Assessment of Executive Functions among a sample of Primary School Children with Learning Disability in Egypt: Comparative Study

Hassnaa Othman Mohammed (MD)*, lecturer of phoniatrics, medical department, Faculty of Postgraduate Childhood Studies, Ain Shams University.
Eman Hany Elsebaie(MD)**, Lecturer of Public Health, Public Health and Community Medicine Department, Faculty of Medicine, Cairo University.
Amiraa Mohamed Dabour (PhD)*, Specialist in Child Health and disability, Medical studies Department for children, Faculty of Postgraduate Childhood Studies, Ain Shams University.
Samia Sami Aziz (PHD)*, Professor of Child Mental Health, Medical Department, Faculty of Postgraduate Childhood Studies, Ain Shams University.

Abstract

Background: Executive Functions (EFs) among children received special interest especially among those with Learning Disability (LD). Different tools developed to make a valid as well as an objective assessment of EFs for children with learning disability. Factors that contribute to variability of EFs scoring among this population remain an area of research.

Aim: This study aimed to explore the executive functions scoring among a sample of the primary school children with learning disability in Egypt.

Methodology: Ninety Primary school children of average intelligence, their ages ranged between 9 to 12 years, underwent an assessment protocol which included: Diagnosis of LD and its comorbid condition by Diagnostic and Statistical Manual- fifth edition (DSM V) based teacher checklist& assessment of Executive Functions by Comprehensive Executive Function Inventory (CEFI)- teacher form.

Results: Seventeen children (18.8%) were diagnosed as (LD). Twenty- four (26.6%) children were diagnosed as Attention Deficit Hyperactivity Disorder (ADHD). CEFI score among children with LD and ADHD were significantly lower than the score received by their control peers in the current study.

Conclusions: Executive functions deficit may be the backbone of different manifestation in Primary school children with LD. Therefore, its comprehensive assessment should be carried as a preliminary step in learning disability assessment.

Keywords: Learning disability, executive functions assessment, ADHD, CEFI.

تقييم الوظائف التنفيذيه لعينه من طلاب المدارس الإبتدائيه فى مصر: دراسه قطعيه

مقدمة: لقد تلقت الوظائف التنفيذية للمخ لدى الأطفال إهتماما بالغاخاصة لدى فئة الأطفالالذين يعانون من صعوبات التعلم. ولقد أستخدم لهذا الغرض العديد من الأدوات لجعل تقييم هذه الوظائف فعلا دقيقا خاصة لدى أطفال صعوبات التعلم. تعد هذه الأدوات ذات قيمه كبيره حيث أنها تحدد المتغيرات التى تؤثر فى هذه الوظائف.

الهدف: تهدف هذه الدراسة إلى تقييم الوظائف التنفيذية بين عينه من أطفال المدارس الإبتدائيه المصريه. وتعمل الدراسه على تحديد نسبة إصابة هؤلاء الأطفال بصعوبات التعلم بنوعيها. ومن ثم تقدم الدراسه تحليلا لبعض العوامل التى قد تؤدى إلى إعتلال الوظائف التنفيذيه لدى طلاب المرحله الإبتدائيه

التصميم: تم جمع ٩٠ مشاركا وفق تقنية العينة العشوائية. وقد خضعوا لبروتوكول التقييم. وبناء على ذلك، تم تصنيفهم إلى مجموعتان: المجموعة-١ الحالات وتشمل هذه المجموعه الأطفال الذين يعانون من صعوبات فى التعلم، والمجموعة- ٢: الأطفال الذين يتطورون طبيعيا ولا يظهر عليهم أى عرض لأى مرض.

طريقه البحث: فى البداية، خضع الأطفال الذين شاركوا فى دراستنا لاختبار رسم الرجل لتقييم الذكاء ومن ثم تمت دراسة الأطفال الذين أظهروا علامات اضطراب فرط الحركة ونقص الانتباه واضطراب التعلم المحدد باستخدام استبيان ADHD و(SLD) القائم علىDMS IV، بعد ذلك تم إعطاء استبيان الوظائف التنفيذية الشاملة (CELF) إلى المعلم لملؤه لجميع المشاركين فى مجموعتنا استبيان الوظائف التنفيذية الشامل (CEFI).

النتائج: وجائت النتائج لتدل على أن حوالى ٢٦% من العينه كانوا يعانون من إضطراب فرط الحركه وتشتت الإنتباه. وأن حوالى ١٨% من العينه يعانى من صعوبات التعلم المحدده" وقد قامت الدراسه بإثبات إن استبيان الوظائف التنفيذية الشامل (CEFI) الصوره العربيه لديه درجه عاليه من الصدق والثبات الأمر الذى يجعله صالحا للإستعمال فى تقييم الأطفال الذين يعانون من صعوبات التعلم. وقد أثبتت الدراسه أن أطفال صعوبات التعلم بنوعيه يعانون من إعتلالات فى الو ظائف التنفيذيه المتعلقه بالذاكرة العاملة، التحكم العاطفى والبدء بالمهام والإنتباه والمنع والترتيب ومراقبة النفس أثناء التنفيذ.

