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The role of intellectual disability with autism spectrum disorder and the documented cooccurring conditions: A population-based study

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Abstract

Previous research has identified that patterns of cooccurring conditions (CoCs) associated with autism spectrum disorder (ASD) differ based on the presence of intellectual disability (ID). This study explored the association of documented CoCs among 8-year-old children with ASD and ID (ASD+ID, $n = 2416$) and ASD without ID (ASD−ID, $n = 5372$) identified by the Autism and Developmental Disabilities Monitoring Network, surveillance years (SYs) 2012 and 2014. After adjusting for demographic variables, record source, surveillance site, and SY, children with ASD+ID, as compared with children with ASD−ID, were more likely to have histories of nonspecific developmental delays and neurological disorders documented in their records but were less likely to have behavioral and psychiatric disorders. ID plays a key role on how children with ASD would experience other CoCs. Our results emphasize how understanding the pattern of CoCs in ASD+ID and ASD−ID can inform comprehensive and multidisciplinary approaches in assessment and management of children in order to develop targeted interventions to reduce possible CoCs or CoCs-related impairments.

Lay Summary

CoCs are common among children with either ASD or ID which can complicate diagnosis and treatment decisions. We compared these CoCs in children with ASD and ID and children with ASD without ID. Our results suggest that children with ASD and ID are more likely to have histories of nonspecific developmental delays and neurological disorders but were less likely to have behavioral and psychiatric conditions compared with children with ASD but not ID.

[†]This article is dedicated to the memory of our dear colleague Li-Ching Lee who passed away on May 20, 2021.

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SUPPORTING INFORMATION Additional supporting information can be found online in the Supporting Information section at the end of this article.

Keywords

autistic disorder; autism spectrum disorder; developmental disabilities; intellectual disability; nervous system diseases

INTRODUCTION

There is substantial variability in the clinical manifestations of autism spectrum disorder (ASD), despite being defined by a core set of social and communication deficits and restricted and repetitive behaviors. The importance of cooccurring conditions (CoCs), such as intellectual disability (ID) and psychiatric conditions, in influencing the clinical manifestation of ASD has been well documented (Doshi-Velez et al., 2014; Grzadzinski et al., 2013; Miles et al., 2005; Siegel, 2018; Simonoff et al., 2008). CoCs are common in ASD, with estimates that over 70% of children with ASD have a cooccurring psychiatric or neurodevelopmental diagnosis (Mannion & Leader, 2013; Mattila et al., 2010; Simonoff et al., 2008). CoCs encompass different aspects of health, including medical and neurological conditions (Doshi-Velez et al., 2014; Feliciano et al., 2019; Kohane et al., 2012), psychiatric diagnoses (Mannion & Leader, 2013; Mattila et al., 2010; Simonoff et al., 2008), developmental delays and impairments (Levy et al., 2010; Mannion & Leader, 2013), and challenging behaviors (Hill et al., 2014). Clustering of these conditions with ASD has also been repeatedly reported in the literature (Fulceri et al., 2016; Levy et al., 2010; Lundström et al., 2015; Soke et al., 2018). A study analyzed earlier data from the Autism and Developmental Disabilities Monitoring Network (ADDM) surveillance year (SY) 2002 and reported that more than 80% of 8-year-old children identified with ASD presented at least one cooccurring developmental condition; of which 10% had at least one psychiatric condition and 16% presented at least one cooccurring neurological condition (Levy et al., 2010). Another study analyzing data from ADDM SY2010 also confirmed the clustering of CoCs and identified at least one cooccurring psychiatric, developmental, or neurologic condition in more than 95% of children (Soke et al., 2018).

