The Open Psychology Journal

Content list available at: https://openpsychologyjournal.com

RESEARCH ARTICLE

Differences in Attention Skill between Children with ADHD and Typically Developing Children in Indonesian Primary Schools

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Abstract:

Background:

Attention Deficit Hyperactivity Disorder (ADHD) is the most common neuropsychological developmental disorder in children. ADHD is characterized by inattention, overactivity, and impulsivity. However, the attention skill is not clearly studied in children with ADHD in Indonesia.

Objective:

The aim of the present study was to investigate the differences in attention skill between children with ADHD and typically developing children (TD), and identify the differences between ADHD subtypes at primary schools in Bandung city Indonesia in terms of the parameter of attention.

Methods:

This study used the quantitative method. The population of this study was children with ADHD and typically developing (TD) school-age children. The data sampling technique was purposive sampling, consisting of 30 children as a group of ADHD children and 30 children as a group of TD children. The instrument to collect data was Wechsler Intelligence Scale for Children (WISC), Indonesian ADHD Rating Scale (IARS), and The D2 test of attention. The analysis method used t-test and SPSS V.24 for Windows.

Results:

This study showed significant differences in attention skill performance between children with ADHD and TD children in the variables including the total number of tasks completed, omission, commission, error rate, total amount minus errors or selective attention skill, fluctuation rate and concentration performance. There have been observed significant differences between ADHD subtypes in terms of total number, omission, commission, error rate, total amount minus errors or selective attention skill, and concentration performance.

Conclusion:

Children with ADHD were found to have lower results than typically developing children in terms of attention skill, inhibiting control, and ability in performance accuracy. Children with ADHD-C subtypes were found to have more inattentive tendencies, hyperactive, and impulsive compared to ADHD-I and ADHD-H. ADHD-C subtype showed more deficits than ADHD-I and ADHD-H in response inhibition and accuracy of performance.

Keywords: Attention, ADHD, Learning, Neuropsychological, Cognitive, Inhibition.

1. INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is a condition in which the child shows a behavioral disorder with the following main symptoms: child's inability to pay attention, impulsivity, and hyperactivity that are inconsistent with the characteristics of the child's developmental stages [1]. When children enter school, it is hoped that they will be able to pay attention, control themselves, organize themselves, and direct themselves to their goals so that they can complete their assignments and understand the information or material that is conveyed properly by the teacher [2]. This demand is certainly difficult for children with ADHD to meet because they counter difficulty in paying attention, selecting between relevant and irrelevant stimuli, and they become easily distracted by other stimuli [3].

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In the learning situation, attention is very important because it acts as the entry gateway for information coming from the environment, which is received by the senses for the brain to process [4]. The information is stored in memory and can be recalled. If someone does well in paying attention, then the information will be received clearly by the memory. Hence it will produce output that is suitable for the purpose [5, 6]. Conversely, if the attention process is poor, the information received by the memory will be unclear, resulting in the inadequate process of the brain and will produce incorrect or unexpected output.

In reality, however, many children have difficulties in paying attention and sustaining the information while studying in class and at home. Their attention is easily diverted from the main focus to any irrelevant stimulus. As an impact, the child will receive incomplete and unclear information, disrupting the information process in the brain [4, 5]. In the end, the resulting output is that the child does not understand what the teacher says or is unable to complete the task. Inattention problem is having difficulty in focusing on one thing. The attention of children is easily shifted to the sounds they hear or the things they see, and they easily get bored with the task after a few minutes. It is very difficult to deliberately pay attention, to focus on managing and completing the tasks or to learn something new [7]. These children with ADHD often forget to do their homework or leave their assignments at school. While at school, children with a low level of attention also display difficulties in following orders, often losing items such as toys, pencils, books, and tools to do assignments. They easily switch from an incomplete activity to another. Children with ADHD tend to be unable to complete the tasks according to the instructions given or within the time limit. The display of this behavior does not represent their potential intelligence which tends to be above average [8].

