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RESEARCH ARTICLE

Developmental profiles of children at risk for autism spectrum disorder at school entry

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Abstract

Functional abilities in children with autism spectrum disorder (ASD) are highly heterogenous, and impairments can overlap with non-ASD neurodevelopmental disorders. We compared the profiles of children assessed for ASD with and without an ASD diagnosis using a retrospective cohort study of 101,739 children born in British Columbia (2000–2008). The children were grouped into the following five comparison groups: (1) ASD− ($n = 1131$), (2) ASD+ ($n = 1583$), (3) Ministry of Education designated ASD+ ($n = 654$), (4) special need other than ASD ($n = 11{,}663$), and (5) typically developing ($n = 86{,}708$). Five developmental domains were assessed using the Early Development Instrument. ANCOVA was used to control for covariates, Tukey's HSD test for multiple comparisons, and Cohen's d for effect size. The ASD− group had slightly higher scores than the ASD+ group with small to medium effect sizes in all domains ($d = 0.20$–0.48). The ASD− group had slightly higher scores than the Ministry of Education ASD+ group in only three domains with small effect sizes ($d = 0.21$–0.25). The ASD− group had lower scores in all domains compared to the typically developing group with large effect sizes in all domains ($d = 1.12$–1.77). The ASD− group received less education funding at school entry than both ASD+ groups. Overall, only small to medium differences in development were detected between the ASD− and ASD+ groups. While these children differ diagnostically, they share similar functional profiles and have substantially more difficulties than typically developing children. Therefore, differences in levels of support at school entry raise critical questions of equity.

Lay Summary

Comparison of children in British Columbia who have been referred for an autism assessment, with or without a diagnosis, shows similarities in their functional and developmental profiles in kindergarten. Furthermore, both groups of children have more difficulties than typically developing children. However, children who have been referred for assessment without an autism diagnosis receive less financial support at school entry, raising important questions on equity.

KEYWORDS
autism spectrum disorder, child development, attention deficit disorder, cohort studies, diagnosis, functional status, health equity

INTRODUCTION

Autism spectrum disorder (ASD) is a highly heterogenous disorder characterized by impairments in social interaction and communication, and the presence of a restricted, stereotyped, and repetitive repertoire of interests and behaviors (American Psychiatric Association, 2013). ASD affects about 1 in 66 children in Canada (Public Health Agency of Canada, 2018). There is considerable variability in social and communication impairments among children with ASD (Wiggins et al., 2012). Georgiades et al. also found that modeling subgroups of children with ASD identified distinct groups within the ASD population that had differing adaptive functioning, language, and cognitive levels (Georgiades et al., 2013).

Challenges in areas such as everyday living skills and communication skills are also not restricted to children with ASD. While evidence remains limited because few studies directly compare children with ASD and children with other neurodevelopmental disorders, research suggests that children with ASD and attention deficit hyperactivity disorder (ADHD), for example, share similar impairments in social skills (Taurines et al., 2012), even if their presentation results in diagnostic differences. Impulsivity, one of the symptoms of ADHD, has been associated with impaired social communication skills (Geurts & Embrechts, 2008). School-aged children with ASD and ADHD may also have similar language profiles (Geurts & Embrechts, 2008), again suggesting that the impairments seen in children with ASD overlap with impairments in children with other neurodevelopmental challenges.

Understanding these similarities and differences, particularly in terms of how they affect a child's function, is important, as many services for children with neurodevelopmental disorders are dependent on identifying a particular diagnosis. For example, the amount of additional funding a student with special needs receives can depend on their medical diagnosis. Additional educational funding in British Columbia is associated with a student's ministry of education code designation for special needs and is provided to the school to support additional services for that student. These designations are associated with three levels of funding (Government of British Columbia, 2021). In 2021, level 1 funding was $44,850, level 2 was $21,288, and level 3 was $10,750. Children with ASD receive level 2 funding.

In this study, we used kindergarten level developmental profiles to compare the functional abilities of children who were assessed through a province-wide ASD assessment network (BC Autism Assessment Network, BCAAN) but who differed with respect to their ASD diagnosis status. We determined the extent to which there are similarities or differences in the functional profiles of these children, and we compared each group with typically developing children. Our hypothesis was that children who had been assessed for ASD, but not diagnosed, share similar functional difficulties as children who have been diagnosed with ASD.

METHODS

Study design

We conducted a retrospective cohort study including all infants born in the province of British Columbia, Canada between March 26, 2000 and December 31, 2008, with follow-up data until December 31, 2016. Only children who remained in British Columbia and had a completed kindergarten developmental profile were included. We obtained ethics approval from the UBC Children's and Women's Research Ethics Board. Data on the children's health services, prescription drug use, and demographics were accessed from Population Data BC.