التوصيات: يجب إعطاء الفرص للتدريب على استخدام الوظائف التنفيذية مثل كيفية التعلم والدراسة والتنظيم، وتحديد الأولويات، والمراجعة، والمشاركة بنشاط فى الصف.

الكلمات الدالة: الوظائف التنفيذية، نقص الانتباه وفرط الحركه وصعوبات التعلم والفروق بين الذكور والإناث فى الوظائف التنفيذيه.

Introduction:

Learning is a complex cognitive process and it depends on a range of skills.[1] Recently, executive functions have been considered as a crucial building block for learning.[2] Executive functions (EFs) can be defined as a supervisory system that is important for planning, reasoning ability and the integration of thought and action.[3] EFs are considered as a multidimensional process that include a variety of correlated but distinct skills such as attention control, cognitive flexibility, self- regulation, inhibition, strategic planning, and impulse control.[4] EFs deficit are a common manifestation among children with (LD) and (ADHD) as well as other conditions (e.g. neurological conditions, mood disorders, Autism Spectrum Disorders (ASD) and acquired brain injury).[5] Literatures proved the unique predictor ability of EFs scoring for school performance and achievements especially in early school years.[6] Studies showed that ADHD and developmental dyslexia are considered as the most commonly diagnosed childhood disorders and they had a high rate of comorbidity.[7] Moreover, the executive functions deficit was accused in the development of comorbidity between the two disorders.[8] Many debates remain about the degree and type of executive functioning difficulties exhibited by children with ADHD and /or LD. The current study aimed to explore the executive functions profile among a sample of primary school children in Egypt and factors that could influence it.

Methodology

Subjects:

A cross sectional case control comparative study was carried in the period between January 2017 and a June 2019. The Ministry of Education provided the researcher with written approval to carry out the study in 3 governmental schools in El- Maadi directorate, Cairo. The studied sample included 200 participants. The age of the participants ranged from (9- 12) years. Written consent was taken from parents of children or one of them before carrying out the work.

1. The Inclusion Criteria Were:
   a. Children aged between (9- 12) years of both sex.
   b. Children with an average or above average intelligent quotient (IQ) (above 89) according to (Draw a Man test).[9]
2. The Exclusion Criteria Were:
   a. Children who obtained below average (below 89) in the IQ score (Draw a Man test).[9]
   b. Children with any sensory impairment, for example, visual and/ or hearing impairment.
   c. Children with a perinatal history of severe complication during pregnancy, labor or postnatal period.
   d. Children with a past history of traumatic brain injury, ASD or any other chronic illnesses.
   e. Children who were under medication to control their inattention, hyperactivity, and impulsivity.

Methods:

Participants were subjected to an assessment protocol, which included:

1. Assessment of children intelligence by (Draw a Man Test).[9]
2. Clinical Interview with the parents: Parents of children who obtained an average score on (Draw a Man Test) were interviewed and asked to answer a sheet of clinical interview including (Personal data, the perinatal history, developmental and past history of any medical condition).
3. The researcher met the class teacher to make a teacher- based assessment of the children clinical state regarding the presence or absence of LD and/ or ADHD by a DSM V based assessment sheet.
4. The researcher asked the class teacher to complete the (CEFI)- teacher form.

Tools:

Initially, 200 students underwent (Draw a man Test)[9] for assessment of intelligence. Then, according to Draw a Man test, children were divided into: Group I: They were 90 children who passed (Draw a Man Test), and fulfill the inclusion criteria. In addition, all of their data were complete, and Group II: They were 110 children who presented with any exclusionary criteria preventing them from participation.

Group I was the only group which completed further assessment protocol in the current work. After that, children in Group I were examined for their behavior in school, their monthly reports, and their attentiveness. The classroom teacher was asked to complete a DSM V based checklist for LD and ADHD[10] for each child.

For children who received ADHD diagnosis, their teachers were asked to fill the Diagnostic and Statistical Manual fourth edition (DSM IV) based checklist[11] in order to classify them into ADHD predominantly inattentive type (ADHD (PI)) and ADHD hyperactivity an impulsivity type (ADHD (HI)) and ADHD combined type (ADHD (CT))

Finally, a checklist of (CEFI- teacher form)[12] was given to the classroom teacher (as they were in close contact with each child in the class). The researcher has chosen the teacher form of the inventory because the teachers desire their students to be active learners, attend to instruction, and to complete work both in and outside their school.

CEFI teacher- form components: The executive functions were assessed by 100 questions that cover the nine Efs Scales: Attention, Emotion Regulation, Flexibility, Inhibitory Control, Initiation, Organization, Planning, Self- Monitoring, and Working Memory. The raw scores is transformed into standard scores and percentile ranks. Completed form scored via The CEFI scoring software program. The interpretation process begins by describing the standard score in table (1).

Table (1) Showed The Qualitative Description Of The Standard Score And Percentile Ranks Of CEFI During The Interpretation Process

Classification	Percentile Rank	Standard Score
Very Superior	≤98	≤ 130
superior	91- 97	120- 129
High Average	75- 90	110- 119
average	25- 74	90- 109
Low Average	9- 24	80- 89
Below Average	2- 8	70- 79
Well Below Average	≥2	≥69

The standard score is the most important reliable indicator of an individual's executive function behavior. Low scores suggest behaviors associated with weakness in executive function. Conversely, high scores indicate behaviors associated with strength in executive function.

