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Effects of child abuse and neglect on executive functions among children diagnosed with learning disabilities or attention deficit and hyperactivity disorder

Aya Maged Hamza^{1,2*} , Soha Abdellatif Ghobashy¹ and Heba Essam Abouelwafa¹

Abstract

Background Studying cognitive deficits due to abuse and neglect in vulnerable children with neurodevelopmental disorders can fuel the battle to save them. We aimed to assess effects of child abuse and neglect on executive functions (EF) among children diagnosed with attention deficit and hyperactivity disorder (ADHD) and specific learning disorders (SLD). Three hundred forty drug-naïve children were divided into four groups according to their diagnosis. They have all been through history taking, clinical interview, assessment of exposure to abuse or neglect, Barkley Deficit in Executive Functioning Scale-Children and Adolescents (BDEFS-CA), and Conners and intelligence quotient (IQ) test.

Results Children with ADHD or SLD were significantly exposed to abuse and neglect showing significant executive dysfunctions. The mostly affected domains with abuse among ADHD were emotion regulation with effect size (ES): 0.576, self-restraint ES: 0.38 and self-motivation ES: 0.256, abuse was significantly associated with lower social class 63.6% ES: 0.377 while neglect was significantly associated with parents' marital status of being divorced 92% ES: 0.621. Abuse and neglect were significantly associated with emotion regulation executive dysfunction with OR 23.5 and 22.8 respectively.

Conclusion Executive dysfunctions are significantly related to exposure to abuse and neglect. The most affected domains were emotion regulation and self-restraint executive functions. Also, we concluded that prevalence of abuse and neglect to be significantly higher in lower social class than average and higher classes and in divorced parents than married ones. Health education and early intervention programs should be directed more specifically to the more vulnerable children diagnosed with neurodevelopmental disorders and of lower social class or of divorced parents.

Keywords ADHD, SLD, Executive functions, Child abuse, Child neglect, Drug naïve

Background

Child abuse and neglect have severe consequences on the public health, and they can be considered a current epidemic. According to a study in 2013 by the United Nations International Children's Emergency Fund (UNICEF) many children in Egypt are being exposed to abuse at the hands of their supposed guardians. Those

*Correspondence:

Aya Maged Hamza
ayamaged1989@gmail.com

¹ Neuropsychiatry Department, Faculty of Medicine, Alexandria University, Alexandria, Egypt

² 2Stanley 28 Abdelhameed Elabady Street Building B 4Th Floor Apartment 46, Alexandria, Egypt

perpetrators even their children often normalize this abuse [1].

The study was done from March to May 2013 in Alexandria, Assiut, and Cairo. They found that most of the children interviewed (65% in Alexandria) reported that they had been exposed to physical abuse over the past year. The study confirmed that physical punishment is the accepted form of discipline by many parents.

Neglect is the most common and serious type of child maltreatment; however, it is the least studied type [2] and it affected 25% of the surveyed children, regarding sexual abuse most girls reported experiencing sexual harassment [1].

Children suffering from developmental disorders as ADHD and SLD are expected to suffer from higher rates of abuse and neglect due to the common mis contribution of their symptoms to misbehaving by their parents especially in Egypt, besides child maltreatment whether abuse or neglect may cause disabilities that mostly precipitate further abuse [3].

Research confirmed that developmental disorders are risk factors for physical abuse and neglect [4]. Difficulty in handling children with ADHD makes them suffer higher rates of neglect and abuse as they need an exceptional tolerance for their behavioral problems [5].

The consequences of the parents residual symptoms of ADHD and their children ADHD behavioral problems besides the absent mental health awareness result in ineffective communication and aggressive relation [6]. Besides studies found that children with specific learning disorders are at increased risk of sexual abuse [7].

Consequences of child abuse and neglect on executive functions

Studies confirmed that child abuse and neglect, produce long-term changes in the central nervous system (CNS) [8] causing mainly executive functioning deficits affecting their behavioral regulation. According to research done by the Bucharest Early Intervention Project team, extreme neglect also affects executive functioning [9].

Spann et al. [10] found that adolescents suffered diminished cognitive flexibility due to physical abuse and neglect. Also, research confirmed that abused and neglected preschoolers suffered lower cognitive functioning [11].

Research found that the main protective factors following abuse are stable family relations and high self-esteem [12].

The EF impairment in ADHD is supported by related structural brain deficits found in imaging studies of those children [13]. So, EF deficits are proven to be a salient feature of ADHD. Each domain of EF is a type of self-regulation, ADHD, involves deficits in problem solving,

response inhibition, emotion regulation, and self-motivation [14].

Methods

Aim of the study

Assessment of the consequences of child abuse and neglect on different executive functions domains in children diagnosed with ADHD, in children diagnosed with specific learning disorders and in healthy control children.

Study design: cross-sectional comparative study

Study setting

This study was carried out at the Child and Adolescent Psychiatry Outpatient Clinic–Alexandria University Hospital.

Participants

All children attending the clinic over a period of 1 year with a diagnosis of ADHD or Specific learning disorder and who were drug-naïve and aged from 6 to 13 years were recruited and random sampling was done using a computer-generated process selecting 240 child out of the recruited 480 child as a sample size of at least 200 children were required to estimate an average difference in executive functions using alpha error=0.05 and to provide a study power of 80%.and then the selected children were classified in to.

Group (I): ADHD only ($n=100$)

Group (II): SLD only ($n=80$).

Group (III): comorbid ADHD and SLD ($n=60$).

Group (IV): healthy control group of normal children with matching age, sex, and educational level ($n=100$) (whom were also randomly selected).

Most studies suggested that stimulant medications improve EF in ADHD, also subjects, single doses of the non-stimulant Atomoxetine cause some improvement in response inhibition so we chose drug-naïve children as an inclusion criteria to exclude the drug effects on EF where most of the previous studies were carried on children already on treatment [15].

The studied children were subjected to:

- I) History taking for the following:
 - A) Demographic data, age of onset of symptoms, developmental history, previous medical and surgical history, family history.
 - B) Assessment of parent's parenting style with special emphasis on children exposure to physical abuse, sexual abuse, and neglect by screening

questions for both the parents and the child separately.

- C) Detailed clinical interview was used to assess the presence of specific learning disorder by screening for symptoms according to DSM V.
- II) II)Physical, neurological examination, and psychiatric assessment using Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS).
- III) III)Psychometric assessment:
 - A) IQ testing using Stanford Binet test [16].
 - B) Conner's parent rating form for ADHD severity assessment [17].
 - C) Socioeconomic standards of the parents using modified Fahmy and Elsherbiny scale which assess 7 different domains. This scale is reliable and valid according to Egyptian culture [18].
 - D) Parent-report rating scale (long form) of the Barkley Deficits In Executive Functioning Scale-Children and Adolescents (BDEFS-CA) [19].