Prevalence of specific CoCs varies significantly across studies (Mannion & Leader, 2013) and can be influenced by study methods including type of sample (clinic-referred or population samples) and how diagnoses are categorized and defined. Patterns of CoCs appear to differ based on the presence of ID in children with ASD. The ADDM Network has reported a significant decrease in prevalence of ID among 8-year–old children with ASD over time, from 47% in SY2002 to 33% in SY2016 (Maenner et al., 2020), with the most recent estimate of 35% in SY2018 (Maenner et al., 2021) (Autism and Developmental Disabilities Monitoring Network Surveillance Year 2002 Principal Investigators & Centers for Disease Control and Prevention, 2007; Maenner et al., 2020). However, children with ASD and ID (referred to as ASD+ID) continue to represent a significant proportion of the ASD population and yet remain understudied compared with children with ASD without ID (referred to as ASD−ID) (Siegel, 2018). Children with ASD+ID face additional complexities compared with children with ASD−ID. Researchers have examined the role of ID in ASD and the ASD phenotype in a variety of ways. In an effort to define phenotypes that might yield genetic findings, Miles et al., 2005 defined two subgroups of ASD, complex, which

is defined as children with a significant number of physical anomalies and/or microcephaly, and essential, in which no physical anomalies are present, and found that children with complex ASD demonstrated lower IQ levels, higher rates of seizures, and pathological EEG and MRI findings compared with children with essential autism (Miles et al., 2005). In a study that used electronic medical records to identify clusters of CoCs in patients with ASD, three clusters were identified based on prevalence of CoCs (Doshi-Velez et al., 2014). Two of the clusters included high rates of children with ASD+ID: one cluster was characterized by seizures present in 77.5%, and the other characterized by multisystem disorders, such as gastrointestinal conditions, cardiac conditions, and vision and hearing anomalies. These two clusters had lower rates of psychiatric diagnoses compared with a third cluster, which was characterized by low presence of ID and high presence of psychiatric conditions. Children with ASD+ID were reported to have a higher risk of behavioral problems such as self-injury, abnormal fear, and eating abnormalities (including pica and being a “picky eater”) (Kurzius-Spencer et al., 2018). It is critical to address that the deficits in social, adaptive, and communication skills can be more severe when both ASD and ID are present (Matson et al., 2009). Furthermore, the presence of ID with neurobehavioral conditions in ASD complicates the diagnosis as well as the treatment time and course (Close et al., 2012; Rieske et al., 2015; Wu et al., 2016). Past studies examining patterns of CoCs in ASD presented mixed results and had several limitations such as using clinicalreferred samples rather than population-based samples, using only parental report for the diagnosis, and investigating only specific or a limited range of CoCs. This present work investigates a population based sample, which will give us a more representative picture in the patterns of documented CoCs in children with ASD+ID and compared with children with ASD−ID.

What we know in the literature highlights the need to investigate the role of ID in ASD by investigating the presence of CoCs among children with ASD+ID and children with ASD−ID. Identifying clinical subgroups or trajectories in ASD may point to distinct etiologies and targeted treatments.

METHODS

Study design

This study utilized a retrospective cross-sectional population-based design, analyzing data from the ADDM SYs 2012 and 2014.

Data source and determination of ASD status and CoCs

ADDM is an ongoing multisource active surveillance system tracking the biennial prevalence of ASD in children in different communities in the US since 2000. All surveillance sites functioned as public health authorities under the Health Insurance Portability and Accountability Act of 1996 Privacy Rule and met applicable local institutional review board, privacy, and confidentiality requirements under 45 CFR 46. Details of ADDM’s methodology can be found in previous publications (Christensen et al., 2018; Soke et al., 2017; Van Naarden Braun et al., 2007). Only children with confirmed ASD case status were included in this analysis. The ADDM Network is funded by the Centers for Disease Control and Prevention (CDC) and included nine sites that participated