The reliability and validity of the CEFI were proved in the following steps:

1. CEFI questionnaire was translated into the Arabic language through forward- translations and back- translations (WHO guidelines).[13]
2. Pre- testing: A pilot study was done on 10 students. Teachers were asked to fill CEFI. Thereafter, changes were made until the final satisfactory version was reached.
3. The reliability and validity of the CEFI were proved via the following statistical work that is applied to a sample of normally developed children (31 males and 31 females). Their ages ranged between (9- 12) years and the mean age was 10.74 years (±0.72) with no statistical differences between males and female ages.
    1. Reliability Was Proved By: Internal consistency: CEFI is a uni-dimensional instrument and Cronbach's alpha[14] is an appropriate estimate of the CEFI's reliability.[15] Cronbach's alpha will generally increase as the inter- correlations among test items increase. Cronbach's alpha coefficiency was α= 0.927. Correlation co- efficiency values are considered excellent when α ≤0.9, good when α≤ 0.8 and< 0.9 and acceptable when α ≤ 0.7 and< 0.8.
    2. Validity: The validity of CEFI was examined by:
        - Content validity (judgments' validity): the preliminary content was determined by a comprehensive review of current theory and research literature. Moreover, two independent, experienced and bilingual professor of child mental health and one psychologist judged all items of the checklist for language and cultural appropriateness as being completely relevant to the purpose for which they were meant. They agreed that nine scales of CEFI were suitable to judge what it was constructed for. See Appendix (1) for the definition and examples.
        - Criterion- related validity: to evaluate the criterion- related validity of CEFI, univariate analysis of variance (ANOVA) was conducted to examine the mean difference between the general population (matched on age, gender) and sample of children diagnosed with learning disability. Table (2) showed that there is a significant difference between mean values of CEFI scales among both normal children and children with LD except the Flexibility scale.

Table (2) Determined the statistical significance between standard score obtained by the normal sample and children with Learning Disability

Sub- Scales	group	Mean	SD	T Test	P- Value
Attention	Normal	103.64	6.75	7.23	<0.001**
	LD	83.12	13.90		
Emotion Regulation	Normal	103.21	6.75	7.577	<0.001**
	LD	82.23	17.90		
Flexibility	Normal	105.66	3.46	5.16	<0.001**
	LD	90.166	24.52		
Inhibitory Control	Normal	98.08	9.15	5.750	<0.001**
	LD	81.64	14.32		
Initiation	Normal	101.81	5.07	8.318	<0.001**
	LD	83.70	14.35		
Organization	Normal	100.19	12.70	3.974	<0.001**
	LD	84.70	18.97		
Planning	Normal	100.85	6.21	4.368	<0.001**
	LD	91.52	12.05		
Self-Monitoring	Normal	101.27	6.43	9.497	<0.001**
	LD	81.52	10.94		
Working Memory	Normal	94.45	8.45	6.014	<0.001**
	LD	78.52	13.32		

Microsoft Excel 2013 was used for data entry and the statistical package for social science (SPSS) version 21[16] was used for data analysis. Simple descriptive statistics (arithmetic mean and standard deviation) used for the summary of quantitative data and frequencies used for qualitative data. The bivariate relationship was displayed in cross- tabulations and comparison of proportions was performed using the chi- square and Fisher's exact tests where appropriate. T- independent, one- way ANOVA and post- hook tests were used to compare normally distributed quantitative data. The level of significance was set at probability P- value <0.05.

Results:

- Descriptive Statistics: The current study was carried on 90- children (36 (40%) males& 54 (60%) females) their ages ranged between (9- 12) years with a mean age equal to 10.73 years (±0.79) and their EFs mean scoring was 97.3 (±10.72). There was no statistical differences between male and female mean ages and EFs scoring (P= 0.92& 0.527 consecutively). Table (3) illustrated the subgroups of the sample after application of the DSM V based learning disability checklist. They were group A (children with LD/ADHD or both) and group B (children without any behavioral or academic deficit). There is a significant statistical difference between the mean EFs scoring among the two studied groups (A, B) (P <0.001).

Table (3) illustrated the subgrouping of the studied sample

The whole studied sample No.	Age range (years)	Mean ages (years±SD)	Sex Distribution				Sub-groups	No.(%)	Mean age (years±SD)	Sex Distribution				E.F scoring	P value
			type	No. (%)	Mean age (years)	P value				type	No. (%)	Mean age (years)	P value		
90 child	9-12	10.73(±0.79)	Male	36 (40%)	10.7(±0.74)	0.92	Group A	29(32.2%)	10.7 (± 0.89)	Male	15 (51.27%)	10.60 (±0.83)	0.727	101.52(±6.498)	<0.001
										Female	14 (48.21%)	10.71(±0.914)			
			Female	54 (60%)	10.7(±0.87)		Group B	61 (67.8%)	10.79(±0.79)	Male	21 (%)	10.81 (±0.68)	0.786	88.8 (±12.96)	
										Female	40 (%)	10.75 (±0.875)			

Further assessment divided group A into group Ai (children with LD only) and group Aii (children with ADHD only) and group Aiii

(children with comorbidity of ADHD and LD). According to DMS IV children with ADHD were divided into: ADHD (PI) (16 children) }6 of them presented with learning disability comorbidity{. ADHD (CT) (6 children) }all of them presented with learning disability comorbidity{ and ADHD (HI) (2 children), }none of them showed learning disability comorbidity{. The three ADHD subtypes results were shown in table (4). There is a significant statistical difference between children with ADHD and those without ADHD and (P < 0.001).