Procedure

- The approval of the Ethical Committee of Alexandria University was obtained by the Committee of Ethics of Alexandria University Faculty of Medicine.
- IRB NO:00012098 (expires 6/10/2022)
- FWA NO: 00018699 (expires 21 January 2026)
- ☐ Informed consent:
- Consent to participate: informed consent to participate in the study has been obtained from parents of all the studied children.
- Consent to publish: parents signed informed consent regarding publishing their children's data if needed.
- Random sampling was done after all children fulfilling the inclusion criteria attending the clinic for 6-month duration were recruited for psychiatric interview.
- IQ assessment using the Stanford Binet Scale
- Conner's parent rating scale was done to assess ADHD symptom severity.
- Clinical interview according to DSM V criteria, confirming ADHD or specific learning disorder diagnosis and any other comorbidities.
- This was followed by Fahmy and El-Sherbini's Social Classification Scale to determine social class, and scholastic school achievement according to the final grades and finally the executive functions assessment using BDEFS-CA.

- Parents were subjected to a full family history assessment and marital status whether married, divorced, or widow.
- Assessment of physical and sexual abuse or neglect of the child was done by separate interviewing of parents and children.
- Regarding control group screening using Conner's rating scale for ADHD was done excluding nine children for having ADHD while psychiatric interview excluded four children for having specific learning disorders.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp.) Qualitative data were described using number and percent. The Kolmogorov–Smirnov test was used to verify the normality of distribution quantitative data were described using range (minimum and maximum), mean, standard deviation, and median. The significance of the obtained results was judged at the 5% level.

The used tests are the following:

1. Chi-square test: for categorical variables, to compare between different groups.
2. Fisher's exact or Monte Carlo correction: correction for chi-square when more than 20% of the cells have expected count less than 5.
3. Regression analysis: to detect the most independent/affecting factor for time management EF, Problem solving and self-organization EF, self-restraint executive function, self-motivation EF, and emotional regulation EF [20, 21].

Results

Abuse and neglect

Table 1 shows that abuse was present in 41% of group I as evident in Fig. 1, in 16.3% of group II as evident in Fig. 2 and 36.7% in group III as demonstrated in Fig. 3, abuse was in the form of physical abuse, sexual or both, a post-comparison test showed statistically significant difference between the first three groups and the control group (group IV) in which only 4% experienced abuse. Neglect was most prevalent in groups I and III where 23% of group I as demonstrated in Fig. 4, 16% of group II as demonstrated in Fig. 5 and 23% of group III as demonstrated in Fig. 6 were exposed to significant neglect while only 2% of the control group (group IV) was exposed to neglect.

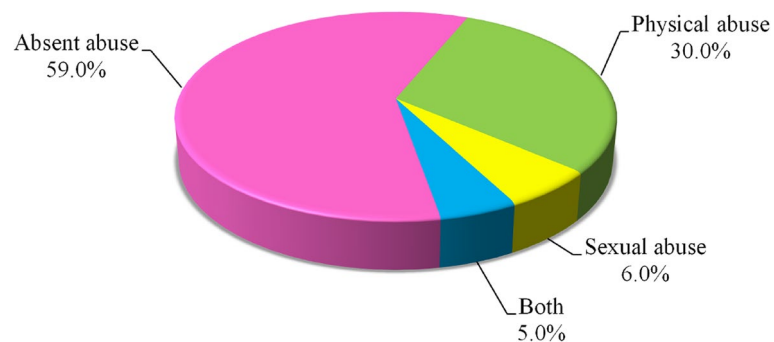
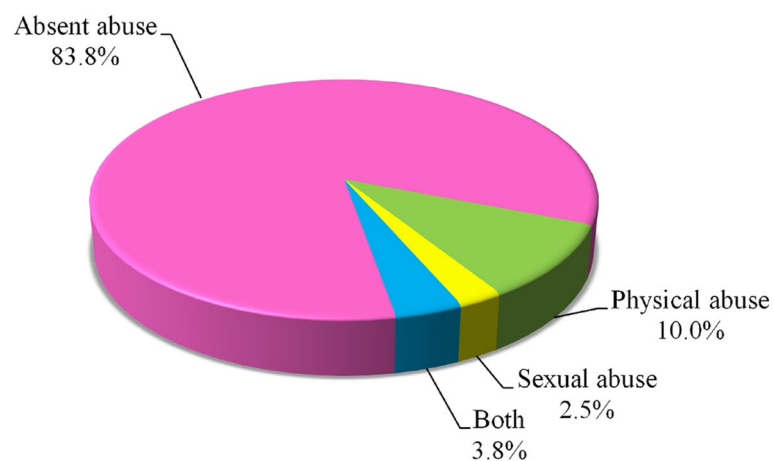
Table 1 Comparison between the Four studied groups according to history of abuse or neglect

	Group I (n = 100)		Group II (n = 80)		Group III (n = 60)		Group IV (n = 100)		Test of sig	p
	No	%	No	%	No	%	No	%		
Abuse										
Absent abuse	59	59.0	67	83.8	38	63.3	96	96.0	53.976*	<0.001*
Physical abuse	30	30.0	8	10.0	20	33.3	4	4.0		
Sexual abuse	6	6.0	2	2.5	1	1.7	0	0.0		
Both	5	5.0	3	3.8	1	1.7	0	0.0		
P ₁			0.003*		0.450		<0.001*			
Sig. bet. Grps			^{MC} p ₂ =0.003*, ^{MC} p ₃ =0.015*,p ₄ <0.001*							
Neglect										
No neglect	77	77.0	67	83.8	46	76.7	98	98.0	21.275*	<0.001*
Neglect	23	23.0	13	16.3	14	23.3	2	2.0		
P ₁			0.261		0.961		<0.001*			
Sig. bet. Grps			p ₂ =0.293,p ₃ =0.001*,p ₄ <0.001*							

