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Prevalence of Attention-Deficit Hyperactivity Disorder (ADHD) among School-Aged Dyslexic Students in Singapore

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Abstract

Over the past few decades, there has been extensive research into the potential impact of attention-deficit hyperactivity disorder (ADHD) and dyslexia on the learning of school-aged children. As a result, dyslexia and ADHD are increasingly being identified at an early age so that parents can seek early intervention to help their children cope with the demands of the Singapore education system and achieve academic success. However, studies that examined the prevalence of ADHD among school-aged dyslexic children have been limited, especially in the Asian context. This aim of this research study is to investigate the prevalence of ADHD among school-aged dyslexic children in Singapore. A total of 228 participant information, aged between 7 to 17 years old, were extracted from the Dyslexia Association of Singapore (DAS). A secondary analysis of archival data was conducted to examine the prevalence of ADHD among this population. Among the 228 participants, 17.1% (n = 39) were found to have comorbid dyslexia and ADHD. However, the study found that there was no statistically significant association between dyslexia and ADHD. These findings suggested that dyslexia and ADHD often co-occurred among school-aged children in Singapore. This highlights the importance of multifaceted interventions that address these neurodevelopmental disorders.

Keywords: dyslexia, attention-deficit hyperactivity disorder, prevalence

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INTRODUCTION

In recent years, the increase in the number of students with special educational needs (SEN) attending mainstream schools in Singapore has resulted in greater attention towards more inclusive educational practices that are better tailored to the needs of these students. In Singapore, the Ministry of Education (MOE) found that there are 35,500 students with SEN and about 80% of these students are enrolled in mainstream schools (Elangovan, 2023). The two most frequently diagnosed neurodevelopmental disorders among these students with SEN are dyslexia and attention-deficit hyperactivity disorders (ADHD). If these learning difficulties are left undetected, they can lead to poor academic performance, problems with social relationships with their peers and in their emotional well-being. As a result, it has become increasingly vital for parents and educators to identify dyslexia and ADHD at a young age, so that these students can receive the support necessary to reach their full academic potential.

Dyslexia is a specific learning difference that is characterised by persistent difficulties with accurate and/or fluent word recognition (Lyon et al., 2003). Children with dyslexia tend to possess poor decoding and spelling skills. These challenges can cause dyslexic children to struggle in school as they are unable to read and understand the task given to them. Dyslexia is the most common learning disability around the world, accounting for approximately 80% of all learning disabilities (Yang et al., 2022). For children with dyslexia, they often have poor phonological awareness. These challenges are unexpected in relation to other cognitive abilities and the provision of effective classroom management. Dyslexia is considered as a neurodevelopmental disorder under the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), with impairments in reading and/or spelling (American Psychiatric Association, 2013). According to the Dyslexia Association of Singapore (DAS) (2019), it is estimated that dyslexia affects about 10% of the population. There are approximately 20,000 students in Singapore who were diagnosed with dyslexia (Tay, 2021). Furthermore, this learning disability can lead to poor performance in other academic areas such as mathematics and arts (Duff et al., 2023). For parents and educators, it is difficult to determine whether a child is dyslexic just by looking at their academic performance as some students may be doing well in school initially. However, as they transition from preschool to primary, primary to secondary, or secondary to tertiary level, they may encounter more difficulties in reading and spelling words as the school curriculum becomes more complicated. If left unattended, these children with dyslexia can develop poor self-esteem and behavioural issues.

ADHD is one of the most prevalent neurodevelopmental disorders characterised by persistent patterns of inattention and/or hyperactivity-impulsivity that interferes with an individual's development or daily functioning (Ayano et al., 2023). For individuals to be diagnosed with ADHD, either symptoms of inattention and/or hyperactivity-impulsivity must be present (Drechsler et al., 2020). Internationally, it is estimated that 5-7% of school

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-aged children are diagnosed with ADHD (Abdelnour et al., 2022). Individuals with ADHD can be categorised into three different presentations of ADHD, either the inattentive presentations, hyperactivity-impulsivity presentation or a combined presentation. According to a study by Lau and colleagues (2021), females had a greater likelihood of being diagnosed with the inattentive presentation of ADHD compared to their male counterparts who are at a higher risk of being diagnosed with hyperactivity and/or impulsivity presentation. Children with ADHD often face challenges in their executive functioning, which can lead to lower functioning in their working memory, self-regulation and cognitive flexibility. These impairments can result in poorer performance in school as students become easily distracted during lessons, the inability to sit still and face persistent challenges in organising oneself and one's schoolwork (Tan et al., 2022). This can lead to reading difficulties and academic failure as they often seem restless and struggle to form relationships with their peers.

