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A Comparison of the Cognitive Profiles of Children with Attention Deficit/Hyperactivity Disorder Receiving Pharmacotherapy and Those Not Receiving Pharmacotherapy in Wechsler Intelligence Scales-Forth Edition

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Abstract: The first group of psychiatric treatments for children with attention deficit/hyperactivity disorder (ADHD) is stimulant drug such as methylphenidate. The aim of this study is investigating cognitive profile in ADHD children who are using medicated treatment and no medicated treatment, in WISC IV. Participants are 29 ADHD children (13 no medicated and 16 medicated) and 25 normal children. The sampling method is convenient. Children were 7 to 12 years old. Result showed significant differences between ADHD group who uses medication and those who don't, and normal and ADHD groups who don't use medication in verbal comprehension and processing indexes. In perceptual reasoning index, there was significant difference between normal group and ADHD group in using medication, also in working memory index there were no significant differences between ADHD groups (with and without medication use). Using medical treatment and changing in the process of disorder toward normal function in children with ADHD following it, can be an evidence of neurological problems in these children.

Keywords: Attention Deficit/ Hyperactivity Disorder, Medicated, No Medicated, WISC-IV

1. Introduction

Attention Deficit/Hyperactivity Disorder is one of the most common neurobehavioral disorders in childhood that it`s symptoms may continue to adolescence and adulthood. This disorder is determined with symptoms of inattention and/or hyperactivity-impulsivity. Children with ADHD disorder may have adjustment problems because their functional levels and behaviors may not correspond to their chronological age (Biederman, Mick, & Faraone, 2000; Homer et al., 2000). The prevalence of ADHD in general population varies from 3% to 7% ("International Consensus Statement on ADHD," 2002).

Complete medical assessment is needed for diagnosing ADHD to detect specific symptoms in this disorder. These symptoms are directly observed and recorded by parents and teachers. Multiple scales have been created to identify specific symptoms in order to diagnose ADHD, but most of the criteria are similar to those of the DSM-IV TR [Diagnostic and Statistical Manual of Mental Disorders Fourth Edition, Text Revision](Valdizán & Izaguerri-Gracia, 2009). ADHD is classified into three subtypes, i.e., ADHD predominantly inattentive (10%–15% of patients), ADHD predominantly hyperactive-impulsive (5%), and ADHD

combined type (80%) (Association, 2000; Gaub & Carlson, 1997). The symptoms of ADHD usually improve with stimulant drugs as that these drugs directly and in the short period of time could reduce hyperactivity and increase attention (Faraone, Spencer, Aleardi, Pagano, & Biederman, 2004). Methylphenidate (Ritalin) is the most common stimulant drugs that is widely used in the treatment of ADHD symptoms (Conners, March, Frances, Wells, & Ross, 2001; Faraone et al., 2004). Barkly (2005) suggested that Pharmacologic treatment has special effect on the improvement of behavior and attention, and also, affect child's performance in the intelligence scales with milder impression (Barkley, 2005).There are many studies support the impact of stimulant drugs on the improvement of behavioral symptoms such as attention, concentration and hyperactivity (Barkley, DuPaul, & McMurray, 1990; Hale & Fiorello, 2004; Pelham, 1999). In addition to behavioral symptoms, many of current researches noted to potential cognitive indicators. Barkly (1998) defined ADHD as impairment in behavioral inhibition that is related to neuropsychological abilities. subjects with ADHD frequently encounter to weak functions in neuropsychological tests that measure prefrontal activities such as inhibition, perseverance, planning, verbal fluency, motor control fluency, and working memory (Barkley, 1997; Barkley et al., 1990; Barkley, Grodzinsky, & DuPaul, 1992; Goodyear & Hynd, 1992). More recent research suggest that the right prefrontal cortex, caudate nucleus and globus pallidus are typically smaller in children with ADHD, demonstrating problems with connectivity between the brain regions that regulate attention, stimulus processing, and impulsivity (Dophide, 2001). Although core diagnostic features in ADHD are behavioral, research suggests that cognitive deficits, such as impairments in attention, response inhibition, and perceptual-motor speed are also fundamental characteristics of the disorder (Barkley et al., 1990; Sykes, Douglas, & Morgenstern, 1973). Cognitive impairments that accompany ADHD need to be considered as part of a comprehensive clinical formulation and multidisciplinary treatment plan (Brown, 2000). In this field, we could use instruments for assessment of cognitive abilities like intelligence scales. Today, many intelligence scales include some of tasks that evaluate various aspects of cognition. For example, Wechsler Intelligence Scale for Children-forth edition (WISC-IV), is able to measure individual function (e.g., processing speed and working memory) in wider range. So, WISC-IV has a high sensitivity for discriminating children with ADHD and non-ADHD children (Bowers et al., 1992). In addition to the FSIQ, the WISC-IV yields four index scores including Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), Processing Speed Index (PSI), and the Working Memory Index (WMI) (Wechsler, 2003).