Table (4) The table described data of the ADHD children and compared it to those without ADHD:

The whole studied sample	Sample subgroups after ADHD checklist						P value	ADHD sub-types			No. of children with L.D	E.F scoring	
	Sub groups	No.	Age (years)	Sex Distribution Type	No.	Mean age (SD)						Mean	P value
90 Children	ADHD children	24	11 (±1)	M	11	(±0.66) 10.89	0.07	ADHD (PI)	M	6	6	88 (±13)	<0.001
									F	10			
				F	13	11(±0.2)		ADHD(HI)	M	2	-		
									F	-			
								ADHD (CT)	M	3	6		
									F	3			
	Non-ADHD children	66	10.81 (±0.68)	M	26	10.73 (±0.60)	0.841	66			78	101.52 (±6.498	
				F	40	10.92 (±0.87)							
	Total	90			90			90			90		

Data of children who received the diagnosis of LD (with and without ADHD) were shown in Table (5). There is a significant statistical difference between LD group and group of children without LD (P<0.001).

Table (5) The table described data of the LD children and compared it to those without LD:

The classification of children according to the presence of learning disability	Number	Mean age	Sex distribution Type	No.	Mean age	Executive function Mean scoring	P value
L.D children	17 (18.9%)	10.72(±0.79)	M	11	10.45 (±0.68)	85 (±15)	<0.001
			F	6	11.00 (±0.89)		
Without L.D	73 (81.1%)	10.74 (±0.75)	M	25	10.72 (±0.68)	102 (±6)	
			F	48	10.78 (±0.78)		

Table (6) compared the standard score and the nine domains' scores for some variables in the current work. These variables included the clinical state (group A and group B), sex, and specific diagnosis (ADHD and LD). Findings showed that the clinical state contributed largely to significant dysfunction in EFs (presence or absence of ADHD and LD). Although there is no statistical difference between children with ADHD and children LD among their CEFI scoring domains, children who diagnosed with LD were lower in their scores in different domains than children who received the ADHD diagnosis.

Table (6); compared between the standard score rating as well as the scale score in different CEFI domain between group A& B, different sexes, and different d diagnoses:

The Assessed Variable	The d score in different scales	St Score	p	AS	p	Er- S	p	FS	p	Ic- S	p	IS	p	OS	p	PS	p	Sm- S	p	Wm- S	p
The Clinical State	Control	101.52±6.49	<0.001	103.98±5.07	<0.001	103.15±6.99	<0.001	109.02±6.122	<0.001	98.82±8.79	<0.001	102.1±5.15	<0.001	102.11±6.77	<0.001	101.21±6.12	<0.001	99.52±8.62	<0.001	94.07±8.65	<0.001
	Case	88.86±12.96		89.86±15.6		88.14±15.96		101.59±8.36		86.21±12.30		89.10±12.34		89.9±14.85		93.17±10.21		88.76±11.57		84.21±12.0	
The Gender	Male	96.56±11.72	0.52	97.22±12.81	0.147	97.64±14.34	0.686	105.64±9.36	0.326	93.47±11.90	0.395	96.52±6.49	0.294	96.64±12.60	0.305	97.52±9.18	0.187	96.75±11.68	0.623	92.64±11.45	0.213
	Female	98.04±10.22		100.52±10.90		98.76±11.70		107.28±9.36		95.61±11.45		98.83±9.97		99.20±10.78		99.59±7.97		95.59±10.355		89.72±10.34	
The Specific Diagnosis	L. D	85±15	0.002	85±18	0.001	84±19	0.234	100±10	0.262	83±14	0.342	86±14	0.342	85±18	0.002	91±12	0.341	87±14	0.232	82±15	0.683
	ADHD	88±13		89±16		86±16		102±7		85±13		88±13		89±16		93±11		88±12		83±12	

ST score= Standard score AS= Attention score ER- S= Emotion- Regulation score FS= flexibility score IC- S= Inhibition- Control score IS= Initiation score OS= Organization score PS= Planning score SM- S= Self- Monitoring Score WM- S= Working Memory Score.

Discussion:

The period of primary school years is a critical period in the acquisition of fundamental academic skills in reading, writing, and mathematical skills. These skills are markedly influenced by many factors (intrinsic and extrinsic). Evidence showed that certain fundamental executive functions skills were considered as an indicator of early academic achievement after controlling for general intelligence.[17][18] Early screening, assessment, and investigation of EFs are essential for early intervention to prevent complication.[19]

The purpose of the current work was mainly to determine some factors influencing teachers' executive functions' scoring among a sample of primary school children in Egypt of average intelligence. It was hypothesized by the current study that executive functions' deficits were strongly affected among children who were average in their cognitive

scoring but with poor academic achievement.