in both 2012 and 2014 (Arkansas, Arizona, Colorado, Georgia, Maryland, Missouri, North Carolina, New Jersey, Wisconsin). Two sites (South Carolina and Utah) participated in SY2012 only, and two sites (Minnesota and Tennessee) participated in SY2014 only, for a total of 13 sites. Children from study sites participating in both ASD and ID surveillances are included to ensure full access to ID data. The total numbers of children were 3734 and 4154 in SY2012 and SY2014, respectively. Educational records were reviewed and abstracted from children who had ever received special education services, whereas health records were reviewed and abstracted from health sources who provide assessments, diagnosis, and treatments for neurodevelopmental disabilities (including ASD). Trained abstractors reviewed records for the presence of documented behavioral descriptors associated with DSM-IV-TR diagnoses of autistic disorder, Asperger syndrome, or pervasive developmental disorder not otherwise specified (PDD-NOS; APA, 2000). Information abstracted from records that contained a behavioral descriptor (e.g., poor eye contact, lack of interest in peer interaction, visual fascination with objects) included verbatim developmental histories, descriptions of ASD symptoms, descriptions of other behaviors and features often associated with ASD, results of developmental tests, and documentation of a clinical ASD diagnosis or special education eligibility statement. Abstractors also abstracted documented diagnostic statements regarding any non-ASD diagnoses documented in the evaluation reports, including additional psychiatric diagnoses, special education eligibility categories, medical conditions, and so forth. Abstracted information was combined into a composite record, which was then reviewed by a clinician reviewer to determine ASD case status. If a child was documented as exhibiting behaviors, any time from birth through age 8, that were consistent with DSM-IV-TR diagnostic criteria for autistic disorder, Asperger syndrome, or PDD-NOS, the child met ADDM's ASD surveillance case definition. This process allowed ASD case status to be based on whether the behaviors and symptoms documented in a child's records supported the presence of ASD rather than whether a formal diagnosis of ASD was given. During the clinician review, all COCs (including ID and ASD) documented from birth to 8 years were reviewed. While ASD case status was reviewed and confirmed, the CoCs were not reviewed clinically in the same manner, and were simply documented if formally diagnosed within the records up to and including age 8.

Key variables, cooccurring conditions

Demographic variables—Demographic variables included SY, site, record source (education records, health records, or both), child race/ethnicity, and child sex (Table 1). Because of potential differences in diagnostic practices across sites, SY, and evaluation source, as well as previously documented differences in ASD prevalence by child sex and race/ethnicity, we adjusted these variables in the analysis.

ID status—Children with ASD were grouped based on presence of ID: children with ASD and ID (ASD+ID) and children with ASD without ID (ASD−ID). ID diagnosis was determined based on the most recent IQ score in a child's record (either education or health records), where IQ score ≤ 70 was determined as ID. IQ score is based on full scale IQ/adaptive scores when available for most tests. If an overall score from an IQ test was not available, nonverbal subscale was used. It should be noted that our study comprises children who were included in both ASD and ID surveillances; 42.8% of children with ASD in

SY2012 and SY2014 had missing IQ data and were not included in the analysis. IQ scores are missing for some children in ADDM for a variety of reasons, one being that IQ testing was never performed, the information could be missing from the record or that the site might not have access to all the information from a source.

CoCs—The CoCs categories are listed in Table 2. CoCs were classified into four categories. Three categories, including developmental diagnoses, psychiatric diagnoses, and neurologic diagnoses were based on a previous publication (Levy et al., 2010). An additional category of nonspecific developmental delays was created which included all documented nonspecific developmental delays to avoid a bias in the analysis since these nonspecific developmental delays might be features of ASD and/or ID rather than distinct conditions. Therefore, we aimed to see the association of nonspecific developmental delays and the non-ASD developmental diagnoses separately. The exact timing of different CoCs were not available.

Data analysis—The statistical software R version 3.6.3 and Stata Version 15.1 were used to perform the statistical analysis (R: The R Project for Statistical Computing, 2020; StataCorp., 2017). We performed descriptive statistics including race/ethnicity, surveillance site, SY, data source, and CoCs. Bivariate logistic regression was used to investigate the association of each CoCs with presence or absence of ID. Multivariable logistic regressions were performed to estimate the adjusted association between CoCs and ID status, adjusting for race/ethnicity, record source, SY, and surveillance site. Odds ratios (OR) and the 95% confidence intervals (CI) were calculated to demonstrate the association between each condition and ASD+ID compared with the reference group ASD−ID. In addition, we performed a secondary analysis for major categories stratified by study site to demonstrate the site-to-site variability adjusting for race/ethnicity, record source and SY.