A study carried out in Brazil, which was conducted on a similar sample population as the current study, estimated that 6.7% of schoolchildren had a high probability of having ADHD, with ADHD predominantly inattentive (ADHD-I) being the most prevalent subtype in 4%, predominantly hyperactive-impulsive (ADHD-H) in 1.7%, and a combination (ADHD-C) of both in 1% of the sample [9]. ADHD is related to a specific deficit in regulation for attentional resources. Previous research has speculated that children with ADHD may have attention difficulty, which also results in learning difficulties at school, consisting of under expectation results for the child's age, IQ, and school level in standard tests. The results of a previous research showed that ADHD symptoms are more strongly associated with learning difficulty found in a sample of school children in Brazil [9].

Based on literature review, study attention skills are relevant for academic foundations and represent an important focus for the field of education. Attention plays an important role in academic performance. A previous study has highlighted three traditional domains relevant to the education literature, including language, literacy, and mathematics. The results consider how attention is implicated in language processing. Results indicate that children, like adults, deploy attention temporally to modulate early sensory processing of linguistic probes. The early enhancement of word-initial processing is a neural mechanism available to young children, and thus, a candidate critical mechanism for parsing and processing the continuous speech stream. Attention skill may be important for shaping auditory sound processing during development, including aspects of sound processing important to language development. Attention in language processing, where auditory attention must be directed to critical points in time, in literature reading requires that visual attention be focused spatially. Without this ability, the printed page would be a sea of visual clutter. For example, all scripts require that attention and selective attention move serially in some ordered fashion (*e.g.*, from left to right across a page and/or from top to bottom), and there is evidence that learning to read biases both the gradient of visual attention and scan patterns to align with the demands of the script being learned. Mathematics is a broad domain, involving the role of attention and selective attention skill in a particular class of mathematics tasks referred to as word problems. An aspect of math skill may be impacted by selective attention. In word problems, an individual must hold on to and retain relevant information presented linguistically for making a computation while not being distracted by extraneous information irrelevant to the computation. Furthermore, the relevant information must then be effectively manipulated to arrive at a computational solution.

Well-developed attention skills allow a person to sort out which stimuli need attention and which stimuli need to be ignored [10, 11]. Attention skill allows the brain to receive signals that activate the behavior inhibition system and behavioral activation system so that a person can direct their behavior to a behavior goal. Attention skills are not well developed in children with ADHD, and they tend to respond to almost all stimuli [12]. The attention skill of children with ADHD is not in accordance with their developmental age. Their attention is easily distracted by the environment and internal boredom when carrying out any tasks. Thus, the task is not completed within the specified time or is finished with results that are not according to the specified orders or instructions.

Based on the data above, the aim of the present study was to investigate the differences in attention skill between children with ADHD and typically developing children (TD) at primary schools in Bandung city Indonesia in terms of the parameter of attention. In addition, the differences in attention skill between ADHD subtypes have also been investigated in this study. Based on the DSM-V regarding ADHD, the subtypes are divided into ADHD-Inattentive (ADHD-I), ADHD-Hyperactive (ADHD-H), and ADHD-Combined (ADHD-C).

2. MATERIALS AND METHODS

This study used comparative design. A comparative study analyzes phenomena and then puts them together to find the points of differentiation and similarity [13]. The present study investigated the differences between children with ADHD and typically developing children in terms of attention skill.

2.1. Participants

Participants in this study were Primary school students in Bandung, Indonesia, belonging to homogeneous socioeconomic status. For data collection, 30 children with ADHD and 30 typically developing children with ages 7-12 years have been selected.

The children with ADHD were selected using purposive sampling. ADHD subtypes are divided into the following three subtypes, 1) predominantly hyperactive/impulsive (ADHD-H), 2) predominantly inattentive (ADHD-I), and 3) predominantly combined (ADHD-C). The resulting participant grouping was 11 children diagnosed with ADHD-I of whom 8 were boys and 3 were girls, 9 children with ADHD-H of whom 8 were boys and 1 was girl, and 10 children with ADHD-C of whom 9 were boys and 1 was girl. ADHD is found to be more common in boys, with the estimated ratio of boys to girls of 3:1 and 4:1 in the clinical population [14]. In this study, it was also found that the number of boys was more than girls in the group of children with ADHD.

30 children were typically developing children without ADHD, of whom 20 were boys and 10 were girls. They were selected using a random sampling method from any primary schools in Bandung. The typically developing children criteria were based on parents' report that their child has no history of psychological disorder or developmental delays. None of the schoolers in the clinical groups was on medication during the entire study period. For all participants, written informed consent was obtained by parents/caregivers, and oral assent was provided by children.