The current work chose the draw a man test to measure the general intelligence. It was chosen as it could measure intelligence apart from EFs assessment.[20]

Among many different tools Standardized BRIEF (Behavior Rating Inventory of Executive Function) was the most commonly used tools.[21] The current study utilized a reliable, valid and standardized Arabic version of CEFI- teacher form. Based on the fact that EFs scoring varies markedly between different settings and in different environment,[21] CEFI- teacher form is considered as the most accurate and comprehensive measure of academic achievement (as it depends on observation of the child's response in the classroom).[12]

In the current study,[29] children (32.22%) of the studied sample were suffering from learning disability with or without ADHD. Seventeen children of them (18.9%) were diagnosed as children with Learning Disability. Brook et.al. 22 was in agreement with the current study regarding the prevalence of LD (17.6%). Farrag et.al.[23] measured the prevalence of reading disability among 2878 children from the 2nd and 3rd grades in elementary schools. Their findings were 3% of their sample only suffered from reading disability. The inclusion of all types of LD among the current work could explain the difference.

In the current study,[24] children (26.7%) children received ADHD diagnosis based on teachers report and this teacher based diagnosis was more related to children's ADHD manifestation as reported by American Academy of pediatrics.[24] The order of ADHD subtypes according to their frequency was in the following sequences: (ADHD- PI (16 children) followed by ADHD- CT (6 children) and finally ADHD- HI (2 children). The rate of ADHD among the current work which is considered higher than the figure reported worldwide was explained by improvement in the clinical diagnosis.[25] However, this figure went with Farahat et.al. and El-Gendy et.al.[26][27] They examined the prevalence of ADHD among Egyptian primary school children. The first work reported a prevalence rate reaching 22%. Whereas the second study estimated that the prevalence was 21.8% and 16.2% based on the informants (teacher for the first and parent for the second). Ford et.al.[28] reported that the prevalence of ADHD was 70% higher if data from teachers was combined with parent report when compared with parent report alone. The prevalence rate of ADHD in the current study was higher than Wang et.al. 29 but similar with it in the order of ADHD sub- types. The wide range, the high mean age and the referral base of their sample could explain the aspect of disagreement with the current work.

The current study showed that 12 (50%) of ADHD children (6 with ADHD- IT and 6 with ADHD- CT) showed comorbidity of ADHD and L.D& 70% of children with LD reported ADHD comorbidity. These findings were supported by Brook et.al.,[22] DuPaul et.al.[30] Furthermore, Wu et.al.[31] and Biederman et.al.[32] explained this high rate of comorbidity by the presence of EFs deficits as common feature between both disorders. Riccio et.al.[33] confirmed in their series that 31% of children with ADHD (PI) and 78% of ADHD (CT) received medication during school time to improve their academic performance.

In the current study, the significantly low executive functions scoring among ADHD children than those without ADHD was supported by Riccio et.al.[32] and Rabiner et.al.[34] Willcutt et.al.[35] and Vélez- van-Meerbeke et.al.[36] Their work demonstrated marked affection of the examined EFs skills among ADHD predominantly inattentive type who suffered from academic problems. Willcutt et.al.[35] and Vélez- van-Meerbeke et.al.[36] determined that weaknesses in EFs were significant in both clinic- referred and population based samples of ADHD and assigned that EFs are considered as an important component of the complex neuropsychological aspect of ADHD.

The attribution of ADHD to the manifestation of learning disability was explained by Barkley's theory.[37][38] They stated that disinhibition and planning problems were the compromised EFs of ADHD-CT and responsible for academic problems among this ADHD subtype. However, set shifting, vigilance, and interference control deficits may be more associated with ADHD- PI and responsible for comorbidity of poor academic achievements among them. Moreover, Schreiber et.al.[39] Nigg et.al.[40] Shallice et.al.[41] Boonstra et.al.[42] Wu et.al.[31] and Brocki et.al.[43] suggested that academic difficulties are more related to inattention symptoms than hyperactivity symptoms. In contrast to this, was Geurts et.al.[44] They did not support different executive functioning profile among different ADHD subtypes.

The EFs scoring among the current study was significantly compromised among group A (children with LD/ ADHD or both of them). This finding was supported by Meltzer,[45] Bull and Scerif&[46] Wilcutt et.al. 8 In the same direction with the current work results' was Sesma et.al.,[47] Geary et.al.[48] and Lima et.al.[49] Sesma et.al.[47] and Lima et.al.[49] determined that working memory and planning, and inattention were the compromised EFs among their studied dyslexic children. Bull and Scerif[48] concluded that children at risk for poor academic achievements showed significant deficits in EFs than their control peers.