RESULTS

The distribution of sociodemographic characteristics and frequencies of reported CoCs by study group (ASD+ID and ASD−ID) are presented in Tables 1 and 3. Across two SYs, a total of 7788 8-year-old children, with 6371 males (81.8%) and 1417 females (18.2%), were included in ASD and ID surveillance. The ASD+ID group is composed of 2416 (31.0%) children, and the ASD−ID group is composed of 5372 (69.0%) children. Both groups were significantly different in sex and race, with more males with white race in the ASD−ID group. In addition, both groups were significantly different in source type and study site but they did not differ by SY. In both groups, the most prevalent nonspecific developmental condition was delayed language (81.9% in ASD+ID and 70.4% in ASD−ID) and the most prevalent non-ASD developmental condition was ADHD (13.5% in ASD+ID and 29.7% in ASD−ID). The most prevalent noted psychiatric condition in ASD+ID group was behavior disorder (5.7%) whereas anxiety (9.8%) was the most prevalent psychiatric condition in ASD−ID group. Epilepsy was the most prevalent reported neurological diagnosis (6.9%) among all children with ASD+ID whereas encephalopathy was the most prevalent documented neurological diagnosis in ASD−ID.

The CoCs and their associations with ASD+ID are reported in Table 3. Statistical analysis was performed for diagnoses with a sample size of ≥5 in males and females. After adjusting for child race/ethnicity, record source, SY, and surveillance site, the nonspecific developmental delays and neurologic diagnoses demonstrate stronger association with ASD+ID group than ASD−ID group, whereas the non-ASD developmental diagnosis and psychiatric diagnoses demonstrate weaker association with ASD+ID group than ASD−ID group. More specifically, in the category of nonspecific developmental delays, the odds of being diagnosed with DD-adaptive (OR = 1.73, 95% CI [1.54, 1.94]), DD-cognitive (OR = 2.59, 95% CI [2.31, 2.91]), DD-general (OR = 3.06, 95% CI [2.57, 3.40]), DDlanguage (OR = 1.68, 95% CI [1.48, 1.91]), DD-motor (OR = 1.45, 95% CI[1.31, 1.61]), and DD-play (OR = 2.25, 95% CI[1.77, 2.88]) was higher in the ASD+ID group compared with the ASD−ID group. In the non-ASD developmental diagnosis category, the odds of documented sensory integration disorder (OR = 0.80, 95% CI [0.66, 0.96]), ADHD (OR = 0.37, 95% CI [0.32, 0.42]), and learning disorder (OR = 0.31, 95% CI [0.23, 0.42]) was lower in children with ASD+ID than in the ASD−ID group.

With regards to psychiatric diagnoses, the odds of being diagnosed with anxiety disorder (OR = 0.35, 95% CI [0.27, 0.45]), mood disorder (OR = 0.46, 95% CI [0.30, 0.69]), and oppositional defiant disorder (OR = 0.52, 95% CI [0.37, 0.75]) was lower in ASD+ID group than the ASD−ID group. In the category of neurologic diagnoses, the odds of having the conditions cerebral palsy (OR = 2.10, 95% CI [1.28, 3.43]), encephalopathy (OR = 1.55, 95% CI [1.17, 2.06]), epilepsy (OR = 2.78, 95% CI [2.18, 3.55]), hearing loss (OR = 2.04, 95% CI [1.37, 3.02]), and visual impairment (OR = 1.83, 95% CI [1.23, 2.72]) was higher in ASD+ID group compared with the ASD−ID group.

The secondary analysis stratified by site demonstrates the site-to-site variability in CoCs in ASD+ID. The details can be seen in the Table S1.

DISCUSSION

In this analysis of a population sample of children with ASD with and without ID, we found that children with ASD+ID were more likely to have nonspecific developmental delays and neurologic diagnoses (including epilepsy) documented in their records but were less likely to have non-ASD developmental disorders and psychiatric disorders compared with children with ASD−ID. Children with ASD+ID had higher odds of being diagnosed with developmental delays of any kind compared with children with ASD−ID. This finding is consistent with previous work identifying the presence of early developmental delays in children with ASD+ID (Salazar et al., 2015). By definition, ID requires the presence of delays in cognitive and adaptive skill development, so it is expected that these features would be captured in evaluation records.