Inclusion criteria were children with ADHD at primary school diagnosed based on semi-structured interview guideline. The guideline was used for evaluating a child for possible ADHD by interviewing parents to find out about the child's ADHD behavioral symptoms in home situations and interviewing teachers for the child's condition at school. Indonesian ADHD Rating Scale (IARS) was used to screen symptoms in children with ADHD based on DSM-V criteria [1, 15]. Diagnoses were made independently by two experienced clinicians: a child psychiatrist and a psychologist specialized in child and adolescent clinical psychology. The participants in the ADHD group did not receive any kind of medication or other treatment prior to their inclusion in the study and did not have comorbid disorders.

Intelligence was also a selection criterion. One of the inclusion criteria for children with ADHD is that their level of intelligence is within the typically developing category. This study used Wechsler Intelligence Scale for Children (WISC) to measure the level of intelligence as proposed by David Wechsler [16]. IQ was measured as a prerequisite for inclusion in the study. Children were required to have an IQ within the normal range (IQ≥90, Wechsler scale) [17]. The Wechsler Intelligence Scale for Children (WISC) is an intelligence test commonly used to measure the level of intelligence in children between the ages of 5 - 16 years. Several studies have used 21``the WISC test to uncover symptoms of clinical disorders in children [18, 19]. Wechsler (1975) explained that intelligence possessed by individuals is highly correlated with individual behavior, which is called intelligent behavior. There are four characteristics of intelligent behavior, which include being aware of their actions and the methods taken, always having a purpose for behaving, thinking logically, and consistently or thinking rationally. The results can be beneficial or useful and have value. Children's level of intelligence greatly affects their cognitive abilities. The higher the intelligence value of the child, the higher is the level of cognitive ability [20]. For classification of IQ score, the Wecshler Intelligence Scale for Children has been used. The average IQ score of children with ADHD was found as follows: 109.73 for ADHD-I group, 109.11 for ADHD-H, 107.10 for ADHD-C, and 113.13 for the typically developing children.

The demographic data presented include age, IQ, and the number of children with ADHD and typically developing children. The results showed that the IQ scores and ages of the two groups were comparable; Levene's test was used to evaluate homogeneity between the ADHD and TD groups. The results showed that the variance has been equal across groups IQ ($F_{(4, 55)} = 0.886$, $p > .05$), and age ($F_{(4, 55)} = 1.938$, $p > .05$), and that the variance was the same between children with ADHD and TD children (Table **1**).

2.2. Instruments

The present study used the d2 test of attention to measure the different aspects of attention: mental concentration, visual perception, visual scanning ability, perceptual speed, and selective attention. The d2 test has some advantages over other tests of selective attention. The advantages of this test are it is short, can be easily administered, does not require extensive instruction, can be administered to a large age range and to groups or individuals alike, and that it has good psychometric properties [21, 22]. Based on the results of the literature review in recent years, there has been increasing interest in the study of performance on attentional functions using the d2 of attention for subjects with symptoms of attention deficit hyperactivity disorder (ADHD) in children [23]. The d2 test of attention is commonly used in neuropsychological studies of children, in studies of the effect of neurofeedback treatment for ADHD, and the influence of methylphenidate on cortical processing of children with ADHD [24]. The test is used widely in clinical psychology due to its convenient procedure [22]. A survey with a special focus on pediatric and adolescent psychiatry revealed that the d2 test of attention is one of the most frequently used performance tests in these fields. In line with findings from older subjects with ADHD found in clinically diagnosed results, it is indicated that they were rated as less attentive and more hyperactive-impulsive, performed tasks slower, and committed more errors in the d2 test of attention. The result revealed that the d2 test of attention parameter was significantly associated with inattention and hyperactivity-impulsivity score in ADHD [25].

Table 1. Demographic variables of ADHD and typically developing groups.