Research about cognitive deficits in children with ADHD is rare, especially in the field of assessment. So, the purpose of present research is to compare the cognitive profiles of children with Attention Deficit/Hyperactivity Disorder receiving pharmacotherapy and whom not receiving pharmacotherapy in Wechsler Intelligence Scales-forth edition and to assess the effect of medical treatment on improvement of cognitive deficits in these children.

2. Material and Methods

2.1. Subjects

The population statistical includes all of normal children in Gorgan-Iran schools, and all of children with ADHD that are diagnosed by psychiatrist in the period April to August, 2014. All of children were between 7 to 12 years old. Method of sampling for all of groups was convenient sampling. The number of children in normal group and ADHD group was 25 and 29 respectively. (13 ones with pharmacotherapy and 16 ones without pharmacotherapy). Also, parents of children filled in consent form and then test was demonstrated on children.

2.2. Methodology

This study was multicenter, observational, retrospective, and non-interventional.

2.3. Instruments

Wechsler scales for children-IV (WISC-IV): Wechsler intelligence scales are one of the common IQ tests that are provided for three age groups: preschool, children and adults. Wechsler scales for children (WISC) are effective tests, because, Wechsler and his colleagues reviewed it more than twice, and to now four forms of the scale have been published. Wechsler scales for children-IV show five type of intelligence: verbal comprehension IQ, perceptual reasoning IQ, working memory IQ, processing speed IQ and total IQ (Wechsler, 2003). In the Iranian population, test -retest reliability was 0/65 to 0/95 and split half reliability was 0/71 to 0/86. Also the validity coefficients have been reported from 0/66 to 0/92 (Sadeghi, 1390).(this time is 2012)

3. Result

The Subtest means and standard deviations of the three groups are listed in Tables 1 and 6

Table 1. *index means Score by group.*

Index Scores	ADHD-D		ADHD-ND		Normal	
	N=16		N=13		N=25	
	M	SD	M	SD	M	SD
VCI	108.06	11.63	98	8.41	112.84	14.55
PRI	92.68	9.55	92.92	15.54	104.34	16.10
WMI	92.18	12.67	85.92	7.83	103.44	14.02
PSI	111.81	9.57	101.23	7.67	112.12	15.64

An ANOVA was utilized to compare VCI, PRI, WMI, PSI mean scores of all three groups. The results of this test revealed that there are significant differences in VCI mean scores between groups (F (2, 51) = 6.03, P=0.004) , in PRI mean scores between groups (F (2, 51) = 4.39, P = 0. 01), P = 0.04), in WMI mean scores between groups (F (2, 51) = 9.51,

P = 0. 000), and in PSI mean scores between groups (F (2, 51) = 3.70 , P=0.03). See Table 1 for the ANOVA results.

Table 2. *Multivariate Analysis for Index Scores.*

Index Scores	SS	Df	MS	F	Sig	η2
VCI	1884.517	2	1373.925	6.03	.004	0.19
PRI	1796.694	2	917.824	4.39	.01	0.14
WMI	2935.813	2	2162.515	9.51	.000	0.27
PSI	1156.588	2	694.173	3.70	.03	0.12

To evaluate significant differences between three groups, post hoc analysis of Tamhane was conducted.

Table 3. *VCI means different Comparisons.*

Group Comparison	M Dif.	SE	Sig
ADHD-D. ADHD-ND	10.06	3.72	0.03
ADHD-D.NORMAL	-4.77	4.00	NS
ADHD-ND.NORMAL	-14.84	3.73	0.01

Post hoc results revealed significant differences in mean VCI scores between the ADHD-D and ADHD-ND groups (P=0.03) and between the ADHD-D group and normal group (P=0.01), but there is no significant difference in mean VCI scores between the ADHD-D and NORMAL groups.

Table 4. *PRI means different Comparisons.*

Group Comparison	M Dif.	SE	Sig
ADHD-D. ADHD-ND	0.23	5.35	NS
ADHD-D.NORMAL	11.67	4	0.01
ADHD-ND.NORMAL	-11.43	4.90	NS

Post hoc results showed significant differences in mean PRI scores between the ADHD-D and normal groups (P=0.01). But significant differences did not occur between the ADHD-D and ADHD-ND groups and between ADHD-ND and normal groups.