In British Columbia, primary care practitioners and pediatricians conduct general developmental surveillance and field concerns from parents. If there is reason to warrant an assessment for ASD, and the family opts to proceed with a publicly funded ASD assessment, the child is referred to the BC Autism Assessment Network (BCAAN) for a clinical evaluation made by pediatricians, psychiatrists or psychologists who have completed additional training for the diagnosis of ASD. Diagnostic assessment for ASD has been standardized within BCAAN since 2004, and are informed by two instruments, the Autism Diagnostic Observation Schedule (ADOS or ADOS-2) and the Autism Diagnostic Interview-Revised (ADI-R). The assessment also draws on clinical history, evaluation of developmental status, as well as reports from schools and other relevant clinicians. Private practitioners are required to use the ADOS or ADOS-2 along with the ADI-R. While there is no specific database to identify private ASD assessments, children who have received an ASD diagnosis from a private assessment will usually be identified through their schools to facilitate access to Ministry of Education funding for children with ASD. To ensure we included cases diagnosed privately, we linked to data held by the BC Ministry of Education that included codes for ASD.

We then stratified our study population into five groups: (1) children assessed through BCAAN without an ASD diagnosis (BCAAN ASD−), (2) children assessed through BCAAN diagnosed with ASD (BCAAN ASD+), (3) children diagnosed with ASD outside of BCAAN with a Ministry of Education designation for ASD (Other ASD+), (4) children with a Ministry of Education special needs designation other than ASD (Other SN), with those identified only as gifted excluded, and (5) typically developing children (TD). The typically developing group included only children with no Ministry of Education designation for special needs and no ICD-9 codes in their medical services plan (MSP) data for other neurodevelopmental disorders or concerns (see

TABLE 1 Child and family characteristics by study group

	BCAAN ASD−	BCAAN ASD+	Other ASD+	Other Ministry of Education special need	Typically developing	X^2
n	1131	1583	654	11,663	86,708	
Age at EDI in months, mean (sd)	68.07 (4.13)	68.7 (4.22)	68.58 (4.47)	67.71 (3.84)	67.57 (3.43)	
Sex, *n* (%)						$p < 0.05$
Female	232 (21)	238 (15)	91 (14)	3683 (32)	44,398 (51)	
Male	835 (74)	1294 (82)	509 (78)	7215 (62)	39,309 (45)	
Unknown	64 (6)	51 (3)	54 (8)	765 (7)	2998 (3)	
Child's first language, *n* (%)						$p < 0.05$
English	951 (84)	1293 (82)	536 (82)	10,017 (86)	66,545 (77)	
French	<5 (0)	<5 (0)	<5 (0)	<5 (0)	<5 (0)	
Cantonese	35 (3)	48 (3)	25 (4)	169 (1)	2727 (3)	
Mandarin	20 (2)	48 (3)	17 (3)	81 (1)	2002 (2)	
Punjabi	39 (3)	30 (2)	14 (2)	390 (3)	5313 (6)	
Filipino/Tagalog	9 (1)	22 (1)	7 (1)	92 (1)	1176 (1)	
Vietnamese	9 (1)	20 (1)	<5 (0)	65 (1)	987 (1)	
Spanish	9 (1)	17 (1)	6 (1)	136 (1)	728 (1)	
Indigenous language	9 (1)	8 (1)	<5 (0)	174 (1)	916 (1)	
Other	48 (4)	84 (5)	30 (5)	420 (4)	5418 (6)	
Unknown	<5 (0)	13 (1)	12 (2)	119 (1)	895 (1)	
Income band quintile, *n* (%)						$p < 0.05$
1 (lowest)	242 (21)	339 (21)	95 (15)	2736 (23)	15,260 (18)	
2	240 (21)	325 (21)	103 (16)	2286 (20)	16,736 (19)	
3	240 (21)	305 (19)	116 (18)	2134 (18)	17,096 (20)	
4	181 (16)	304 (19)	173 (26)	1908 (16)	17,604 (20)	
5 (highest)	156 (14)	230 (15)	108 (17)	1609 (14)	15,887 (18)	
Unknown	72 (6)	80 (5)	59 (9)	990 (8)	4125 (5)	
Intellectual disability diagnosis, *n* (%)						$p < 0.05$
Mild	117 (10)	53 (3)	18 (3)	751 (6)		
Moderate to profound	107 (9)	91 (6)	35 (5)	455 (4)		
Ministry of Education funding at school entry, *n* (%)[a]						$p < 0.05$
Level 1 funding	<5 (0)	12 (0.76)	<5 (0)	115 (1)		
Level 2 funding	198 (18)	999 (63)	428 (65	1713 (15)		
Level 3 funding	84 (7)	53 (3)	13 (1)	562 (5)		
No supplemental funding	804 (71)	497 (31)	205 (31)	9120 (78)		
Medical services provider billing ICD-9 codes for other neurodevelopmental disorders, *n* (%)						$p < 0.05$
ICD 296 Affective psychoses	48 (4)	42 (3)	25 (4)	403 (3)		
ICD 300 Neurotic disorders including anxiety states, obsessive compulsive disorders	408 (36)	433 (27)	233 (36)	2818 (24)		
ICD 307 Special symptoms including tics and stereotyped repetitive movements	170 (15)	201 (13)	93 (14)	1201 (10)		
ICD 309 Adjustment reaction including depressive reaction, disturbance of other emotions, and disturbance of conduct	137 (12)	123 (8)	63 (10)	1089 (9)		
ICD 311 Depressive disorder	139 (12)	111 (7)	71 (11)	1157 (10)		
ICD 312 Disturbance of conduct including compulsive conduct disorder and mixed disturbance of conduct and emotions	516 (46)	634 (40)	275 (42)	3241 (28)		