The current study determined that children in group Ai and Aii have a significantly lower EFs score than children in group B. The methodology of the current study was similar to what has been drawn by Willcutlt et.al.[35] Results revealed that ADHD was associated with inhibition deficits whereas; children with RD was associated with significant deficits on measures of PA and verbal working memory. The comorbidity of ADHD and RD showed impairment of all of the all assessed measures. Gooch et.al.[50] were in the same direction as the current work data in the aspect that comorbidity of ADHD and learning disability exhibited a greater EFs deficit than each disorder alone. Marzocchi et.al.[51] and Klaver et.al.[52] result was in disagreement with the current work results'. Their findings showed that EFs deficits were evident findings in ADHD children; whereas the reading disabled children showed almost spared executive functions. Klaver et.al.[52] proved their findings by unique protocol that was composed of: a neuropsychological test battery and an 8

minute structural magnetic resonance imaging (MRI). Fadaei et.al.[53] explained the heterogeneity of variables that might affect EFs scoring among literature by differences in the severity of LD (that was not mentioned) among different studies.

The current study showed that although children with LD and ADHD were significantly lower in their EFs scoring, ADHD children scored higher than LD children. This finding was supported by Clark et.al.&[54] Holmes et.al.[55] and Doyle et.al.[56]

The current work demonstrated that primary school children in Egypt obtained high score in mental flexibility even for the case group. This finding might indicate the positive effect of the Egyptian environment (with continuous change) on children's executive functions and nurture their flexibility. However, Reiter et.al.[57] and Brosnan et.al.[58] showed that 83.3% of dyslexic children showed affection of mental flexibility.

In the current study sex variation did not play a role in executive function scoring. This result was supported and explained by Biederman et.al.,[32] Gaub et.al.[59] and Roufael et.al.[60] They explained the pseudo-majority of boys with executive dysfunction as bias, as there were under diagnosis among girls because they disrupt less in class.

Conclusion:

The current study indicated that most of the examined executive functions were significantly compromised among children with learning disability and ADHD. These clinical presentations could be considered as a determinant factor for EFs deficit among the studied sample of Egyptian school children.

It was recommended by the current work that learning disability assessment protocol should include a comprehensive assessment of the child's executive function abilities. This assessment protocol could be also enrolled during the school readiness assessment. Intervention studies for executive functions dysfunction should be carried up to promote school success in children at high risk for school failure, especially in young age.

Limitation of the study: the major limitation of the current work was in obtaining the approval for the second time in order to complete the missing data of some children. This reason was behind the shrinkage of the number of the participating children from 200 to 90.

References:

1. Abreu PN, Abreu NN, Nikaedo CC, et.al. 2014) Executive functioning and reading achievement in school: a study of Brazilian children assessed by their teachers as "Poor Readers". **Front. Psychol**. June: 10.
2. Nelto ML, Rose G, Medina J. et.al. (2016) Assessing executive functions in preschoolers using Shape school task. Frontiers in **Psychology**: 1489.
3. Shallice T, Burgess P (1996) The domain of supervisory processes and temporal organization of behavior, Philosophical Transactions of the Royal Society **B- Biological Science**. 351(1346): 1405- 11.
4. Reader MJ, Harris EL, Schuerholz LJ et.al. (1994) Attention deficit hyperactivity disorder and executive dysfunction. **Developmental Neuropsychologlay** (10): 493- 512.
5. Rebecca E (2003) Executive Functions and Their Disorders, **British Medical Bulletin** 65(1); 49- 59.
6. Zelazo PD, Blair CB, and Willoughby MT (2016) **Executive Function: Implications for Education (NCER 2017- 2000)** Washington, DC: National Center for Education Research, Institute of Education Sciences, U. S. Department of Education.
7. Willcutt EG, Pennington BF (2000) Comorbidity of reading disability and attention deficit/ hyperactivity disorder: Differences by gender and subtype. **Journal of Learning Disabilities** 33(2): 179- 191.
8. Willcutt EG, Pennington BF, Boada R, Ogline JS, Tunick RA, Chhabildas NA, Olson RK (2001) A comparison of the cognitive deficits in reading disability and attention- deficit/hyperactivity disorder. **Journal of Abnormal Psychology** 110(1): 157- 72.
9. Harris DB (1963) **Children's drawings as measures of intellectual maturity**. New York: Harcourt, Brace& World, Inc.
10. American Psychiatric Association (2013). **Diagnostic and statistical manual of mental disorders (DSM),** Washington, D. C. : American Psychiatric Association
11. American Psychiatric Association (2000) **Diagnostic and Statistical Manual of Mental Disorders (4th ed. , text revision)**. Washington, DC: Author.
12. Naglieri JA, Goldstein S (2013) **Comprehensive Executive Functioning Index**. Toronto: Multi Health Systems.
13. Harpaz I (2003) "The Essence of Performing Meaningful Comparative International Survey Research", in Punnett, B. J. and Shenkar, O. (Eds.), **Hand book for International Management Research**, Ann Arbor, MI: University of Michigan Press, 2nd ed., pp.17- 48.
14. Cronbach LJ. (1951) Coefficient alpha and the internal structure of tests. **Psychometrika**, 16, 297- 334.
15. Cortina J. M. (1993) What Is Coefficient Alpha: An Examination of Theory and Applications? **Journal of Applied Psychology**, 78, 98- 104.
16. Field A. **Discovering statistics using SPSS** (2009) 3rd ed. London: SAGE Publications Ltd.
17. Blair C., Steinhard N (2013) **Executive Functions in the Classroom. Encyclopedia of early childhood development**. USA January.
18. Carlson SA. (2005) Developmentally sensitive measures of executive function in preschool children. **Developmental Neuropsycholog** 28(2): 595- 616.
19. Gupta SK, Venkatesnn S (2014) Efficacy of training program on executive functions in children with learning disability, **Guru journal of behavioral and social sciences** 2(2): 283- 91.
20. Seidenberg M, Giordani B, Berent S. et.al. (1983) IQ level and performance of the Halstead- Reitan Neuropsychological Test battery for older children. **Journal of Consulting and Clinical Psychology** 51 (3): 406- 13.
21. Willoughby MT, Wirth RJ, Blair CB (2011) Contributions of modern