Group	Participants										
	N	Boys	Girls	Mean. age	Min age	Max .age	Var .age	Mean. IQ	Min. IQ	Max. IQ	Var .IQ
ADHD-Inattentive	11	8	3	9.1	8	9.5	0.181	109.73	99	120	43.764
ADHD-Hyperactive	9	8	1	9.8	8.9	10.2	0.134	109.11	99	117	22.861
ADHD-Combined	10	9	1	9.1	8.8	10	0.124	107.10	99	116	33.656
Typically developing	30	20	10	9.3	8	9.5	0.235	113.13	99	123	31.154

The children with ADHD and typically developing children were selected from those in school ages in order to be certain that they had sufficient knowledge of the characters used in the d2 test of attention. This is because children who have not learned the difference between the characters "d" and "p" cannot be tested with the d2 test of attention [22]. This test is a paper-and-pencil task requiring the participants to identify targets (the letter d with two apostrophe marks that may be located either both above, both below, or one above and one below the d) and to ignore/suppressing irrelevant distracters (the letter d with one, three, or four marks, or the letter p with one or two marks). The stimuli were arranged in 14 rows containing 47 letters each (658 total elements, 229 relevant targets). Task instructions required the individual to scan each row from left to right for 20 seconds, crossing out as many relevant elements as possible before the examiner prompted the participant to move to the subsequent row. The total test duration was between 8 and 10 minutes [22, 23, 26]. The test is designed to be used in a wide age range (7–99 years).

Seven parameters of the d2 test of attention were assessed: 1) the total number of items processed (TN), 2) Sum of the number of target symbols not canceled or omission error (E1), 3) Sum of the number of target symbols not canceled or commission error (E2), 4) raw score of errors percentage (E%), 5) total number of correct responses items minus error scores (TN-E), 6) variability which is based on the difference in correct responses between the rows with the highest and lowest number of correct responses or fluctuation rate (FR), and 7) concentration performance (CP); the number of correct d2 items minus commission errors. The performance of the above-listed measures was referenced to normative data to control for the effect of age [27].

The d2 test has also been shown to have strong psychometric properties with high values of internal consistency, ranging between 0.95 and 0.98, and a validity coefficient of 0.47. Reliability was assessed by measuring internal consistency on 6000 subjects with Spearman-Brown formula analysis. Correlation coefficient obtained was $r = 0.92$. The d2 of attention test shows that the measurement tool is reliable for determining the ability of selective and inhibitory attention [28].

2.3. Data Analysis

The first stage of statistical analysis for quantitative data involved the use of Levene's test to evaluate the homogeneity of variance between children with ADHD and TD children. Levene's test was used to identify if there were differences between group scores. The second stage analysis began with

finding the differences between children with ADHD group and TD group and by using independent sample t-test to measure the differences. Next, to assess the differences among the three groups of ADHD subtypes, we conducted a one-way analysis of variance (one-way ANOVA), and Tukey's honestly significant difference (HSD) test was used for post hoc analysis when the F value was significant. All of the analysis was completed using IBM SPSS version 24 for Windows [29].

For the first hypothesis "There are differences in attention skill between children with ADHD and typically developing children", an independent t-test was used by comparing the attention skill parameter score in children with ADHD and typically developing children. The mean and standard deviation (SD) was used for descriptive analysis. The formulation of the statistical hypothesis problem was: 1) H: there is no difference in the attention skill score in the group of children with ADHD and the group of typically developing children. 2) H_1: there is a difference in the attention skill score in the group of children with ADHD and the group of typically developing children. The criteria for testing are as follows: 1) if the value is Sig. (2-tailed) > 0.05, the hypothesis is rejected, which means that there is no difference in the attention skill score in the group of children with ADHD and the group of typically developing children, 2) if the value is Sig. (2-tailed) < 0.05, the hypothesis is accepted, which means that there is a difference in the attention skill score in the group of children with ADHD and the group of typically developing children. For the second hypothesis, there was a significant difference observed in attention between the ADHD-I, ADHD-H, and ADHD-C groups.

3. RESULTS

3.1. Comparison between ADHD and Typically Developing Children

Data analysis showed score differences in mean and standard deviation for each attention parameter measured using the d2 test of attention. Table **2** presents the detailed statistical analysis results of the t-test calculations to answer the research hypothesis against the testing criteria with a significance level of 0.05 from the d2 test of attention. Significant difference has been observed between the ADHD group and the typically developing group seen in the calculation result of the parameter: total number (TN) ($p \leq 0,000$), omission error (E1) ($p \leq 0.000$), commission error (E2) ($p \leq 0.000$), percentage of error (E%) ($p \leq 0.000$), total amount minus errors or selective attention skill (TN-E) ($p \leq 0.000$), concentration performance ($p \leq 0.000$) and fluctuation rate (FR) parameter ($p < 0.009$) (Table **2**).