McGrath and Stoodley (2019) revealed that there is a significant overlap between dyslexia and ADHD as the comorbidity rates for dyslexia and ADHD ranges from 15% to 40%. Comorbidity refers to the simultaneous presence of two or more disorders within the same individual (Nordgaard et al., 2023). For parents and educators, the overlap between ADHD and dyslexia can blur the lines of whether the challenges faced were attributed to their dyslexia or ADHD diagnoses. For children diagnosed with both dyslexia and ADHD, they are at a higher risk of facing emotional problems, academic failure and having poor relationships with their peers compared to students who are diagnosed with only one disorder (Willcutt & Petrill, 2023). Furthermore, this comorbidity complicates educational interventions as students with both dyslexia and ADHD may require multifaceted approaches that can address their reading difficulties and impairments in their executive functioning (Katsarou et al., 2024). This can cause these students to fall behind their peers if they do not receive the proper support. Due to the competitive nature of the Singapore education system, this can place greater academic pressures on students with dyslexia and/or ADHD to perform in school (Ng, 2020). Therefore, it is important for parents and educators to understand the prevalence between dyslexia and ADHD so that these students can be identified early and receive necessary intervention to achieve their full academic potential. In this research study, we seek to examine the prevalence of ADHD among school-aged dyslexic students in Singapore.

RESEARCH BACKGROUND

For students to be formally diagnosed with dyslexia, they must encounter difficulties learning the spelling and pronunciations of words (Andresen & Monsrud, 2021). Furthermore, children with dyslexia must have received at least 6 months of intervention. This helped psychologists to rule out the lack of exposure to the language or the education system and ensure that challenges faced are attributed to dyslexia diagnosis. These children must be performing at a level below that predicted by their chronological

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age. All these criteria must be fulfilled before these children are able to be diagnosed with dyslexia. This is done by a psychologist after conducting standardised tests, observations and interviews with the child's parents and educators (American Psychiatric Association, 2013). These challenges with literacy acquisition can serve as barriers that impact the learning of dyslexia individuals throughout their lifetime. Children with dyslexia often have problems with reading comprehension and poor reading experience that slows down the growth of their vocabulary skills (Stark et al., 2022). This can lead to feelings of frustration, low self-esteem and anxiety issues as they struggle to keep up with their classmates in school. If not properly addressed, these emotional struggles can lead to behavioural problems as these dyslexic students become disengaged with learning or exhibit disruptive behaviours to mask their academic difficulties (Zuppardo et al., 2023). This highlights the importance of early identification as it helps parents and educators to determine the source of the child's difficulties. In addition, a formal diagnosis of dyslexia can help parents and educators to determine whether the child requires additional support such as exemption from certain subjects in the school curriculum.

According to Kofler and colleagues (2020), children with ADHD often experience cognitive impairments such as poor working memory, lower processing speed and inattention. For childhood ADHD diagnosis, children must display 6 or more symptoms of inattention and/or hyperactivity-impulsivity (Danielson et al., 2024). These symptoms must have been presented for a minimum of 6 months that are inappropriate for the child's developmental level. These students often struggle to control their behaviours and pay attention in classroom settings, which can result in poor reading development and academic achievement (McDougal et al., 2023). These students often encounter academic challenges as they are unable to follow classroom instructions, meet assignment deadlines and focus their attention during lessons, all of which are essential for performing well in school. Furthermore, ADHD is often associated with poor emotional regulation, which can manifest as irritability, frustration or oppositional behaviour in the classroom (Astenvald et al., 2022). For childhood ADHD, the most common symptoms are hyperactivity and impulsivity. However, these symptoms become less prominent during adulthood as children learnt to control their impulses and inattention becomes the primary symptom for adult ADHD (Sibley et al., 2022). According to Lau and colleagues (2021), boys are more likely to be diagnosed with ADHD than girls as the reported male to female ratio for children with ADHD is 3:1. However Lau and colleagues (2021) have found that the gender ratio for boys and girls with ADHD can increase up to 16:1.

There has been growing attention towards the comorbidity of neurodevelopmental disorders. There has been growing recognition among healthcare professions, educators and psychologists that neurodevelopmental disorders rarely exists in isolation and the co-occurrence of comorbid learning disabilities has become more prevalent (Antolini & Colizzi, 2023). The prevalence of this comorbid relationship can be challenging for parents and educators to manage as children with both ADHD and dyslexia tend to experience more severe academic difficulties than those children who are diagnosed

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with only one condition (Bonti et al., 2024). According to McGrath and Stoodley (2019), they found that dyslexia and ADHD are the two most commonly associated learning difficulties. Studies found that there is a bidirectional association between dyslexia and ADHD since there is a high comorbidity if one examines ADHD students for dyslexia (Bergen et al., 2025) or dyslexic students for ADHD (Brimo et al., 2021). Furthermore, Willcutt and Pennington (2000) found that the association between dyslexia and ADHD was stronger for inattention presentation of ADHD than those with hyperactivity or impulsivity presentation. This suggested that inattention can undermine the development of the child's reading skills as children with ADHD struggle to focus their attention on the words in front of them. This can affect their learning in school as most assignments require some form of reading and understanding of instructions. This can cause students with learning disabilities to avoid reading all together due to their dysfluency (Stark et al., 2022).