χ^2 : Chi-square test

p: p value for comparing between the studied groups

* Statistically significant at $p \leq 0.05$

**Fig. 1** Abuse in group I**Fig. 2** Abuse in group II

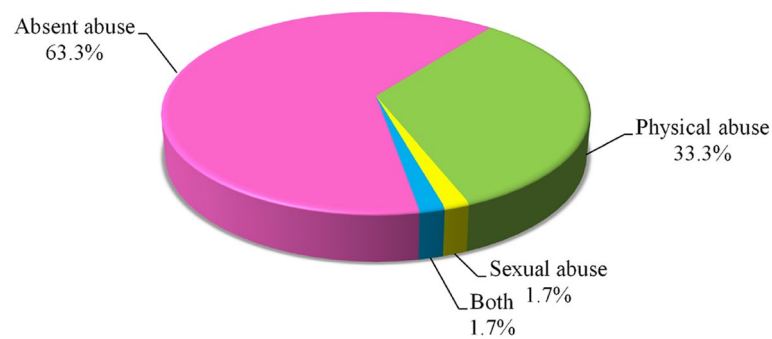


Fig. 3 Abuse in group III

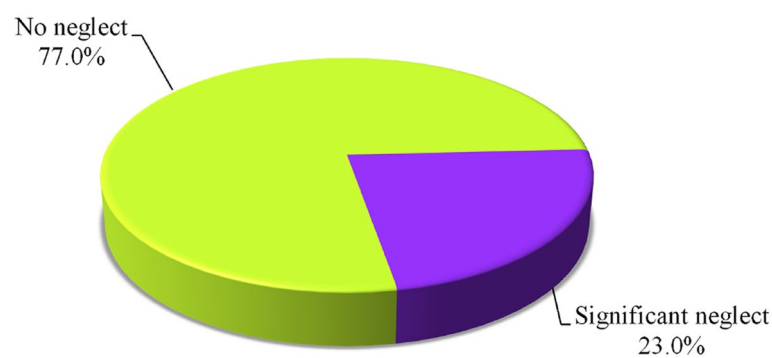


Fig. 4 Neglect in group I

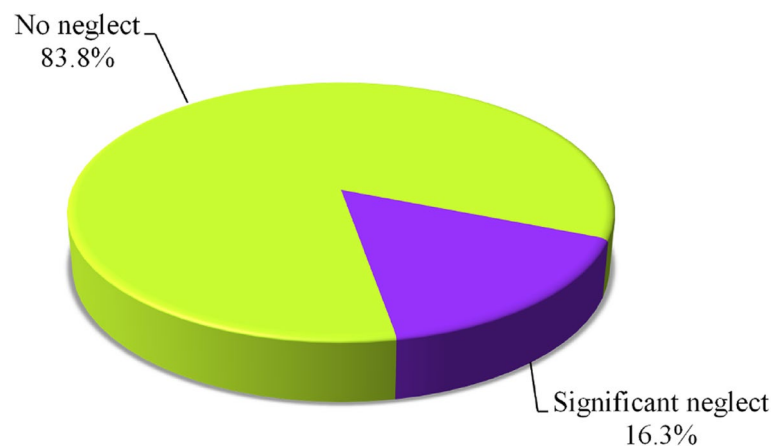


Fig. 5 Neglect in group II

Relation between EF and abuse

Table 2 shows that on relating types of abuse to EF among the whole sample of the studied children ($n=340$), emotion regulation EF showed the highest significant association with exposure to physical abuse, sexual abuse, and both types of abuse together to be affected in 93.5% of those exposed to physical abuse, 88.8% of those exposed to sexual abuse and in 88.8% in

children exposed to both types of abuse together, followed by self-restraint EF affected in 74.2% of physical abuse, in 100% of children exposed to sexual abuse and in 88.9% in case of exposure to both together physical and sexual abuse followed by self-motivation EF affected in 64.5% of those exposed to physical abuse, 66.7% in children exposed to sexual abuse and in 66.7% of those exposed to both types of abuse while time

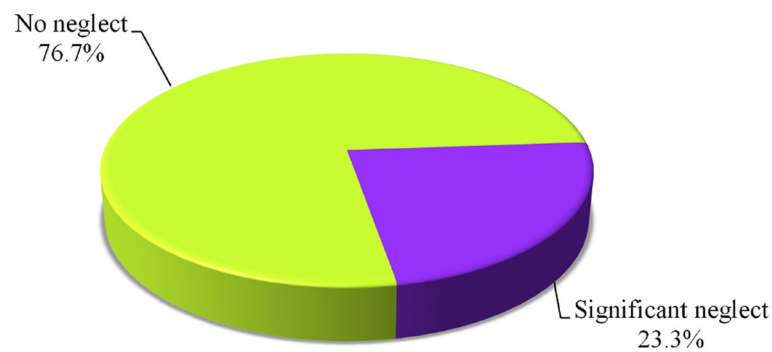


Fig. 6 Neglect in group III

Table 2 Relation between abuse and executive functions among studied children ($n = 340$)

	Abuse								χ^2	MCp
	Absent abuse (n = 260)		Physical abuse (n = 62)		Sexual abuse (n = 9)		Both types of abuse (n = 9)			
	No	%	No	%	No	%	No	%		
Time management EF										
No	137	52.7	20	32.3	2	22.2	3	33.3	11.489*	0.008*
Yes	123	47.3	42	67.7	7	77.8	6	66.7		
Sig. bet. Grps	$p_1=0.004^{*,FE}, p_2=0.094^{FE}, p_3=0.319^{FE}, p_4=0.711^{FE}, p_5=1.000^{FE}, p_6=1.000^{FE}$									
Problem solving and self-organization EF										
No	151	58.1	27	43.5	6	66.7	4	44.4	5.163	0.154
Yes	109	41.9	35	56.5	3	33.3	5	55.6		
Self-restraint executive function										
No	164	63.1	16	25.8	0	0.0	1	11.1	46.664*	<0.001*
Yes	96	36.9	46	74.2	9	100.0	8	88.9		
Sig. bet. grps	$p_1<0.001^{*,FE}, p_2<0.001^{*,FE}, p_3=0.003^{*,FE}, p_4=0.193^{FE}, p_5=0.677^{FE}, p_6=1.000^{FE}$									
Self-motivation EF										
No	160	61.5	22	35.5	3	33.3	3	33.3	17.299*	0.001*
Yes	100	38.5	40	64.5	6	66.7	6	66.7		
Sig. bet. grps	$p_1<0.001^{*,FE}, p_2=0.161^{FE}, p_3=0.161^{FE}, p_4=1.000^{FE}, p_5=1.000^{FE}, p_6=1.000^{FE}$									
Emotional regulation EF										
No	181	69.6	4	6.5	1	11.2	1	11.2	103.354*	<0.001*
Yes	79	30.4	58	93.5	8	88.8	8	88.8		
Sig. bet. grps	$p_1<0.001^{*,FE}, p_2=0.001^{*,FE}, p_3=0.001^{*,FE}, p_4=0.503^{FE}, p_5=0.503^{FE}, p_6=1.000^{FE}$									

χ^2 : Chi-square test, MC Monte Carlo, FE Fisher exact

p: p value for comparing between the studied groups

p_1 : p value for comparing between Absent abuse and Physical abuse

p_2 : p value for comparing between Absent abuse and Sexual abuse

p_3 : p value for comparing between Absent abuse and Both types of abuse

p_4 : p value for comparing between Physical abuse and Both types of abuse

p_5 : p value for comparing between Physical abuse and Both types of abuse

p_6 : p value for comparing between Sexual abuse and Both types of abuse

* Statistically significant at $p \leq 0.05$

management and problem solving EF showed insignificant association with different types of abuse.

Table 3 shows that on relating types of abuse to EF among group I (pure ADHD group) emotion regulation EF was the highest EF to show significant association with exposure to different types of abuse being affected in 96.7% in those exposed to physical abuse, 88.3% in those exposed to sexual abuse while in case of exposure to both types of abuse together to be affected in 80%, different types of abuse whether physical, sexual, or both affected EF among group I with emotion regulation EF effect size: 0.576, self-restraint ES: 0.38 and self-motivation ES: 0.256.

Table 4 shows that on relating types of abuse to EF among group II (pure LD group) emotion regulation EF was the only EF to show significant association with exposure to different types of abuse being affected in 100% of those exposed to physical abuse, sexual abuse, or both together.

