the privacy of individuals whose data have been linked (Brook et al., 2008). Data used in this study are not available for sharing due to privacy and ethical reasons. Other researchers may apply to access these data following the usual application processes to the WA Data Linkage Branch, the WA Department of Health Human Research Ethics Committee, and the relevant data custodians. The authors can provide the parameters for the data application upon request.

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Declaration of Competing Interest

None.

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Appendix A. Codes for identifying diagnoses of maternal mental illness and substance use disorders

Table A1

International Classification of Diseases 9th Edition (ICD-9) and 10th Edition, Australian *Modification (ICD-10-AM)* codes used in this study to identify diagnoses of maternal mental illness and substance use disorders.

Major Diagnostic Category	ICD-9 Codes	ICD-10-AM Codes
Organic disorders	290,293, 294, 310	F00-F09
Substance use disorders	291, 292, 303.9, 304, 305.1–305.7	F10-F19
Psychotic disorders	295, 297, 298	F20-F29
Mood disorders	296, 301.13, 309.1, 311, 300.4	F30-F39
Anxiety disorders	300, 300.0–300.3, 300.5–300.9, 306, 307.54, 307.8, 308, 309, 309.0, 309.2, 309.22–309.24, 309.28, 309.29, 309.8, 309.80–309.82, 309.9	F40-F49
Behavioral syndromes	302.7, 307.1, 307.4, 307.5, 307.50, 307.51, 307.53, 305.8, 305.9, 316	F50-F59
Personality disorders	301.0, 301.1, 301.10–301.12, 301.2–301.9, 302.0–302.6, 302.8, 302.9, 312.3	F60-F69
Developmental disorders	299, 315	F80-F89
Childhood disorders	307, 307.0, 307.2, 307.3, 307.52, 307.59, 307.6, 307.7, 307.9, 309.21, 309.83, 313, 314, 312.0–312.2, 312.4, 312.8, 312.9	F90-F98
Unspecified		F99

Note. Records sourced from the Hospital Morbidity Data System, the Emergency Department Data Collection, and the Mental Health Information System. ICD-9 codes used for records dated 1994–1998; ICD-10-AM codes used for records dated 1999–2013.

Appendix B. Definitions of and Data Sources for Variables Included in Multivariate Models

Table B1

Variable	Definition	Data Source (Custodian)
<i>Covariates</i>		
Child sex	Child's sex as recorded at birth – male or female	<ul style="list-style-type: none"> Midwives Notification System (Western Australian Department of Health) Birth Registration (Register of Births, Deaths, and Marriages)
Aboriginal and/or Torres Strait Islander status	Whether the child was identified as Aboriginal and/or Torres Strait Islander at birth, as reported by parents (Birth Registration) or attending midwives (Midwives record)	<ul style="list-style-type: none"> Midwives Notification System (Western Australian Department of Health) Birth Registration (Register of Births, Deaths, and Marriages)
Maternal age at child's birth	Mother's age at the birth of the cohort child	<ul style="list-style-type: none"> Midwives Notification System (Western Australian Department of Health) Birth Registration (Register of Births, Deaths, and Marriages)
Geographic location of home address at birth	<i>Metropolitan, regional, remote.</i> The Australian Standard Geographical Classification classifies a geographical area as metropolitan, inner/outer regional, or remote/very remote, based on access to goods, services, and opportunities for social interaction in an area.	<ul style="list-style-type: none"> Midwives Notification System (Western Australian Department of Health) Australian Standard Geographical Classification - Australian Bureau of Statistics
Area-based socioeconomic index for home address at birth	Quintile of socioeconomic disadvantage based on the Index of Relative Socioeconomic Disadvantage (IRSD). The IRSD is derived from census information that reflects area-level disadvantage such as low income, low educational attainment, high unemployment, and jobs in relatively unskilled occupations. The IRSD was converted into quintiles, with lower quintiles representing greater disadvantage (i.e., 1 = <i>most disadvantaged</i> to 5 = <i>least disadvantaged</i>)	<ul style="list-style-type: none"> Midwives Notification System (Western Australian Department of Health) Index of Relative Socioeconomic Disadvantage - Australian Bureau of Statistics
Highest parent education level	Recorded as highest education level (high school, vocational, tertiary) achieved by Parent 1 and/or Parent 2. Sex of parent is not specified.	<ul style="list-style-type: none"> National Assessment Program – Literacy and Numeracy (Western Australian Department of Education)

Appendix C. Unadjusted logistic regressions

Table C1
Predictors of Grade 3 Reading and Numeracy Attainment (Relative to Average Attainment).