Table 2. Mean, SD score, and comparison between ADHD and typically developing children group in the d2 test of attention.

Parameter	ADHD		TD		Levene's test		t	P
	Mean	SD	Mean	SD	F	Sig		
Total number (TN)	292.30	31.340	395.57	26.863	0.966	0.330	-13.703	0.000
Omission (E1)	6.40	3.936	2.40	1.589	0.062	0.805	5.162	0.000
Commission (E2)	8.33	3.43	4.604	1.654	0.493	0.485	5.486	0.000
Percentage of errors (E%)	4.9530	2.56420	1.44653	.865323	0.034	0.855	7.219	0.000
Total number minus error (TN-E)	277.97	33.032	389.77	25.832	2.187	0.145	-14.603	0.000
Fluctuation rate (FR)	12.27	2.888	10.57	2.888	2.394	0.127	2.691	0.009
Concentration performance	109.27	16.977	154.17	7.575	3.764	0.057	-13.229	0.000

*p<0.05

3.2. Comparison between ADHD Subtypes

The comparison of the d2 test of attention assessment scores in children with ADHD subtypes in the ADHD-Inattentive (ADHD-I), ADHD-Hyperactive (ADHD-H), and ADHD-Combined (ADHD-C) groups is shown in Table **3**.

The mean scores of the Total Number (TN) were as follows: 311.64 (SD = 27.15) for ADHD-I, 277.78 (SD = 28.28) for ADHD-H, and 284.10(SD = 29.86) for ADHD-C. There was a significant main effect observed of group (F (2, 27) = 4.14, p<.05). Post hoc analysis using the Tukey test revealed that TN score had a significantly different result in the ADHD-I than either the ADHD-H or the ADHD-C groups.

Results from the Omission (E1) were as follows: 3.82 (SD = 2.27) for ADHD-I, 5.67 (SD = 1.00) for ADHD-H, and 9.90 (SD = 4.58) for ADHD-C. There was a significant main effect observed of group (F (2,27) = 10.9, p>.05). Post hoc test revealed that the ADHD-H group had significantly higher scores than ADHD-I, and that the ADHD-C had significantly higher scores than the ADHD-H groups. This result suggests that children with ADHD-H and ADHD-C had more inattention symptoms.

The mean scores of Comission (E2) were as follows: 5.82 (SD = 2.52) for ADHD-I, 6.56 (SD = 1.51) for ADHD-H, and 12.70 (SD = 5.21) for ADHD-C. There was a significant main effect observed of group (F (2, 27) = 11.96, p<.05), and the post hoc analysis with Tukey test showed that the ADHD-C group had significantly higher scores than ADHD-I and ADHD-H group. This result suggests that children with ADHD-C had more impulsivity symptoms.

The mean percentage of errors (E%) scores were as follows: 3.12 (SD = 1.11) for ADHD-I, 4.45 (SD = 0.91) for ADHD-H, and 7.41 (SD = 2.83) for ADHD-C. There was a significant main effect observed of group (F (2, 27) = 414.72, p<.05), and the post hoc analysis with Tukey test showed that the ADHD-C group had significantly higher scores than ADHD-I.

Results for the mean Total Number minus Error (TN-E) scores were as follows: 301.45 (SD = 27.02) for ADHD-I, 265.56 (SD = 28.55) for ADHD-H, 263.30 (SD = 30.21) for ADHD-C. There was a significant main effect found of group (F (2, 27) = 5.88, p>.05). Post hoc analysis using the Tukey test revealed that TN-E score had significantly different scores in the ADHD-I than either the ADHD-H or the ADHD-C groups.

Table 3. The d2 test of attention scores for children with ADHD among Inattentive, Hyperactive, and Combined subtypes.