(Continues)

TABLE 1 (Continued)

	BCAAN ASD−	BCAAN ASD+	Other ASD+	Other Ministry of Education special need	Typically developing	X^2
ICD 313 Disturbance of emotions including anxiety, unhappiness, shyness, social withdrawal, and relationship problems	312 (28)	267 (17)	148 (23)	1613 (14)		
ICD 314 Hyperkinetic syndrome of childhood including disturbance in activity and attention and hyperkinesis	730 (65)	749 (47)	317 (48)	5003 (43)		
ICD 315 Specific delays including reading, arithmetic, learning, speech, language, and motor	713 (63)	964 (61)	441 (67)	3894 (33)		
Number of psychotropic medications prescribed, *n* (%)						$p < 0.05$
At least one medication	664 (59)	753 (48)	334 (51)	5063 (43)	6477 (7)	
Only one medication	237 (21)	296 (19)	115 (18)	2260 (19)	6024 (7)	
Two medications	124 (11)	164 (10)	64 (10)	1184 (10)	359 (0)	
Three medications	112 (10)	105 (7)	47 (7)	602 (5)	58 (0)	
Four medications	82 (7)	69 (4)	33 (5)	413 (4)	22 (0)	
Five or more medications	109 (10)	119 (8)	75 (11)	604 (5)	14 (0)	
Psychotropic medications prescribed by medication class, *n* (%)						$p < 0.05$
Antiepileptics	68 (6)	115 (7)	58 (9)	630 (5)	498 (1)	
Anxiolytics	154 (14)	233 (15)	121 (19)	1330 (11)	5320 (6)	
Antipsychotics	172 (15)	192 (12)	99 (15)	762 (7)	15 (0)	
Antidepressants	286 (25)	293 (19)	168 (26)	1736 (15)	265 (0)	
Psychostimulants	507 (45)	473 (30)	210 (32)	3373 (29)	63 (0)	
Hypnotics and sedatives	21 (2)	40 (3)	15 (2)	215 (2)	599 (1)	

Abbreviations: ASD, autism spectrum disorder; BCAAN, BC Autism Assessment Network.

[a]Amount of funding provided by the Ministry of Education changes from year to year. The level of funding is associated with a student's Ministry of Education code designation for special needs and is provided to the school to support additional services for that student. Level 1 receives the most funding. For example, in 2021, level 1 funding was $44,850, level 2 was $21,288, and level 3 was $10,750. Level 1 includes funding for children identified as physically dependent or deafblind; level 2 includes funding for children identified as having moderate to profound intellectual disability, a physical disability or chronic health impairment, visual impairment, who are deaf or hard of hearing, or diagnosed with autism spectrum disorder; and level three includes funding for children identified as needing intensive behavior interventions or having a serious mental illness.

Table 1, other neurodevelopmental disorders for relevant codes).