Table 5 shows that on relating types of abuse to EF among group III (combined ADHD and LD group) emotion regulation EF was the most significantly affected EF in association with exposure to different types of abuse being affected in 95% of those exposed to physical abuse and in 100% of children exposed to sexual abuse or both types of abuse together.

Table 6 shows that on relating types of abuse to EF among group IV (the control group) different EF domains

were insignificantly affected in relation to exposure to different types of abuse.

Relation between EF and neglect

Table 7 shows that on relating EF affection to exposure to neglect among the whole sample of the studied children ($n=340$), emotion regulation EF was the highest EF related to exposure to neglect affecting 92.3% of them, followed by self-restraint EF affected in 70%, and then self-motivation EF affected in 62% of children exposed to neglect.

Table 8 shows that on relating EF affection to exposure to neglect among group I (pure ADHD), emotion regulation EF was the only EF significantly affected in relation to exposure to neglect affecting 91.3% of those children.

Table 9 shows that on relating EF affection to exposure to neglect among group II (pure LD), emotion regulation EF was the only EF significantly affected in relation to exposure to neglect affecting 100% of those children.

Tables 10 and 11 show that on relating EF affection to exposure to neglect among group IV (control group), time management EF was the only EF significantly affected in relation to exposure to neglect affecting 100% of those children.

Table 12 shows that level of social class was significantly associated with exposure to abuse where 63.6% of children living in below average socioeconomic standards were exposed either to physical abuse or sexual abuse or

Table 3 Relation between abuse and executive functions among studied children in group I ($n=100$)

	Abuse								χ^2	MC _p
	Absent abuse (n = 59)		Physical abuse (n = 30)		Sexual abuse (n = 6)		Both types of abuse (n = 5)			
	No	%	No	%	No	%	No	%		
Time management EF										
No	25	42.4	15	50.0	2	33.3	1	20.0	1.798	0.659
Yes	34	57.6	15	50.0	4	66.7	4	80.0		
Problem solving and self-organization EF										
No	37	62.7	14	46.7	5	83.3	3	60.0	3.569	0.316
Yes	22	37.3	16	53.3	1	16.7	2	40.0		
Self-restraint executive function										
No	7	11.9	0	0.0	0	0.0	0	0.0	4.104	0.228
Yes	52	88.1	30	100.0	6	100.0	5	100.0		
Self-motivation EF										
No	23	39.0	12	40.0	3	50.0	2	40.0	0.511	0.959
Yes	36	61.0	18	60.0	3	50.0	3	60.0		
Emotional regulation EF										
No	28	47.5	1	3.3	1	16.7	1	20.0	21.043*	<0.001*
Yes	31	52.5	29	96.7	5	83.3	4	80.0		
Sig. bet. grps	p ₁ < 0.001*, ^{FE} p ₂ = 0.213, ^{FE} p ₃ = 0.366, ^{FE} p ₄ = 0.310, ^{FE} p ₅ = 0.269, ^{FE} p ₆ = 1.000									

* Statistically significant at $p \leq 0.05$

Table 4 Relation between abuse and executive functions among studied children in group II ($n=80$)

	Abuse								χ^2	MCp
	Absent abuse (n = 67)		Physical abuse (n = 8)		Sexual abuse (n = 2)		Both types of abuse (n = 3)			
	No	%	No	%	No	%	No	%		
Time management EF										
No	12	17.9	2	25.0	0	0.0	1	33.3	1.594	0.682
Yes	55	82.1	6	75.0	2	100.0	2	66.7		
Problem solving and self-organization EF										
No	12	17.9	1	12.5	1	50.0	1	33.3	2.713	0.347
Yes	55	82.1	7	87.5	1	50.0	2	66.7		
Self-restraint executive function										
No	52	77.6	6	75.0	0	0.0	1	33.3	7.422*	0.045*
Yes	15	22.4	2	25.0	2	100.0	2	66.7		
Sig. bet. grps	^{FE} p ₁ = 1.000, ^{FE} p ₂ = 0.058, ^{FE} p ₃ = 0.144, p ₄ = 0.133, p ₅ = 0.491, p ₆ = 1.000									
Self-motivation EF										
No	31	46.3	2	25.0	0	0.0	1	33.3	2.587	0.525
Yes	36	53.7	6	75.0	2	100.0	2	66.7		
Emotional regulation EF										
No	43	64.2	0	0.0	0	0.0	0	0.0	17.749*	<0.001*
Yes	24	35.8	8	100.0	2	100.0	3	100.0		
Sig. bet. grps	^{FE} p ₁ = 0.001*, ^{FE} p ₂ = 0.139*, ^{FE} p ₃ = 0.053, p ₄ = -, p ₅ = -, p ₆ = -									

* Statistically significant at $p \leq 0.05$ **Table 5** Relation between abuse and executive functions among studied children in group III ($n=60$)

	Abuse								χ^2	MCp
	Absent abuse (n = 38)		Physical abuse (n = 20)		Sexual abuse (n = 1)		Both types of abuse (n = 1)			
	No	%	No	%	No	%	No	%		
Time management EF										
No	5	13.2	0	0.0	0	0.0	1	100.0	8.376*	0.045*
Yes	33	86.8	20	100.0	1	100.0	0	0.0		
Sig. bet. Grps	p ₁ =0.153, ^{FE} p ₂ =1.000, ^{FE} p ₃ =1.000, p ₄ =-, ^{FE} p ₅ =0.048*, ^{FE} p ₆ =1.000									
Problem solving and self-organization EF										
No	7	18.4	8	40.0	0	0.0	0	0.0	3.990	0.255
Yes	31	81.6	12	60.0	1	100.0	1	100.0		
Self-restraint executive function										
No	9	23.7	7	35.0	0	0.0	0	0.0	1.786	0.663
Yes	29	76.3	13	65.0	1	100.0	1	100.0		
Self-motivation EF										
No	12	31.6	4	20.0	0	0.0	0	0.0	1.711	0.749
Yes	26	68.4	16	80.0	1	100.0	1	100.0		
Emotional regulation EF										
No	16	42.1	1	5.0	0	0.0	0	0.0	10.268*	0.004*
Yes	22	57.9	19	95.0	1	100.0	1	100.0		
Sig. bet. grps	p ₁ =0.003*, ^{FE} p ₂ =1.000, ^{FE} p ₃ =1.000, ^{FE} p ₄ =1.000, ^{FE} p ₅ =1.000, ^{FE} p ₆ =-									

* Statistically significant at $p \leq 0.05$

Table 6 Relation between abuse and executive functions among studied children in group IV ($n = 100$)