	Numeracy				Reading			
	Below average		Above average		Below average		Above average	
	uOR [95% CI]	<i>p</i>						
<i>Exposures at baseline</i> ^b								
None	REF		REF		REF		REF	
Maternal incarceration	1.70 [1.28, 2.25]	< 0.001	0.37 [0.22, 0.63]	< 0.001	1.79 [1.33, 2.40]	< 0.001	0.48 [0.31, 0.73]	< 0.001
+ CPS contact	2.83 [2.31, 3.47]	< 0.001	0.42 [0.28, 0.63]	< 0.001	2.18 [1.77, 2.67]	< 0.001	0.26 [0.18, 0.38]	< 0.001
+ maternal mental illness	2.26 [1.60, 3.18]	< 0.001	0.52 [0.28, 0.95]	0.034	1.45 [1.02, 2.06]	0.037	0.40 [0.24, 0.68]	< 0.001
+ CPS contact & maternal mental illness	2.47 [2.06, 2.95]	< 0.001	0.39 [0.27, 0.55]	< 0.001	1.99 [1.65, 2.39]	< 0.001	0.36 [0.27, 0.48]	< 0.001
CPS contact and/or maternal mental illness (no maternal incarceration)	2.11 [1.82, 2.45]	< 0.001	0.42 [0.32, 0.55]	< 0.001	1.71 [1.47, 2.00]	< 0.001	0.43 [0.35, 0.54]	< 0.001
<i>Sociodemographic factors</i>								
Non-Aboriginal	REF		REF		REF		REF	
Aboriginal	3.82 [3.40, 4.30]	< 0.001	0.29 [0.23, 0.35]	< 0.001	3.12 [2.77, 3.51]	< 0.001	0.26 [0.22, 0.31]	< 0.001
Female	REF		REF		REF		REF	
Male	1.21 [1.08, 1.35]	< 0.001	1.33 [1.14, 1.55]	< 0.001	1.41 [1.25, 1.58]	< 0.001	0.87 [0.76, 1.00]	0.054
Year of birth	1.02 [0.99, 1.05]	0.253	0.99 [0.94, 1.03]	0.504	0.97 [0.94, 1.01]	0.122	1.00 [0.96, 1.04]	0.939
<i>Mother age</i> ^a								
≤ 19 years	2.55 [2.13, 3.06]	< 0.001	0.30 [0.22, 0.41]	< 0.001	2.00 [1.66, 2.41]	< 0.001	0.29 [0.23, 0.38]	< 0.001
20–25 years	1.87 [1.61, 2.17]	< 0.001	0.35 [0.28, 0.43]	< 0.001	1.66 [1.42, 1.94]	< 0.001	0.38 [0.32, 0.46]	< 0.001
26–30 years	1.39 [1.19, 1.63]	< 0.001	0.70 [0.58, 0.84]	< 0.001	1.08 [0.91, 1.27]	0.382	0.59 [0.50, 0.70]	< 0.001
≥ 31 years +	REF		REF		REF		REF	
<i>Parent highest education level</i> ^b								
University	REF		REF		REF		REF	
Vocational	1.66 [1.11, 2.48]	0.013	0.37 [0.27, 0.50]	< 0.001	1.26 [0.84, 1.89]	0.274	0.38 [0.27, 0.52]	< 0.001
High school	3.00 [2.04, 4.40]	< 0.001	0.25 [0.18, 0.34]	< 0.001	2.43 [1.64, 3.60]	< 0.001	0.22 [0.16, 0.31]	< 0.001
Not reported	2.99 [2.04, 4.37]	< 0.001	0.33 [0.25, 0.45]	< 0.001	2.49 [1.69, 3.67]	< 0.001	0.34 [0.25, 0.46]	< 0.001
<i>Geographic remoteness</i> ^a								
Metropolitan	REF		REF		REF		REF	
Regional	1.29 [1.12, 1.47]	< 0.001	0.66 [0.55, 0.80]	< 0.001	1.40 [1.22, 1.62]	< 0.001	0.69 [0.58, 0.82]	< 0.001
Remote	2.96 [2.55, 3.43]	< 0.001	0.42 [0.32, 0.56]	< 0.001	2.92 [2.50, 3.40]	< 0.001	0.43 [0.34, 0.55]	< 0.001
<i>Index of relative socioeconomic disadvantage</i> ^a								
Most disadvantaged	5.52 [4.17, 7.31]	< 0.001	0.27 [0.21, 0.35]	< 0.001	4.42 [3.34, 5.85]	< 0.001	0.26 [0.20, 0.32]	< 0.001
2	2.95 [2.20, 3.95]	< 0.001	0.39 [0.30, 0.50]	< 0.001	2.93 [2.19, 3.93]	< 0.001	0.47 [0.37, 0.60]	< 0.001
3	2.77 [2.04, 3.77]	< 0.001	0.52 [0.40, 0.68]	< 0.001	2.38 [1.75, 3.25]	< 0.001	0.54 [0.42, 0.70]	< 0.001
4	1.79 [1.30, 2.48]	< 0.001	0.70 [0.54, 0.91]	0.008	1.59 [1.15, 2.20]	0.006	0.74 [0.58, 0.95]	0.020
Least disadvantaged	REF		REF		REF		REF	

