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Injury-related treatments and outcomes in preschool children with autism spectrum disorder: Study to Explore Early Development (SEED)

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Abstract

Background: Evidence about injury management and outcomes in children with autism spectrum disorder (ASD) is limited.

Method: Cross-sectional analyses included children aged 30–68 months with at least one medically attended injury. Standardized diagnostic instruments determined ASD cases. Parent-reported injury treatments and outcomes were examined in ASD cases (n = 224) versus developmental delays/disorders (DD) (n = 188) and population (POP) (n = 267) controls, adjusting for child and family characteristics using logistic regression.

Results: Injury characteristics were similar between groups. Most children (82.5%) had emergency care (EC) or hospitalization after injury. Nearly half (46.4%) ever received a medication or injection, mostly analgesics (53.4%) and local anesthetics (23.8%), while 9.4% ever received surgery, most often for open wound (47.0%) or fracture (16.7%). ASD group children were less likely than DD group children to receive medication/injection (41.1% vs. 53.2%, adjusted odds ratio [aOR] = 0.60 [0.40, 0.90]); receipt of EC/hospitalization and surgery were comparable. Children with ASD more often had surgery than POP children (14.3% vs. 4.9%, aOR = 2.62 [1.31, 5.25]); receipt of EC/hospitalization and medication/injection were similar. Loss of consciousness was uncommon (ASD = 6.3%, DD = 5.3%, POP = 3.4%), as was long-term or significant behavior change (ASD = 5.4%, DD = 3.2%, POP = 3.2%); differences were not significant.

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Conclusions: Injured children with ASD received fewer medications/injections than children with non-ASD developmental delays/disorders and more surgical treatments than general population children. Injury management was otherwise similar between groups. Understanding whether these results reflect child or injury characteristics or provider perceptions about behaviors and pain thresholds of children with ASD, and how these may influence care, requires further study.

Keywords

ASD; Injuries; Surgery; Emergency care; Injury outcomes; Treatment

1. Introduction

Several studies have examined the risk of medically-attended injuries among children with autism spectrum disorder (ASD), with results ranging from significantly increased risk (Lee, Harrington, Chang, & Connors, 2008; McDermott, Zhou, & Mann, 2008) to little or no difference in risk (DiGuiseppi et al., 2018; Jain et al., 2014), depending on injury definition (i.e., parent-reported injury requiring medical attention, injury requiring emergency department or hospital treatment, or injury resulting in medical and/or pharmacy insurance claims), risk period, and modeled covariates. In children with ASD, injuries are most commonly caused by falls or being struck by or against a person or object; they most often affect the head, face and neck or an extremity and result in contusion, open wound or fracture (DiGuiseppi et al., 2018; Kalb et al., 2016; McDermott et al., 2008).

There is less evidence about injury treatments and outcomes for children with ASD. Due to ASD-related symptoms (e.g., sensory sensitivities) or co-occurring conditions (e.g., anxiety), some children with ASD demonstrate severe distress or resistive behaviors during medical examinations or procedures or when taking medication (Andersen, Zweidorff, Hjelde, & Rødland, 1995; MacNeil, Lopes, & Mines, 2009; Riviere, Becquet, Peltret, Facon, & Darcheville, 2011). Children with ASD may also differ in their pain perception or expression (Allely, 2013). These differences could result in differences in treatment of injured children with ASD or consequences from treated injuries.

This study aimed to examine parent-reported treatments and outcomes after medically attended injuries among children with ASD compared to children with non-ASD developmental disorders and children from the general population.

2. Methods

2.1. Design

SEED is a multi-site case-control study, for which the methods have been detailed (Schendel et al., 2012). All six Phase 1 sites (California, Colorado, Georgia, Maryland, North Carolina, and Pennsylvania) were included in this cross-sectional analysis of SEED data. Cases included children who met study criteria for ASD (defined below). Two control groups comprised children from the general population (POP) and children with non-ASD developmental delays/disorders (DD) (e.g., attention-deficit/hyperactivity disorder, language delay).

