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Prevalence of ADHD symptoms and their association with learning-related skills in Grade 1 children in South Africa

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Attention Deficit / Hyperactivity Disorders (ADHD) are developmental disorders in children with 3 symptom clusters, namely hyperactivity, attention deficit and impulsivity, and a combination. We investigated the prevalence of the 3 symptom clusters and their association with learning-related skills among children aged 6 to 7 years in Bloemfontein, Free State province, South Africa. The Aptitude Test for School Beginners (ASB) was applied to determine learning-related skills, and the Strength and Weaknesses of ADHD Symptoms Normal Behaviour rating scale (SWAN) was used to determine ADHD symptoms. Data on SWAN scores were available for 390 children, while data on both the SWAN and ASB were available for 345 children (189 girls and 156 boys) with a mean age of 6 years and 8 months. The prevalence of ADHD symptoms was as follows: 74.6% of the children did not fulfil the criteria for ADD/ADHD, 7.7% presented with the combined subtype, 6.7% presented with hyperactivity and impulsiveness, and 11.0% with inattentiveness. The presence of ADHD symptoms had a significant effect $p = < 0.05$ on reasoning, numerical abilities, gestalt, coordination and memory. We conclude that ADHD symptoms are a significant risk factor for 5 of the 8 learning-related skills in children, namely numerical skills, memory, reasoning, gestalt and coordination.

Keywords: Aptitude Test for School Beginners (ASB); Attention Deficit/Hyperactivity Disorder (ADHD); children; learning-related skills; Strength and Weaknesses of ADHD Symptoms Normal Behaviour (SWAN) rating scale

Introduction

Attention Deficit / Hyperactivity Disorders (ADHD) are neurodevelopmental disorders that manifest early during the developmental phase of children, often before the child enters formal education (American Psychiatric Association [APA], 2013; Auxter, Pyfer, Zittel & Roth, 2010; Roth, Zittel, Pyfer & Auxter, 2017). However, the causes of this neurodevelopmental disorder are still unknown (Roth et al., 2017). The involvement of the prefrontal cortex, basal ganglia as well as the cerebellum can cause difficulties with self-inhibition (Yu-Feng, Yong, Chao-Zhe, Qing-Jiu, Man-Qiu, Meng, Li-Xia, Tian-Zi & Yu-Feng, 2007). According to the Centers for Disease Control and Prevention (CDC, 2015 cited in Roth et al., 2017), ADHD might be a genetic disorder; although negative responses to bad additives or the sensitivity to various chemicals in addition to fungi and moulds, and the exposure to toxins might also be contributors to ADHD.

Schellack and Meyer (2012, 2016) report that information regarding the prevalence of ADHD in South Africa is limited, but estimate its prevalence to be between 5% and 10%. According to the APA (2013), ADHD affects 5% of American school-aged children. However, according to the CDC (2015), the prevalence of ADHD is even higher (11%). Observed prevalence rates may fluctuate due to various diagnostic and methodological practices used across different regions (APA, 2013; Schellack & Meyer, 2012, 2016).

According to APA (2013, cited in Roth et al., 2017:610), ADHD consists of three major symptom clusters: 1) inattentiveness: “make careless mistakes, doesn’t seem to listen, don’t follow through on instruction, difficulty organizing tasks, avoids tasks requiring sustained mental effort, loses things necessary for tasks, easily distracted, forgetful in daily activities; 2) hyperactivity/impulsiveness: fidgets and squirms in seat, leaves seat often, runs about or climbs excessively, difficulty playing or engaging in leisure activities quietly, often on the go, talks excessively, blurts out answer before question is complete, has difficulty waiting turn, interrupts or intrudes on others, and 3) the combined type: most common type in children, a combination of characteristics demonstrated in the other two types.” Due to these negative characteristics, early identification of ADHD is important, as this disorder may create obstacles to learning and place children at educational risk (APA, 2013; National Joint Committee on Learning Disabilities, 2007; Schellack & Meyer, 2012, 2016).