Research on the comorbidity of dyslexia and ADHD in twins found that children with both neurodevelopmental disorders experience higher levels of cognitive impairments as well as more significant levels of genetic loading for both dyslexia and ADHD (Erbeli et al., 2021). These children are more likely to experience deficits in their verbal working memory and processing speed (Katsarou et al., 2024). These cognitive functioning skills are important for reading comprehension and task completion, which are critical skills for learning. These children also display greater difficulties in shifting between tasks and performing timed tasks, as both neurodevelopmental disorders are associated with impairments in time management and task organisation (Crisci et al., 2021). This can cause students with dyslexia and ADHD to perform poorly on timed tasks in school such as examinations, which often determine whether students can progress to the next level of their academic journey. These children also show increased impairments in their orthographic and decoding skills (Fernández-Andrés et al., 2021), and they struggle to read well and have poor phonological awareness (Liu et al., 2023).

Children with dyslexia often encounter difficulties with reading assignments because of their poor phonological awareness and decoding skills while their ADHD counterparts faced similar problems with reading due to their inability to focus. These similarities between children with dyslexia and children with ADHD have raised concerns regarding the accuracy of unambiguous diagnosis. According to McGrath and Stoodley (2019), dyslexia and ADHD symptoms often exhibit significant overlaps in presentation. These overlaps include being easily distracted, poor handwriting skills and poor reading fluency. While these two groups of children may appear to lose focus and be distracted during lessons, the reason behind their inability to focus varies (Quercia et al., 2013). Children with dyslexia have issues focusing during reading tasks due to their difficulties with decoding and reading the words out loud. This causes them to lose focus and avoid the task altogether. However, children with ADHD seem distracted during reading assignments due to their short attention span and inability to focus solely on reading. Furthermore, children with dyslexia and ADHD also display significant overlap in terms of

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their reading fluency (Cohen et al., 1999). Due to their poor decoding skills and phonological awareness, children with dyslexia often are not able to recognise words fast enough to read smoothly. For children with ADHD, their inability to focus and pay attention causes them to have poor reading fluency as they get easily distracted when trying to complete reading tasks in school. These overlaps in the presentation of dyslexia and ADHD raised concerns regarding the accuracy of unambiguous diagnosis as ADHD symptoms may have been masked or misunderstood as dyslexic symptoms (Manos et al., 2017). This highlights the importance of understanding the prevalence and comorbidity of dyslexia and ADHD among school-aged children so that educators and parents are more equipped to recognise and differentiate these learning disabilities.

Furthermore, children with dyslexia may encounter difficulties with reading as they need to analyse words phonetically. This can make the decoding and reading process tiring for children with dyslexia as they easily become fatigued after reading (López-Zamora et al., 2025). For children with ADHD, they struggle to read fluently as their lack of concentration can cause them to skip, substitute, reverse and/or transpose words and phrases in text when engaging in reading assignments (Sousa, 2014). These neurodevelopmental disorders can impact the students' ability to comprehend what they have read. This can cause children with dyslexia and ADHD to have an unpleasant experience when reading (Wilmot et al., 2023). In addition, dyslexia and ADHD appear to cause impairment in the child's memory, executive functioning and ability to process symbols rapid and efficiently (Al Dahhan et al., 2022). All these overlaps between dyslexia and ADHD can mask the symptoms of the other neurodevelopmental disorder as parents and educators may assume that all the child's problems were caused by their dyslexia or ADHD condition. Furthermore, this can create problems for the diagnostic criteria, which can lead to an underdiagnoses of certain learning difficulties.

Recent studies on the impact of dyslexia and ADHD on executive functioning found that these neurodevelopmental disorders can cause significant impairments in the child's executive functioning (Crisci et al., 2021). Español-Martín and colleagues (2023) found that these deficiencies in executive functioning can lead to poor learning outcomes in school for children with dyslexia and/or ADHD. These executive functioning skills are important for academic success as they can help students to retain information and focus during lessons. Children with dyslexia often have poor decoding skills and phonological awareness while children with ADHD are unable to sit still and focus during reading tasks. When these two neurodevelopmental disorders occur together, they can create more academic difficulties as these students struggle to decode words and focus during classes. This can create even more difficulties for educators as they need to address both conditions for the child to learn during classes. Educators will need to utilise a multifaceted approach that addresses both the reading difficulties associated with dyslexia and the executive functioning deficits associated with ADHD. Al Dahhan and colleagues (2022) found that children with both dyslexia and ADHD benefited greatly from an intervention approach that utilised both phonological training and executive

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function interventions to address their poor reading comprehension and inattention. Without proper intervention, children with both dyslexia and ADHD have a greater likelihood of retaining or dropping out of school, or experience academic and social impairment compared to their peers with either dyslexia or ADHD in isolation. A thorough review of the literature provided insight on the association between dyslexia and ADHD among school-aged children. Past research also provided the theoretical frame for understanding the impact of comorbid dyslexia and ADHD and how this can impact the child's learning experience.

