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Behavior rating and intelligence testing in primary school children exposed to multiple adverse experiences

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Abstract

Background: Early childhood frequent exposure to toxic stress such as abuse or neglect, parental substance abuse or parental mental illness, and violence can have a cumulative impact on the child's mental health. Therefore, the study aimed to assess the association between frequent exposures to family-related adverse experiences and the development of behavioral and cognitive impairment in a random sample of Egyptian primary school children.

Results: Witnessing household member treated violently was the most prevalent adversity in 90.4% of the studied students, followed by emotional neglect in 88.6%. The highly exposed children were more likely to have below-average performance IQ, 2.5 times more than the exposed group ($P = 0.03$) [IQ score is considered average if it ranged 90–110 and below average if it ranged 70–89]. They were nearly 3 times at risk to develop behavioral problems ($P = 0.003$), 2.5 times more likely to develop attention deficit ($P = 0.02$), and nearly 5 times more likely to develop externalizing behavior ($P < 0.001$) than their peers.

Conclusion: Early exposure to adverse experiences increases the child's vulnerability to attention deficit and externalizing behavior with negative impact on IQ scores especially performance IQ.

Keywords: Childhood adversity, Cognitive, Behavioral disturbances

Background

Adverse childhood experiences (ACEs) or childhood maltreatment indicates some of the major intensive causes of stress that a child possibly suffers early in life. These experiences include neglect, abuse, witnessing violence between parents or caregivers, different kinds of household dysfunction such as parental substance abuse or alcohol addiction, and peer or community violence. Studies showed that stress in childhood has life-long consequences for health and well-being, which could be explained by disruption of early brain development and compromising of immune and nervous systems [1].

History of early adverse life experiences has been linked to impairment of memory, concentration, and verbal ability in midlife [2]. Adverse childhood events

have been associated with a greater risk of psychiatric disorders in adult life as well [3, 4], and it is likely to be an important determinant of mental ill-health [5]. This association was found significantly with anxiety, substance abuse, mood, and behavior disorders, either one of them or more than one simultaneously [3, 4, 6].

Furthermore, adversity-related variables such as multiple exposure and age of exposure were found to be more important determinants of risk than the exposure itself [7]. The majority of the considered biological bases for these influencers is the glucocorticoid cascades hypothesis, where persistent stressor triggers long-lasting hyperactivity of the hypothalamic-pituitary-adrenal (HPA) axis [8], leading to hypercortisolemia and accompanied atrophy of the hippocampus, a main neural substrate for learning and memory [9]. In addition, it was evidenced that elevated glucocorticoids impair neuronal growth and survival [10].

Most research has focused on the consequences of early childhood adversities on physical and psychological

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health in adults and old age [11, 12]. There is insufficient information about such effects during childhood and adolescence, which is an issue of potential clinical importance. The current study hypothesized that early exposure to multiple or recurrent life difficulties would adversely affect cognitive and behavioral characteristics of children.

Hence, the objective of this study was to assess the association between frequent exposure to family-related adverse experiences and the development of behavioral and cognitive impairment in a random sample of Egyptian primary school children.

Methods

The current study is a cross-sectional comparative study. Exposure to adverse childhood experiences was the main variable which classified children into two groups: exposed and non-exposed. Behavior and cognitive abilities were the outcomes compared in the two groups. The study was conducted along the period from April 2015 to December 2016.

Calculation of sample size

There is a shortage of large-scale, international research on the prevalence of negative life events which may constitute potential childhood adversity. Vanaelst et al. [13] found that 53.4% and 40.3% of the children experienced at least one familial and social adversities or negative life events in 8 European countries, but this prevalence has changed by region and age group. No previous studies have estimated the prevalence of childhood adversity in Egyptian primary school children, so we are guessing that 50% of the primary school children aged 7–11 years have a history of childhood adversity.

Sample size is calculated using the equation published by Dawson-Saunders and Trapp:

$$n = \frac{t^2 \times p \times (1-p)}{m^2}$$

where n = required sample size, t = confidence level at 95% (standard value of 1.96), p = estimated prevalence of the problem in the study area, and m = margin of error at 5% (standard value of 0.05).

Therefore, to detect a true difference of 5% with a confidence level of 95%, a power of 80%, and 10% losses, the assessment would require 60 children for each group (120 for both exposed group and non-exposed group).

The study was planned to recruit 120 students, but it was carried out on 114 students after the omission of subjects whose parents refused to participate.

Setting

This research was conducted within the framework of community services applied by the National Research Centre to El-Dokki inhabitants. Children were recruited from public primary schools located in El-Dokki district nearby the National Research Centre in Giza governorate. From a list of public primary schools in this district, a representative number of public schools (4 schools) were randomly chosen. In each school, children who had any chronic disease or any disability known to affect cognitive performance or impacting behavior were excluded [14, 15] (e.g., children with hearing or visual defects, children with history of neonatal traumatic brain injury or meningitis, children with endocrinal diseases or hormonal disturbances, or children with mental affection or motor disability). Then, a systematic random sampling of students from grade 3 to grade 5 was performed. Every 5th student in the class list was invited to participate till the sample size was completed.

Subjects

The invited students from both sexes who accepted to participate were recruited in the study. Their ages ranged from 7.5 to 11 years old. Younger children were not included because they were unable to answer the researcher's questions in the pilot stage of this study. Similarly, older students were excluded to avoid the confounding effect of pubertal period on behavior. As well, children who had exposed to inevitable adversities were excluded (e.g., orphans).

Ethical concern

Approval by the Ethical Committees of the National Research Centre with the number (13-038), the Institute of Postgraduate Childhood Studies, and the Egyptian Ministry of Education was attained. In addition, written informed parental consents were obtained.

All children included in the study were subjected to the following.

