



Changes in Autism and Co-Occurring Conditions from Preschool to Adolescence: Considerations for Precision Monitoring and Treatment Planning

Lisa D. Wiggins^{1,7} · Katie Overwyk¹ · Patrick Powell¹ · Julie Daniels² · Carolyn DiGuseppi³ · Cy Nadler⁴ · Nuri Reyes³ · Brian Barger⁵ · Eric Moody⁶ · Karen Pazol¹

Accepted: 30 August 2024

This is a U.S. Government work and not under copyright protection in the US; foreign copyright protection may apply 2024

Abstract

Purpose To describe retention of an autism spectrum disorder (ASD) diagnosis from preschool to adolescence and the most common co-occurring diagnoses among children with ASD in preschool and adolescence. A second objective was to identify co-occurring diagnoses more likely to emerge between preschool and adolescence among children with ASD vs. another developmental or mental health diagnosis in preschool.

Methods Children completed a case-control study when they were between 2 and 5 years of age. Caregivers reported their child's diagnoses of ASD and attention deficit hyperactivity disorder (ADHD), any developmental delay (DD), epilepsy/seizure disorder, obsessive-compulsive disorder, sensory integration disorder, and speech/language disorder when the child was preschool age and, separately, during adolescence. Any anxiety and depression/mood disorder, intellectual disability (ID), and learning disability (LD) were considered only in adolescence.

Results 85.5% of preschool children retained their ASD diagnosis in adolescence. DD, sensory integration disorder, and speech-language disorder co-occurred in over 20% of preschool age children with ASD. These same conditions, along with anxiety disorders, ADHD, ID, and LD, co-occurred in over 20% of adolescents with ASD. Significantly more children with ASD vs. another developmental or mental health diagnosis in preschool gained diagnoses of ADHD, DD, sensory integration disorder, and speech-language disorder by adolescence.

Conclusion ASD is a highly stable diagnosis and co-occurring conditions are common. The prevalence of co-occurring diagnoses may depend on age, with some persisting from preschool to adolescence and others emerging over time. Health and education providers can use these findings to inform precision monitoring and treatment planning.

Keywords Autism · Co-occurring conditions · Monitoring · Trajectory · Treatment planning

✉ Lisa D. Wiggins
lwiggins@cdc.gov

- ¹ Centers for Disease Control and Prevention, Atlanta, GA, USA
- ² University of North Carolina Chapel-Hill, Chapel Hill, NC, USA
- ³ University of Colorado-Anschutz Medical Campus, Aurora, CO, USA
- ⁴ Children's Mercy Kansas City, Kansas City, MO, USA
- ⁵ Georgia State University, Atlanta, GA, USA
- ⁶ University of Wyoming, Laramie, WY, USA
- ⁷ NCBDDD/DHDD/CDC, 4770 Buford Highway, MS S106-4, Atlanta, GA, USA

Developmental disabilities are chronic conditions that manifest before 22 years of age and cause functional limitations in at least three major life activities (e.g., language, learning, and self-care) (American Psychiatric Association (APA), 2022). Symptoms of developmental disabilities persist into adulthood and require individually planned and coordinated services and supports (APA, 2022). Autism spectrum disorder (ASD) is one of the fastest growing developmental disabilities and was reported to affect one in 36 children aged 8-years in 2020 (Maenner et al., 2023; Zablotsky et al., 2019). The etiology of ASD is multifaceted and likely caused by diverse biological and environmental factors (Hyman et al., 2020).

Conditions that co-occur with ASD are common (Micai et al., 2023). Previous estimates suggest that more than 90% of children with ASD ages 3–17 years have at least one co-occurring condition (Close et al., 2012). Frequent co-occurring conditions in preschool children with ASD are any developmental delay (DD) and speech-language disorder (Close et al., 2012; Soke et al., 2018); conditions that may emerge over time include attention deficit hyperactivity disorder (ADHD) and anxiety disorders (Soke et al., 2018). Understanding the prevalence and trajectory of ASD and co-occurring diagnoses can inform precision monitoring and treatment planning at different stages of development.

Our objectives were to describe retention of an ASD diagnosis and the most common co-occurring diagnoses among children with ASD in preschool and adolescence. A second objective was to identify co-occurring diagnoses more likely to emerge between preschool and adolescence among children with ASD compared to children with other developmental or mental health diagnosis in preschool.