Note. CPS = Child Protective Services; uOR = Unadjusted Odds Ratio; CI = Confidence Interval; REF = Reference Category. Results significant at $p < .05$ indicated in **bold**.

^a Measured at birth.

^b Measured May 31 of the year the child was in Grade 3.

Table C2

Predictors of Grade 5 Reading and Numeracy Attainment (Relative to Average Attainment).

	Numeracy				Reading			
	Below average		Above average		Below average		Above average	
	uOR [95% CI]	<i>p</i>	uOR [95% CI]	<i>p</i>	uOR [95% CI]	<i>p</i>	uOR [95% CI]	<i>p</i>
<i>Exposures at baseline</i> ^b								
None	REF		REF		REF		REF	
Maternal incarceration	1.70 [1.30, 2.23]	< 0.001	0.37 [0.20, 0.67]	0.001	2.19 [1.66, 2.88]	< 0.001	0.43 [0.26, 0.71]	0.001
+ CPS contact	2.94 [2.41, 3.58]	< 0.001	0.27 [0.16, 0.47]	< 0.001	2.52 [2.07, 3.06]	< 0.001	0.31 [0.21, 0.48]	< 0.001
+ maternal mental illness	2.37 [1.70, 3.29]	< 0.001	0.65 [0.35, 1.22]	0.182	2.25 [1.60, 3.15]	< 0.001	0.70 [0.41, 1.18]	0.177
+ CPS contact & maternal mental illness	2.82 [2.39, 3.34]	< 0.001	0.25 [0.15, 0.40]	< 0.001	2.50 [2.11, 2.96]	< 0.001	0.34 [0.24, 0.48]	< 0.001
CPS contact and/or maternal mental illness (no maternal incarceration)	2.35 [2.04, 2.70]	< 0.001	0.40 [0.30, 0.54]	< 0.001	2.02 [1.75, 2.33]	< 0.001	0.55 [0.44, 0.70]	< 0.001
<i>Sociodemographic factors</i>								
Non-Aboriginal	REF		REF		REF		REF	
Aboriginal	5.65 [5.05, 6.31]	< 0.001	0.30 [0.23, 0.40]	< 0.001	5.04 [4.51, 5.65]	< 0.001	0.38 [0.31, 0.46]	< 0.001
Female	REF		REF		REF		REF	
Male	0.94 [0.85, 1.04]	0.204	1.47 [1.24, 1.74]	< 0.001	1.21 [1.09, 1.34]	< 0.001	0.94 [0.81, 1.08]	0.358
Year of birth	0.98 [0.95, 1.00]	0.097	1.01 [0.96, 1.06]	0.715	0.92 [0.89, 0.94]	< 0.001	0.98 [0.94, 1.02]	0.257
Mother age ^a								
≤ 19 years	3.12 [2.63, 3.72]	< 0.001	0.43 [0.31, 0.60]	< 0.001	2.52 [2.11, 3.00]	< 0.001	0.31 [0.23, 0.42]	< 0.001