2.2. Participants

Eligible children were born September 2003 to August 2006, aged 2–5 years at enrollment, and currently resided in a defined study catchment area with an adult parent or caregiver who had continuously cared for the child since age six months and who spoke English or, at two sites, English or Spanish. Children who had received education services for an ASD or related condition (e.g., language delay, learning disability), or had an ASD or related diagnosis (e.g., intellectual disability) from a clinician, were recruited from clinical and educational sources for the ASD and DD groups. In each catchment area, POP control children were recruited from randomly sampled birth certificates. Families were sent an introductory letter followed by a phone call to assess eligibility. SEED participant and study site characteristics have been described (DiGuiseppi et al., 2016; Schendel et al., 2012; Wiggins, Levy et al., 2015).

Institutional Review Board (IRB)-C, CDC Human Research Protection Office, and the individual review boards of each participating institution approved this study. All study procedures were performed in accordance with the Declaration of Helsinki and its later amendments. All participating families provided written informed consent.

2.3. Case identification and clinical assessment

All enrolled families completed multiple questionnaires and standardized instruments, including the Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003) to identify possibly undiagnosed ASD, defined as a score ≥ 11 (Allen, Silove, Williams, & Hutchins, 2007; Lee, David, Rusyniak, Landa, & Newschaffer, 2007), the Mullen Scales of Early Learning (MSEL) (Mullen, 1995) to assess cognitive functioning and the Child Behavior Checklist (CBCL) (Achenbach, 1992) to assess behavioral characteristics. Children at risk for ASD (SCQ score ≥11, prior ASD diagnosis, or ASD symptoms observed during the MSEL, regardless of recruitment source) were evaluated using the Autism Diagnostic Observation Schedule (ADOS) (Lord, Rutter, DiLavore, & Risi, 1999) and Autism Diagnostic Interview-Revised (ADI-R) (Gotham, Risi, Pickles, & Lord, 2007). Those meeting ADOS cutoff scores and one of four ADI-R algorithms were classified as ASD (Schendel et al., 2012; Wiggins, Reynolds et al., 2015). Children at risk for ASD who did not meet study criteria for case status after evaluation were excluded from this analysis, in order to avoid potential bias from misclassifying any children with ASD as having a non-ASD DD. Children determined not to be at risk for ASD (SCQ < 11, no prior ASD diagnosis) were classified as DD if recruited from a clinical or educational source (i.e., with an ASD-related diagnosis or condition) and as POP if recruited from the birth certificate sample.

2.4. Data collection

During a 60-minute computer-assisted telephone questionnaire on the child’s developmental and medical history and the mother’s reproductive and pregnancy history, the caregiver (99% mothers) was asked (1) “Has (CHILD) ever had an injury that required medical attention?" (yes/no) and, if yes, for each injury occurrence, (2) "What was the injury?" (short answer, e.g., "inhaled sunflower seed," "broken arm"). Two investigators (CD, KS) independently categorized each short answer, to the extent possible, by nature, body region, and mechanism (Fingerhut & Warner, 2006; National Center for Health Statistics, 2002); κ = 0.79, 0.61 and 0.48, respectively, for the first reported injury. Injuries with discrepant codes were independently reviewed by a third investigator (SL). Discrepancies were resolved through consensus. Children lacking a completed injury history (N = 43) and events not representing an injury (i.e., acute physical trauma) (e.g., 'fever') (n = 72) were excluded. The three study groups revealed similar numbers per child and nature, region and mechanism of reported injuries (DiGuiseppi et al., 2018). Children with at least one medically attended injury were included in this analysis. For each injury, the caregiver was asked whether, as a result of the injury, the child lost consciousness, visited an emergency department or was hospitalized ('ED visit/hospitalization'), had surgery, or had long-term or significant changes in behavior afterward (all responses yes/no), or took any medications or received injections ('medication/injection') (yes/no, and if yes, the name(s) of each). Two investigators (CD, KS) coded each medication/injection reported into one of eight categories (antibiotic, analgesic, sedative, general anesthetic, local anesthetic, anti-emetic, antihistamine, other specified (e.g., 'steroids'), or unspecified (e.g., 'eyedrops') or excluded it as not a medication or injection (e.g., 'sutures'). Discrepancies were resolved through consensus. Each injury-related treatment and outcome was categorized as "Ever" if the caregiver reported its occurrence after at least one injury, otherwise as "Never."

Caregiver-reported characteristics included sociodemographic variables and selected physician-diagnosed child and maternal health conditions (Table 1).