However, research studies that examined the prevalence of ADHD among school-aged dyslexic children have been limited, especially in the Asian context. Most of the research focuses on the prevalence of ADHD among dyslexic children in Western cultures. Furthermore, no published literature on the prevalence of ADHD among school-aged dyslexic children in Singapore is currently available. This research study attempts to bridge the gap in the existing literature by examining the comorbidity and prevalence of ADHD among school-aged dyslexic children in Singapore. The motivation behind this research study was based on the increasing concern and recognition of the importance of addressing neurodevelopmental disorders in the educational context. Without receiving proper support or intervention, children with dyslexia and ADHD may fall behind their peers, especially given Singapore's competitive education system. By understanding the prevalence of dyslexia and ADHD, this can help to ensure that these children receive appropriate educational support in school to thrive. Furthermore, this can help educators to better allocate their resources and design intervention strategies to meet the diverse needs of these students. In the long run, this can help to improve the academic outcomes and increase the overall well-being of children with both dyslexia and ADHD in Singapore.

The aim of this research study is to investigate the prevalence of ADHD among school-aged dyslexic children in Singapore. This study aims to explore the following hypotheses. Firstly, the null hypothesis (H0) predicts that there is no significant association between dyslexic and ADHD among school-aged children in Singapore while the alternative hypothesis (H1) predicts that there is a significant association between dyslexic and ADHD among school-aged children in Singapore.

METHODOLOGY

Research Design

A quantitative research approach was adopted to test the research hypotheses regarding the prevalence of ADHD among school-aged dyslexic students. This allowed for statistical analysis of the relationship between dyslexia and ADHD, which can help provide a clearer picture of the association between dyslexia and ADHD among children in Singapore. This was a retrospective study that utilised existing the database

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maintained by the Dyslexia Association of Singapore (DAS). This helped to provide access to vulnerable and hard-to-reach populations which might have been difficult to study due to ethical considerations that needed to be considered when recruiting participants from vulnerable populations such as children and individuals with learning disabilities.

Data Source

Given the study's reliance on secondary data analysis, the study partnered with the DAS to access and analyse existing student information from the DAS instead of directly recruiting participants. The student database from DAS served as the primary source of data for this study. The DAS is a non-profit organisation dedicated to supporting individuals with dyslexia and other learning difficulties in Singapore. The primary mission of the DAS is to empower individuals who learn differently, including those with dyslexia, to achieve their true potential by providing them with specialised educational interventions, support services and advocacy. The organisation offers a wide range of programmes and services that are dedicated to meet the diverse needs of these individuals who learn differently. The DAS database contains extensive records of children diagnosed with dyslexia and other learning disabilities who have attended their various programmes or received intervention from the organisation. This comprehensive database includes demographic information, details on dyslexia diagnosis and information on ADHD diagnoses and symptoms. This helped to provide information on dyslexia and ADHD diagnoses among school-aged children in Singapore, which helped to eliminate the need for direct recruitment of participants and addressed any potential ethical issues associated with recruiting individuals from vulnerable populations.

Sample and Participants

In this research study, the target population were school-aged children diagnosed with dyslexia in Singapore and the sampling frame selected were school-aged dyslexic children who are receiving intervention from DAS. A total of 228 participant information aged between 7 to 17 years old was provided by the DAS for this research study. These school-aged children undergone for a dyslexia assessment between 2014 to 2023. This age group was selected as they represent the age range of children who are attending primary and secondary schools who are likely to benefit from early identification and intervention for specific learning differences. The inclusion criteria included students who received a diagnosis of dyslexia by certificated psychologists. The availability of data on ADHD diagnosis or symptoms within the DAS database helped to further refine the research sample for analysis. Potential participants with other characteristics which were deemed to be primary diagnoses such as low intelligence, educational deprivation and other comorbidities were excluded from the study. The sample size used for this research was determined using the G*Power software to ensure that there was sufficient statistical power for meaningful analysis to determine the association between dyslexia and ADHD.

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DAS provided sufficient student data to meet the recommended sample size of 80. A non-random purposive sampling method was selected as the data was extracted from the DAS database.

Data Collection Procedures

As the primary data collection involved secondary analysis, the study did not directly employ materials, tasks or questionnaires. The data collection process involved seeking approval from DAS to obtain access to their extracted DAS database. The extracted database included relevant demographic information, dyslexia diagnosis and information on symptoms or diagnoses of ADHD. The extracted information included information from an 11-item teacher questionnaire (Appendix A), which DAS previously collected to provide insights into the classroom performance and behaviour of each student. The extracted dataset was reviewed, cleaned and organised to prepare for statistical analysis. This involved coding categorical variables and checking for any missing entries.