Table 5. *WMI means different Comparisons.*

Group Comparison	M Dif.	SE	Sig
ADHD-D. ADHD-ND	6.26	3.83	NS
ADHD-D.NORMAL	11.25	4 .23	0.03
ADHD-ND.NORMAL	-17.51	3.54	0.000

Post hoc results showed significant differences in mean WMI scores between the ADHD-D and normal groups (P=0.03) and between the ADHD-ND and normal groups (P=0.000). There were no significant differences between ADHD-D and ADHD-ND groups.

Table 6. *PSI means different Comparison.*

Group Comparison	M Dif.	SE	Sig
ADHD-D. ADHD-ND	10.58	3.20	0.008
ADHD-D.NORMAL	-0.38	3.93	NS
ADHD-ND.NORMAL	-10.96	3.78	0.01

Post hoc results revealed significant differences in WMI mean scores between the ADHD-D and ADHD-ND groups (0.008) and between ADHD-ND and normal groups (0.01), but there were no significant differences between ADHD-D and normal groups.

4. Conclusion

Present study indicated that in verbal comprehension factor there was no significant difference between normal group and ADHD group that was not receiving pharmacotherapy. As we know, a lot of children with ADHD have low performance in neurological battery which examine functions of frontal lobe such as inhibition, planning, psychomotor control and verbal mobility (Barkley, 1997; Barkley et al., 1990; Barkley et al., 1992; Goodyear & Hynd, 1992). So neurological deficits in frontal cortex, like cognitive deficits affect the performance of children on educational tasks, and this matter results in the weak performance in verbal comprehension subscales in ADHD children. Furthermore, medical treatment affects these deficits and the scores of children with ADHD would increase in this index impressively as the result of treatment.

The only significant difference between groups in perceptual reasoning index was between ADHD group who received pharmacotherapy and normal groups, and there was significant difference between other groups; however, Pharmacotherapy group and normal group had more motivation and responses to the instrument than ADHD group not receiving pharmacotherapy in clinical observation during performance of perceptual reasoning subscale. Attention, persistence for completing and desires to attractive tasks are affective factors in the performance of children. There are limited literatures relating to the subject of this article and we couldn't compare the results of present research with relevant articles. However, performances of ADHD children are lower than children without neurological deficits because it can affect cognitive and intellectual performance as we see in this index. Also the result of working memory index showed that the performance of normal children was better than ADHD group.

Children with ADHD demonstrate cognitive deficits in sustained attention and inhibitory control, which are related to subtle frontal lobe impairments in the brain as measured on neuropsychological testing (Barkley et al., 1992). ADHD arisen the impairment in brain regions that are responsible for working memory and processing speed (Barkley, 2005). Also, this study showed no significant differences between children receiving pharmacotherapy and whose not receiving pharmacotherapy because of some crucial variables such as dosage and duration of drug use, and perhaps these intervening variables affect the results and previous relevant literature are confused about this issue.

Some studies have attempted to measure the effects of methylphenidate (MPH) on cognitive functions in children with ADHD. Research in this area is conflicting; some studies show that MPH improves both visual-spatial and auditory-verbal working memory (Bedard, Martinussen, Ickowicz, & Tannock, 2004; Mehta, Goodyer, & Sahakian, 2004; Tannock, Ickowicz, & Schachar, 1995), but others don`t (Rhodes, Coghill, & Matthews, 2006).

In speed processing index, there were no significant differences between normal and pharmacotherapy groups in this index but these groups had higher performance than no pharmacotherapy group. Many studies have also found that ADHD students tend to perform less well on measures of processing speed than nonclinical controls (Prifitera & Dersh, 1993; Rucklidge & Tannock, 2001; Tiholov, Zawallich, & Janzen, 1996; Michael D Weiler, Bernstein, Bellinger, & Waber, 2000; Michael David Weiler, Bernstein, Bellinger, & Waber, 2002). Although diagnostic criteria for ADHD are primarily behavioral in nature, research suggests that cognitive deficits, such as impairments in attention, response inhibition, and perceptual-motor speed are also core features of the disorder (Barkley et al., 1990; Sykes et al., 1973). Drug has some effect on speed processing index but doesn't affect working memory index. In this study it was found that, in addition to increasing attention and decreasing hyperactivity, drug improves motor-perceptual speeding disorder in children with ADHD disorders. Further in cancellation, coding, symbol search subscales, researchers found that children receiving pharmacotherapy try to answer intensively.

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