20–25 years	2.21 [1.93, 2.54]	< 0.001	0.43 [0.34, 0.53]	< 0.001	2.05 [1.78, 2.36]	< 0.001	0.45 [0.37, 0.54]	< 0.001
26–30 years	1.55 [1.34, 1.79]	< 0.001	0.75 [0.62, 0.92]	0.005	1.37 [1.18, 1.59]	< 0.001	0.64 [0.53, 0.76]	< 0.001
≥ 31 years	REF		REF		REF		REF	
Parent highest education level ^b								
University	REF		REF		REF		REF	
Vocational	1.41 [0.99, 2.00]	0.054	0.46 [0.33, 0.66]	< 0.001	1.18 [0.82, 1.71]	0.372	0.34 [0.25, 0.48]	< 0.001
High school	2.83 [2.02, 3.96]	< 0.001	0.23 [0.16, 0.32]	< 0.001	2.16 [1.51, 3.08]	< 0.001	0.22 [0.16, 0.30]	< 0.001
Not reported	2.81 [2.02, 3.92]	< 0.001	0.47 [0.34, 0.64]	< 0.001	2.35 [1.66, 3.32]	< 0.001	0.39 [0.29, 0.53]	< 0.001
Geographic remoteness ^a								
Metropolitan	REF		REF		REF		REF	
Regional	1.40 [1.24, 1.59]	< 0.001	0.59 [0.47, 0.74]	< 0.001	1.38 [1.21, 1.56]	< 0.001	0.71 [0.59, 0.85]	< 0.001
Remote	3.97 [3.43, 4.60]	< 0.001	0.69 [0.52, 0.93]	0.015	3.57 [3.08, 4.13]	< 0.001	0.65 [0.51, 0.84]	< 0.001
Index of relative socioeconomic disadvantage ^a								
Most disadvantaged	6.62 [5.10, 8.59]	< 0.001	0.20 [0.15, 0.26]	< 0.001	7.02 [5.37, 9.18]	< 0.001	0.30 [0.24, 0.39]	< 0.001
2	3.70 [2.82, 4.84]	< 0.001	0.30 [0.23, 0.39]	< 0.001	3.92 [2.97, 5.18]	< 0.001	0.45 [0.36, 0.57]	< 0.001
3	2.36 [1.78, 3.12]	< 0.001	0.32 [0.24, 0.42]	< 0.001	2.97 [2.22, 3.97]	< 0.001	0.62 [0.49, 0.79]	< 0.001
4	1.93 [1.43, 2.60]	< 0.001	0.52 [0.39, 0.67]	< 0.001	2.02 [1.48, 2.74]	< 0.001	0.68 [0.53, 0.88]	0.003
Least disadvantaged	REF		REF		REF		REF	

Note. CPS = Child Protective Services; uOR = Unadjusted Odds Ratio; CI = Confidence Interval; REF = Reference Category. Results significant at $p < .05$ indicated in **bold**.

^a Measured at birth.

^b Measured May 31 of the year the child was in Grade 5.

Table C3
Predictors of Grade 7 Reading and Numeracy Attainment (Relative to Average Attainment).