Variables and Measures

In this research study, a formal diagnosis of dyslexia served as the independent variable for this study while the presence or absence of an ADHD diagnosis among the dyslexic students served as the primary dependent variable. This allowed for statistical analysis of the prevalence of ADHD among school-aged dyslexic children in Singapore. Furthermore, age and gender were included as control variables to investigate for any possible variations in the prevalence of ADHD across different age groups and gender.

Data Analysis

All data analysis was performed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics was calculated using the SPSS software to provide a summary of the demographic of the extracted sample from DAS such as their ages and genders. After which, frequencies and percentages were computed to provide a comprehensive overview of the characteristics of the dataset. In this study, the prevalence of ADHD among dyslexic children in Singapore was calculated using the percentage of dyslexic children with an ADHD diagnosis. This data analysis provided insights into the comorbidity of dyslexia and ADHD among the extracted datasets. The chi-square test of independence was conducted to examine the association between dyslexia and ADHD. The chi-square test helped to determine whether to accept or reject the research hypothesis by investigating if the prevalence of ADHD among school-aged dyslexic children was significantly higher than expected by chance. Chi-square test was the most suitable statistical test for examining the association between dyslexia and ADHD diagnosis as they are both categorical variables (Field, 2018). Furthermore, logistic regression analysis was conducted to control for potential confounding variables such as

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age and gender, which helped to investigate potential variations in the prevalence of ADHD among dyslexic children. In logistic regression, the presence or absence of ADHD was the dependent variable while dyslexia diagnosis, age and gender were utilised as the independent variables. This allowed for more in-depth analysis determining whether dyslexia are a significant predictor of an ADHD diagnosis after controlling for demographic variables like age and gender. In this research study, the statistical significance was set at $p < 0.05$ for all statistical analysis. The results from these data analysis were used to determine whether to accept or reject the research hypotheses and assess the main objective of the study.

Ethical Considerations

Since the study utilised secondary analysis of archived data involving children, ethical considerations were essential as children with learning disabilities are considered a vulnerable population. Firstly, ethical clearance for this research study was sought and obtained from the Psychology Programme Ethics Review Committee (PERC) from the Singapore University of Social Sciences (SUSS). This helped to ensure that the ethical standards were being adhered to, especially when the target population involved vulnerable participants such as children with learning difficulties.

After obtaining ethical approval from SUSS PERC, ethical approval was sought and obtained from the DAS research committee to access and utilise their database for the research study. This is essential as the study utilises sensitive information regarding children with learning disabilities. The DAS had previously obtained informed consent from the parents or legal guardians to utilise their child's information for future research purposes, prior to their registration into the DAS programmes. Furthermore, this study did not involve any direct recruitment of participants, which helped to mitigate any potential ethical risk associated with the data collection process. The researcher, who is a DAS staff member, worked closely with the DAS research committee to extract anonymised data for eligible participants. After which, each student was assigned a unique identification number. This allowed the researcher to analyse the data without compromising the privacy of the students.

RESULTS

In this study, 228 participant information were extracted from the DAS database. The extracted dataset consisted of 128 boys (56.1%) and 100 girls (43.9%). The age range of these 228 participants ranged from 7 years old to 17 years old (mean age = 11.04, SD = 2.57). Out of these 228 participants, 225 (98.7%) participants including 100 girls and 125 boys were formally diagnosed with dyslexia. In the extracted dataset, 223 participants are attending mainstream schools in Singapore with 126 participants enrolled in primary school while the remaining 97 participants are attending secondary schools. There were

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no participants excluded from the extracted dataset due to missing values for any of the variables.

Among the 225 participants with dyslexia, 39 of these participants (17.1%) were also diagnosed with ADHD while the remaining 189 participants (82.9%) did not have a diagnosis of ADHD. Of these 39 participants with both dyslexia and ADHD, 27 were boys while 11 were girls with a male to female ratio of 3:1. The gender ratio of boys with ADHD to girls with ADHD was consistent with those found in overseas and local clinical studies (Lau et al., 2021). The demographic characteristics of the extracted participant information were presented in Table 1.

Table 1. Demographic Characteristic of Participants

	Neither ADHD nor dyslexia diagnosis		**ADHD diagnosis (ADHD)**		**Dyslexia diagnosis**		**Both ADHD and dyslexia diagnosis**	
	n	%	*n*	%	*n*	%	*n*	%
Gender								
Female	0	0%	0	0%	89	39.0%	11	4.8%
Male	2	0.9%	1	0.4%	98	43.0%	27	11.8%
Age								
7	0	0%	0	0%	10	4.4%	2	0.9%
8	0	0%	0	0%	19	8.3%	2	0.9%
9	0	0%	0	0%	17	7.5%	1	0.4%
10	0	0%	1	0.4%	17	7.5%	2	0.9%
11	0	0%	0	0%	19	8.3%	4	1.8%
12	1	0.4%	0	0%	27	11.8%	5	2.2%
13	1	0.4%	0	0%	26	11.4%	7	3.1%
14	0	0%	0	0%	22	9.6%	3	1.3%
15	0	0%	0	0%	11	4.8%	6	2.6%
16	0	0%	0	0%	16	7.0%	4	1.8%
17	0	0%	0	0%	3	1.3%	2	0.9%