Data sources and outcome measure

Data from the early development instrument (EDI; Human Early Learning Partnership, 2016) was used as the main outcome measure. In British Columbia, EDI data is collected by the Human Early Learning Partnership. The EDI is completed at a population level in British Columbia and is collected in waves, where subsets of the provincial population are sampled each year until there is full coverage of all neighborhoods in the province. The EDI is used to measure a child's readiness at school entry and covers the following five broad development domains: physical health and well-being, social competence, emotional maturity, language and cognitive development, and communication skills and general knowledge (Janus & Offord, 2007). The EDI includes 103 items grouped into five developmental domains. Each domain score is a mean of all responses within that domain. In February, the child's kindergarten teacher completes the questionnaire. The EDI has been used in 12 out of 13 provinces and territories in Canada and other jurisdictions around the world, including at a national level in Australia, and its psychometric properties and validity have been examined in previous studies (Brinkman et al., 2017; Goldfeld et al., 2009; Guhn et al., 2007; Hymel et al., 2011; Janus et al., 2011). The EDI also included data on a child's first language as documented by the child's teacher based on school records and parent and caregiver reports.

BCAAN ASD diagnostic data was obtained from the BCAAN clinical database (British Columbia Autism Assessment Network, 2016). We also used data from the

BC Perinatal Data Registry to link child and maternal data to determine geographical household income (Perinatal Services BC, 2009), the MSP payment information file (British Columbia Ministry of Health, 2016a; British Columbia Ministry of Health, 2016b; British Columbia Ministry of Health, 2017) to examine ICD-9 diagnostic codes, BC Pharmanet (BC Ministry of Health, 2016) for psychopharmacological medication prescriptions, Vital Statistics (BC Vital Statistics Agency, 2016) for demographic data (age and sex), the BC Ministry of Education (British Columbia Ministry of Education, 2015) for ministry codes for children with special needs, and census geodata (Statistics Canada, 2018) for geographical household income. All inferences, opinions, and conclusions drawn are those of the authors and do not reflect the opinions or policies of the data stewards.

Covariates

The following covariates were used in the main analysis: age at EDI assessment, sex, child's first language, average household income band quintile based on census geographic data, and presence of comorbid intellectual disability. Sex, age, and language spoken at home have previously been found to have statistically significant effect on EDI scores (Janus et al., 2019). Household income was used as a proxy measure for socioeconomic status. Household income band quintiles were obtained through Canadian census data based on a family's postal code and represent neighborhood income bands rather than individual family incomes. Intellectual disability was also included as a covariate, as it has major impact on a child's adaptive skills, many of which are measured on the EDI. We also examined level of Ministry of Education funding for children with special needs, ICD-9 codes for neurodevelopmental disorders other than ASD, and psychopharmacological medication use across the groups. The included medications with their anatomical therapeutic chemical classification codes (WHO Collaborating Centre for Drug Statistics Methodology, 2021) were antiepileptics (N03A), anxiolytics (N05B), antipsychotics (N05A), antidepressants (NO6A), psychostimulants (N06B), and hypnotics and sedatives (N05C).

Analysis

We first looked at the unadjusted z-standardized EDI domain scores. Z-standardized scores were used as domain scores are not comparable across domains. To understand how developmental profiles of our five groups of children differ, we compared the EDI domain scores across groups using ANCOVA and Tukey's HSD test to control for multiple comparisons. Tukey HSD is considered a conservative post hoc test when there are unequal sample sizes (Hayter, 1984; Tse, 1989). We controlled for age, sex, household income, English as a first language, and presence of intellectual disability. Effect size was reported for statistically significant differences between groups using Cohen's d (Cohen, 2013; Sullivan & Feinn, 2012), which has been used in other studies examining EDI scores (Janus et al., 2010). A d of 0.2 is generally considered a small effect size, 0.5 a medium effect size, and 0.8 a large effect size. Analyses were conducted in R version 4.0.3 (R Core Team, 2020).

RESULTS

Our initial cohort included 370,881 births in British Columbia, Canada between March 26, 2000, and December 31, 2008. We excluded all children for whom we did not have EDI information or Ministry of Education data (n = 236,399). Among this group of excluded children, 3832 had been assessed by BCAAN, 57% had a BCAAN ASD+ outcome, and 42% had a BCAAN ASD− outcome, which is the same proportion as the included children. There were also an additional 1197 children not seen through BCAAN but who had a Ministry of Education designation for ASD, which is 0.5 percent of the excluded children, comparable with 0.5 of the included children who had a Ministry of Education designation for ASD. Among the children who were excluded, 49% were female and 51% were male, which is the same proportion as the cohort group.