Educational risks are learning difficulties that include delays in speech and language development (Perold, Louw & Kleynhans, 2010) and perception and reasoning, all of which are prerequisites for academic achievement and the meeting of educational goals (National Joint Committee on Learning Disabilities, 2007). Difficulties with reading, spelling or arithmetic also occur at school (Wender, 2000). The ability to concentrate is vital in order to be successful in school (Huang-Pollock & Karalunas, 2010; Pienaar, Du Toit, Stickling, Peens, Botha, Kemp & Coetzee, 2012).

According to Roth et al. (2017) children presenting with the impulsive subtype can experience severe difficulties, and these children might struggle more in a school setting. Furthermore, they indicate that impulsivity is related to the inability to attend to instruction, to follow the instructions and to complete instructional activities in addition to complying with the rules in the classroom (Roth et al., 2017). Thus, children with ADHD are at risk of reduced school performance (APA, 2013; Schellack & Meyer, 2012, 2016). The inability to control functional movements often remains during the course of the school years, and children do not outgrow ADHD (Schellack & Meyer, 2012, 2016; Visser, Danielson, Bitsko, Holbrook, Kogan, Ghandour, Perou & Blumberg, 2014).

In South Africa, little is known about the prevalence of ADHD (Schellack & Meyer, 2012, 2016) and about the effects of ADHD symptoms on learning-related skills among children (Wessels, Pienaar & Peens, 2008). Therefore, the aim of the study reported on here was to determine the prevalence of ADHD symptoms and their effects on learning-related skills among Grade 1 children in Bloemfontein, South Africa.

Methodology

Research Design

This was an analytical study conducted in four mainstream primary schools categorised as former model C schools, which formed part of a larger randomly selected sample of 13 schools invited to participate. Six schools were excluded because they did not meet the inclusion criteria, and of the remaining seven schools only four used the ASB. All participating schools were located within 30 km from the University of the Free State in Bloemfontein, and all were from a high socio-economic environment.

Children between the ages of 6 and 7 years adhered to the inclusion criteria. Exclusion criteria for children were parental permission not obtained, incomplete informed consent, or parents indicating that the child would not be able to attend all the testing sessions due to the fact that the family would relocate during the study. In addition, children were excluded if they missed one session during the testing procedure.

The Aptitude Test for School Beginners (ASB) was applied to determine learning-related skills, and the SWAN was used to determine ADHD symptoms (either the inattentive, hyperactive or combined clusters of ADD/ADHD); details are provided in the next section.

The lead investigator explained to the heads of departments (HOD) at the participating schools how the SWAN rating scale was to be completed. The HODs were expected to explain the procedure to the Grade 1 teachers, since they could not attend the information session. A prerequisite of the SWAN is that teachers need to be familiar with each child and

consequently needs to observe each child's behaviour for at least six months. According to the APA (2013), symptoms of ADHD should be present for at least six months before a child can be identified with ADD/ADHD. Furthermore, each participant was assessed using the ASB, conducted and interpreted by the teachers. There were between 25 and 30 children in each class.

Measuring Instruments

Aptitude Test for School Beginners (ASB)

The ASB is a South African test, and therefore culturally appropriate for the participants of this study. During the first six months of the school year all the participating children were assessed by qualified teachers using the ASB. A prerequisite of the ASB is that it must be offered and completed in a child's home (first) language. The participants were all from Afrikaans-medium schools and homes. Thus, the teachers administered the ASB in Afrikaans.

The ASB is a norm-based instrument and consists of eight sub-items (Olivier & Swart, 1996; Van Zyl, 2004): perception, spatial orientation, reasoning, numerical skills, gestalt, coordination, memory and verbal comprehension. Each sub-item is scored between one and five. A score of 1 or 2 is regarded as below average, 3 as average and 4 or 5 as above average. The sub-items are then added up. The ASB has a reliability coefficient for the total test score of 0.80, thus a valid and reliable tool to use.