	Numeracy				Reading			
	Below average		Above average		Below average		Above average	
	uOR [95% CI]	<i>p</i>	uOR [95% CI]	<i>p</i>	uOR [95% CI]	<i>p</i>	uOR [95% CI]	<i>p</i>
<i>Exposures at baseline^b</i>								
None	REF		REF		REF		REF	
Maternal incarceration	1.95 [1.49, 2.55]	< 0.001	0.37 [0.22, 0.64]	< 0.001	2.13 [1.63, 2.78]	< 0.001	0.35 [0.20, 0.61]	< 0.001
+ CPS contact	2.89 [2.34, 3.57]	< 0.001	0.19 [0.11, 0.35]	< 0.001	3.02 [2.44, 3.74]	< 0.001	0.24 [0.14, 0.42]	< 0.001
+ maternal mental illness	1.96 [1.43, 2.67]	< 0.001	0.45 [0.25, 0.81]	0.007	2.25 [1.63, 3.09]	< 0.001	0.53 [0.30, 0.93]	0.026
+ CPS contact & maternal mental illness	2.84 [2.39, 3.38]	< 0.001	0.35 [0.24, 0.51]	< 0.001	2.37 [2.00, 2.81]	< 0.001	0.35 [0.20, 0.61]	< 0.001
CPS contact and/or maternal mental illness (no maternal incarceration)	2.08 [1.80, 2.41]	< 0.001	0.46 [0.36, 0.60]	< 0.001	2.18 [1.88, 2.52]	< 0.001	0.63 [0.50, 0.79]	< 0.001
<i>Sociodemographic factors</i>								
Non-Aboriginal	REF		REF		REF		REF	
Aboriginal	5.31 [4.73, 5.97]	< 0.001	0.24 [0.19, 0.31]	< 0.001	5.16 [4.60, 5.80]	< 0.001	0.30 [0.24, 0.37]	< 0.001
Female	REF		REF		REF		REF	
Male	1.09 [0.98, 1.21]	0.116	1.51 [1.29, 1.77]	< 0.001	1.33 [1.20, 1.49]	< 0.001	0.98 [0.84, 1.14]	0.791
Year of birth	0.97 [0.94, 1.00]	0.066	1.01 [0.96, 1.06]	0.650	0.93 [0.90, 0.96]	< 0.001	0.99 [0.95, 1.04]	0.695
Mother age ^a								
≤ 19 years	2.81 [2.34, 3.36]	< 0.001	0.26 [0.19, 0.36]	< 0.001	3.23 [2.70, 3.88]	< 0.001	0.34 [0.25, 0.47]	< 0.001
20–25 years	2.08 [1.79, 2.42]	< 0.001	0.38 [0.31, 0.47]	< 0.001	2.06 [1.77, 2.39]	< 0.001	0.45 [0.37, 0.54]	< 0.001
26–30 years	1.41 [1.21, 1.66]	< 0.001	0.64 [0.53, 0.77]	< 0.001	1.35 [1.15, 1.58]	< 0.001	0.68 [0.56, 0.81]	< 0.001
≥ 31 years	REF		REF		REF		REF	
Parent highest education level ^b								
University	REF		REF		REF		REF	
Vocational	1.19 [0.78, 1.81]	0.427	0.39 [0.27, 0.56]	< 0.001	0.99 [0.65, 1.50]	0.950	0.29 [0.20, 0.42]	< 0.001
High school	2.38 [1.59, 3.55]	< 0.001	0.18 [0.13, 0.26]	< 0.001	2.04 [1.37, 3.03]	< 0.001	0.19 [0.13, 0.27]	< 0.001
Not reported	2.33 [1.57, 3.46]	< 0.001	0.41 [0.29, 0.57]	< 0.001	1.95 [1.32, 2.89]	< 0.001	0.34 [0.25, 0.48]	< 0.001
Geographic remoteness ^a								
Metropolitan	REF		REF		REF		REF	
Regional	1.30 [1.14, 1.49]	< 0.001	0.62 [0.51, 0.75]	< 0.001	1.46 [1.28, 1.67]	< 0.001	0.79 [0.66, 0.95]	0.011
Remote	3.82 [3.31, 4.42]	< 0.001	0.56 [0.43, 0.74]	< 0.001	3.45 [2.99, 3.97]	< 0.001	0.55 [0.42, 0.71]	< 0.001
Index of relative socioeconomic disadvantage ^a								
Most disadvantaged	7.81 [5.74, 10.62]	< 0.001	0.22 [0.17, 0.29]	< 0.001	6.99 [5.21, 9.38]	< 0.001	0.26 [0.20, 0.33]	< 0.001
2	4.21 [3.07, 5.78]	< 0.001	0.36 [0.28, 0.45]	< 0.001	3.77 [2.78, 5.09]	< 0.001	0.41 [0.32, 0.53]	< 0.001
3	3.09 [2.23, 4.28]	< 0.001	0.43 [0.33, 0.55]	< 0.001	2.78 [2.03, 3.80]	< 0.001	0.50 [0.39, 0.64]	< 0.001
4	1.94 [1.37, 2.74]	< 0.001	0.53 [0.41, 0.69]	< 0.001	1.69 [1.21, 2.37]	< 0.001	0.62 [0.48, 0.80]	0.002
Least disadvantaged	REF		REF		REF		REF	