	Abuse				χ^2	FE _p
	Absent abuse (<i>n</i> = 96)		Physical abuse (<i>n</i> = 4)			
	No	%	No	%		
Time management EF						
No	95	99.0	3	75.0	11.246	0.079
Yes	1	1.0	1	25.0		
Problem solving and self-organization EF						
No	95	99.0	4	100.0	0.042	1.000
Yes	1	1.0	0	0.0		
Self-restraint executive function						
No	96	100.0	3	75.0	24.242*	0.040*
Yes	0	0.0	1	25.0		
Self-motivation EF						
No	94	97.9	4	100.0	0.085	1.000
Yes	2	2.1	0	0.0		
Emotional regulation EF						
No	94	97.9	2	50.0	22.960*	0.007*
Yes	2	2.1	2	50.0		

* Statistically significant at $p \leq 0.05$ **Table 7** Relation between neglect and executive function in the studied groups

	Neglect				χ^2	P
	No neglect ($n = 290$)		Neglect ($n = 50$)			
	No	%	No	%		
Time management EF						
No	143	49.3	19	38.0	2.187	0.139
Yes	147	50.7	31	62.0		
Problem solving and self-organization EF						
No	167	57.6	21	42.0	4.191*	0.041*
Yes	123	42.4	29	58.0		
Self-restraint executive function						
No	166	57.2	15	30.0	12.712*	<0.001*
Yes	124	42.8	35	70.0		
Self-motivation EF						
No	169	58.3	19	38.0	7.093*	0.008*
Yes	121	41.7	31	62.0		
Emotional regulation EF						
No	183	63.5	4	7.7	55.511*	<0.001*
Yes	105	36.5	48	92.3		

* Statistically significant at $p \leq 0.05$

both together (ES: 0.37) while only 2.5% of above average class and 17.8% of average class were exposed to different types of abuse.

Also, social class was significantly associated with exposure to neglect in children where 32% of those living

in low socioeconomic standards were exposed to neglect but only 5% in the above average class and 13.7 in the average class were exposed to neglect.

Table 13 shows that parent's marital status (being divorced) was significantly associated with exposure to

Table 8 Relation between neglect and executive function in group I ($n = 100$)

	Neglect				χ^2	p
	No neglect ($n = 77$)		Neglect ($n = 23$)			
	No	%	No	%		
Time management EF						
No	31	40.3	12	52.2	1.026	0.311
Yes	46	59.7	11	47.8		
Problem solving and self-organization EF						
No	45	58.4	14	60.9	0.043	0.835
Yes	32	41.6	9	39.1		
Self-restraint executive function						
No	7	9.1	0	0.0	2.248	^{FE} $p = 0.347$
Yes	70	90.9	23	100.0		
Self-motivation EF						
No	32	41.6	8	34.8	0.339	0.561
Yes	45	58.4	15	65.2		
Emotional regulation EF						
No	29	37.7	2	8.7	6.947*	0.008*
Yes	48	62.3	21	91.3		

* Statistically significant at $p \leq 0.05$ **Table 9** Relation between neglect and executive function in group II ($n = 80$)

	Neglect				χ^2	P
	No neglect ($n = 67$)		Neglect ($n = 13$)			
	No	%	No	%		
Time management EF						
No	10	14.9	5	38.5	3.959	$F_E p = 0.061$
Yes	57	85.1	8	61.5		
Problem solving and self-organization EF						
No	10	14.9	5	38.5	3.959	$F_E p = 0.061$
Yes	57	85.1	8	61.5		
Self-restraint executive function						
No	48	71.6	11	84.6	0.947	$F_E p = 0.496$
Yes	19	28.4	2	15.4		
Self-motivation EF						
No	27	40.3	7	53.8	0.818	0.366
Yes	40	59.7	6	46.2		
Emotional regulation EF						
No	43	64.2	0	0.0	18.040*	< 0.001*
Yes	24	35.8	13	100.0		

* Statistically significant at $p \leq 0.05$

neglect (ES: 0.62) where 92% of children of divorced parents were exposed to neglect and 50% of children of one dead parent. While only 8.3% of children of married parents were exposed to neglect.

Table 14 shows that parent's marital status (being divorced) was significantly associated with exposure to significant neglect where 92% of children of divorced parents were exposed to significant neglect and 50% of

Table 10 Relation between neglect and executive function in group III ($n = 60$)

	Neglect				χ^2	P
	No neglect ($n = 46$)		Neglect ($n = 14$)			
	No	%	No	%		
Time management EF						
No	4	8.7	2	14.3	0.373	0.617
Yes	42	91.3	12	85.7		
Problem solving and self-organization EF						
No	13	28.3	2	14.3	1.118	0.483
Yes	33	71.7	12	85.7		
Self-restraint executive function						
No	12	26.1	4	28.6	0.034	1.000
Yes	34	73.9	10	71.4		
Self-motivation EF						
No	12	26.1	4	28.6	0.034	1.000
Yes	34	73.9	10	71.4		
Emotional regulation EF						
No	16	34.8	0	0.0	6.640*	0.013*
Yes	30	65.2	14	100.0		

* Statistically significant at $p \leq 0.05$ **Table 11** Relation between neglect and executive function in group IV ($n = 100$)

	Neglect				χ^2	FE p
	No neglect (n = 46)		Neglect (n = 14)			
	No	%	No	%		
Time management EF						
No	98	100.0	0	0.0	100.0*	<0.001*
Yes	0	0.0	2	100.0		
Problem solving and self-organization EF						
No	97	99.0	2	100.0	0.021	1.000
Yes	1	1.0	0	0.0		
Self-restraint executive function						
No	97	99.0	2	100.0	0.021	1.000
Yes	1	1.0	0	0.0		
Self-motivation EF						
No	96	98.0	2	100.0	0.042	1.000
Yes	2	2.0	0	0.0		
Emotional regulation EF						
No	94	95.9	2	100.0	0.085	1.000
Yes	4	4.1	0	0.0		

* Statistically significant at $p \leq 0.05$

children of one dead parent. While only 8.3% of children of married parents were exposed to significant neglect.

Table 15 shows that the variables which showed significant association with emotion regulation EF in group I was below average social class, bad academic

outcome, other psychiatric comorbidity, exposure to abuse and exposure to neglect. On the other hand, the variables which showed significant association with emotion regulation EF in group II were other comorbidity, exposure to abuse and exposure to neglect, as for

Table 12 Relation Between Social class and exposure to abuse or neglect in total sample ($n = 340$)

	Social class						χ^2	p
	Above average ($n = 120$)		Average ($n = 146$)		Below average ($n = 74$)			
	No	%	No	%	No	%		
Abuse								
No abuse	117	97.5	120	82.2	27	36.4	99.417*	^{MC} p<0.001*
Physical abuse or school bullying	2	1.7	18	12.3	38	51.4		
Sexual abuse	1	0.8	5	3.4	3	4.1		
Both	0	0.0	3	2.1	6	8.1		
Neglect								
No neglect	114	95.0	126	86.3	50	67.6	27.669*	<0.001*
Neglect	6	5.0	20	13.7	24	32.4		

* Statistically significant at $p \leq 0.05$ **Table 13** Relation between neglect and parent marital status in total sample ($n = 340$) (% from row)