measurement theory to measuring executive function in early childhood: An empirical demonstration. **Journal of Experimental Child Psychology** 108:414- 35.

22. Brook U, Boaz M (2005) Attention deficit and learning disabilities (ADHD/ LD) among high school pupils in Holon (Israel). **Patient Education and Counseling** 58: 164- 167.
23. Farrag AF, El- Behairy AA., Kandil MR (1988) Prevalence of specific reading disability in Egypt. **Lancet** https://doi.org/10.1016/S0140-6736(88)92794-8. Get rights and content
24. American Academy of Pediatrics (2000) clinical practice guideline: diagnosis and evaluation of the child with attention- deficit/ hyperactivity disorder. **Pediatrics** 105:1158- 1170.
25. Global Research on Developmental Disabilities Collaborators (2018): **Developmental disabilities among children younger than 5 years in 195 countries and territories**, 1990- 2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Glob Health 2018; 6: e1100- 21 Published Online August 29, 2018. http://dx.doi.org /10.1016/S2214-109X(18)30309-7.
26. Farahat T, Alkot M, Rajab A, Anbar R. (2014) Attention- Deficit Hyperactive Disorder among Primary School Children in Menoufia Governorate, Egypt. **International Journal of Family Medicine**. 2014: 7. http://dx.doi.org/10.1155/2014/257369.
27. EL- Gendy SD, El- Bitar EA, El- Awady MA, Bayomy HE, Agwa EM (2017) Attention- Deficit/Hyperactivity Disorder: Prevalence and risk factors in Egyptian primary School Children. **The Egyptian Journal of Community Medicine** (35); 1.
28. Ford T, Goodman R, Meltzer H (2003) The British Child and Adolescent Mental Health Survey 1999: the prevalence of DSM- IV disorders. **J Am Acad Child Adolesc Psychiatry**. 2003; 42(10): 1203-1211.
29. Wang T, Liu K, Li Z, Xu Y et.al. (2017) Prevalence of attention deficit/ hyperactivity disorder among children and adolescents in China: a systematic review and meta- analysis. **BMC Psychiatry BMC series** 17:32.
30. DuPaul GJ, Gormley MJ, Laracy SD (2013) Comorbidity of LD and ADHD: implications of DSM- 5 for assessment and treatment. **J Learn Disabil** Jan- Feb; 46(1): 43- 51
31. Wu KK, Anderson V, Castiello U (2010) **Neuropsychological Evaluation of Deficits in Executive Functioning for ADHD Children With or Without Learning Disabilities**. June: 501- 531.
32. Biederman J, Monuteaux MC, Doyle AE, et.al. (2004) Impact of executive function deficits and attention- deficit/ hyperactivity disorder (ADHD) on academic outcomes in children. **J Consult Clin Psychol** Oct; 72(5): 757- 766.
33. Riccio CA. Homack S. Jarratt KP. Wolfe ME (2006) Differences in academic and executive function domains among children with ADHD Predominantly Inattentive and Combined Types**. Archives of Clinical Neuropsychology** 21: 657- 67
34. Rabiner DL. Murray DW. Schmid L. Malone PS (2004)An exploration of the relationship between ethnicity, attention problems, and academic achievement. **School Psychology Review** 33: 498- 509.
35. Willcutt EG, Doyle AE, Nigg JT, Faraone SV, Pennington BF (2013) Validity of the Executive Function Theory of Attention- Deficit/ Hyperactivity Disorder: A Meta- Analytic Review. **BIOL Psychiatry** 57:1336- 46.
36. Vélez- van- Meerbeke A, Zamora IP, Guzmán G, Figueroa B, López Cabra CA, Talero- Gutiérrez C (2013) Evaluating executive function in schoolchildren with symptoms of attention deficit hyperactivity disorder. **Neurologia** Jul- Aug; 28(6): 348- 55. doi: 10.1016/j. nrl. 2012.06.011.
37. Barkley RA (1997a) Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. **Psychological Bulletin** 121: 65- 94.
38. Barkley RA. (1997b) **ADHD and the nature of self- control**. New York: Guilford.
39. Schreiber JE. Possin KL (2014) Girard JM. Rey- Casserly C. Executive Function in Children with Attention Deficit/Hyperactivity Disorder: the NIH Examiner battery. **J Int Neuropsychol Soc** January; 20(1): 41- 51. doi: 10.1017/S1355617713001100.
40. Nigg JT (2005) Neuropsychologic theory and findings in attention-deficit/ hyperactivity disorder: The state of the field and salient challenges for the coming decade. **Biological Psychiatry** 57: 1424- 35.
41. Shallice T, Marzocchi GM, Coser S. et.al. (2002) Executive function profile of children with attention deficit hyperactivity disorder. **Dev Neuropsychol** 21(1): 43- 71.
42. Boonstra AM, Oosterlaan J, Sergeant JA, Buitelaar J (2005) Executive functioning in adult ADHD: A meta- analytic review. **Psychological Medicine** 35: 1097- 108.
43. Brocki KC, Eninger L, Thorell LB, Bohlin G (2010) Interrelations Between Executive Function and Symptoms of Hyperactivity/ Impulsivity and Inattention in Preschoolers: A Two Year Longitudinal Study **J Abnorm Child Psychol** 38:163- 171. DOI 10.1007/s10802-009- 9354- 9.
44. Geurts HM, Verté S, Oosterlaan J, Roeyers H, Sergeant JA (2005) ADHD subtypes: do they differ in their executive functioning profile? **Arch Clin Neuropsychol** 20:457- 77.
45. 45 Meltzer, L. (Ed.) (2007) **Executive function in education**: From theory to practice. New York, NY, US: Guilford Press.
46. Bull R, Scerif G (2001) Executive Functioning as a Predictor of Children's Mathematics Ability: Inhibition, Switching, and Working Memory. **Developmental Neuropsychology** 19(3): 273- 293.
47. Sesma HW, Kennedy Krieger Institute, Baltimore, MD, USA; Johns Hopkins University School of Medicine, Baltimore, MD, USA Mahone EM, Kennedy Krieger Institute, Baltimore, MD, USA; Johns Hopkins University School of Medicine, Baltimore, MD, USA Levine T, Kennedy Krieger Institute, Baltimore, MD, USA; Johns Hopkins