Note. CPS = Child Protective Services; uOR = Unadjusted Odds Ratio; CI = Confidence Interval; REF = Reference Category. Results significant at $p < .05$ indicated in **bold**.

^a Measured at birth.

^b Measured May 31 of the year the child was in Grade 7.

Table C4
Predictors of Grade 9 Reading and Numeracy Attainment (Relative to Average Attainment).

	Numeracy				Reading			
	Below average		Above average		Below average		Above average	
	uOR [95% CI]	<i>p</i>	uOR [95% CI]	<i>p</i>	uOR [95% CI]	<i>p</i>	uOR [95% CI]	<i>p</i>
<i>Exposures at baseline^b</i>								
None	REF		REF		REF		REF	
Maternal incarceration	2.21 [1.65, 2.97]	< 0.001	0.40 [0.21, 0.75]	0.004	2.10 [1.58, 2.80]	< 0.001	0.29 [0.13, 0.63]	0.002
+ CPS contact	3.09 [2.40, 3.98]	< 0.001	0.12 [0.04, 0.32]	< 0.001	3.13 [2.41, 4.04]	< 0.001	0.19 [0.08, 0.46]	< 0.001
+ maternal mental illness	2.20 [1.59, 3.05]	< 0.001	0.09 [0.02, 0.37]	< 0.001	2.44 [1.74, 3.43]	< 0.001	0.18 [0.06, 0.59]	0.004
+ CPS contact & maternal mental illness	2.85 [2.33, 3.48]	< 0.001	0.29 [0.17, 0.48]	< 0.001	2.50 [2.05, 3.04]	< 0.001	0.54 [0.36, 0.81]	0.003
CPS contact and/or maternal mental illness (no maternal incarceration)	2.12 [1.81, 2.48]	< 0.001	0.48 [0.36, 0.65]	< 0.001	2.14 [1.84, 2.50]	< 0.001	0.54 [0.40, 0.73]	< 0.001
<i>Sociodemographic factors</i>								
Non-Aboriginal	REF		REF		REF		REF	
Aboriginal	5.60 [4.94, 6.35]	< 0.001	0.24 [0.18, 0.33]	< 0.001	5.25 [4.64, 5.94]	< 0.001	0.29 [0.22, 0.40]	< 0.001
Female	REF		REF		REF		REF	
Male	0.93 [0.83, 1.04]	0.180	1.37 [1.15, 1.63]	< 0.001	1.28 [1.15, 1.43]	< 0.001	0.89 [0.74, 1.06]	0.184
Year of birth	0.99 [0.95, 1.02]	0.393	1.11 [1.05, 1.17]	< 0.001	0.94 [0.90, 0.97]	< 0.001	1.01 [0.96, 1.07]	0.685
<i>Mother age^a</i>								
≤ 19 years	3.63 [2.99, 4.41]	< 0.001	0.24 [0.16, 0.37]	< 0.001	3.74 [3.08, 4.53]	< 0.001	0.34 [0.23, 0.50]	< 0.001
20–25 years	2.05 [1.75, 2.39]	< 0.001	0.33 [0.26, 0.42]	< 0.001	2.49 [2.13, 2.90]	< 0.001	0.40 [0.31, 0.51]	< 0.001
26–30 years	1.37 [1.17, 1.62]	< 0.001	0.72 [0.59, 0.88]	0.001	1.45 [1.24, 1.71]	< 0.001	0.65 [0.53, 0.81]	< 0.001
≥ 31 years	REF		REF		REF		REF	
<i>Parent highest education level^b</i>								
University	REF		REF		REF		REF	
Vocational	1.09 [0.69, 1.73]	0.715	0.34 [0.21, 0.55]	< 0.001	1.06 [0.67, 1.66]	0.815	0.32 [0.20, 0.51]	< 0.001
High school	1.77 [1.14, 2.76]	0.012	0.19 [0.12, 0.30]	< 0.001	1.74 [1.13, 2.68]	0.012	0.16 [0.10, 0.25]	< 0.001
Not reported	1.32 [0.86, 2.04]	0.204	0.32 [0.21, 0.49]	< 0.001	1.33 [0.87, 2.02]	0.189	0.32 [0.21, 0.48]	< 0.001
<i>Geographic remoteness^a</i>								
Metropolitan	REF		REF		REF		REF	
Regional	1.35 [1.18, 1.55]	< 0.001	0.74 [0.60, 0.92]	0.006	1.28 [1.12, 1.47]	< 0.001	0.74 [0.60, 0.93]	0.009
Remote	3.24 [2.76, 3.79]	< 0.001	0.54 [0.39, 0.74]	< 0.001	3.17 [2.71, 3.70]	< 0.001	0.48 [0.34, 0.67]	< 0.001
<i>Index of relative socioeconomic disadvantage^a</i>								
Most disadvantaged	7.18 [5.48, 9.42]	< 0.001	0.25 [0.19, 0.33]	< 0.001	7.91 [6.02, 10.37]	< 0.001	0.28 [0.21, 0.37]	< 0.001
2	3.85 [2.91, 5.08]	< 0.001	0.39 [0.30, 0.51]	< 0.001	4.33 [3.28, 5.73]	< 0.001	0.42 [0.36, 0.63]	< 0.001
3	2.48 [1.86, 3.30]	< 0.001	0.44 [0.34, 0.58]	< 0.001	2.90 [2.17, 3.86]	< 0.001	0.48 [0.36, 0.63]	< 0.001
4	1.74 [1.27, 2.37]	< 0.001	0.51 [0.38, 0.67]	< 0.001	2.47 [1.82, 3.36]	< 0.001	0.63 [0.47, 0.85]	0.002
Least disadvantaged	REF		REF		REF		REF	