	Neglect				χ^2	^{MC} p
	No neglect (n = 290)		Neglect (n = 50)			
	No	%	No	%		
Parent marital status						
Married	287	91.7	26	8.3	88.065*	< 0.001*
Divorced	2	8.0	23	92.0		
Dead one	1	50.0	1	50.0		

* Statistically significant at $p \leq 0.05$ **Table 14** Shows that parent Marital status (being divorced) was significantly more associated with exposure to sexual abuse as only 33.3% of the children of married couples were exposed to sexual abuse but double the percent (66.7%) of children of divorced couples were exposed to sexual abuse

	Abuse								χ^2	^{MC}p
	Absent abuse ($n = 260$)		Physical abuse ($n = 62$)		Sexual abuse ($n = 9$)		Both types of abuse ($n = 9$)			
	No	%	No	%	No	%	No	%		
Parent marital status										
Married	244	93.8	57	91.9	3	33.3	9	100.0	26.553*	<0.001*
Divorced	15	5.8	4	6.5	6	66.7	0	0.0		
Dead one	1	0.4	1	1.6	0	0.0	0	0.0		
Sig. bet. grps	$^{MC}p_1 = 0.0423, ^{MC}p_2 < 0.001^*, ^{MC}p_3 = 1.000, ^{FE}p_4 < 0.001^*, ^{FE}p_5 = 1.000, ^{FE}p_6 = 0.009^*$									

* Statistically significant at $p \leq 0.05$

group III emotion regulation was related to low social class, other comorbidities, exposure to abuse, and exposure to neglect.

Table 16 shows that using multivariate regression analysis the significant risk factors for emotion regulation EF affection in the total sample was other comorbidity (odds ratio=25 and CI (11–56)), exposure to

abuse (odds ratio=23.5 and CI (7.3–74)), and exposure to neglect (odds ratio=22.8 and CI (6–85.7)).

Table 17 shows that using multivariate regression analysis exposure to abuse was a significant risk factor for emotion regulation EF affection in group I (OR 6.844) CI(1.569–29.85).

Table 15 Relation between emotional regulation and different variables among the studied groups

	Emotional regulation EF											
	Group I				Group II				Group III			
	No (n = 31)		Yes (n = 69)		No (n = 43)		Yes (n = 37)		No (n = 17)		Yes (n = 43)	
	No	%	No	%	No	%	No	%	No	%	No	%
Age (years)												
< 10	24	77.4	46	66.7	25	58.1	21	56.8	11	64.7	25	58.1
> 10	7	22.6	23	33.3	18	41.9	16	43.2	6	35.3	18	41.9
X ² (p)	1.178(0.278)				0.016(0.901)				0.219(0.640)			
Gender												
Male	23	74.2	57	82.6	27	62.8	27	73.0	15	88.2	30	69.8
Female	8	25.8	12	17.4	16	37.2	10	27.0	2	11.8	13	30.2
X ² (p)	0.947(0.331)				0.940(0.332)				2.216(^{FE} p=0.137)			
Social class												
≤ Average	18	58.1	12	17.4	23	53.5	15	40.5	8	47.1	6	14.0
> Average	13	41.9	57	82.6	20	46.5	22	59.5	9	52.9	37	86.0
X ² p)	16.850(<0.001*)				1.337(0.248)				7.464*(^{FE} p=0.015*)			
Academic achievement												
Good outcome	18	58.1	25	36.2	19	44.2	16	43.2	5	29.4	11	25.6
Bad outcome	13	41.9	44	63.8	24	55.8	21	56.8	12	70.6	32	74.4
X ² (p)	4.160(0.041*)				0.007(0.992)				0.091(^{FE} p=0.756)			
Comorbidity												
No	23	74.2	14	20.3	35	81.4	10	27.0	14	82.4	7	16.3
Yes	8	25.8	55	79.7	8	18.6	27	73.0	3	17.6	36	83.7
X ² (p)	26.663*(< 0.001*)				23.888*(< 0.001*)				23.380*(< 0.001*)			
Abuse												
No	28	90.3	31	44.9	43	100.0	24	64.9	16	94.1	22	51.2
Yes	3	9.7	38	55.1	0	0.0	13	35.1	1	5.9	21	48.8
X ² (p)	18.222*(< 0.001*)				18.040(< 0.001*)				9.680*(0.002*)			
Neglect												
No neglect	29	93.5	48	69.6	43	100.0	24	64.9	17	100.0	29	67.4
Neglect	2	6.5	21	30.4	0	0.0	13	35.1	0	0.0	14	32.6
X ² (p)	6.947*(0.008*)				18.040(< 0.001*)				7.219(^{FE} p=0.006*)			
IQ												
< 100	3	9.7	13	18.8	4	9.3	4	10.8	2	11.8	4	9.3
≥ 100	28	90.3	56	81.2	39	90.7	33	89.2	15	88.2	39	90.7
X ² (^{FE} p)	1.336(0.378)				0.050(1.000)				0.082(^{FE} p= 1.000)			
Conner's scale												
≤ 25	26	83.9	48	69.6	41	95.3	34	91.9	16	94.1	30	69.8
> 25	5	16.1	21	30.4	2	4.7	3	8.1	1	5.9	13	30.2
X ² (^{FE} p)	2.275(0.131)				0.406(0.658)				4.038(^{FE} p=0.051)			

* Statistically significant at $p \leq 0.05$

Table 18 shows the demographic characteristics of the studied sample as follows:

A) Age: insignificant statistical difference between the four groups as

The majority of children in the studied groups aged below 10 years, and the groups were matched for age ($F = 0.825$, $P = 0.481$).

B) Gender: insignificant statistical difference between the four groups where.

Table 16 Univariate and multivariate logistic regression analysis for the parameters affecting emotional regulation EF in total sample

	Univariate		#Multivariate	
	<i>P</i>	OR (95%C.I.)	<i>p</i>	OR (95%C.I.)
Age (years) (> 10)	0.946	1.015(0.652–1.580)		
Gender (female)	0.249	0.754(0.466–1.219)		
Social class (<= Average)	< 0.001*	2.810(1.748–4.516)	0.077	0.485(0.218–1.080)
Academic achievement (bad outcome)	< 0.001*	4.157(2.637–6.553)	0.576	1.241(0.582–2.650)
Comorbidity	< 0.001*	29.811(16.26–54.65)	< 0.001*	25.062(11.03–56.93)
Abuse	< 0.001*	28.257(11.80–67.65)	< 0.001*	23.517(7.39–74.80)
Neglect	< 0.001*	20.914(7.33–59.64)	< 0.001*	22.848(6.09–85.78)
IQ (\geq 100)	0.010*	0.355(0.162–0.779)	0.595	1.362(0.436–4.255)
Conner's scale (> 25)	< 0.001*	7.137(3.210–15.869)	0.175	2.150(0.711–6.501)

* Statistically significant at $p \leq 0.05$ **Table 17** Univariate and multivariate logistic regression analysis for the parameters affecting emotional regulation EF in group I