ADHD Symptoms Normal Behaviour rating scale (SWAN)

The SWAN rating scale was developed by Swanson, Schuck, Porter, Carlson, Hartman, Sergeant, Clevenger, Wasdell, McCleary, Lakes and Wigal (2012). The SWAN consists of 18 questions/statements on which the participant is rated by the educator or a parent. The questionnaire should be completed after a period of six months of formal schooling in order to ensure that the educators are familiar with each child in the classroom (Swanson et al., 2012). This recommendation was applied in our study. When completing the scale, a value of 1 is allocated if the response to the statement is "not at all" or "just a little" and 0 if the response is "quite a bit" or "very much." The scores allocated to the statements are then added up and if the sum is ≥ 6 for questions 1 to 9, the participant is likely to have inattentive subtype ADD/ADHD. If the sum is ≥ 6 for statements 10 to 18, the participant is likely to have hyperactive/impulsive subtype ADD/ADHD. If the sum of both groups of statements (1–9 and 10–18) is ≥ 6 , the participant is likely to have combined subtype ADD/ADHD. If neither adds up to ≥ 6 , the participant is unlikely to have ADHD or the symptoms are controlled by medication (Swanson et al., 2012). The psychometric properties for the SWAN was reconfirmed by recent studies (Swanson et al., 2012).

Ethical Considerations

Permission for the study was obtained from the Free State Department of Education and the principals of the schools that gave consent for the research to be conducted on the school premises. Approval was also obtained from the Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS57/2012). The parents/legal guardians completed an informed consent form for each child, and the children signed assent forms.

Data Analysis

We captured the data obtained from the ASB and SWAN electronically in a Microsoft Excel spreadsheet. A statistician performed the data analysis using SAS (SAS Institute Inc, 2017). Frequencies and percentages were calculated for categorical data. The association between ADHD symptoms and the scores on the various ASB items was tested as follows. Firstly, the ASB scores of children in the three subtypes of ADHD were compared using the Mantel-Haenszel chi-square test (mean score test; SAS procedure FREQ). Since the ASB scores for the three ADHD subtypes did not differ significantly with respect to any items, the three groups of children with ADHD symptoms were combined. Subsequently, children without ADHD symptoms were compared with the combined group of children with

ADHD symptoms, again using the Mantel-Haenszel mean score test.

Results

Scores on the SWAN were obtained for 390 Grade 1 children and scores on both the SWAN and the ASB for a total of 345 Grade 1 children (156 boys and 189 girls). The mean age of the children was 6 years and 8 months (range 6 years to 7 years and 9 months) with a standard deviation of 0.4.

Figure 1 presents the prevalence of the three major symptom clusters of ADHD by gender among the 390 children with ADHD and gender information. Overall, 291/390 children (74.6%) did not fulfil the criteria for ADD/ADHD, 30/390 (7.7%) presented with the combined subtype, 26/390 (6.7%) presented with hyperactivity and impulsiveness, and 43/390 (11.0%) with inattentiveness. Furthermore, there was a significant difference between girls and boys with regard to ADHD symptoms ($p < 0.0001$; Fisher's exact test). The results of the current study concur with findings reported in both the American (APA, 2013; Auxter et al., 2010) and South African (Pienaar et al., 2012; Wessels et al., 2008) literature, indicating that boys are at higher risk of having ADHD symptoms compared to their female counterparts.