In the non-ASD developmental diagnosis category, children in ASD+ID group were less likely to have sensory integration disorder, ADHD, and learning disorder documented in their records than the ASD−ID group. While not recognized as a clinical diagnosis, sensory integration disorder has been frequently described in children with ID as well as with ASD (APA, 2013; Engel-Yeger et al., 2016; Kiani & Miller, 2010; Levy et al., 2010). By contrast

to the previous literature demonstrating that impaired sensory processing is independent of IQ in children with ASD (Boyd et al., 2010; Green et al., 2016; Kurzius-Spencer et al., 2018), our results indicate an association of IQ with sensory integration disorder. Some investigators described an association of lower IQ in ASD with ADHD than ASD without ADHD in clinical samples (Craig et al., 2015; Muratori et al., 2019). Others indicate that the prevalence of cooccurrent ADHD is high irrespective of IQ level, and ID is a predictor of ADHD symptoms in ASD (Lamanna et al., 2017; Mayes et al., 2012). The contrast between the current study's findings and these findings can be explained by the population investigated in the study.

Finally, children with ASD+ID were less likely to be diagnosed with learning disorder. This may be because the diagnosis of ID already explained the learning deficits. In addition, a diagnosis of learning disability is made based on a significant discrepancy between IQ and academic achievement, and children with ID may not have shown discrepancies between their cognitive skills and academic achievement.

In the psychiatric diagnosis category, children with ASD+ID were less likely to have mood disorder, anxiety disorder, and oppositional defiant disorder. The relationship between ID and psychiatric disorders in ASD has mixed results in the previous literature. Our results are in line with previous reported population-based studies that found decreased depression and mood disorders in children with ASD+ID compared with those without ID (Kurzius-Spencer et al., 2018; Rai et al., 2018). On the other hand, another study conducted with clinic-referred preschoolers observed a strong association between affective symptoms and lower performance IQ in ASD children (Muratori et al., 2019). Still other studies did not identify any relationship with affective symptoms and ID in children with ASD (Goldin et al., 2014; Tureck et al., 2014). In both of the latter studies, small sample sizes as well as definition of mood symptoms might have led to the failure to find a relationship between ID and depression. There is also evidence that children with ASD+ID are less likely to have documented anxiety. Two clinical studies reported a decreased risk of anxiety in children with ASD+ID compared with ASD−ID (Mayes et al., 2011; Salazar et al., 2015). A longitudinal study also reported a decreased risk of anxiety and depression in children with ASD+ID (Estes et al., 2007).

Our findings indicate that children with ASD+ID are less likely to have documented oppositional defiant disorder. A previous ADDM study reported no differences in argumentative/oppositional/defiant behavior and temper tantrums in ASD+ID compared with ASD−ID (Kurzius-Spencer et al., 2018) whereas studies of clinic-referred children reported higher rates of aggression and temper tantrums in children with ASD+ID compared with ASD−ID (Estes et al., 2007; Tureck et al., 2014). However, a study conducted in toddlers with ASD identified higher rates of over-reactivity and tantrum behaviors in ASD−ID compared with ASD+ID (Cervantes et al., 2014), and a clinic-referred sample reported no association between ID and temper tantrums in children with ASD (Goldin et al., 2014).

Among the category of neurologic diagnoses, the odds of receiving a diagnosis for cerebral palsy, encephalopathy, epilepsy, hearing loss, or visual impairment was higher in ASD+ID

compared with ASD−ID. Our findings support the previous literature identifying a subgroup in autism with ID and higher rates of medical and neurological CoCs compared with children with ASD−ID (Doshi-Velez et al., 2014; Flor et al., 2017; Miles et al., 2005, 2008; Shapira et al., 2019).

Finally, there were significant differences in the findings if stratified by study site, which may reflect differences in state policy and practices, as well as differences in sites' access to educational records. It seems to be a layer of complication that factors outside of the child could also be impacting diagnostic decision-making process.