Methods

Preschool Data Collection

The Study to Explore Early Development is a case-control study of ASD sponsored by the Centers for Disease Control and Prevention (CDC). Phase 1 (SEED1) was conducted in communities in California, Colorado, Georgia, Maryland, North Carolina, and Pennsylvania. Eligible children were 2–5 years old, born and resided in one of the study catchment areas, and lived with a caregiver who spoke English or, in California and Colorado, English or Spanish. The SEED1 protocol was approved by Institutional Review Boards (IRBs) at CDC and each site.

Children with ASD and related conditions were identified from health and education providers. Children in a population comparison sample were identified from state vital records. Data collection included a caregiver telephone interview (99% of respondents were mothers) that asked if a health provider diagnosed the index child with ASD, or one of the following used to define co-occurring conditions in preschool: ADHD, DD, epilepsy/seizure disorder, obsessive-compulsive disorder, sensory integration disorder, or speech-language disorder. SEED1 procedures are detailed in Schendel et al., 2012.

Adolescent Data Collection

Caregivers who participated in SEED1 in Georgia, Maryland, North Carolina, and Pennsylvania and agreed to future contact were asked to complete a survey about their child's

health and development when their children were 12–16 years old, herein referred to as SEED Teen. The SEED Teen protocol was approved by IRBs at CDC and sites collecting survey data (i.e., Georgia and North Carolina).

The SEED Teen survey also asked caregivers if a health provider diagnosed their adolescent with ASD or another condition. Co-occurring conditions in adolescence were defined as any of the co-occurring conditions collected in SEED1, any anxiety or depression/mood disorder (not collected in SEED1), intellectual disability (ID), or learning disability. The SEED Teen survey did not probe specific anxiety or mood disorders and instead asked parents only about general categories of these mental health conditions. ID and learning disability were considered in adolescence, but not in preschool, since academic and cognitive skills are still rapidly developing between 2 and 5 years of age. Positive endorsement of a current diagnosis was used to classify ASD and co-occurring diagnoses in adolescence.

Statistical Analyses

For the first objective, the presence of an ASD diagnosis in both preschool and adolescence indicated retention of an ASD diagnosis. The prevalence of co-occurring diagnoses was calculated for children with ASD in preschool and, separately, in adolescence. Common co-occurring diagnoses were defined as those present in over 20% of the sample, which is higher than the prevalence of at least one developmental disability or mental health diagnosis in general population samples of children 3–17 years of age (Ghandour et al., 2019; Li et al., 2023; Zablotsky et al., 2019).

For the second objective, only co-occurring conditions inquired about in SEED1 and SEED Teen were considered. First, separately for each condition analyzed, children with that condition in preschool were excluded. Second, children were categorized as having gained the condition (i.e., condition reported only in adolescence) or never being diagnosed with the condition (i.e., condition not reported in preschool or adolescence). Third, each condition was separately analyzed by comparing the numbers of children with ASD and DD who gained the condition to the numbers of children who were never diagnosed with the condition. Results from these analyses were recorded in a 2×2 table stratified by preschool ASD vs. other DD diagnosis and gained vs. never diagnosed with the condition. Chi-square p values, odds ratios, and 95% confidence intervals are reported.

Results

Of 1,039 caregivers enrolled in SEED Teen, 865 (83.2%) completed the survey and reported co-occurring diagnoses during preschool and adolescence. Preschool diagnoses among the sample of 865 children were ASD ($n=214$), another developmental or mental health condition (not ASD; $n=336$), and no diagnosis included in the analysis ($n=315$). ASD diagnosis was retained by 85.5% of the 214 children diagnosed in preschool. An additional 53 children were diagnosed with ASD by adolescence ($n=236$). Characteristics of the study sample are highlighted in Table 1.

Among the 214 participants diagnosed with ASD in preschool, DD, sensory integration disorder, and

speech-language disorder co-occurred in over 20% of the sample. Among the 236 participants diagnosed with ASD in adolescence, ADHD, anxiety disorders, DD, ID, LD, sensory integration disorder, and speech-language disorder co-occurred in over 20% of the sample. These descriptive cross-sectional findings are outlined in Fig. 1.