-	ADHD-I (N=11)	ADHD-H (N=9)	ADHD-C (N=10)	F[a]	Post Hoc analysis [b]
Total number (TN) score M (SD)	311.64 (27.156)	277.78 (28.28)	284.10 (29.86)	4.14*	ADHD-I > ADHD-H
Omission (E1) score M (SD)	3.82 (2.27)	5.67 (1.00)	9.90 (4.58)	10.9*	ADHD-I < ADHD C ADHD-H < ADHD-C
Commission (E2) score M (SD)	5.82 (2.53)	6.56 (1.51)	12.70 (5.21)	11.96*	ADHD-I < ADHD-H AHDH < ADHD-C
Percentage of errors (E%) score M (SD)	3.12 (1.11)	4.45 (0.91)	7.41 (2.83)	14.72*	ADHD-I < ADHD-C ADHD-H < ADHD-C
Total number-error (TN-E) score M (SD)	301.45 (27.02)	265.56 (28.55)	263.30 (30.21)	5.88*	ADHD-I > ADHD-H ADHD-I > ADH-C
Fluctuation rate (FR) score M (SD)	12.09 (1.86)	13.22 (4.23)	11.60 (2.36)	0.77	-
Concentration performance (CP) score M (SD)	122.73 (12.82)	104.78 (14.77)	98.50 (13.460)	8.96*	ADHD-I > ADHD-H ADHD-I > ADHD-C

[a]One-way analysis of variance, all differences in scores are significant. *p < .05.
[b] Tukey Method

The mean Fluctuation Rate (FR) scores were as follows: 12.09 (SD = 1.86) for ADHD-I, 13.22 (SD = 4.23) for ADHD-H, and 11.60 (SD = 2.36) for ADHD-C. There was no significant main effect observed of group (F (2, 27) = 0.77, p>.05). Post hoc analysis using the Tukey test revealed that FR score was not significantly different in the ADHD-I than either the ADHD-H or the ADHD-C groups.

In addition, the mean Concentration Performance (CP) scores were as follows: 122.73 (SD = 12.83) for ADHD-I, 104.78 (SD = 14.77) for ADHD-H, and 98.50 (SD = 13.46) for ADHD-C. There was a significant main effect found of group (F (2, 27) = 8.96, p<.05), and the post hoc analysis with Tukey test showed that the ADHD-I group had significantly higher scores than the ADHD-C group. This suggests that children with ADHD-C showed more inattentive tendencies, and showed hyperactive and impulsive symptoms rather than tendencies shown by children with ADHD-I.

4. DISCUSSION

This study is very important because it aimed to observe the differences in attention skill between children with ADHD and typically developing (TD) children at primary school age. Previous studies have also been conducted on the development of attention skill and selective attention across childhood; Brodeur and Pond (2001) reported better performance in 9- to 11-year-old children than in 6- to 8-year-old children. Klenberg and colleagues (2001) also reported that development was complete by 10 years. In summary, attention skill and selective attention appear to be fully developed by about 10 years of age in school children [21]. Based on a previous study, the general results showed that the attention skill of children with ADHD is much lower than TD children. The findings show poor performance by children with ADHD as a commonly documented phenomenon that can be explained in several ways. It can be interpreted as evidence that children with ADHD have a fundamental difficulty in carrying out the task. Children with ADHD are disrupted more by the presence of distracters than TD children. Difficulty with basic visual stimulus processing leading to overall performance deficits is common in children with ADHD.

This study's finding is similar to the data published by Pondé, Carlos, and Freire (2006) in the literature on learning disorders in which the prevalence of learning problems was significantly higher (62.1%) in children with attention deficit compared to those without attention deficit (37.9%; p< .005) [30]. From the results of this study, differences found in parameters of the total number of completed items (TN) illustrate the difference in the speed of children in processing a number of task stimuli. The average score obtained by children with ADHD in managing task stimuli was lower than that of typically developing children. With respect to the high standard deviation score, it indicates that the condition of children with ADHD attention skill varies widely. Inadequacy to complete tasks in children with ADHD becomes a barrier in the school context. The impact is that the school achievement of children with ADHD is not satisfactory with low work results [31]. Children with low attention ability also display a lower level of processing information or performing a task. This indicates that

the child is less able to control effective and ineffective behavioral responses that must be displayed in carrying out tasks accurately and appropriately. The difficulty of controlling effective and ineffective behavior causes the performance of children with ADHD to become non optimally in line with their potential [32]. Their achievement is inconsistent and they are often below the potential ability and below the class norm compared to other typically developing children.