In sum, the pattern of these results suggests that differences in verbalization, recognition, and experiencing of conditions in ASD−ID versus ASD+ID may lead to the differences in reporting CoCs. Low verbal and cognitive skills may decrease the ability to report and detect anxiety and depression symptoms in children with ASD+ID. Children with ASD+ID may have difficulties to express their symptoms due to their less developed verbal and cognitive skills. In addition, manifestation of anxiety and depression may differ in children with ASD+ID compared with ASD−ID which may complicate to recognize and misclassify these symptoms (Estes et al., 2007; Mayes et al., 2011; Rai et al., 2018). In addition, considering overall developmental level complicates the picture in determining ADHD in ASD+ID. ADHD may have been lower in the ASD+ID group because clinicians were considering the developmental level and deciding the attention/hyperactivity issues were in keeping with overall development. It's also possible that ID overshadows the other diagnoses, which may or may not lead to accurate identification (or ruling out) of ADHD. Therefore, our study may increase the awareness of associated conditions in ASD+ID so that further clinical and research should focus on developing specific assessments for validated screening and diagnostic tools that capture anxiety and depression symptoms in subgroups of ASD.

Although this is the first study investigating the association of a large number of documented CoCs in ASD+ID and ASD−ID in a large population-based sample, our findings reported herein should be interpreted with a few limitations. First, the study is conducted with cross-sectional surveillance data, which do not allow us to examine the temporal and causal relationship between CoCs in ASD+ID. Second, we selected the children in the ASD+ID group based on their IQ scores. We did not have information about the severity of impairment based on adaptive functioning such as conceptual, social, and practical skills, which might also play a role in association with the cooccurrence of CoCs. Third, a potential measurement error in the assessment of CoCs is another limitation. CoCs were not directly and systematically assessed, and we relied on the documentation in the records of children; therefore, we do not know how the providers arrived at their diagnoses and the reliability and validity of the approach in their assessment. In addition, the lack of information on timing of CoCs relative to ID/ASD diagnosis is another limitation to be mentioned. In addition, we might have missed CoCs in our sample of children with ASD if the relevant records were not available for abstraction and review process. Finally, we did not have detailed information on the timing of CoCs diagnosis. As these CoCs were identified at any point between birth and age 8, some of these diagnoses may have been subsequently ruled out, resolved over time, or replaced by ASD. In particular, nonspecific developmental conditions may have been assigned prior to formal assessment of ASD, and

then later attributed to ASD rather than representing distinct “cooccurring” conditions. It is also possible that ASD and CoCs detected in an evaluation may not be present in a later evaluation, and if the later evaluation was not available for us, we could have overestimated the CoCs. Despite this limitation, capturing the CoCs from birth to age 8 provides us with a picture of the diversity and complexity of the psychopathology of children with ASD+ID. This study contributes to the current knowledge base in that our study sample is not confined to one dataset or health system (or a clinic-referred sample with top-notch research reliable clinicians) but rather is representative of community practices in multiple regions of the US. In addition, we were able to access educational as well as medical records, which better captures underrepresented populations (Esler et al., 2022). This study depicts the information about what diagnoses are being assigned to children with autism with and without ID. As mentioned above, some of our findings did not line up with previous studies which shows the difficulties of differential diagnosis in the context of autism and especially autism with ID. In addition, clinic-referred studies support the lack of consensus on diagnosing these reported conditions in autism. Reaching a consensus to improve accuracy and consistency in diagnosis of CoCs is needed: particularly in the presentation of anxiety and depression in autism, ID, and autism with ID, assigning diagnoses of ADHD and Oppositional defiant disorder within the context of general developmental level, and also the challenging nature of Sensory processing disorder that it does not exist as a diagnosis and there is inconsistency across clinicians as to whether it is its own disorder or a core feature of autism. Therefore, our findings may shine on all of these mentioned areas that have not been well resolved within research or clinical practice.