When examining longitudinal changes in co-occurring diagnoses, significantly more children with ASD gained diagnoses of ADHD, DD, sensory integration disorder, and speech-language disorder by adolescence compared to children with another developmental or mental health diagnosis in preschool (Table 2).

Discussion

Our findings reinforce that ASD is a highly stable diagnosis likely to persist from preschool to adolescence (Anderson et al., 2014; Baghdadli, Michelon, Pernon et al., 2018). DD, sensory integration disorder, and speech-language disorder were diagnosed in over 20% of children with ASD in both preschool and adolescence. ADHD, anxiety disorders, ID, and LD were diagnosed in over 20% of adolescents with ASD. These results suggest that co-occurring conditions within ASD are common. As early identification of ASD continues to improve (Shaw et al., 2022), monitoring and treating these co-occurring conditions at multiple stages of development and in various settings may benefit children with ASD throughout the lifespan.

Health and education providers can use these findings to identify conditions that become more common as children with ASD age to inform precision monitoring. ADHD was more commonly reported in adolescence compared to preschool among children with ASD. This finding is supported by previous research that found a substantial increase in ADHD diagnoses among children with ASD from preschool to adolescence (Soke et al., 2018). ADHD was also the condition most often gained over time among children with other DD. These findings are not surprising given the mean age of ADHD diagnosis is between 6.2 and 18.1 years (Rocco et al., 2021) and prevalence increases with age (Danielson et al., 2024). Moreover, clinically significant symptoms of inattention and hyperactivity are much more common among children with ASD and other DD than their neurotypical peers (Gnanaval et al., 2019; McClain et al., 2017). Consequently, children with atypical development in preschool may benefit from screening for ADHD symptoms during the school-aged years.

Anxiety disorders, ID, and LD were collected or considered only in adolescence due to the young age of the preschool sample. However, each of these conditions were diagnosed in over 20% of adolescents with ASD – a finding

Table 1 Characteristics of children and families who completed the study to explore Early Development (SEED) Phase1 and SEED teen Survey, stratified by preschool diagnosis

	Preschool ASD diagnosis $N=214$ N(%)	Preschool other diagnosis $N=336$ N(%)	Preschool No diagnosis $N=315$ N(%)
Characteristics			
Child sex			
Male	168 (78.5)	218 (64.9)	152 (48.3)
Female	46 (21.5)	118 (35.1)	163 (51.7)
Family income			
<100% FPL	25 (12.3)	25 (7.9)	14 (4.6)
100–199% FPL	35 (17.2)	40 (12.0)	30 (7.9)
200–299% FPL	33 (16.3)	54 (12.3)	46 (12.1)
$\geq 300\%$ FPL	110 (54.2)	199 (67.9)	215 (75.4)
Maternal education			
Less than high school	14 (6.7)	29 (8.8)	15 (4.8)
High school graduate	34 (16.3)	25 (7.6)	34 (11.0)
Some college or more	161 (77.0)	275 (83.6)	261 (84.2)
Maternal race/ethnicity			
Non-Hispanic White	127 (59.4)	242 (72.0)	248 (78.7)
Non-Hispanic Black	55 (25.7)	68 (20.2)	37 (11.8)
Hispanic	18 (8.4)	19 (5.7)	18 (5.7)
Other	14 (6.5)	7 (2.1)	12 (3.8)
Diagnostic changes			
Adolescent ASD			
Adolescent ASD	183 (85.5)	48 (14.3)	5 (1.6)
Diagnosis			
Adolescent Other DD	28 (13.1)	207 (61.6)	33 (10.5)
Diagnosis only			
Adolescent No	3 (1.4)	80 (23.8)	277 (87.9)

Acronyms: Autism spectrum disorder (ASD), developmental delay (DD), federal poverty level (FPL); *Note:* Thirty-nine and eighteen participants had missing values for family income and education; percentages reported exclude missing values; preschool other diagnoses are attention deficit hyperactivity disorder, developmental delay, epilepsy/seizure disorder, obsessive-compulsive disorder, sensory integration disorder, or speech-language disorder; adolescence other diagnoses additionally include any anxiety or depression/mood disorder, intellectual disability, and learning disability

