Prevalence of Dyslexia in Developmental Stuttering

Original Article

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ABSTRACT

Introduction: Communication is an essential human ability that facilitates relationships, enhances understanding, and promotes development across all areas of life. Hence, developmental stuttering interferes with the fluency of speech, which may impair children's reading abilities.

Objective: Our study aimed to ascertain the prevalence of dyslexia in children with developmental stuttering and the relationship between the two conditions.

Methods: Our study was conducted on two hundred children, divided into two groups: one hundred children with developmental stuttering and one hundred with typical fluent speech. Demographic data were collected with a focus on stuttering symptoms. Speech samples, Stuttering Severity Index, and the Arabic Reading Test were administered to all children.

Results: Highly statistically significant differences were observed between the two groups in nearly all subtests of the Arabic Reading Test, including phonological awareness, auditory perception, short-term memory, comprehension, spelling subtests, and the total ART score $p<0.001$). Additionally, a substantial negative correlation between the severity of stuttering and ART scores was observed.

Conclusion: Dyslexia occurs at a significantly higher rate in children who experience developmental stuttering. This speech disorder is linked to deficits in phonological awareness, short-term memory, and phonological processing, which elevate the likelihood of dyslexia in these children.

Key Words: Developmental stuttering, Dyslexia, fluency disorders.

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INTRODUCTION

Stuttering is a speech condition characterized by irregular fluency in spoken sentences and involuntary, audible, or silent repetitions or prolongations of sounds or syllables. It is not easily regulated and may coincide with other movements and adverse feelings such as dread, shame, or agitation, and it is linked to elevated levels of social anxiety[1].

The etiology of stuttering remains contentious. No discernible reason has been established. One etiological view of stuttering is the psychological theory, which posits that anxiety, frustration, and despair may lead to the onset of stuttering[2].

Dyslexia is a prevalent neurodevelopmental disorder characterized by reading difficulties, affecting 7-10% of the population[3].

Students who stutter (SWS) may face significant difficulties interacting with classmates and teachers. Moreover, it has been observed that SWS have negative attitudes about participating in academic activities. The social participation of other children with SWS is also lacking. This condition led to children stuttering and being behind in acquiring concepts and skills throughout their education[4].

Stuttering and dyslexia are two processing deficits that impact a person's social and academic lives, mainly as they usually affect the pediatric population more than adults. Even though they affect different domains, they have similar characteristics in their pathogenesis, epidemiology, and impact on life[5]. Our study aimed to ascertain the prevalence of dyslexia in children with developmental stuttering and the relationship between the two conditions.

METHODS

After This case-control study involved 200 children and was conducted at the phoniatric unit of Minia University Hospital between December 2024 and June 2025. The research received ethical approval from the Minia Faculty of Medicine's ethical committee under approval number 1301/10/2024. The study was also registered as a clinical trial with approval NCT06836115 https://clinicaltrials.gov/study/NCT06836115. All assessments of the study were

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conducted after the submission of consent by all parents. Participants were divided into a study group (100 children with developmental stuttering) and a control group (100 children without stuttering). The study group consisted of children aged 9 to 10 years who had developmental stuttering, while the control group included children of the same age with typical speech and language. Children were excluded from the study group if they had delayed language development, hearing loss, or neurological problems. For the control group, exclusions included any stuttering, cluttering, or a family history of stuttering.

All participants received a thorough evaluation, which involved collecting detailed background information and conducting clinical assessments. These evaluations included auditory perceptual evaluations and analyzing speech samples to identify disruptions such as repetitions of syllables or words, sound prolongations, speech blocks, and interjections. The Stuttering Severity Index scale was only done for the stutterer by (Rifaie, 1999)[6]. Participants' stuttering severity was assessed using the Stuttering Severity Instrument-Arabic form (SSI-Arabic). This objective tool assesses three key areas:

1. Frequency of stuttering episodes, which range from 4 to 18, including repetitions and prolongations of sounds or syllables.

2. On a scale of 0 to 18, the average length of the longest stuttering episodes.

3. Physical behaviours that are seen and rated on a scale of 0 to 20 include head movements, limb movements, facial grimaces, and auditory distractions.

These three elements add up to the overall severity score. The score is subsequently compared to age-specific norms utilizing conversion tables to ascertain a percentile rank or severity level, which varies from mild to severe. Furthermore, speech rate was assessed; a normal average rate of 167 words per minute (range: 129–222 words/min) was established. Children who stuttered were evaluated by reading the identical text to generate these norms[6].

The Arabic Reading Test (ART) was applied for all participants: ART, developed by Abou El-Ella and colleagues in 2004[7], is a standardised assessment designed to identify reading difficulties—especially dyslexia—among Arabic-speaking children.