CONCLUSION

We found that children with ASD+ID were more likely to have DD and neurologic diagnoses (including epilepsy) documented in a population level study but were less likely to have non-ASD developmental disorders and psychiatric disorders in their records compared with children with ASD−ID. Our results support that patterns of CoCs vary differently within ASD+ID versus ASD−ID and points to differences in the underlying biology with increased ID (Miles et al., 2005) as well as differences in verbalization, recognition, and experiencing of conditions in ASD+ID versus ASD−ID. Results emphasize how understanding the pattern of CoCs in ASD+ID and ASD−ID can inform comprehensive and multidisciplinary approach in assessment and management of children with ASD+ID and ASD−ID. Therefore, our study may increase the awareness of associated conditions in ASD+ID so that further clinical and research should focus on developing specific assessments for validated screening and diagnostic tools that capture anxiety and depression symptoms in subgroups of ASD. In addition, longitudinal studies in children with ASD+ID could investigate the temporal and causal relationship of CoCs in ASD+ID to detect changes in a more accurate way as well as develop preventive interventions. The identification of CoCs, particularly behavioral and psychiatric conditions at an early stage in ASD+ID, would have implications for the clinical assessment, individualized treatments, and education programs for interventions to maximize potential of affected children. Specific diagnostic tools and treatments for this subgroup of children with ASD+ID could be developed to identify behavioral and psychiatric conditions at early stage.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from CDC. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from the author(s) with the permission of CDC.

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TABLE 1

Sociodemographic characteristic of children with autism spectrum disorder by intellectual disability (ID) in ADDM network surveillance year 2012 and 2014

Total sample size	**ASD+ID *n* = 2416 *n* (%)**	**ASD−ID *n* = 5372 *n* (%)**	***p*-value for the Pearson's chi-square test**
Child sex			<0.001
Male	1887 (78.1)	4484 (83.5)	
Female	529 (21.9)	888 (16.5)	
Surveillance year			0.473
2012	1173 (48.5)	2561 (47.7)	
2014	1243 (51.5)	2811 (52.3)	
Race/Ethnicity			<0.001
Black	732 (30.3)	874 (16.3)	
Hispanic	435 (18.0)	818 (15.2)	
White	986 (40.8)	3175 (59.1)	
Other	263 (10.9)	505 (9.4)	
Source type			<0.001
Education only	653 (27.0)	1906 (35.5)	
Health only	634 (26.3)	1488 (27.7)	
Health and education	1114 (46.1)	1928 (35.9)	
Unknown	15 (0.6)	50 (0.9)	
Site			<0.001
Arkansas	217 (9.0)	362 (6.7)	
Arizona	195 (8.1)	516 (9.6)	
Colorado	155 (6.4)	559 (10.4)	
Georgia	488 (20.2)	901 (16.8)	
Maryland	124 (5.1)	241 (4.5)	
Minnesota	49 (2.0)	172 (3.2)	
Missouri	45 (1.9)	154 (2.9)	
North Carolina	343 (14.2)	709 (13.2)	
New Jersey	330 (13.7)	918 (17.1)	
South Carolina	112 (4.6)	135 (2.5)	

Total sample size	ASD+ID *n* = 2416 *n* (%)	ASD−ID *n* = 5372 *n* (%)	*p*-value for the Pearson's chi-square test
Tennessee	104 (4.3)	166 (3.1)	
Utah	63 (2.6)	252 (4.7)	
Wisconsin	191 (7.9)	287 (5.3)	

TABLE 2

Classification of the cooccurring conditions

Category[a]	Conditions
Nonspecific developmental delays	Developmental delay (DD) in adaptive behavior (DD-adaptive), in cognitive function (DD-cognitive), in general (DD-general), in language (DD-language), in motor function (DD-motor), in play (DD-play), in social function (DD-social)
Non-ASD developmental diagnoses	Attention-deficit/hyperactivity disorder (ADHD), learning disorder, nonverbal learning disorder, and sensory integration disorder
Psychiatric diagnoses	Mood disorder, depression, bipolar disorder, anxiety disorder, emotional disorder, psychosis, schizophrenia, oppositional defiant disorder, conduct disorder, mutism, behavior disorder, reactive attachment disorder, obsessive–compulsive disorders, and personality disorder
Neurologic diagnoses	Epilepsy, encephalopathy, cerebral palsy, traumatic brain injury, brain injury, Tourette's syndrome/tics, visual impairment, and hearing loss

[a]Categories developmental diagnoses, psychiatric diagnoses, neurologic diagnoses were taken from the publication (Levy et al., 2010).