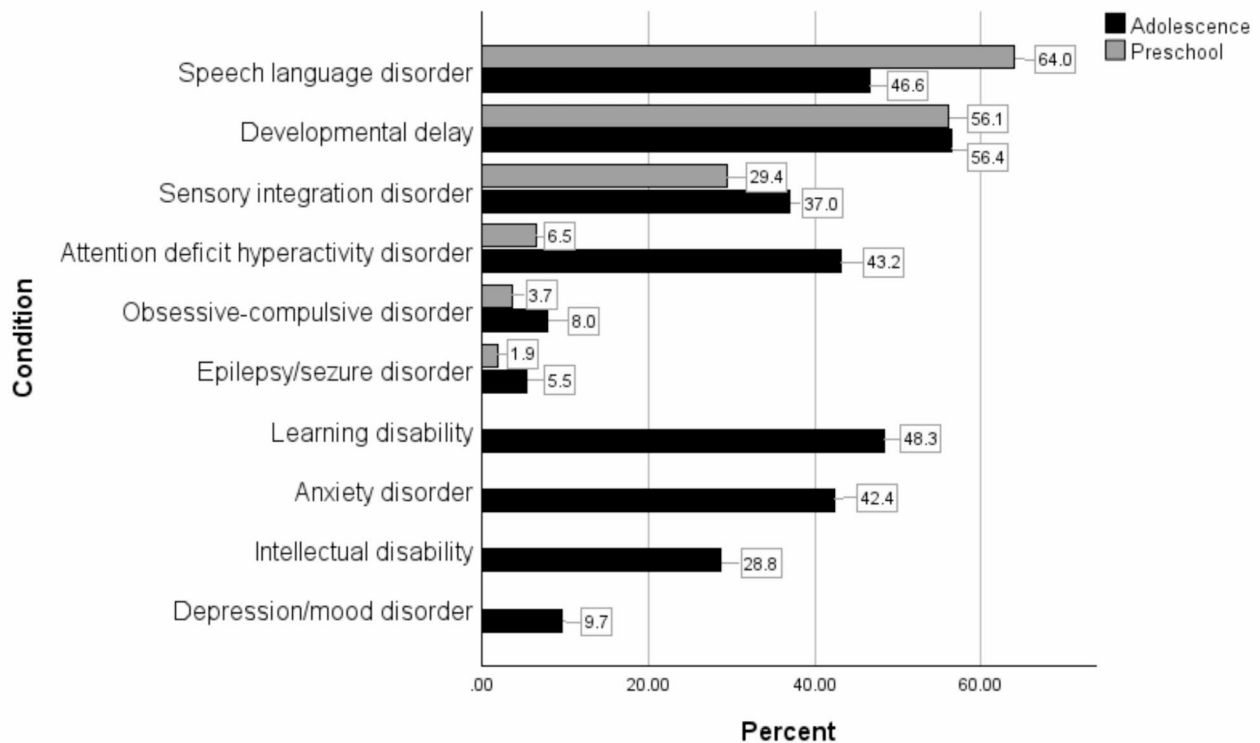


Fig. 1 Co-occurring diagnoses among children with an autism spectrum disorder (ASD) diagnosis in preschool ($N=214$) and adolescence ($N=236$). *Note:* Learning disability, anxiety disorders, intellectual dis-

ability, and depression/mood disorders were only collected or considered in adolescence due to the young age of the preschool sample

Table 2 Differences in children who gained or were never diagnosed with certain conditions from preschool to adolescence, stratified by preschool diagnosis

	Preschool ASD Diagnosis		Preschool Other Diagnosis		Preschool ASD vs. Other Diagnosis x Gained vs. Never Diagnosed with Condition	
	Gained Condi- tion N (%)	Never Diagnosed ($N\%$)	Gained Condi- tion N (%)	Never Diagnosed ($N\%$)	Chi Square p value	OR (CI)
Attention deficit hyperactivity disorder $N=509$	77 (38.5)	123 (61.5)	84 (27.2)	225 (72.8)	0.0073	1.68 (1.15, 2.45)
Developmental delay $N=305$	41 (43.6)	53 (56.4)	38 (18.0)	173 (82.0)	<0.0001	3.52 (2.06, 6.03)
Sensory integration disorder $N=451$	37 (24.5)	114 (75.5)	29 (9.7)	271 (90.3)	<0.0001	3.03 (1.78, 5.17)
Speech-language disorder $N=216$	25 (32.5)	52 (67.5)	23 (16.5)	116 (83.5)	0.0070	2.43 (1.26, 4.66)

