

Background

- Individuals with Down syndrome (DS) are known to have different literacy development schedules compared to their neurotypical peers.
- Children with DS also have a higher incidence of co-occurring conditions compared to the typically developing population, including autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD).
- While children with ASD and ADHD have been identified as having different learning patterns for literacy skills, little is known when combined with a diagnosis of DS.

Objectives

- To identify literacy skill patterns for children with a DS-ASD or DS-ADHD dual diagnosis compared to their peers with DS only.

Methods

- Retrospective, cohort review of children with DS receiving care at the Sie Center for Down Syndrome at Children's Hospital Colorado.
- Literacy Development Parent Questionnaire (LDPQ) responses collected from caregivers of 415 children 3-18 years of age that were seen by an education specialist.
- One-way ANOVAs were conducted to determine if literacy scores were different for the DS-only (n=359; mean age=9.0 years \pm 4.0), DS-ASD (n=44; mean age=9.0 \pm 3.6), and DS-ADHD(n=12; mean age=11.0 \pm 4.0) groups by age.

Literacy Development Parent Questionnaire

- The literacy skills focused on alphabetic principle, phonological awareness, and phonics.
- One hundred literacy skills were organized into seven literacy stages:
 - Foundational Reader**
 - Examples: *Turns or looks to me when I call their name; Copies or makes similar sound*
 - Early Emergent**
 - Turns pages of board books; Knows their own name in print*
 - Emergent Reader**
 - Can point out/read 5-20 sight words; Can clap words into syllables*
 - Developing Reader**
 - Knows 17-26 letters by sound, can point to/name when sound is said; Can match upper to lowercase letters*
 - Early Fluent Reader**
 - Can sound out words with 2 or 3 sounds; Can name/point to 50-100 sight words; Can answer WHAT, WHO, WHERE if stated in text*
 - Emergent Fluent Reader**
 - Can mix known chunks of words to get unknown words; Sounds out words with silent "e"*
 - Fluent Reader**
 - Can substitute one phoneme for another; Can sound out new, complex words; Can answer implied WH- questions*

Results

Age at Emerging Literacy Reading Level

- Scoring of literacy level achievement
 - For each skill, an answer of "Yes"=2 points, "Sometimes"=1 point, and "No"=0 points.
 - If a child achieved 70% or more of the total possible score, they were identified as within the literacy level

Literacy Stage	Age	$\geq 70\%$ Achieve Level
Foundational Reader	3 years	17-24 points
Early Emergent Reader	5 years	25-36 points
Emergent Reader	7 years	24-34 points
Developing Reader	8 years	21-30 points
Early Fluent Reader	8 years	11-16 points
Emergent Fluent Reader	11-12 years	24-34 points
Fluent Reader	11-12 years	18-26 point

Literacy Score Differences in Children with DS-Only, DS-ASD, and DS-ADHD

- Mean LDPQ scores were higher in all age intervals for children with DS-Only and DS- ADHD compared to the mean LDPQ score for children that had DS-ASD (Table 2).
- Mean LDPQ scores were statistically different between the three groups for the age intervals 5, 9-10, and 13-14 years.

Table 2. Literacy scores in children with Down syndrome (DS) by DS-only, DS-ASD, and DS-ADHD group

	TOTAL n	DS-Only		DS-ASD		DS-ADHD		Results
		n	mean \pm SD	n	mean \pm SD	n	mean \pm SD	
3-4 years	56	50	44.1 \pm 24.0	6	29.0 \pm 8.8	-	-	t(54)=-1.522, p=.134
5 years	62	53	58.9 \pm 35.5	7	25.9 \pm 18.8	2	30.0 \pm 2.8	F(2,59)=3.475, p=.037
6 years	47	43	75.5 \pm 32.7	3	27.0 \pm 11.5	-	-	t(44)=-2.534, p=.015
7 years	54	47	77.0 \pm 41.6	6	74.3 \pm 43.7	-	-	t(51)=-.145, p=.885
8 years	54	45	89.2 \pm 48.3	8	52.9 \pm 41.4	-	-	t(51)=-1.998, p=.051
9-10 years	75	67	85.9 \pm 46.3	5	41.4 \pm 47.0	3	132.3 \pm 42.2	F(2,72)=3.810, p=.027
11-12 years	38	30	111.5 \pm 50.6	5	55.2 \pm 38.9	3	110.7 \pm 73.4	F(2,35)=2.635, p=.086
13-14 years	59	46	107.2 \pm 52.2	10	61.4 \pm 32.0	3	99.0 \pm 16.0	F(2,56)=3.649, p=.032
15-16 years	30	27	94.6 \pm 53.2	2	50.0 \pm 28.3	-	-	t(27)=-1.160, p=.256
17-18 years	20	18	110.2 \pm 51.0	-	-	-	-	

Autism spectrum disorder (ASD); Attention-deficit/hyperactivity disorder (ADHD)

Conclusions

- Group differences were found across ages with children with DS-only and DS-ADHD achieving higher literacy scores compared to children with DS-ASD.
- Overall, mean LDPQ scores are higher in each age interval for children with DS-only and DS-ADHD compared to DS-ASD.

Implications

- The difference in literacy scores between children with DS and ASD compared to children with DS only and DS with ADHD warrants further study.
- Future research should work to determine specific strategies aligned with the unique learning profile to deliver effective timely interventions.
- Next steps include evaluating the age at which this difference begins and applying interventions to support literacy level development.

Limitations

- The LDPQ was developed by taking into account Down syndrome specific timelines and stages of literacy development. Having a diagnosis such as hyperlexia, which is more prevalent in autistic individuals, would skew in favor of a timeline that may show advanced literacy skills for DS and ASD.
- There is an additional limitation in the number of DS ADHD participants, caution should be used in interpreting these specific results.

Disclosures

The authors declare that they have no conflict of interest with respect to the research and authorship of this article. The authors received no financial support for the research, authorship, and/or publication of this article.