TABLE 3

Associations between cooccurring conditions and intellectual disability status among children with autism spectrum disorder

Variable	ASD+ID (*n*= 2416) *n* (%)	ASD−ID (*n*= 5372) *n* (%)	OR (95% CI) unadjusted	OR (95% CI) adjusted[a]
Nonspecific developmental delays				
DD, Adaptive	967 (40.0)	1403 (26.1)	**1.89 (1.70, 2.09)**	**1.73 (1.54, 1.94)**
DD, Cognitive	1075 (44.5)	1177 (21.9)	**2.86 (2.58, 3.17)**	**2.59 (2.31, 2.91)**
DD, General	1332 (55.1)	1436 (26.7)	**3.37 (3.05, 3.72)**	**3.06 (2.75, 3.40)**
DD, Language	1978 (81.9)	3780 (70.4)	**1.90 (1.69, 2.14)**	**1.68 (1.48, 1.91)**
DD, Motor	1177 (48.7)	2181 (40.6)	**1.39 (1.26, 1.53)**	**1.45 (1.31, 1.61)**
DD, Play	145 (6.0)	154 (2.9)	**2.16 (1.71, 2.73)**	**2.25 (1.77, 2.88)**
DD, Social	774 (32.0)	1491 (27.8)	**1.23 (1.10, 1.36)**	1.09 (0.97, 1.22)
Non-ASD developmental diagnoses				
ADHD	326 (13.5)	1594 (29.7)	**0.37 (0.32, 0.42)**	**0.37 (0.32, 0.42)**
Sensory integration disorder	234 (9.7)	626 (11.6)	**0.81 (0.69, 0.95)**	**0.80 (0.66, 0.96)**
Learning disorder	52 (2.1)	365 (6.8)	**0.30 (0.22, 0.40)**	**0.31 (0.23, 0.42)**
Psychiatric diagnoses				
Anxiety disorder	78 (3.2)	527 (9.8)	**0.31 (0.24, 0.39)**	**0.35 (0.27, 0.45)**
Behavior disorder	139 (5.7)	276 (5.1)	1.13 (0.91, 1.39)	0.97 (0.77, 1.23)
Mood disorder	29 (1.2)	154 (2.9)	**0.41 (0.28, 0.61)**	**0.46 (0.30, 0.69)**
Oppositional defiant disorder	42 (1.7)	177 (3.3)	**0.52 (0.37, 0.73)**	**0.52 (0.37, 0.75)**
Neurologic diagnoses				
Cerebral palsy	34 (1.4)	35 (0.6)	**2.18 (1.35, 3.50)**	**2.10 (1.28, 3.43)**
Encephalopathy	120 (5.0)	178 (3.3)	**1.52 (1.20, 1.93)**	**1.55 (1.17, 2.06)**
Epilepsy	168 (6.9)	133 (2.5)	**2.94 (2.33, 3.71)**	**2.78 (2.18, 3.55)**
Hearing loss	53 (2.2)	56 (1.0)	**2.13 (1.46, 3.11)**	**2.04 (1.37, 3.02)**
Visual impairment	53 (2.2)	57 (1.1)	**2.09 (1.43, 3.05)**	**1.83 (1.23, 2.72)**
≥ 1 Condition	2318 (95.9)	4996 (93.0)	**1.78 (1.42, 2.23)**	**1.60 (1.26, 2.04)**
≥ 1 Nonspecific DD	2279 (94.3)	4465 (83.1)	**3.38 (2.80, 4.07)**	**3.03 (2.49, 3.69)**
≥ 1 Non-ASD developmental diagnoses	536 (22.2)	2173 (40.4)	**0.42 (0.37, 0.47)**	**0.40 (0.35, 0.45)**
≥ 1 Neurologic diagnoses	358 (14.8)	438 (8.1)	**1.96 (1.69, 2.27)**	**1.95 (1.66, 2.30)**
≥ 1 Psychiatric diagnoses	257 (10.6)	1026 (19.1)	**0.50 (0.43, 0.58)**	**0.49 (0.42, 0.58)**

Note: Significant findings are bolded ($p < 0.05$). OR >1, condition more common among children with ID. OR <1, condition less common among children with ID.

Abbreviations: ADHD, attention-deficit/hyperactivity disorder; ASD, autism spectrum disorder; DD, developmental delay; ID, intellectual disability.

[a] Adjusted for race, record source, site, study year.