The ART includes tasks that target multiple reading skills: Phonological awareness, spelling, auditory perception, short-term memory, comprehension, and spelling, which are subskills necessary for reading in Arabic. The ART can predict dyslexia—even among preschoolers—by identifying early phonological awareness and related skills deficits. The ART is a valid and dependable instrument for evaluating the reading skills of 9–10-year-old Arabic-speaking youngsters. Dyslexic children are those who receive an ART score of 40 or lower out of a possible 97. This categorization divides the sample at the median score of 54 into four categories: scores from 0 to 40 indicate dyslexia; scores above 40 up to 54 are classified as low average; scores above 54 up to 64 are categorized as high average; and scores above 64 up to 97 fall within the normal range[7].

Statistical analysis:

The analysis of data was performed utilizing SPSS Version 25. While numbers and percentages were used to report qualitative data, the median and interquartile range were used to summarize quantitative variables. The Kolmogorov-Smirnov test was utilized to evaluate the normality of quantitative data. To compare non-normally distributed quantitative data, the Mann-Whitney *U* test was employed for two groups, whereas the Kruskal-Wallis test was utilized for four groups. The Chi-square test was used to compare qualitative data across two groups.

The correlation coefficient (r) signifies the strength and direction of a linear relationship between variables, classified as follows: 0.00–0.24 indicates weak or no connection, 0.25–0.49 signifies good correlation, 0.50–0.74 represents moderate correlation, and values beyond 0.75 denote significant correlation. A *p*-value below 0.05 was deemed statistically significant.

RESULTS

The demographic analysis indicated the presence of consanguinity, predominant right-handedness, and a family history of stuttering among the participants in the study group $p<0.001$ (Table 1).

Table 1: Demographic information in the groups under the study:

Variable	stutterer *n*= 100	Control *n*= 100	*P*-value
Age (years) Median (IQR)	9.6(9.3-10)	9.7(9.3–10)	0.607
Sex			
Male	58(58%)	53(53%)	0.477
Female	42(42%)	47(47%)	
Handedness			
Right	70(70%)	92(92%)	0.001*
Left	30(30%)	8(8%)	
Consanguinity			
Positive	50(50%)	17(17%)	0.001*
Negative	50(50%)	83(83%)	
Family history of stuttering			
Positive	39(39%)	1(1%)	0.001*
Negative	61(61%)	99(99%)	

When comparing non-parametric quantitative data between two groups, the Mann-Whitney test is utilized. The two groups' qualitative data were compared using the chi-square test *: Considerable variation (p value≤0.05).

A secondary reaction was observed in 37 cases. Regarding stuttering severity, 33 cases exhibited a profound degree, 25 cases a severe degree, 21 cases a moderate degree, and 21 cases a mild degree. The median total score on the Stuttering Severity Index was 31.5, the median stuttering event length was 9, and the median stuttering frequency was 28 (Table 2).

Table 2: SSI assessment results for the studied cases (*n*=100):

Variable	Cases (*n*=100)
Secondary reaction	
Present	37(37%)
Absent	63(63%)
Frequency of stuttering	
Median (IQR)	28(19-35)
Stuttering event length	
Median (IQR)	9(4 - 17)
Degree of stuttering	
Mild	21(21%)
Moderate	21(21%)
Sever	25(25%)
Profound	33(33%)
Total score of SSI	
Median (IQR)	31.5(24.25-38)

Highly statistically significant disparities were noted between both groups in nearly all subtests of the Arabic Reading Test, including phonological awareness, auditory perception, short-term memory, comprehension, spelling subtests, and the total ART score $p<0.001$(Table3).

Table 3: Scores of ART of the studied groups:

Variable	Cases (*n*=100)	Control (*n*=100)	*P*-value
Phonological awareness subset			
Median (IQR)	18(9-26)	32(30-34)	0.001*
Auditory perception subsets			
Median (IQR)	2(2-3)	3(3-3)	0.001*
Short-term memory subset			
Median (IQR)	7(5-9)	9(9-10)	0.001*
Comprehension subset			
Median (IQR)	7(5-8)	9(9-10)	0.001*
Spelling subset			
Median (IQR)	16.5(5-26.75)	29.5(23.25-35)	0.001*
The total score of ART			
Median (IQR)	2(1-3)	82.5(76-88.7)	0.001*

Two groups' non-parametric quantitative data are compared using the Mann-Whitney test; *: Significant difference [p value≤0.05].

There was a substantial relationship between the degree of stuttering and nearly all subtests of the Arabic Reading Test (ART), such that higher degrees of stuttering were associated with greater impairment and lower scores in phonological awareness, auditory perception, short-term memory, comprehension, spelling subtests, and the total ART score ($p<0.001$) (Table 4).