Note CPS = Child Protective Services; uOR = Unadjusted Odds Ratio; CI = Confidence Interval; REF = Reference Category. Results significant at $p < .05$ indicated in **bold**.

^a Measured at birth.

^b Measured May 31 of the year the child was in Grade 9.

Appendix D. Numeracy and Reading Outcomes

Table D1

Proportions of Children in Each Numeracy and Reading Attainment Category by Grade for Children with and without Maternal Incarceration Exposure.

	Grade 3		Grade 5		Grade 7		Grade 9	
	No maternal incarceration	Maternal incarceration						
<i>Numeracy attainment</i>								
Above average	781 (17.5)	99 (6.4)	632 (12.8)	57 (3.3)	798 (17.1)	77 (4.8)	647 (15.0)	34 (2.8)
Average	2116 (47.4)	582 (38.0)	2274 (46.2)	578 (33.8)	2172 (46.6)	572 (35.9)	1912 (44.2)	389 (31.7)
Below average	1566 (35.1)	852 (55.6)	2021 (41.0)	1077 (62.9)	1694 (36.3)	943 (59.2)	1762 (40.8)	805 (65.5)
Total	4463 (100.0)	1533 (100.0)	4927 (100.0)	1712 (100.0)	4664 (100.0)	1592 (100.0)	4321 (100.0)	1228 (100.0)
<i>Reading attainment</i>								
Above average	1166 (25.9)	146 (9.4)	936 (18.8)	106 (6.0)	843 (18.0)	92 (5.7)	552 (12.7)	43 (3.5)
Average	1667 (37.0)	521 (33.7)	2060 (41.4)	562 (31.9)	2129 (45.4)	576 (35.9)	1978 (45.4)	396 (32.5)
Below average	1669 (37.1)	881 (56.9)	1979 (39.8)	1095 (62.1)	1722 (36.7)	937 (58.4)	1823 (41.9)	780 (64.0)
Total	4502 (100.0)	1548 (100.0)	5414 (100.0)	1763 (100.0)	4694 (100.0)	1605 (100.0)	4353 (100.0)	1219 (100.0)

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