	Univariate		#Multivariate	
	<i>p</i>	OR (95%C.I.)	<i>p</i>	OR (95%C.I.)
Age (years) (> 10)	0.281	1.714(0.644–4.565)		
Gender (female)	0.333	0.605(0.219–1.674)		
Social class (<= Average)	< 0.001*	6.577(2.552–16.952)	0.966	0.970(0.244–3.862)
Academic achievement (Bad outcome)	0.044*	2.437(1.025–5.793)	0.217	2.065(0.653–6.534)
Comorbidity	< 0.001*	11.295(4.17–30.57)	0.006*	5.926(1.668–21.054)
Abuse	< 0.001*	11.441(3.18–41.22)	0.010*	6.844(1.569–29.851)
Neglect	0.017*	6.344(1.385–29.060)	0.123	4.057(0.686–24.007)
IQ (\geq 100)	0.256	0.462(0.121–1.754)		
Conner's scale (> 25)	0.138	2.275(0.768–6.738)		

OR odd's ratio, C.I confidence interval, LL lower limit, UL upper limit

All variables with $p < 0.05$ was included in the multivariate* Statistically significant at $p \leq 0.05$

The predominant gender among our studied groups were boys; the groups were matched for gender ($p=0.1$).

III) Residency.

Urban residency was found to be the highest among the control group and the lowest among group I where statistically significant difference was found ($p=0.002$), post-comparison test showed that the statistically significant difference was between the control group and group I, the control group and group II and also between the control group and group III.

IV) Social class.

Above average social class was most prevalent in group II. Average social class was most prevalent in the control group and below average social class was most prevalent in group III; there was a statistically significant difference ($p < 0.001$), post-comparison test showed the significant difference to be between the control group and the

three groups (I, II, and III) and also between group II and group III.

E) Birth order.

Statistically significant difference was found ($p < 0.001$), post-comparison test was made and showed the significant difference was between the control group and the other three groups and also between group II and III.

F) School grades.

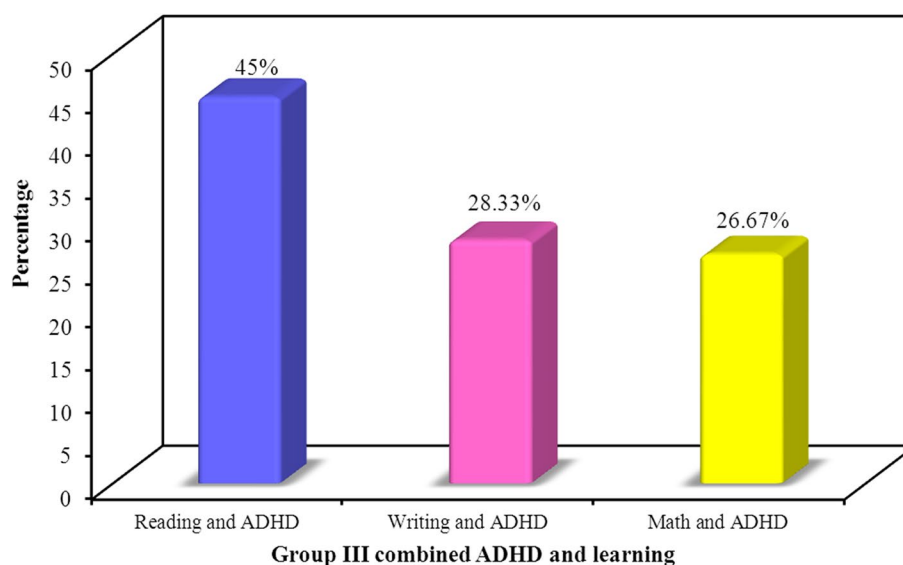
Most of the children in the four studied groups belonged to junior grades (70% of each group) and a statistically significant difference was present ($p=0.06$), post-comparison test showed that the significant difference was between group I and group II, the control group and group II.

Table 18 Comparison between the different studied groups according to history and demographic data

	Group I (n = 100)		Group II (n = 80)		Group III (n = 60)		Group IV (n = 100)		Test of sig	p
	No	%	No	%	No	%	No	%		
Age (years)										
≤ 10	54	54.0	49	61.3	37	61.7	72	72.0	$\chi^2=6.990$	0.072
> 10	46	46.0	31	38.8	23	38.3	28	28.0		
Min.–max	6.0–13.0		6.0–13.0		6.0–13.0		6.0–13.0		F=0.825	0.481
Mean±SD	9.18±2.62		9.48±2.96		9.38±2.88		9.79±2.72			
Median	9.0		9.0		9.0		10.0			
Gender										
Male	80	80.0	54	67.5	45	75.0	66	66.0	$\chi^2=6.039$	0.110
Female	20	20.0	26	32.5	15	25.0	34	34.0		
Address										
Urban	87	87.0	76	95.0	55	91.7	100	100.0	$\chi^2=$	0.002*
Rural	13	13.0	4	5.0	5	8.3	0	0.0	14.593*	
p ₁			<0.001*		^{FE} p=0.037*		^{FE} p=0.007*			
Sig. bet. Grps			p ₂ =0.068,p ₃ =0.366, ^{FE} p ₄ =0.497							
Social class										
Above average	30	30.0	38	47.5	14	23.3	38	38.0	$\chi^2=$	<0.001*
Average	36	36.0	27	33.8	21	35.0	62	62.0	58.743*	
Below average	34	34.0	15	18.8	25	41.7	0	0.0		
p ₁			<0.001*		<0.001*		<0.001*			
Sig. bet. Grps			p ₂ =0.024*,p ₃ =0.545,p ₄ =0.003*							
Birth order										
First	48	48.0	47	58.8	34	56.7	100	100.0	$\chi^2=$	^{MC} p<0.001*
Second	29	29.0	26	32.5	10	16.7	0	0.0	103.488*	
Third	17	17.0	5	6.3	8	13.3	0	0.0		
Fourth	3	3.0	1	1.3	6	10.0	0	0.0		
Fifth	3	3.0	1	1.3	2	3.3	0	0.0		
^{MC} p ₁			<0.001*		<0.001*		<0.001*			
Sig. bet. Grps			^{MC} p ₂ =0.154, ^{MC} p ₃ =0.157, ^{MC} p ₄ =0.018*							
Grade										
No schooling	2	2.0	0	0.0	0	0.0	0	0.0	$\chi^2=$	^{MC} p=0.006*
KG	15	15.0	3	3.8	5	8.3	9	9.0	20.229*	
Junior grades	74	74.0	58	72.5	46	76.7	84	84.0		
Preparatory grades	9	9.0	19	23.8	9	15.0	7	7.0		
p ₁			^{MC} p=0.234		0.004*		0.264			
Sig. bet. Grps			^{MC} p ₂ =0.003*, ^{MC} p ₃ =0.354, ^{MC} p ₄ =0.291							
Academic achievement										
Excellent	12	12.0	7	8.8	4	6.7	31	31.0	$\chi^2=$	<0.001*
Good	31	31.0	28	35.0	12	20.0	63	63.0	99.585*	
Below average	33	33.0	33	41.3	24	40.0	6	6.0		
Poor	24	24.0	12	15.0	20	33.3	0	0.0		
p ₁			<0.001*		<0.001*		<0.001*			
Sig. bet. Grps			p ₂ =0.350,p ₃ =0.216,p ₄ =0.047*							