The aim of the present study was to investigate the differences between ADHD subtypes in terms of attention skill. Previous studies have shown inconsistent findings in this regard, such as Houghton *et al*. (1999) investigated the attention skill in 94 children with ADHD in terms of subtype and gender using five tests of the Wisconsin Card Sorting Test, the Stroop Color-Word Test, the Matching Familiar Figures Test, the Trail Making Test, and the Tower of London. They found that children with both types of ADHD (ADHD-I and ADHD-C) differed from TD children in terms of perseveration and response inhibition, but this difference was significant in ADHD-C only. Consistent with this finding, in another study, Klorman *et al*. (1999) found that children with ADHD-C revealed more non-perseverative errors in WCST and solved fewer puzzles and also violated more rules on the Tower of Hanoi (TOH) than ADHD-I. Children with ADHD showed that the impairments in attention skill were obviously found in ADHD, particularly in the ADHD-C, providing support for Barkley's theory of ADHD [33]. The findings of this study differ from those of Li *et al*. (2008), who reported no significant differences between the ADHD subtypes in their study. This study showed significant differences between the three ADHD subtypes in attention skills.

We investigated a total number of three ADHD subtypes in our analyses of ADHD differences in attention. The quantitative result showed that the ADHD-I group had more attention ability to process a number of stimulus tasks, attention, and inhibitory control than ADHD-H and ADHD-C. Actually, children with Attention Deficit Hyperactivity Disorder (ADHD) displayed poor attention difficulties in perceiving, responding to stimuli with sustained attention processing, inhibitory, and impaired timing [34].

The result showed that children with ADHD also make many mistakes in completing tasks, such as in finding omission errors, which indicates that children with ADHD do not carry out tasks or miss task stimuli that they should be doing. The ADHD-C group had higher scores than the ADHD-I and ADHD-H groups in omission errors. This means that children with ADHD-C had more inattention symptoms than ADHD-I and ADHD-H. Their inattention symptoms were measured by the percentage of errors of omission which involved making errors in responding to the target stimulus. The results clearly showed that children with ADHD-C were slower and made more inattention errors because they had more clinical attention problems in daily life performance [24].

Our results of the commission error also show that children with ADHD tend to do tasks that are not their job or they are not instructed to do. Impulsivity symptoms were measured by the percentage of errors of commission. The higher commission error was observed in the ADHD-C group. Their

difficulty in sustaining attention for the task might be associated with longer duration of time to complete the task. However, this appears not to be the case here because the duration of the d2 test of attention is 4 minutes and 40 seconds. Instead, sustained attention is known to be compromised in children with ADHD [35].

Percentage of errors (E%) measured performance quality aspects as shown by subjects. Smaller E% number indicated more accurate work performance of the subjects. The results of high error score explain that children with ADHD often make mistakes in responding to non-target stimuli, are impulsive, and the result also shows a decline in their quality of work performance. Common errors are related to the sensitive ability to control attention, rule compliance, inhibitory control, cognitive flexibility, and quality of performance. The impact of school setting, poor working memory and difficulty in inhibiting unwanted behavior cause academic and behavioral problems in children with ADHD [36].

Recent research indicates that inhibition control was more impaired among children with ADHD relative to ASD and TD children. The inhibitory control mechanism has a function to prevent children from hyperactivity, doing something that is out of control, and doing something that is not correct. 70% of our brain works to inhibit the other 30%. When the inhibitor mechanism of the brain of children with ADHD cannot function properly, the result is a "dis-inhibitor disorder", such as impulsive behavior [37]. Inhibitory control refers to a series of interrelated cognitive processes that underlie the ability to hold (action restraint) or stop (action cancellation) an ongoing response [38]. Inhibition is the basic attention function with the ability to withhold, stop or slow down behavior. The present study found that children with ADHD-C have a higher sensitivity than ADHD-I and ADHDH groups to respond to stimuli from the surrounding environment. Therefore, they tend to react to almost all existing visual and auditory stimuli and have difficulty displaying attention skills [7]. This illustrates the role of attention ability control, cognitive flexibility, planning and information processing in children with ADHD which leads them to not work well. In the control domain, attention ability, the capacity to select a more specific stimulus and the ability to maintain attention over a longer period of time are very complex processes. Attention ability holds great importance in what an individual perceives, remembers, thinks, feels, or does.