2.5. Analysis

Associations between ASD and each injury treatment and outcome were examined using logistic regression models. Children with ASD were compared separately to POP and DD controls. All models were adjusted *a priori* for child sex and maternal education. Other sociodemographic variables and maternal and child health conditions were assessed as potential confounding variables and retained in the model if the regression estimate changed by > 10%. In exploratory analyses, we examined each injury treatment and outcome in children with ASD versus DD stratified by MSEL Early Learning Composite Standard Score (intellectual disability [ID] [< 70] vs. no ID [≥70]) and CBCL T-scores for attention problems (clinical/borderline [≥65] vs. normal [< 65]). Stratified analyses for ASD vs. POP children were not implemented because few POP children had scores below normal on either test. Results are reported as odds ratios with 95% confidence interval (CI). Analyses were completed using SAS 9.3.

3. Results

Of 2295 children who completed a clinic visit and received an ASD, DD or POP classification, 679 (29.6%) had at least one medically attended injury: 224 children with ASD, 188 children with DD and 267 POP children. There were 838 total injuries (mean 1.2 injuries per child). Only 24 children experienced more than two injuries (ASD, 3.1%;

DD, 4.3%; POP, 3.4%). Table 1 shows study group characteristics. Substantial proportions of caregivers failed to describe nature, region or mechanism of injury in their responses.

Most children (82.5%) had at least one injury-related ED visit or hospitalization. Surgical treatment was reported for 9.4% of children, most often for an open wound (47.0%), fracture (16.7%), foreign body (6.1%) or burn (4.5%); nature of injury was unspecified for 18.2% of surgically treated injuries. Nearly half of injured children (46.4%) received at least one medication/injection, most commonly analgesics (53.4%), local anesthetics (23.8%) and antibiotics (7.9%); 5.5% of medications/injections were unspecified. Injuries rarely required sedation (n = 15 injuries, 2.2%) or general anesthesia (n = 7, 1.0%). Few children ever lost consciousness (4.9%) or had any long-term or significant behavior change after injury (4.0%).

Compared to POP children, children with ASD were significantly more likely to have had surgical treatment for an injury; the association was attenuated but remained significant in adjusted analysis (Table 2). Most surgical treatment in both groups was for open wounds or fractures (57.6% in ASD, 69.2% in POP), few of which required general anesthesia or sedation (12.1% and 7.7%, respectively). The odds of having lost consciousness post-injury were strengthened after adjustment for sociodemographic characteristics and number of children in the home but did not reach statistical significance. There were no other significant differences in treatments or outcomes between children with ASD and POP children.

Compared to injured children with DD, those with ASD were significantly less likely to have ever received a medication/injection, in both unadjusted and adjusted analyses (Table 2). There were no other significant differences in treatments or outcomes between children with ASD versus DD.

Exploratory analyses suggested possible differences in injury treatment in ASD versus DD according to presence or absence of attention problems. Among children *with* attention problems, children with ASD were significantly less likely than children with DD to receive a medication/injection (OR = 0.38; 95% CI: 0.15, 0.98), whereas the odds did not differ significantly among children *without* attention problems (OR = 0.70; 95% CI: 0.42, 1.14). In contrast, receipt of surgical treatment was similar in children with ASD and DD among those *with* attention problems (OR = 0.83, 95% CI: 0.21, 3.21), whereas among children *without* attention problems, children with ASD were significantly more likely than children with DD to have had surgical treatment (OR = 2.30; 95% CI: 1.08, 4.89). Differences according to the presence or absence of ID were not observed, although loss of consciousness and behavior change could not be evaluated as neither was reported among children with DD and ID.

4. Discussion

Parents of children with ASD reported significant differences in injury treatment compared to children with non-ASD DD and children from the general population. Children with ASD were less likely to receive medication or injection after injury compared to children with DD and more likely to undergo surgical treatment after injury compared to POP children. The presence of attention problems may have influenced management, as the reduced odds of receiving medication after injury in ASD vs. DD was observed only among children with attention problems. Loss of consciousness and long-term or significant behavior change after injury were rare and did not differ between groups.