University School of Medicine, Baltimore, MD, USA et.al. , Kennedy Krieger Institute, Baltimore, MD, USA; Johns Hopkins University School of Medicine, Baltimore, MD, USA (2009) Kennedy Krieger Institute, Baltimore, MD, USA; Johns Hopkins University School of Medicine, Baltimore, MD, USA Correspondence cutting@ kennedykrieger.org The Contribution of Executive Skills to Reading Comprehension. **Journal Child Neuropsychology** 15(3): 232- 46.

48. Geary DC, Hoard MK, Hamson CO (1999) Numerical and arithmetical cognition: Patterns of functions and deficits in children at risk for a mathematical disability. **Journal of Experimental Child Psychology** 74: 213- 39.
49. Lima RF, Azoni CA, Ciasca SM (2011) Attentional Performance and Executive Functions in Children with Learning Difficulties. **Psicologia: Reflexão e Crítica** 24 (4), 685- 91.
50. Gooch D, Snowling M, Hulme C (2011)Time perception, phonological skills and executive function in children with dyslexia and/or ADHD symptoms. **J Child Psychol Psychiatry** Feb; 52(2): 195- 203.
51. Marzocchi GM, Oosterlaan J, Zuddas A, et.al. (2008) Contrasting deficits on executive functions between ADHD and reading disabled children. **Journal of Child Psychology and Psychiatry** 49(5): 543- 52.
52. Klaver JM, DiLalla LF, Klaver J, Kibby M (2013) Anatomical Correlates of Executive Functioning in Children with Attention-deficit/hyperactivity Disorder and Developmental Dyslexia. Thesis Submitted in Partial Fulfillment of the Requirement for the **Master of Arts Degree**. In the field of Clinical Psychology. Semantic scholar.
53. Fadaei E, Tavakol M, Tahmasebi A, Narimani M, Shiri V, Shiri E (2017) the relationship between executive functions with reading difficulty in children with specific learning disability. **Arch Neurosci October**; 4(4).
54. Clark C, Prior M, Kinsella GJ (2000) Do executive function deficits differentiate between adolescents with ADHD and oppositional defiant/ conduct disorder? A neuropsychological study using the six elements test and Hayling sentence completion test. **Journal of Abnormal Child Psychology** 28:403- 14.
55. Holmes J, Gathercole SE, Dunning DL (2009) Adaptive training leads to sustained enhancement of poor working memory in children. **Dev. Sci** 12, F9- F15. doi: 10.1111/j. 1467- 7687.2009.00848. x
56. Doyle AE (2006) Executive functions in attention- deficit/ hyperactivity disorder. **Journal of Clinical Psychiatry** 67(8).
57. Reiter A, Tucha O, Lange KW (2005) Executive functions in children with dyslexia. **Dyslexia** 11: 116- 31.
58. Brosnan JD, Hamill S, Robson K, Shepherd H, Cody G (2002) Executive functioning in adults and children with developmental dyslexia. **Neuropsychologia** 40: 2144- 55.
59. Gaub M, Carlson CL (1997) Gender differences in ADHD: a meta-analysis and critical review**. J Am Acad Child Adol Psychiat** 36: 1036- 45.
60. Roufael R, El- Bakry A, Amer D, Refaat O, Emad- Eldin M (2012) **Gender differences in executive functions and reading abilities in children with attention deficit hyperactivity disorder** 33 (2): 63-73.