There is a strong, substantial negative correlation between the total score of ART and the total score of SSI and stuttering event length r> 0.75 (Table 5, Figure 1 and 2).

Table 4: Relation between scores of ART and severity of stuttering of the studied cases (*n*=100):

Variable	Mild (*n*=21)	Moderate (*n*=21)	Sever (*n*=25)	Profound (*n*=33)	*P*-value
Phonological awareness subset Median (IQR)	30(28.5-31)	23(20-25.5)	18(17- 19)	7(5-9)	0.001*
Auditory perception subsets Median (IQR)	3(3-3)	3(2-3)	2(1- 3)	2(1-2)	0.001*
Short-term memory subset Median (IQR)	9(8-10)	8(6.5-9)	7(5- 8.5)	5(4-7)	0.001*
Comprehension subset Median (IQR)	9(8-9.5)	8(7- 8.5)	7(5- 7.5)	4(3-5.5)	0.001*
Spelling subset Median (IQR)	30(28-33)	23(18.5-26.5)	15(10- 19.5)	3(2-6.5)	0.001*
Total score of ART Median (IQR)	4(4-4)	3(3-3)	2(2- 2)	1(1-1)	0.001*

Utilizing the Kruskal-Wallis test, four groups' non-parametric quantitative data are compared; *: Significant difference [p value ≤ 0.05].

Table 5: Correlation between total score of ART with total score of SSI and stuttering event length of case group (*n*=100):

Variable	Total score of ART (*n*=100)
Total score of SSI	
r	-0.900
P value	0.001*
Stuttering event length	
r	-0.888
P value	0.001*

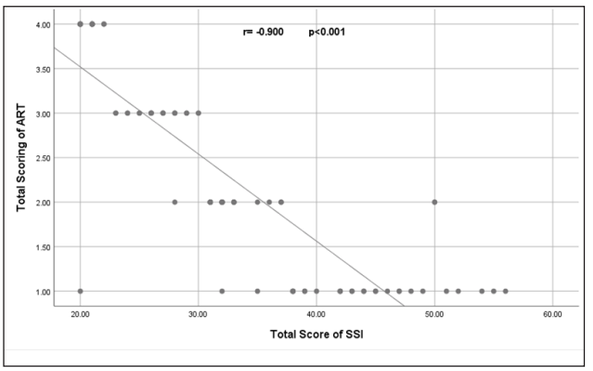

Fig. 1: The total ART score and the total SSI score have a strong, substantial negative connection.

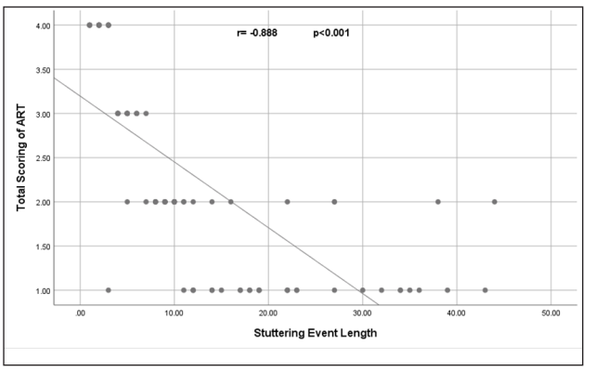

Fig 2: A strong negative correlation exists between the total ART score and stuttering event length.

DISCUSSION

The American Speech-Language Hearing Association defined stuttering as a speech event that includes silent fixations (block), prolongation, monosyllabic, whole word, and part-word repetition in addition to intraphonemic disruption. Stuttering may or may not be accompanied by secondary behaviours employed to evade or circumvent this speaking circumstance[8].

Multiple lines of evidence indicate a relationship between stuttering and dyslexia, rooted in shared phonological processing weaknesses. Our study was conducted on two hundred children, divided into two groups: one hundred children with developmental stuttering and one hundred with typical speech. The research aimed to ascertain the prevalence of dyslexia in children with developmental stuttering and to investigate the relationship between the two conditions.

When comparing children who have developmental stuttering to children with typical speech (the control group), the two groups differed in a meaningful way in these specific areas: handedness, consanguinity, and family history of stuttering, and these findings could be explained by the fact that hereditary factors and genetic predisposition influence Developmental stuttering. These findings were aligned with Yairi and Ambrose[9], who reported that twin and family studies have provided compelling evidence for the significant genetic influence on the development of stuttering. In a genetic non-parametric survey, Shugart *et al*., (2004)[10] obtained DNA samples from members of six stuttering-affected families, either by blood draws or buccal swabs, and found markers on a particular chromosome associated with a genetic locus that may predispose people to the disorder. Stuttering susceptibility is influenced by essential loci found by genome-wide association studies (GWAS). One notable finding is a protective variant near the gene SSUH2 that influences gene expression relevant to stuttering risk[11]. Brosch *et al*., (1999)[12] found that left-handed children had a poorer chance of achieving speech fluency than right-handed stutterers, suggesting that handedness may affect stuttering outcomes.