Children with ASD were significantly less likely to receive any medication/injection for their injury compared to children with DD, and their odds of receiving medication/injection were also (non-significantly) lower compared to POP children. Children with ASD may have difficulty swallowing medication (Andersen et al., 1995), and higher levels of anxiety related to medical procedures such as injections, compared to community-based populations (MacNeil et al., 2009), which might explain reduced use of medication or injections in such children. Further, some reports have suggested that children with ASD have a higher pain threshold than other children, although a review found that most experimental studies reported similar or greater sensitivity to pain among children with ASD compared to controls (Allely, 2013). This review suggested that children with ASD might express physical discomfort differently from children without ASD, which could lead parents or clinicians to believe that the child is not in pain, potentially explaining reduced usage of analgesics, sedation or local anesthetics.

Increased likelihood of surgical treatment in injured children with ASD compared to POP children might reflect differential care of children with ASD based on disability characteristics and status. For example, children with ASD may require sedation or even general anesthesia during treatment due to uncooperative behaviors or distress (Braff & Nealon, 1979); if this were required for wound suturing, parents might be more likely to report it as 'surgery.' However, study children who received surgical treatment were rarely reported to have received sedation or general anesthesia. Differences in the likelihood of undergoing surgical treatment after injury could also reflect differences in injury severity between groups, which our data did not capture, although proxy measures for more serious injuries (i.e., loss of consciousness and ED visit/hospitalization) appeared similar in the two groups. There may also have been differences in the type of injury encountered. The types most often treated surgically were similar in the three study groups, but caregivers failed to specify the nature of more than 25% of injuries; hence, differences may have existed among those not specified. The fact that parents of children with DD also reported higher rates of surgical treatment raises the possibility of recall bias related to the child's underlying condition but may also indicate true differences in how injured children with neurodevelopmental disorders are generally managed. Studies that include more detailed data on injury characteristics and treatments could help to distinguish among these possibilities.

This study's strengths include research-reliable administration of standardized instruments to evaluate and classify children with ASD, inclusion of previously undiagnosed children with ASD, comprehensive data collection on clinical and behavioral covariates, and inclusion of two comparison groups (Schendel et al., 2012). There are also limitations. Information on injury treatments and outcomes were based on caregiver recall about medically-attended injuries occurring since birth; such recall has been shown to decline substantially with time (Cummings, Rivara, Thompson, & Reid, 2005). Effect estimates may have been biased if recall were differential between groups. Further, parent report of treatments such as surgery or injections may not have been accurate, and the questionnaire did not ask for details about these treatments. Injury severity was not collected, nor was there detailed information about the injury itself. Hence, we were unable to assess whether differences in injury characteristics or severity could explain observed treatment differences. We did not have information on any medications the child was already taking at the time of injury; it is possible that concerns about potential drug interactions influenced provider decisions about giving medications or injections. There may have been differences in how mothers of children with ASD reported injury treatments and outcomes. Maternal psychiatric conditions, which were somewhat more common in the ASD group, have been shown to result in over-reporting of child symptoms (see Rubenstein et al., 2017) and might similarly affect reporting of injury treatment and outcomes. However, the presence of maternal psychiatric conditions did not appear to confound estimates related to injury treatment. SEED's relatively low recruitment contact rate, as previously reported (Schendel et al., 2012), reduced the representativeness of the enrolled population sample compared to the birth cohort; low response rates may have increased the potential for biased measures of association. Finally, as described previously (DiGuiseppi et al., 2016), there were important sociodemographic differences between the three study groups. While adjustment for measured differences had little effect on the findings, unmeasured differences between groups may have influenced these results.

5. Implications

We observed several differences in the injury-related treatments received by injured children with ASD compared to injured children with non-ASD DD or from the general population. Further study is needed to understand whether these results reveal true differences in practice that potentially reflect characteristics of injured children with ASD or perceptions about them that may influence their care and outcomes. Studies involving medical record review could provide more detailed information on the use of medications, injections and surgeries in injured children with ASD, as well as examine other characteristics that may influence their use (e.g., risk of aspiration, need for sedation). The possibility that providers may be undertreating pain in injured children with ASD, if confirmed in other studies, has important implications for the assessment and management of pain in these children. In addition, further exploration is needed of the long-term consequences of injury for behavior, and of the potential influence of attention problems on injury management in children with ASD, in larger samples that collect detailed data on injury characteristics, severity and treatments.