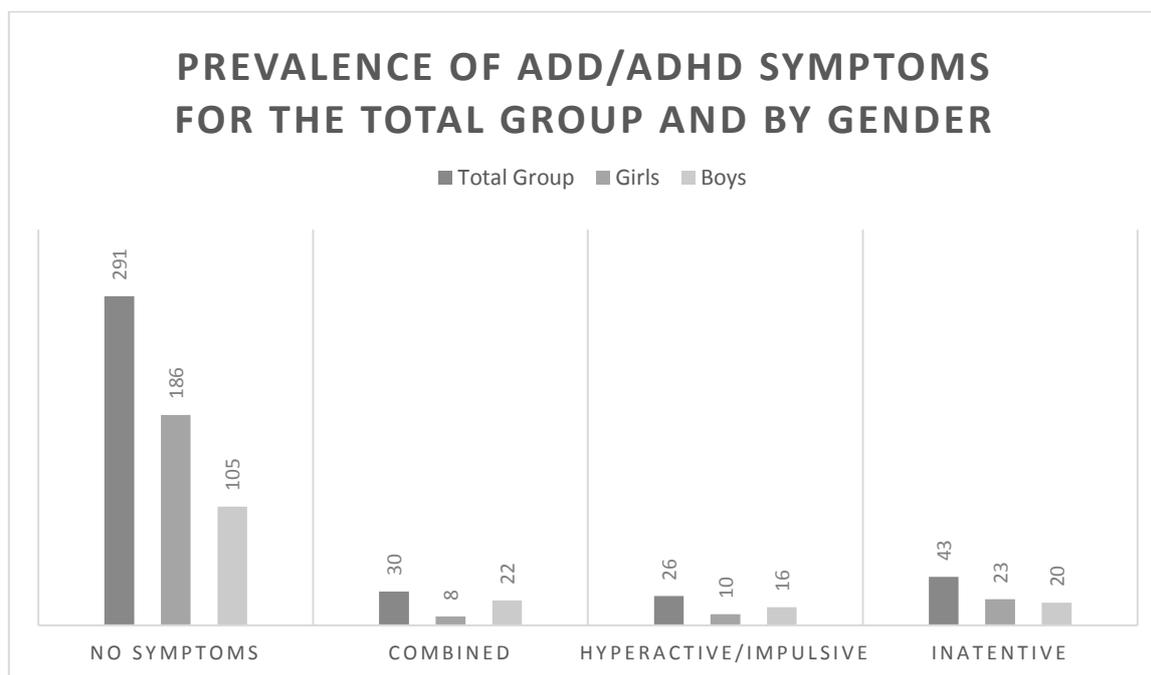


Figure 1 Prevalence of hyperactivity/impulsiveness and inattentiveness symptoms for the total group and by gender ($n = 390$ children with SWAN data)

ASB scores for the various learning-related skills by the three ADHD symptom clusters (hyperactivity/impulsiveness, inattentiveness and combined), compared to children with no ADHD symptoms, are summarised in Table 1. In the preliminary

test comparing children within the three ADD/ADHD symptom clusters, no significant differences were observed with respect to any ASB items (see p -value^a in Table 1). However, comparing children without ADHD symptoms to the combined

group of children in any of the three ADHD symptom groups, five of the eight learning-related skills, namely numerical skills ($p < 0.0001$), memory ($p = 0.0185$), reasoning skills ($p = 0.0055$), gestalt ($p < 0.0001$) and coordination ($p < 0.0001$) showed sig-

nificant differences in ASB scores. With regard to these skills, children without ADHD symptoms significantly outperformed their peers presenting with ADD/ADHD symptoms.

Table 1 Association of ADHD symptoms with Aptitude Test for School Beginners (ASB) scores (*N* = 345 children with SWAN and ASB data)

ASB item	ADHD symptoms (<i>n</i> = 83)												<i>p</i> -value ^a	<i>p</i> -value ^b
	Without ADHD symptoms (<i>n</i> = 261)			Hyperactivity/impulsiveness (<i>n</i> = 20)			Inattentiveness (<i>n</i> = 37)			Combined (<i>n</i> = 27)				
	ASB score			ASB score			ASB score			ASB score				
	1-2 ^b	3 ^c	4-5 ^d	1-2	3	4-5	1-2	3	4-5	1-2	3	4-5		
Perception	1 ^e	4	95	0	0	100	0	11	89	4	3	93	0.2747	0.0841
Spatial skills	7	24	69	0	37	63	8	14	78	7	43	50	0.2965	0.1433
Verbal comprehension	13	40	47	26	32	42	22	36	42	28	36	36	0.8128	0.0628
Numerical skills	10	30	60	26	32	42	14	42	44	32	39	36	0.3143	< 0.0001*
Memory	15	5	80	26	11	63	22	8	70	18	11	72	0.4510	0.0185*
Reasoning	5	12	83	10	16	74	19	22	58	18	21	61	0.1211	0.0055*
Gestalt	5	24	71	16	26	58	11	47	42	29	32	36	0.3833	< 0.0001*
Coordination	32	47	21	47	47	6	61	36	3	68	28	4	0.5268	< 0.0001*

Note. ^a*p*-value for difference between three ADHD symptom groups. ^b*p*-value for difference between symptom-free children and combined group of children in any of the three ADHD symptom groups. **p* ≤ 0.05 = statistically significant. ^c1-2 = below average. ^d3 = average. ^e4-5 = above average.