This study found that fluctuation rate (FR) indicates the consistency and stability of the subject's performance. An overly high FR score indicates inconsistent work performance [27]. Differences have been observed in the fluctuation rate (FR) parameter, *i.e.* the ability to show consistency and stability in the child's performance in completing tasks. The average FR score of the children with ADHD is higher than the typically developing group. Children with ADHD tend to get high scores, which means that they show inconsistent work performance. There are several factors that influence the inconsistent work performance in children. One that affects the consistency of children in completing a task is the emotional factor. As a child, the limbic system which regulates emotions and alertness of a person is still developing and needs

stimulation. The limbic system that works orderly will affect the mood and consistency of a child when carrying out activities. Typically developing limbic system regulates typically developing emotional changes, typically developing energy levels, and typically developing routines. If there is dysfunction in the limbic system, it will cause problems [31].

The attention skill of a child is the gateway for information that they will receive. When they are able to optimize their attention skill, the brain can receive signals that activate behavior inhibition. A person can make their behavior goal-directed behavior. One can also do three things, *i.e.* delay unnecessary responses or behavior to a certain extent, the ability to stop unnecessary responses or behavior, and restrain and control distraction. These are not found in the behavior of children with ADHD, and they become attention skill disorders [32].

5. LIMITATION

The current study has a number of limitations that need to be considered. The sample in the study was not large, and the ratio of males to females was imbalanced. Students in both groups were not matched by gender and age. Then, for the random sampling of TD students, the size of the sample was obtained from only one geographic area, *i.e.*, Bandung, Indonesia. Future studies should expand the sample to other geographical areas of the country, thereby increasing the representativeness of the sample.

Although the d2 test is one of the most used instruments to evaluate attention, for future study, it is very important to keep in mind that no learning disorder or clinical diagnosis should be made based solely on the scores of this test alone. Combined with clinical history, learning process behavioral observations and objective questionnaires that measure attention skills in multiple settings, this test should be integrated as part of a comprehensive battery that evaluates these processes in detail.

6. IMPLICATIONS

Attention deficit hyperactivity disorder (ADHD) is a neuropsychological disorder that most often occurs in children. It is also a chronic condition that most often affects school-age children, and it is a mental disorder often found in children. ADHD is characterized by having difficulty paying attention, which includes increased distractibility and difficulty in maintaining attention, difficulty in maintaining impulse control, and overactivity of motor movement to respond to tasks that are not supposed to be done.

The difficulty in controlling attention behavior causes the performance of children with ADHD to be less than their potential. ADHD-C subtype shows more deficits than ADHD-I and ADHD-H in response inhibition and accuracy of performance. The achievement is inconsistent and is often below the potential of children and below the class norm when compared to other typically developing children [8]. Therefore, we need special, specific, and simple instructions for children with ADHD to complete a task. This will help support the successful achievement of children's attention ability leading to propoer completion of their tasks. In this sense, children who are identified as having attention difficulty should be provided

with extra learning support from the school to enable them to cope better with possible learning difficulties. The results of this study are expected to contribute to educational practice or clinical practice across Indonesia by improving the quality of how attention is assessed during educational or clinical evaluations.

CONCLUSION

In clinical research, the measurements of attention skill in children with ADHD are used to assess the clinical state of children with ADHD. The results of measuring their attention skill can also be used in studies that involve treatment of children with ADHD to measure changes in their behavior before and after receiving treatment.

When children can pay attention to what they are doing and only select stimulus information that is relevant to their task, the chances of completing the task are greater. This will help children to meet the demands of attention abilities and characteristics of school children. If this succeeds, it will help fulfill one of the developmental tasks of primary school-age children, *i.e.*, children will learn the attention skills needed by primary school children.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Research Ethics Committee of Universitas Padjadjaran, Bandung, Indonesia (1272/UN6. KEP/EC/2019).

HUMAN AND ANIMAL RIGHTS

No animals were used for studies that are the basis of this research. All the human procedures used were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was taken from all the participants of this study.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

FUNDING

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

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