N = 228

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In this research study, the prevalence of ADHD among school-aged dyslexic children in Singapore was found to be 17.1%. The prevalence rate was consistent with those found in overseas studies of 15% to 40% (McGrath & Stoodley, 2019). This suggests that dyslexia and ADHD frequently co-occurred among individuals with neurodevelopmental disorders. After which, the chi-square test of independence was conducted to examine the association between dyslexia and ADHD. The study found that there was no statistically significant association between dyslexia and ADHD diagnosis ($\chi 2 = 0.565$, df = 1, p = 0.452) (Table 2). These research findings suggest that while ADHD is prevalent among children with dyslexia, there is no statistically significant relationship between the two neurodevelopmental disorders. Therefore, we accept the null hypothesis that there is no significant association between dyslexic and ADHD among school-aged children in Singapore.

Table 2. Chi-Square Analysis

	Value ($\chi 2$)	Degree of Freedom (df)	Significance Level (p-value)
Pearson Chi-Square	0.565	1	0.452

In the logistic regression model predicting the diagnosis of ADHD among school-aged children, diagnosis of dyslexia, age and gender was utilised as predictor variables. Among the predictors, age (B = -0.136, p = 0.050) and gender (B = 0.814, p = 0.037) were significant predictors (Table 3). This showed that the odds of being diagnosed with ADHD decrease as children become older (Exp(B) = 0.873). Furthermore, the study found that boys had more than twice the odds (Exp(B) = 2.256) of being diagnosed with ADHD compared to girls. This is consistent with past research that found that boys were more likely to be diagnosed with ADHD than their female counterparts. The logistic regression analysis also found that a diagnosis of dyslexia was not a significant predictor of ADHD diagnosis (B = 0.662, p = 0.596). These findings suggested that the presence of dyslexia among children does not significantly predict the presence of ADHD.

Table 3. Logistic Regression Analysis

Predictor	Estimated Coefficient (B)	Degree of Freedom (df)	Significance Level (p-value)	Odds Ratio (Exp(B))
Dyslexia Diagnosis	0.662	1	0.596	1.939
Age	-0.136	1	0.050	0.873
Gender	0.814	1	0.037	2.256

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DISCUSSION

This study aimed to elucidate the prevalence of ADHD among school-aged dyslexic students in Singapore using information regarding their dyslexia and/or ADHD diagnosis extracted from the DAS database. In this research study, data analysis found that the prevalence of ADHD among school-aged dyslexic children in Singapore is 17.1%. This is consistent with Western studies that found that prevalence of ADHD diagnosis among dyslexic individuals ranged between 15% to 40% (McGrath & Stoodley, 2019). These findings suggested that dyslexia and ADHD often co-occurred among school-aged children in Singapore. As a result, it is important for parents and educators to identify these neurodevelopmental disorders early so that these children with dyslexia and ADHD can receive early intervention to help them in their academic journey. This is crucial for their learning as children with both ADHD and dyslexia tend to experience more severe academic difficulties than those children who are diagnosed with only one condition (Bonti et al., 2024). The high rates of comorbidity between dyslexia and ADHD raised concerns that overlaps between the symptoms of dyslexia and ADHD may mask the child's symptoms of inattention or hyperactivity-impulsivity. This can lead to an underdiagnoses of ADHD among children with dyslexia. The research findings highlighted the importance of ADHD risk assessment for children with dyslexia so that parents and educators can provide them with the appropriate support tailored to their individual needs.

However, the study found that there was no statistically significant association between dyslexia and ADHD. This suggested that the presence of dyslexia does not indicate the presence of ADHD or vice versa (Stark et al., 2022). This could be explained by several reasons such as cultural factors and the education system that may lead to the underdiagnoses of ADHD among school-aged children in Singapore. Firstly, cultural factors between Singapore and Western cultures can lead to differences in research findings. Compared to Western education system, Singapore placed strong emphasis on academic performance and discipline (Sudo et al., 2023). This can help to create a strict classroom environment where students are expected to behave appropriately during lessons. This can help to reduce hyperactive behaviours among students with mild ADHD symptoms for the fear of being punished. This can lead to an underdiagnoses of ADHD among students in Singapore. Furthermore, Singaporean parents, similar to most Asian parents, are highly concerned with their child's performance in school (Göransson et al., 2022). This can cause them to overlook high functioning children who are able to meet academic expectations despite their difficulties with attention and/or hyperactivity-impulsivity. Therefore, it is possible for these students with mild ADHD symptoms to be overlooked as the academic performance may mask the symptoms of their ADHD. As these students are coping well in school, they may not be flagged by teachers for learning support programmes in school. This will reduce the likelihood that these students will be referred to educational psychologists for assessment. This will lead to an underdiagnoses of these ADHD and dyslexia.