Acronym: Autism spectrum disorder (ASD); *Note:* preschool other diagnoses are attention deficit hyperactivity disorder, developmental delay, epilepsy/seizure disorder, obsessive-compulsive disorder, sensory integration disorder, or speech-language disorder; “preschool ASD diagnosis” represents children with an ASD diagnosis exclusive of the other conditions specified in each row, “preschool other diagnosis” represents one of the aforementioned diagnosis exclusive of the condition specified in each row

in line with previous research (Micai, Fatta, Gila et al., 2023; van Steensel et al., 2011). Poor academic performance can prompt evaluations of ID and LD whereas symptoms of anxiety in adolescents with ASD are often unrecognized or misdiagnosed (MacNeil et al., 2009). Anxiety within ASD is associated with poor health outcomes, including suicidal thoughts and behaviors (Kölves et al., 2021). Anxiety may

therefore be an important focus of screening and treatment, if indicated, for children with ASD as early as middle school.

Health and education providers can also use these findings to inform treatment planning. DD, sensory integration disorder, and speech-language disorder were common among children with ASD in both preschool and adolescent samples and more likely gained over time when compared to children with another developmental or mental health

diagnosis in preschool. Speech-language services are the most frequently reported therapy for children with ASD (Berg et al., 2024; Payakachat et al., 2018). Other therapies like occupational therapy, physical therapy, and social skills training are less common (Berg et al., 2024; Payakachat et al., 2018). Our findings suggest that, in addition to speech-language therapy, occupational therapy or other sensory supports and services that address specific developmental delays experienced by the child may benefit children with ASD regardless of age.

One strength of this analysis is the multi-site longitudinal study design. One limitation is reliance on caregiver-reported diagnoses given by a healthcare provider instead of clinical evaluation or medical record review. However, this methodology is shared by numerous population-based surveys like the National Health Interview Survey and National Survey of Children's Health. Another limitation is the small numbers of children with obsessive-compulsive disorder and epilepsy/seizure disorder, which precluded longitudinal analyses of these diagnoses. Nevertheless, our findings highlight the importance of screening for multiple co-occurring conditions, including ADHD and anxiety disorders, as children with ASD age. Our findings also highlight the importance of considering DD, sensory, and speech-language supports as potential long-term treatment modalities for children with ASD. Health and education providers can use these findings to inform precision monitoring and treatment planning and help coordinate individualized treatment plans.

Acknowledgements This work was supported by cooperative agreements between study sites and the Centers for Disease Control and Prevention (CDC). We would like to thank children and families who completed the Study to Explore Early Development (SEED) and SEED Teen survey. We would also like to thank the SEED Data Coordinating Center team at the Clinical and Translational Sciences Institute of Michigan State University for their technical support. None of the authors has a financial or other conflict of interest. The findings and conclusions in this report are those of the authors and do not necessarily reflect the views of the CDC.