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Table 1

Child, Maternal and Household Characteristics among Injured Children with Autism Spectrum Disorder (ASD), Other Developmental Delays or Disorders (DD) and from the General Population (POP) Enrolled in the Study to Explore Early Development*.

	At Least One Medically Attended Injury		
	ASD (n = 224)	DD (n = 188)	POP (n = 267)
Child Age at Enrollment, mean (SD) (months)	56.3 (6.6)	55.7 (7.5)	56.1 (7.3)
Child Sex (N, %)			
Female	41 (18.3)	62 (33.0)	108 (40.4)
Male	183 (81.7)	126 (67.0)	159 (59.6)
Mullen ELC Standard Score, mean (SD)	68.3 (21.4)	91.2 (19.3)	103.4 (13.5)
Externalizing Behavior - CBCL T-score, mean (SD)	60.0 (12.2)	47.1 (11.4)	45.1 (10.5)
Attention Problems - CBCL T-score, mean (SD)	63.4 (9.1)	54.5 (7.0)	52.7 (4.6)
Attention-Deficit/Hyperactivity Problems - CBCL T- score, mean (SD)	60.5 (8.7)	53.2 (5.8)	52.1 (4.1)
Attention-Deficit/Hyperactivity Disorder (Prior Diagnosis) (N, %)	26 (11.6)	10 (5.3)	3 (1.1)
Behavior Problems (N, %)	34 (15.2)	10 (5.3)	4 (1.5)
Self-injurious Behavior (N, %)	17 (7.6)	3 (1.6)	0 (0.0)
Maternal Age at Birth, mean (SD) (years)	31.6 (5.4)	32.4 (5.1)	32.3 (5.5)
Maternal Education Level (N, %)			
Less Than Bachelor’s Degree	106 (47.3)	66 (35.5)	80 (30.0)
Bachelor’s Degree	60 (26.8)	58 (31.2)	109 (40.8)
Graduate Degree	58 (25.9)	62 (33.3)	78 (29.2)
Maternal Race (N, %)			
White Non-Hispanic	138 (61.6)	137 (74.5)	202 (76.5)
Other	86 (38.4)	47 (25.5)	62 (23.5)
Maternal Place of Birth (N, %)			
USA	185 (82.6)	163 (87.6)	236 (88.7)
Other	39 (17.4)	23 (12.4)	30 (11.3)
Maternal Primary Language (N, %)			
English	210 (93.8)	174 (93.5)	261 (97.8)
Other	14 (6.3)	12 (6.5)	6 (2.2)
Maternal Neurodevelopmental Condition (N, %)	25 (11.9)	20 (11.6)	11 (4.3)
Maternal Psychiatric condition (N, %)	74 (35.2)	57 (32.9)	70 (27.5)
Maternal Depression (N, %)	60 (29.0)	44 (25.6)	51 (20.0)
Household Income			
Less than $50,000	77 (34.8)	55 (30.4)	69 (26.2)
$50,000-$89,999	83 (37.6)	68 (37.6)	84 (31.9)
$90,000 or More	61 (27.6)	58 (32.0)	110 (41.8)
Number of Children in the Home (N, %)			
1	54 (24.2)	33 (17.6)	30 (11.3)
2	103 (46.2)	78 (41.7)	137 (51.5)
3	48 (21.5)	49 (26.2)	77 (28.9)

	At Least One Medically Attended Injury		
4 +	18 (8.1)	27 (14.4)	22 (8.3)
Number of People in the Home (N, %)			
2–3	59 (26.5)	35 (18.7)	42 (15.8)
4 +	164 (73.5)	152 (81.3)	224 (84.2)
More than One Reported Injury	42 (18.7)	36 (19.2)	50 (18.8)
Total Number of Reported Injuries (N)	279	232	327
Nature of All Reported Injuries (N, %)			
Open Wound	87 (31.2)	70 (30.2)	115 (35.2)
Fracture	46 (16.5)	46 (19.8)	57 (17.4)
Dislocation, Sprain or Strain	21 (7.5)	10 (4.3)	20 (6.1)
Burn	6 (2.2)	5 (2.2)	9 (2.8)
Other Specified[a]	42 (15.1)	35 (15.1)	55 (16.8)
Unspecified	77 (27.6)	66 (28.4)	71 (21.7)
Region of Reported Injuries			
Head Injury (including traumatic brain injury)	143 (51.3)	129 (55.6)	180 (55.0)
Upper Extremity	59 (21.1)	51 (22.0)	73 (22.3)
Lower Extremity	31 (11.1)	22 (9.5)	32 (9.8)
Other Specified	12 (4.3)	6 (2.6)	14 (4.3)
Unspecified	34 (12.2)	24 (10.3)	28 (8.6)
Mechanism of Reported Injuries			
Fall	61 (21.9)	63 (27.2)	73 (22.3)
Struck by or against Object or Person	12 (4.3)	17 (7.3)	17 (5.2)
Fire / Flame / Hot Object or Substance / Smoke	4 (1.4)	11 (4.7)	12 (3.7)
Other Specified[b]	33 (11.8)	26 (11.2)	33 (10.1)
Unspecified	169 (60.6)	115 (49.6)	192 (58.7)