Significant statistical differences were found between the developmental stuttering group and the control group on the Arabic Reading Test. In particular, the stuttering group demonstrated notably lower scores in phonological awareness, auditory perception, short-term memory, comprehension, spelling subtests, and overall ART scores than the control group. These findings mean that children with stuttering are at risk of developing dyslexia. Science Communication may elucidate that this observation is an essential human ability that facilitates relationships, enhances understanding, and promotes development across all areas of life. However, stuttering in children can interfere with their communication within school environments, leading to lowered self-esteem and impaired social interactions compared to their fluent peers. Children with developmental stuttering often experience increased social anxiety and negative perceptions of communication situations, which can predispose them to academic difficulties and reduced social engagement.

Furthermore, heightened social anxiety in children who stutter can hinder their connections with teachers and peers, resulting in decreased participation in academic activities. Another explanation is that children with developmental stuttering may experience delayed language development, which can interfere with learning and academic achievement. Our findings agreed with Algaidi *et al.,* (2023)[5], who reported that dyslexia and stuttering are processing deficiencies that disrupt a person's social and

intellectual life, particularly as they often affect children more than adults.

Also, Elsherif *et al* , (2021)[13] found in their study that childhood stuttering was less common in people with mild dyslexia (15%) than in those with severe dyslexia (47%). Moreover, half of the adults who stuttered (AWS) met criteria for dyslexia despite never being diagnosed. Both adults who stutter and those with dyslexia showed similar reductions in phonological working memory, awareness, and retrieval compared to typical adults. These results suggest that stuttering and dyslexia may have a shared phonological deficit.

The study by Algaidi *et al* , (2023)[5] reported that 34% of adults with dyslexia had a history of stuttering, varying based on dyslexia severity: 15% in moderate cases and 47% in severe cases. Additionally, 50% of adults who stuttered had dyslexia in childhood. Patients with dyslexia and stuttering showed similar decreases in phonological working memory, perception, and retrieval.

Sari and Gökdag (2017)[4] reported that stuttering disrupts the natural rhythm of speech, which can negatively impact reading fluency over time. This persistent challenge may affect the academic and social success of children and adults who stutter, especially in situations like presentations, reading aloud in class, and performing arts. Franke *et al.,* (2021)[14] reported in their study that there is initial evidence of disparities in reading fluency between young readers who stutter and their comparable classmates.

Our research demonstrated a substantial correlation between stuttering and ART scores; as stuttering severity increased, ART scores generally diminished. These results indicate that a significant level of stuttering is frequently associated with dyslexia. Moreover, a substantial negative association exists between the total score of ART and the stuttering event length. These findings could be explained by the fact that stuttering and dyslexia may share the same neurological basis and have the same neuropathophysiology. O'Brien *et al*., (2011)[15] indicated that children who stutter generally achieve below-average academic performance. One would anticipate that stutterers will have lower educational achievement since good communication is necessary for scholastic advancement and success.

Algaidy *et al*., (2023)[5] reported that both developmental dyslexia and chronic developmental stuttering are characterized by decreased brain activity in important language-related regions, such as the left inferior temporal gyrus, inferior parietal gyrus, and left inferior frontal gyrus, according to functional MRI and voxel-based morphometry studies. Reading, speech production, and phonological processing all depend on these areas. Additionally, there is a discernible reduction in gray matter volume in the left inferior frontal gyrus in children with these diseases.

Neuroscientific studies indicate that stuttering is associated with anomalies in speech motor control regions, including the left speech motor cortex and premotor cortex, alongside impaired connectivity among motor, language, and auditory brain areas. Individuals with dyslexia exhibit challenges in verbal-motor coordination, as indicated by reduced rapid syllable repetition rates (diadochokinetic rates). This suggests that stuttering and dyslexia may originate from impaired brain networks responsible for the planning and execution of speech movements, hence impacting fluent verbal communication[17].

Williams *et al.,* (1969)[16] applied two studies investigating the academic achievement of young children who exhibit stuttering. When sixth-grade students who stuttered were compared to their nonstuttering counterparts with analogous backgrounds, the stuttering cohort exhibited diminished academic performance.

CONCLUSION

Dyslexia occurs at a significantly higher rate in children who experience developmental stuttering. This speech disorder is linked to deficits in phonological awareness, short-term memory, and phonological processing, which elevate the likelihood of dyslexia in these children.

LIST OF ABBREVIATIONS

SWS: Students who stutter; **ART**: The Arabic Reading Test; **SSI**: Stuttering Severity Index.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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