Table 18 (continued)

	Group I (n = 100)		Group II (n = 80)		Group III (n = 60)		Group IV (n = 100)		Test of sig	p
	No	%	No	%	No	%	No	%		
Family history										
No related family history	71	71.0	33	41.3	26	43.3	100	100.0	$\chi^2 =$	$^{MC}p < 0.001^*$
+ve Consanguinity	3	3.0	5	6.3	5	8.3	0	0.0	116.306	
ADHD history	8	8.0	5	6.3	8	13.3	0	0.0		
Learning disorder history	1	1.0	14	17.5	7	11.7	0	0.0		
Psychiatric disorder history	10	10.0	11	13.8	9	15.0	0	0.0		
Medical disorder	7	7.0	12	15.0	5	8.3	0	0.0		
p_1			$^{MC}p < 0.001^*$		$^{MC}p < 0.001^*$		$^{MC}p < 0.001^*$			
Sig. bet. Grps			$p_2 < 0.001^*, ^{MC}p_3 = 0.003^*, p_4 = 0.526$							

* Statistically significant at $p \leq 0.05$ **Fig. 7** Learning disorders subtypes among group III

Regarding distribution of subtypes of SLD in the studied sample

Reading disorder was the most prevalent LD among group II where it constituted 31%, writing disorder constituted 16% while Math disorder constituted 19%.

Combined reading and Math disorder is 7.5%, writing and Math disorder is 7.5% while reading and writing disorder constituted 19%.

While as shown in Fig. 7, the most prevalent LD in group III was reading disorder as combined ADHD and reading disability constituted 45%, combined ADHD and writing disorder in 26%, while combined ADHD and Math disorder in 26%

Discussion

Emotion regulation was the most significant EF associated with exposure to physical and sexual abuse and neglect and this might be explained by higher incidence of PTSD and depression in this population of children.

And in agreement with what is previously mentioned in literature that in the case of maltreatment children fail to adopt effective strategies for emotion regulation mostly due to the threatening response of abusive parents to their children distress or the unresponsive and nonempathic response of neglectful parents [22, 23].

Processing of cues is very important ability for emotion regulation. Research confirmed that abused children fail to detect anger in the face while having no problems in processing happy faces [24, 25]. So, abused children have a bias toward angry faces but not a general deficit in processing faces [26]. This bias may be actually a coping mechanism when living with the threat cue of parents anger [27]. Unfortunately, this mechanism can lead to aggressive responses because of faulty assumptions of hostile intent in a rather benign situation [28]. However neglected children show a general deficit at identifying facial expressions [29].

According to our results emotion regulation EF significant affection was followed by self-restraint EF and then self-motivation EF in case of abuse and was followed by self-restraint EF affection in case of neglect.

This came in agreement with literature as studies found that abused and neglected preschool children showed poorer inhibitory control, i.e., self-restraint EF [11].

While Nikulina and Widom [30], Mezzacappa et al. [31] and Spann, Mayes [10] reached the same finding yet a systematic review by Irigaray et al. [32], included six studies that found no association between child abuse and cognitive function. The results in review of literature in this area were conflicting mostly due to differences in the methodology whether self-report or retrospective, the studied type of abuse and in the studied samples gender [33, 34].

Child abuse and neglect can affect brain development especially the left neocortex; the hippocampus and the amygdala besides disturbing the stress response through the hypothalamic pituitary adrenal axis [35].

Also, our finding of child exposure to abuse and neglect being more prevalent in lower social class came in agreement with what was previously mentioned in literature that children living in lower social classes were almost 2 times more likely to be exposed to maltreatment (OR=1.91) this may be explained by the stress that economic difficulties place on the caregivers letting them behave in abusive manner with their children [36].

As regards the results of higher prevalence of child abuse and neglect in case of divorced parents in our study, this can be explained by the fact that after divorce the parenting skills of parents diminish severely and there is evidence in the literature that children of single parents have many emotional hardships and they are more vulnerable for developing psychiatric illness [37].

Conclusion

Executive dysfunctions are significantly related to exposure to abuse and neglect. The mostly affected domains were emotion regulation and self-restraint executive functions.

The mostly affected domains with abuse among ADHD were emotion regulation with Effect size:0.576, self-restraint ES: 0.38 and self-motivation ES:0.256, abuse was significantly associated with lower social class 63.6% ES: 0.377 while neglect was significantly associated with parents' marital status of being divorced 92% ES: 0.621.

It is reflected on child school achievement as problem solving, time management and self-motivation EF, emotional lability as emotion regulation EF and frequency of accidents as self-restraint EF and therefore, EF should be assessed and trained to improve children welfare.

Child abuse and neglect can be considered as significant risk factors for emotion regulation executive dysfunctions with odds ratio 23.5 and 22.8 respectively.

Also, we concluded that prevalence of abuse and neglect to be significantly higher in lower social class than average and higher classes and in divorced parents than married ones.

Recommendations

Further research using valid tools for categorizing severity and types of abuse and neglect and its effects on executive to confirm if abuse and neglect are just consequences to the present disorders of ADHD and LD or can also be considered significant risk factors for developing those disorders psychopathology.

Health education and early intervention programs to be directed more specifically to the more vulnerable children of lower social class and of divorced parents and diagnosed with neurodevelopmental disorders.

Limitations

The authors did not use a specific tool for assessment of abuse and neglect and they only relied on the clinical assessment and interview of both the child and the parent to screen if the child is being exposed to different types of abuse or neglect.

Abbreviations

ADHD	Attention deficit hyperactivity disorder
BDEFS-CA	Barkley deficits in executive functions scale child and adolescent
CNS	Central nervous system
EF	Executive functions
ES	Effect size
IQ	Intelligence quotient
K-SADS	Kiddie Schedule for Affective Disorders and Schizophrenia
LD	Learning disabilities
SLD	Specific learning disabilities
UNICEF	United Nations International Children's Emergency Fund

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Authors' contributions

Contributor A.M: Aya Maged Hamza, contributor S.A: Soha A. Ghobashy, contributor H.E: Heba E. Abou EL Wafa. All the three authors contributed to the conceptualization of the study and recruitment of the participants. Additionally, author A.M was responsible for statistical analysis of the data besides writing the main manuscript while author S.A and author H.E were responsible for reviewing the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Submitted as supplementary material.

Declarations

Ethics approval and consent to participate

All experimental protocols were approved by the committee of ethics at Alexandria university faculty of medicine.
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No. of protocol approval 0104484.
All experiments were performed in accordance with Helsinki guidelines and regulations.

Consent for publication

All authors guarantee that the research findings have not been previously published and consent for publishing this article at the Child Psychiatry & Human Development journal.

Competing interests

The authors declare that they have no competing interests.

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