We also excluded children who had not been assessed at BCAAN and were not given a Ministry of Education code for other neurodevelopmental disability, but who had an MSP code in the physician visits data indicating a neurodevelopmental disability or concern (n = 31,596). We excluded children only identified as gifted in the Ministry of Education (n = 1071), and children missing Ministry of Education and physician visits data (n = 76), resulting in a study sample of 101,739 (Figure 1). Of those assessed in BCAAN (n = 2714), 1131 were not diagnosed with ASD (BCAAN ASD−), and 1583 were diagnosed with ASD (BCAAN ASD+). An additional 654 children with an ASD diagnosis were identified through Ministry of Education data (Other ASD+). There were 11,663 children identified through the Ministry of Education to have a special need other than ASD (Other SN; Government of British Columbia, 2002), and there were 86,708 children in the typically developing comparison group (TD).

Demographic data are compared across the five groups of children in Table 1. Age at EDI was similar across groups. The female and male ratio varied across groups, with more male children in all groups except for typically developing children. The four groups of children with neurodevelopmental disabilities had 82%–86% of children with English as their first language, while the

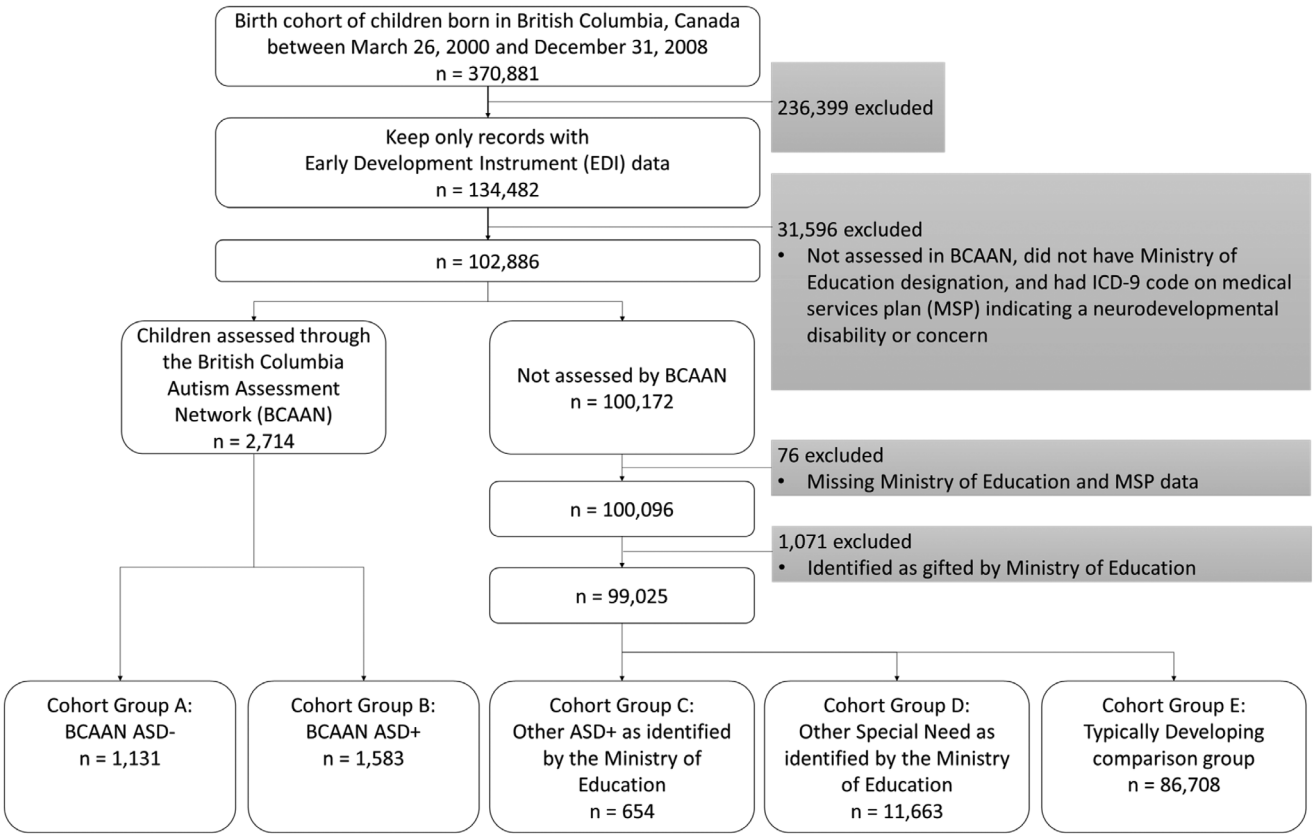

FIGURE 1 Participant flowchart with inclusion and exclusion criteria

control group of typically developing children had 77% of children with English as their first language. Of the children assessed through BCAAN, 30% of those in the ASD− group and 34% of those diagnosed in the ASD+ were in the top two income quintiles. Forty-three percent of children diagnosed with ASD outside of BCAAN (Other ASD+) were in the top two income quintiles.