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Secondly, the social stigma towards neurodevelopmental disorders in Asian societies can lead to an underdiagnoses of dyslexia and ADHD among children in Singapore. This can cause many parents to avoid seeking formal diagnosis for their child as they fear that societal judgement or negative consequences (Ee et al., 2021). Many parents feared that their children would be treated differently by their peers and teachers if they were given a formal diagnosis of dyslexia and ADHD. They may be afraid that as a result of the diagnosis, their child might be labelled as a "problem child". This reluctance can lead to an underdiagnoses of learning disabilities in Singapore, where academic success is often viewed as a measure of the child's future. These different cultural factors and education systems between Singapore and Western cultures can be used to explain the difference in research findings.

In addition, logistic regression analysis found that dyslexia diagnosis was not a predictor of ADHD diagnosis among school-aged children. However, the research study found that age and gender can significantly predict the presence of ADHD among school-aged dyslexic children. In this research study, younger children were found to have greater odds of being diagnosed with ADHD compared to their older counterparts. The research findings may reflect developmental trends among children as they learn to better control their behaviours as they grow older. For younger children, they tend to display more overt hyperactive and inattentive behaviours during lessons which causes them to be flagged out and diagnosed with ADHD. However, these hyperactive and inattentive behaviours tend to decrease as children grow older (Wootton et al. 2022). This inverse relationship between age and ADHD diagnosis highlights the importance of early identification and intervention so that these young children can receive proper support and skills to manage their behaviour as they progress through the educational system. Furthermore, gender can serve as a significant predictor of ADHD among school-aged children. The logistic regression analysis found that boys have a greater likelihood of being diagnosed with ADHD compared to girls. This is consistent with past research that boys were three times more likely to be diagnosed with ADHD than girls (Lau et al., 2021). According to Lau and colleagues (2021), boys are at a higher risk of being diagnosed with hyperactivity and/or impulsivity presentation. These patterns of behaviours are more easily identified in classroom settings compared to inattention presentations. This can cause boys to be flagged out more often by teachers for displaying symptoms of ADHD. For girls, they have a greater likelihood of being diagnosed with the inattentive presentation of ADHD (Lau et al., 2021). These symptoms are less noticeable to teachers as they have to manage a class of 30 to 40 students. This can cause them to miss out these symptoms, which can lead to an underdiagnoses of ADHD among dyslexic girls.

The findings of this research study have highlighted the importance of professional development for educators in Singapore so that they are better equipped to work with children with different learning disabilities. The Singapore education system has made significant progress as they have developed an after-school learning support

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programme to help students who may be struggling. However, there is still a gap in knowledge when it comes to working with students with multiple neurodevelopmental disorders. When teachers are well-informed about the unique challenges faced by children with both dyslexia and ADHD, they are able to provide effective classroom strategies and intervention for these children (Stark et al., 2022). This can help to ensure that students receive the support necessary to achieve their full academic potential. Studies on the treatment response patterns in children with co-occurring ADHD and reading difficulties found that children who received both ADHD and reading interventions demonstrated significant improvements in their academic performance compared to those who just received ADHD or reading interventions (Dvorsky et al., 2021). Denton and colleagues (2020) found that children who received reading intervention and combined treatment showed greater improvements in their phonemic decoding fluency compared to the ADHD treatment group. On the other hand, the ADHD treatment group had significantly better outcomes than the Reading intervention group. These results indicate that while reading interventions enhance decoding skills, ADHD treatment may support comprehension abilities. This highlights the importance of a multifaceted approach to intervention for children with both dyslexia and ADHD.
Implications for future studies

This research study highlighted several implications for future studies. Firstly, this study utilised secondary data extracted from the DAS database to examine the prevalence of ADHD among school-aged dyslexic children. Future studies can consider conducting a small-scale primary data collection component to complement the archival data extracted from the DAS database. This can help to provide additional insights and validate the findings of the secondary data analysis. Furthermore, future studies can focus on longitudinal research to examine the long-term impact of dyslexia and ADHD. This can help to provide more insights into the interactions between dyslexia and ADHD and how they can impact the academic progress of school-aged children in Singapore. By looking at the developmental trajectories of children with both dyslexia and ADHD, researchers and teachers can have a better understanding of how these two neurodevelopmental disorders evolve, interact and impact the emotional well-being and academic performance of school-aged children. This longitudinal study can also allow researchers to determine the effectiveness of interventions on the academic performance of children with only dyslexia, children with only ADHD and children with comorbid dyslexia and ADHD. This can help inform educators on how to tailor educational interventions to fit the specific needs of these children with neurodevelopmental disorders.