References

- American Psychiatric Association (2022). *Diagnostic and statistical manual of mental disorders* (5th ed., text rev.). American Psychiatric Publishing.
- Anderson, D. K., Liang, J. W., & Lord, C. (2014). Predicting young adult outcome among more and less cognitively able individuals with autism spectrum disorders. *Journal of Child Psychology and Psychiatry*, 55(5), 485–494.
- Baghdadli, A., Michelon, C., Pernon, E., et al. (2018). Adaptive trajectories and early risk factors in the autism spectrum: A 15-year prospective study. *Autism Research*, 11(11), 1455–1467.
- Berg, J., Sideridis, G. D., DePilllis, R. (2024). Types and predictors of service use among young children recommended to receive intensive services after initial autism spectrum disorder diagnosis. *Journal of Autism and Developmental Disorders*.
- Close, H., Lee, L.-C., Kaufmann, C., & Zimmerman, A. (2012). Co-occurring conditions and change in diagnosis in autism spectrum disorders. *Pediatrics*, 129(2), e305–e316.
- Danielson, M. L., Claussen, A. H., Bitsko, R. H., Katz, S. M., Newsome, K., Blumberg, S., et al. (2024). ADHD prevalence among U.S. children and adolescents in 2022: Diagnosis, severity, co-occurring disorder, and treatment. *Journal of Clinical Child and Adolescent Psychology*, 53(3), 343–360.
- Ghandour, R., Sherman, L., Vladuti, C., Lynch, S., Bitsko, R., & Blumberg, S. (2019). Prevalence and treatment of depression, anxiety, and conduct problems in US children. *Journal of Pediatrics*, 206, 256–267.
- Gnanaval, S., Sharma, P., Kaushal, P., & Hussain, S. (2019). Attention deficit hyperactivity disorder and comorbidity: A review of literature. *World Journal of Clinical Cases*, 7, 2420–2426.
- Hyman, S., Levy, S., Myers, S., & Council on Children with Disabilities, Section on Developmental and Behavioral Pediatrics, American Academy of Pediatrics. (2020). Identification, evaluation, and management of children with autism spectrum disorder. *Pediatrics*, 145(1), e20193447.
- Kölves, K., Fitzgerald, C., Nordentoft, M., Wood, S., & Erlangsen, A. (2021). Assessment of suicidal behaviors among individuals with autism spectrum disorder in Denmark. *JAMA Network Open*, 4(1), e2033565.
- Li, Q., Li, Y., Zheng, J., Yan, X., Huang, J., Xu, Y., et al. (2023). Prevalence and trends of developmental disabilities among US children and adolescents aged 3 to 17 years, 2018–2021. *Scientific Reports*, 13, 17254.
- MacNeil, B. M., Lopes, V. A., & Minnes, P. M. (2009). Anxiety in children and adolescents with autism spectrum disorders. *Research in Autism Spectrum Disorders*, 3, 1–21.
- Maenner, M., Warren, Z., Williams, A. R., et al. (2023). Prevalence and characteristics of autism spectrum disorder among children aged 8 years – autism and Developmental Disabilities Monitoring Network, 11 sites, United States, 2020. *MMWR Surveillance Summaries*, 72(SS-2), 1–14.
- McClain, M. B., Hasty-Mills, A. M., & Murphy, L. E. (2017). Inattention and hyperactivity/impulsivity among children with attention-deficit/hyperactivity disorder, autism spectrum disorder, and intellectual disability. *Research in Developmental Disabilities*, 70, 175–184.
- Micai, M., Fatta, L. M., Gila, L., et al. (2023). Prevalence of co-occurring conditions in children and adults with autism spectrum disorder: A systematic review and meta-analysis. *Neuroscience and Biobehavioral Review*, 155, 105436.
- Payakachat, N., Tilford, J. M., & Kuhlthau, K. A. (2018). Parent-reported use of interventions by toddlers and preschoolers with autism spectrum disorder. *Psychiatric Services*, 69, 186–194.
- Rocco, I., Corso, B., Bonati, M., et al. (2021). Time of onset and/or diagnosis of ADHD in European children: A systematic review. *Bmc Psychiatry*, 21, 575.
- Schendel, D., DiGuseppi, C., Croen, L., et al. (2012). The study to explore Early Development (SEED): A multi-site epidemiologic study of autism by the centers for autism and developmental disabilities research and epidemiology (CADDRE) network. *Journal of Autism and Developmental Disorders*, 42, 2121–2140.
- Shaw, K., McArthur, D., Hughes, M., et al. (2022). Progress and disparities in early identification of autism spectrum disorder: Autism and developmental disabilities monitoring network, 2002–2016. *Journal of the American Academy of Child and Adolescent Psychiatry*, 61, 905–914.
- Soke, G. N., Maenner, M. J., Christensen, D., Kurzius-Spencer, M., & Schieve, L. A. (2018). Prevalence of co-occurring medical and behavioral conditions/symptoms among 4- and 8-year-old

children with autism spectrum disorder in selected areas of the United States in 2010. *Journal of Autism and Developmental Disorders*, 48(8), 2663–2676.

van Steensel, F. J., Bögels, S. M., & Perrin, S. (2011). Anxiety disorders in children and adolescents with autistic spectrum disorders: A meta-analysis. *Clinical Child and Family Psychology Review*, 14(3), 302–317.

Zablotsky, B., Black, L. I., Maenner, M. J. (2019). Prevalence and trends of developmental disabilities among children in the United States: 2009–2017. *Pediatrics*, 144(4), e20190811.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.