SD = standard deviation.

[*] Data missing for ≤1% of participants, except household income (missing 2.1%), maternal neurodevelopmental and psychiatric conditions (each missing 6.0%) and maternal depression (6.6%).

[a] Other specified injury natures combined here due to small numbers included: internal organ injury; burn; crushing; effects of foreign body entering orifice; contusion or other superficial injury; other effects of external causes; poisoning by drugs, medications, or biological substances; toxic effects of substances - nonmedicinal; and multiple injuries.

[b] Other specified injury mechanisms combined here due to small numbers included: natural/environment; cut/pierce; motor vehicle crash; poisoning; pedal cycling not involving motorized vehicle; suffocation; exposure to various specified inanimate mechanical forces such as explosion and rupture of boiler, gas cylinder or pressurized tire; discharge of firework; foreign body entering eye or other orifice; exposure to electric current or radiation; and other specified not classifiable.

Table 2

Among Injured Children, Odds Ratios for Treatments and Outcomes after Injury in Children with Autism Spectrum Disorder (ASD) Compared to Children with Other Developmental Delays or Disorders (DD) and to Children from the General Population (POP).

	ASD (n = 224)	DD (n = 188)	Crude Estimate, ASD vs. DD				Adjusted Estimate, ASD vs. DD			
Injury Outcome	N (%)	N (%)	OR	95% CI		p-value	OR	95% CI		p-value
ED visit or hospitalization	184 (82.1%)	158 (84.0%)	0.87	0.52	1.47	0.6092	0.80	0.47	1.37	0.4154
Surgery	32 (14.3%)	19 (10.1%)	1.48	0.81	2.71	0.2016	1.37	0.74	2.55	0.3124
Medication or Injection	92 (41.1%)	100 (53.2%)	0.61	0.42	0.91	0.0143 *	0.60	0.40	0.90	0.0133 *
Lost Consciousness	14 (6.3%)	10 (5.3%)	1.19	0.51	2.74	0.6881	1.34[a]	0.55	3.24	0.5163
Behavior Change	12 (5.4%)	6 (3.2%)	1.72	0.63	4.67	0.2893	1.62	0.59	4.48	0.3524
	ASD (n = 224)	POP (n = 267)	Crude Estimate, ASD vs. POP				Adjusted Estimate, ASD vs POP			
	N (%)	N (%)	OR	95% CI		p-value	OR	95% CI		p-value
ED visit or hospitalization	184 (82.1%)	218 (81.6%)	1.03	0.65	1.64	0.8874	0.88	0.54	1.44	0.6078
Surgery	32 (14.3%)	13 (4.9%)	3.26	1.66	6.37	0.0006 *	2.62	1.31	5.25	0.0066 *
Medication or Injection	92 (41.1%)	123 (46.1%)	0.82	0.57	1.17	0.2666	0.78	0.53	1.13	0.1882
Lost Consciousness	14 (6.3%)	9 (3.4%)	1.91	0.81	4.50	0.1385	2.18[b]	0.87	5.44	0.0957
Behavior Change	12 (5.4%)	9 (3.4%)	1.62	0.67	3.92	0.2827	1.34[c]	0.50	3.61	0.5654

All models are adjusted for maternal education and child sex. Selected models were adjusted in addition for:

[a] maternal age at child's birth,

[b] number of children in the home, and

[c] maternal neurodevelopment disorders and maternal depression.

[*] p-value < < 0.05 considered statistically significant.