In addition, future studies can explore further on the prevalence of dyslexia among the different presentations of ADHD. Children with comorbid dyslexia and inattention presentation of ADHD may experience different academic challenges compared to their counterparts with comorbid dyslexia and hyperactivity-impulsivity presentation of ADHD. Future studies can focus on how these different presentations can lead to different

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challenges for school-aged children, and this can have very different implications for their academic performance and emotional well-being. For example, children with comorbid dyslexia and hyperactivity-impulsivity presentation of ADHD can be flagged for more often in school by teachers as they are more easily identifiable. This can cause them to be labelled "naughty" and have negative implications on their emotional well-being. On the other hand, children with comorbid dyslexia and inattention presentation of ADHD may be quietly suffering in class as their difficulties are less noticeable. Future studies that examine this prevalence can help educators and parents to be better equipped to identify these different presentations. Finally, future research can conduct comparative studies to better understand how different cultural contexts and education systems influence the prevalence of ADHD among school-aged dyslexic children. This help provides researchers with a better understanding of how societal attitudes and educational expectations can influence the prevalence of ADHD and dyslexia among school-aged children.

LIMITATIONS

There were several limitations in this research study. Firstly, the participants for this study were not recruited by nationwide population sampling but they were extracted from the DAS database. This can potentially limit the generalisability of the research study. However, since DAS is a well-known organisation that works with children with various learning disabilities, we expect minimal impact on the research findings. Secondly, the extracted dataset was collected using a non-random purposive sampling method. This can lead to potential biases in the research studies. Due to the tight timeline for this dissertation study, there was a lack of time to adopt a random sampling method when extracting the dataset for this research study. This can be mitigated for future research study by working closely with the DAS to extract their entire dataset and randomly selecting participants to be part of the extracted sample. This can help to avoid any potential bias that may arise when using non-random sampling approaches. Thirdly, this research study utilised analysis of archival data to examine the prevalence of ADHD among school-aged dyslexic children in Singapore. This results in limited control over the data collection process which can lead to potential biases in the research study.

CONCLUSION

In conclusion, this research study found that the prevalence of ADHD among school-aged dyslexic children was 17.1%. This indicates that ADHD often co-occur among dyslexic children in Singapore. However, the study found that there was no statistically significant association between dyslexia and ADHD. This means that the presence of dyslexia does not lead to a diagnosis of ADHD among school-aged children. In addition, the study also found that age and gender are significant predictors of ADHD diagnosis. The study revealed that younger children were more likely to be diagnosed with ADHD while boys had more than twice the odds of having ADHD than their female counterparts. To our

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knowledge, this study is the first in Singapore that examines the prevalence of ADHD among school-aged dyslexia children in Singapore. This study can also help to increase awareness of the prevalence of ADHD among dyslexic children. The overlaps between dyslexia and ADHD symptoms may mask the symptoms of ADHD as parents and educators may attribute the students' difficulties to their dyslexia. However, in reality, their challenges may be caused by a different learning disability that affects their academic performance.

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APPENDIX—TEACHER QUESTIONNAIRE

Part I - Applicant's Particulars

Name : _____ School : _____

Level : _____

Part II – Questionnaire

Dear Teacher,
Your student has sought an assessment or has been referred to the Dyslexia Association of Singapore (DAS) by his/her parents for a psycho-educational assessment. We would appreciate your help in providing information about the student and the difficulties (s)he might face in the classroom. If you have any questions, please contact the SpLD Assessment Services at enrol@das.org.sg.

1. How would you rate this student academically as compared to his/her classmates?

   Below average / Average / Above average *(please circle the appropriate one)*

2. Do you think the student is putting in his/her best effort? *Yes /No*

3. Details of your Teaching Context *(Size of class, overall abilities of class, any additional support given?)*

_____
_____
_____

4. Have you ever been concerned about this student's progress in reading, spelling, or writing? *Yes /No*

   If YES, please elaborate:

_____
_____
_____

5. Are there any other concerns regarding the student's learning? (e.g. handwriting, maths, language)

_____
_____
_____

6. How is the student being supported in school at present? (e.g. learning support, remedial, access arrangement, modification of teaching materials)

_____
_____
_____

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7. How well does the student understand and carry out instructions? Please elaborate.

_____
_____
_____

8. Please provide information about the student's social and emotional functioning, including how he/she relates to teachers and fellow classmates.

_____
_____
_____

9. Please provide information about the student's attitude towards learning and behaviour in the classroom, including his/her attention and concentration during lessons.

_____
_____
_____

10. Please provide information about the student's attitude towards CCA and other non-academic subjects, including any special skills or behavioural traits he/she displays (e.g., leadership skills, organisational ability).

_____
_____
_____

11. If applicable, what do you think are possible reasons for the student's problem?

_____
_____
_____

If there is any additional relevant information about the student, please use this space below, or attach the relevant documents.

_____
_____
_____

Form completed by : _____ Position : _____

Contact Email : _____ Contact No : _____

How long have you known this student? _____ years _____ months

Date of Completion dd/mm/yyyy

Thank you for your time.

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