The BCAAN ASD− children were less likely to be receiving Ministry of Education funding at time of EDI completion. Eighteen percent of the BCAAN ASD− group and 15% of the Other Special Needs group were receiving level 2 or higher Ministry of Education funding, compared to 64% in the BCAAN ASD+ group and 65% in the Other ASD+ group.

In terms of ICD-9 diagnoses for other neurodevelopmental disorders, the BCAAN ASD− group had a higher percentage (28%) of ICD-9 codes for "disturbance of emotion" which includes symptoms of "anxiety and fearfulness," "misery and unhappiness," "sensitivity, shyness, and social withdrawal," and "relationship problems," compared to the other groups (14%–23%). They also had a higher percentage (65%) of codes for "hyperkinetic syndrome," which includes symptoms of inattention and hyperactivity, compared to the other groups (43%–47%). The BCAAN ASD− group was also more likely to have been prescribed a psychotropic medication. Fifty-nine percent of children in the BCAAN ASD− group were prescribed a psychotropic medication, compared to 48% and 51% in the BCAAN ASD+ and Other ASD+ groups. In the BCAAN ASD− group 45% were prescribed a stimulant medication, compared to 30% and 32% in the BCAAN and Other ASD+ groups, respectively.

EDI scores across groups

The EDI standardized mean domain scores for each group is presented in Figure 2 and the Table S1. Figure 2 illustrates that the children in the BCAAN ASD− group had a similar pattern in their scores on the five domains of the EDI to the children who are diagnosed with ASD at BCAAN (BCAAN ASD+) and the children diagnosed with ASD outside of BCAAN (Other ASD+). The BCAAN ASD− group, like the ASD+ groups, also scored lower in almost all domains compared to the other special needs group and the typically developing group.

The effect size or Cohen *d* for all statistically significant differences ($p < 0.05$) between groups are shown in Tables 2 and 3. There were no statistically significant changes to the unadjusted analyses after controlling for age at EDI assessment, sex, child's first language, average household income band quintile based on census geographic data, and presence of comorbid intellectual