Discussion

The study reported on in this paper set out to determine the prevalence of the inattentive, hyperactive/impulsive and combined clusters of ADHD symptoms and no ADHD symptoms among children aged 6 to 7 years. In addition, the study aimed to investigate a possible association between ADHD symptoms and children's ASB scores on specific learning-related skills.

With reference to the prevalence of ADD/ADHD-related symptoms, we found results (namely 25.4% of children identified with these symptoms) that are in contrast to the findings reported by Schellack and Meyer (2012, 2016), who indicated that the prevalence of ADHD in South African children to be between 5% and 10%. The current results also differ from previous findings that 5% of American children are diagnosed with ADHD (APA, 2013), while the CDC (2015) reported a slightly higher prevalence of 11%.

The findings show that the presence of ADHD symptoms does have a significant negative effect on children's learning-related skills, specifically with regard to reasoning, gestalt, coordination, numerical skills and memory.

With regard to reasoning, children with ADHD symptoms find it difficult to think logically and they have comprehension-related shortcomings. According to the APA (2013) and Auxter et al. (2010) children with ADHD have a limited ability to gauge social situations, causing them to make comments out of turn, initiate conversations at inappropriate times and intrude on others. Furthermore, they frequently make careless mistakes and rush through tasks without thinking (Roth et al., 2017). An additional factor contributing to poor comprehension is that children are inattentive or daydreaming (Roth et al., 2017).

Moreover, children with ADHD find it hard to organise tasks, which could influence their gestalt abilities (Auxter et al., 2010). Since gestalt is related to writing activities, low levels of concentration can influence the ability to complete written work, influencing this specific learning-related skill. Cheatum and Hammond (2000) assert that low levels of concentration may be attributed to insufficient functioning of the eyes. Thus, eye problems experienced by a child during gestalt skills, may influence his/her ability to complete the task successfully. Roth et al. (2017) further found that children with ADHD seldom complete a task, or they do not follow through on instructions given by the teacher.

Learning-related coordination refers specifically to fine-motor coordination skills such as writing and tracing. Thus, coordination may directly be linked to gestalt, because both of these learning-related skills involve writing activities. Wessels et al. (2008) found that children with ADHD also experience additional disorders such as Developmental

Coordination Disorder (DCD), and may have coordination impairments in conjunction with an ADHD diagnosis.

Difficulties in memory and numerical skills (as shown in this study) could explain why children with ADHD often avoid tasks that demand sustained mental effort (Huang-Pollock & Karalunas, 2010; Wender, 2000). With regard to memory, the school beginner depends to a large extent on visual memory, supporting the statement by Cheatum and Hammond (2000) on the importance of proper eye functioning for school success.

No statistically significant differences were found between children with and without ADHD symptoms with regard to perception, spatial orientation and verbal comprehension, possibly because these skills may be evaluating areas that are inherent relative strengths for children with ADHD. Children with ADHD tend to talk excessively, which can contribute to good verbal comprehension.

The results of this study confirmed that ADHD symptoms have an effect on learning-related skills. These results are in agreement with the findings of other researchers (Shimabukuro, Prater, Jenkins & Edelen-Smith, 1999; Wessels et al., 2008, 2009) who show that there is a strong association between ADHD and learning-related skills and that numerous children with ADHD experience complications with their academic and learning performances.

The results of this study are imperative for teachers, because a child showing ADHD symptoms when entering formal school may experience an assortment of learning-related skills required to be successful in a school setting. Thus, the teachers who are aware of children with ADHD symptoms can take these limitations regarding learning-related skills into consideration and address these problems by means of new preventative strategies. Thus, ADHD in addition to learning-related difficulties, should be addressed in order to assist children with difficulties they might experience with regard to their academic performance.

Conclusion

ADHD symptoms are significantly associated with learning-related skills such as reasoning, numerical skills, gestalt, coordination and memory. No significant difference was found in this study between the different ADHD clusters and the learning-related skills of perception, spatial and verbal comprehension as measured on the ASB.

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Notes

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Authors' Contribution

MdM planned the research and wrote the article in addition EdB and MSC collected the data. Data analysis was done by RS. All authors reviewed the final manuscript.

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