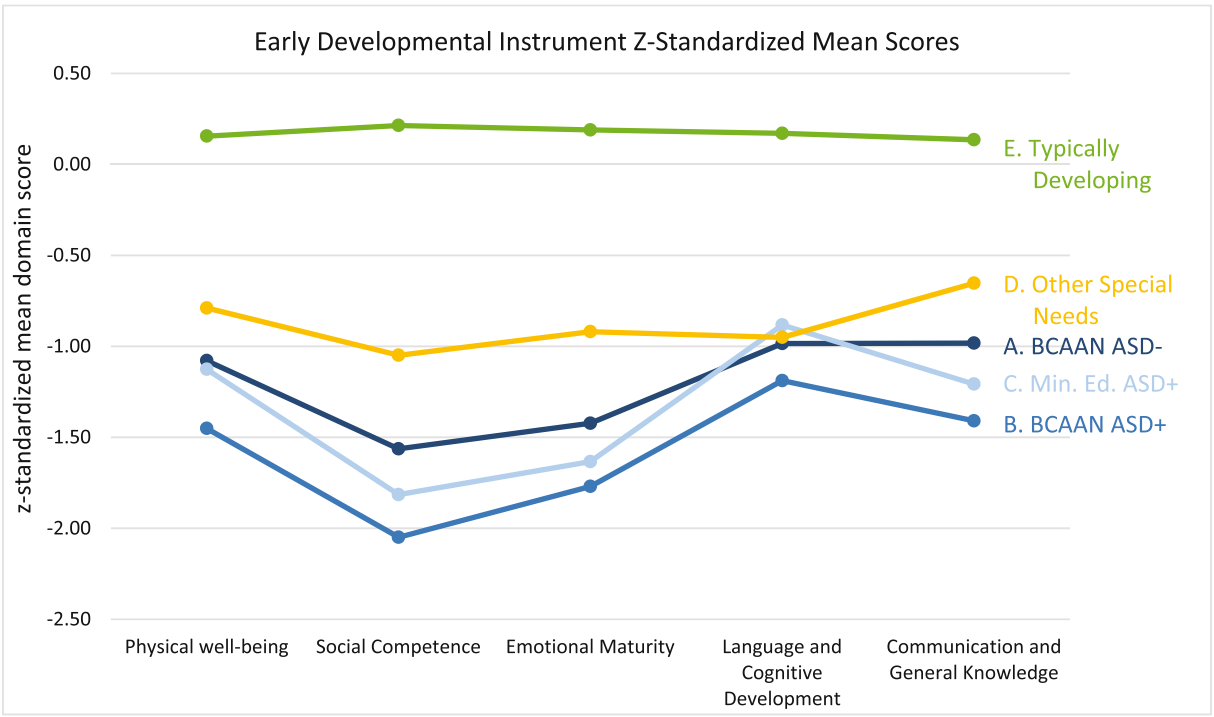

FIGURE 2 Main outcome scores—early developmental instrument z-standardized mean domain scores. (a) BCAAN ASD− ($n = 1131$). (b) BCAAN ASD+ ($n = 1583$). (c) Ministry of Education ASD+ ($n = 654$). (d) Other Ministry of Education special needs code ($n = 11,663$). (e) Typically developing ($n = 86, 708$). ASD, autism spectrum disorder; BCAAN, BC Autism Assessment Network

TABLE 2 EDI domain score effect sizes for statistically significant differences between BCAAN ASD− and other groups

	BCAAN ASD− vs. BCAAN ASD +	BCAAN ASD− vs. other ASD+	BCAAN ASD− vs. other min. Ed. special needs designation	BCAAN ASD− vs. typically developing
Physical well-being	0.37	0.05[a]	−0.29	−1.23
Social competence	0.48	0.25	−0.51	−1.77
Emotional maturity	0.35	0.21	−0.50	−1.61
Language and cognitive development	0.20	−0.10[a]	−0.03[a]	−1.15
Communication and general knowledge	0.43	0.23	−0.33	−1.12

Abbreviations: ASD, autism spectrum disorder; BCAAN, BC Autism Assessment Network; EDI, early development instrument.
[a]No statistically significant difference (Tukey HSD $p > 0.05$).

TABLE 3 EDI domain score effect sizes for statistically significant differences for ASD+ groups

	BCAAN ASD+ vs. other ASD+	BCAAN ASD+ vs. other special needs	BCAAN ASD+ vs. typically developing	Other ASD+ vs. other special needs	Other ASD+ vs. typically developing
Physical well-being	−0.32	−0.66	−1.61	−0.34	−1.28
Social competence	−0.23	−1.00	−2.26	−0.76	−2.02
Emotional maturity	−0.14	−0.85	−1.96	−0.71	−1.82
Language and cognitive development	−0.31	−0.24	−1.36	+0.07[a]	−1.05
Communication and general knowledge	−0.20	−0.76	−1.54	−0.55	−1.34

Abbreviations: ASD, autism spectrum disorder; BCAAN, BC Autism Assessment Network; EDI, early development instrument.
[a]No statistically significant difference (Tukey HSD $p > 0.05$).

disability. Table 2 shows that the BCAAN ASD− group had slightly higher scores compared to the BCAAN ASD+ group with medium effect sizes in all domains ($d = 0.35$–0.48) except for language and cognitive development, where there was a small effect size ($d = 0.2$). When comparing the BCAAN ASD− group and Other ASD+ group, the statistically significant differences between the children were in the social competence, emotional maturity, and communication and general knowledge domains, with the BCAAN ASD− group scoring slightly higher; the effect size was small for all three domains ($d = 0.21$–0.25). The BCAAN ASD− group scored lower in all domains compared to the typically developing group with large effect sizes, as did the BCAAN ASD+ and Other ASD+ group. Table 3 shows the results of the ASD+ groups compared to the other groups.

DISCUSSION

Our results from this population-based study of all children assessed for ASD at the BC Autism Assessment Network in British Columbia, Canada, revealed how similar the children who were assessed but not diagnosed with ASD are to the children who were found to be ASD positive, as measured by the Early Development Instrument at kindergarten. While there were statistically significant differences among the ASD− group and the ASD+ groups, these differences had only small to medium effect sizes across all domains. These findings suggest that although these children may differ diagnostically, from a functional point of view, children who have been assessed for ASD but not diagnosed may have comparable functional needs for developmental and learning supports as children who have been diagnosed with ASD. Indeed, other studies have found that diagnostic and functional status of children with neurodevelopmental disability often do not match, (Miller et al., 2013) although these studies have not focused on our study population.

Notably, children assessed at BCAAN (both ASD+ and ASD−) all had medium to large differences and lower domain scores compared to the other special needs group in all domains except for "language and cognitive development." This profile may be because the language and cognitive development domain captures more academic based skills such as numeracy, reading, and writing, and is less affected by difficulties in social communication, an impairment that often leads to a child being referred for an ASD assessment. The social competence, emotional maturity, and communication domains contain more questions related to impairments that overlap with ASD. The physical well-being domain contains questions about daily living skills and independence that are also often impaired in children with ASD, and in our study, these impairments are also found in the ASD− group.

Understanding ways in which these children do and do not differ in terms of developmental domains is important, as funding for extra assistance at school is often based on a neurodevelopmental diagnosis. As the data in Table 1 shows, even though the ASD− and ASD+ groups have similar functional profiles, the ASD+ groups are more likely to receive any additional Ministry of Education funding and more likely to receive a higher level of funding, which is used to provide these children with additional classroom supports. BCAAN ASD− children were more likely to be diagnosed with ICD codes for "hyperkinetic syndrome," suggestive of concerns for ADHD symptoms, and they were more likely to be prescribed a psychotropic medication, and a stimulant medication. This increased use of psychotropic medications in the BCAAN ASD− children may be indicative of ongoing challenging or pharmacotherapy-resistant behaviors that are difficult to manage without a clear diagnosis or behavioral supports. Children with ADHD or ADHD-type symptoms can also have significant functional challenges. Our results suggest that the BCAAN ASD− children have ongoing challenges but are not receiving diagnoses that make them eligible for additional school funding in the current system. This finding raises critical questions about equity in access to services. Further research should examine whether these children may benefit from additional funding and school support, given their similar functional profile to children with ASD (Kern et al., 2015; Matson et al., 2013).

The findings also illustrate some potentially important barriers to accessing ASD diagnostic assessments due to socio-economic factors and social determinants of health (Hertzman, 2009). In our population-based cohort, we found that children who were assessed or identified with a special need were more likely to speak English as their first language than typically developing children, suggesting that English-speaking families are more likely to successfully access diagnosis and receive school-based funding and supports. Moreover, the findings suggest that the children diagnosed with ASD outside of BCAAN, were, on average, more affluent than the children seen through BCAAN. Presumably, many of the families of children assessed outside of BCAAN were able to afford a private assessment, and thus avoided the wait times in the public system.

Our study is strengthened by its population-based nature. We also had access to high quality child-specific clinical diagnostic data on ASD diagnosis through our data linkage with the BC Autism Assessment Network (BCAAN), which made the comparison between children who ended up with an ASD diagnosis and those without possible. To our knowledge, no other study has made a population-based comparison of developmental domains of these groups of children at kindergarten age.

Our study is not without limitations. We are limited in our identification of other specific neurodevelopmental disorders in our BCAAN ASD− group, as there are no Ministry of Education codes for ADHD or language disorder, for example, and MSP ICD-9 codes may represent symptoms, concerns, or a diagnosis, and thus lack specificity. Children are also often identified by the Ministry of Education special needs code for the highest level of funding they are eligible for; therefore, this study would not capture children who might be eligible for multiple codes. It is also important to note that clustering at the level of the teacher could be playing a role in our results. We did not adjust our analyses for this possible clustering, and thus our standard errors are smaller than they would be had this clustering been accounted for. We are also limited by the lack of access to information regarding specific additional funding and interventions families may have received prior to school entry; therefore, we do not know which children may be accessing public or private therapy. Despite missing these data, the group profiles are quite similar at kindergarten age, but further follow-up will be required to reveal whether differences develop in later childhood. Furthermore, the EDI broad domains only provide a wide view of these children's developmental profiles, and further exploration into specific sub-domains may reveal clearer differences between the ASD− and ASD+ groups. However, the similarities of these broad profiles, in combination with the differences in education funding and socio-economic factors, highlights important questions around health services, funding, and equity.

CONCLUSION

Our study reveals that children who were assessed as ASD− and children who were assessed as ASD+ at the BC Autism Assessment Network by practitioners trained in the diagnosis of ASD, are rated as very similar across five developmental domains by their kindergarten teacher. These children share significantly more difficulties than typically developing children, suggesting that both groups of children may need similar levels of support at school entry, yet levels of school-based funding differed between ASD+ and ASD− children. This critical gap in support for the children who were assessed for ASD but found to be ASD− should shape future research and policies.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from Population Data BC. The data are not publicly available due to privacy and ethical restrictions. Access to data provided by the Data Stewards is subject to approval, but can be requested for research projects through the Data Stewards or their designated service providers. All inferences, opinions, and conclusions drawn in this publication are those of the authors, and do not reflect the opinions or policies of the Data Stewards.

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