A structured questionnaire for gathering relevant personal data

This questionnaire was filled out by the caregiver while the child was interviewed by the researcher. Data included name, age, sex, residence, maternal and paternal education and occupation, monthly income, and number of family members "for assessment of socioeconomic standard." Thorough medical, perinatal, and developmental histories were obtained.

Adverse Childhood Experiences International Questionnaire

The original Adverse Childhood Experience Questionnaire (ACE-Q) was a short rating scale designed and first published by Felitti et al. [16]. It has provided a link

between cumulative exposure of ACEs in subjects before the age of 19 and the development of adult physical and mental health problems [16]. ACE event scores were measured for neglect, abuse (physical, sexual, and emotional), and household dysfunction. Respondents were adults, parents of children, or youth themselves. Many questionnaires have been developed after the first ACE questionnaire. All of them were similar in core content and scoring methods and showed consistent associations with poor health outcomes. However, important variations in results of these tools were detected due to different nationalities, cultural background, economic status, age, gender, and professional groups examined [17]. An international questionnaire was developed by the WHO (ACE-IQ). This questionnaire was field tested in seven countries (China, the Former Yugoslav Republic of Macedonia, Philippines, Thailand, Saudi Arabia, South Africa, and Vietnam). In each country, the ACE-IQ was translated including back-translation into one official language. Respondents were all aged 18 years and over. Questions cover family background, household dysfunction; physical, sexual and emotional abuse and neglect by parents or caregivers; peer violence; witnessing community violence; and exposure to war or collective violence. It was shown that most of its items were easily understood by respondents and easily delivered by interviewers. The aim of the production of this standardized international questionnaire was to reflect the range of adversity prevalence across low-, middle-, and high-income countries. ACE-IQ is being validated through trial implementation as part of broader health surveys [18].

The ACE-IQ also enables the measurement of childhood adversities in all countries and allows comparisons between them, and to assess the associations between childhood adversities and health-risk behaviors and health outcomes in later life [18]. Although ACE-IQ is considered a good standardized measure of ACEs, potential distortion of results could exist due to memory defects, as the respondent is trying to remember old events.

ACE-IQ in the current study

In the current study, authors tried to avoid the effect of memory by asking children about the current ACE using the standardized measure (ACE-IQ). Some questions concerned with marriage, work, war, and community violence were omitted from the original form to be appropriate for young age students. Arabic translation of the questionnaire with back translation was achieved by peers efficient in the English language. The questionnaire comprised 23 questions with 4 responses for each question indicating the degree of exposure. The questions' responses include never, once, few times, and many times. Exposure to one adversity is considered

when the student's response is many times, except for sexual abuse. Each student was face to face interviewed to answer the questionnaire. Duration of interview ranged from 20 to 30 min.

According to the number of adversities to which the student was exposed, subjects were classified into two groups: group A, the less exposed group including students who were exposed frequently to one or two adverse experiences, and group B, the highly exposed group including students with frequent or multiple exposure to more than three adverse experiences.

Assessment of socioeconomic standard

This was done according to the socio-economic level of the Egyptian family scale of Abd Elaziz El Shakhs [19]. It is based on parental education and occupation and family monthly income.

Behavioral screening using the Pediatric Symptom

Checklist-17

PSC-17 was designed to facilitate the recognition of emotional and behavioral problems so that appropriate interventions can be initiated as early as possible. The PSC-17 consists of 17 items that are rated by parents as "never," "sometimes," or "often" present. A value of 0 is assigned to "never," 1 to "sometimes," and 2 to "often." The total score is calculated by adding together the score for each of the 17 items. A PSC-17 score of 15 or higher suggests the presence of significant behavioral or emotional problems. Three subscales are recognized within the PSC: the PSC-17 Internalizing Subscale (cutoff score of 5 or more), the Attention Subscale (cutoff score of 7 or more), and the Externalizing Subscale (cutoff score of 7 or more) [20].

Cognitive functions assessment

Cognitive and intellectual functioning was assessed through the application of the Wechsler Intelligence Scale for Children (WISC-R), the Arabic version [21]. It is an individually administered intelligence test for children between the ages of 6 and 16 years. It is designed to assess and measure the child's verbal, performance, and full-scale IQ through assessment of different functions (short- and long-term memory, comprehension, information, abstract thinking, problem-solving, and speed of information processing).

Statistical analysis

The data was collected and analyzed on personal computer using the Statistical Package for the Social Science (SPSS) version number 18. Description of quantitative (numerical) variables is in the form of mean \pm standard deviation and range. Qualitative (nominal) variables were in the form of number and percentage. Student's *t* test

of 2 independent samples was used to compare 2 quantitative variables. Odds ratio was used to estimate the risk of developing abnormalities in relation to multiplicity of exposure. A *P* value of < 0.05 was considered significant.

Results

The study included 114 students, 61 were females (53.5%) and 53 were males (46.5%). Age of the students ranged from 7.5 to 11 years with a mean of 9.93 ± 0.93 years. Characteristics of the studied sample are shown in Table 1. The number of non-exposed students to adverse experiences was 3 students only, which represented a very small percentage of the whole sample (2.6%). However, the rest of the study population were exposed frequently to 1 or more types of adverse experiences. Statistical analysis and comparison focused on the 2 main groups: the less exposed group (48.2 %) (who were exposed to 1 or 2 adverse experiences) and the

highly exposed group (49.1%) (who were exposed to 3 or more adverse experiences).

The distribution of average and below-average students as regards different IQ scales is presented in Table 1. The percentages of students with affected and non-affected behavior are shown in the same table.

The percentage distribution of exposed students to different types of adverse experiences is shown in Fig. 1. The majority of the studied sample (90.4%) was exposed to witnessing household member treated violently, while emotional neglect appeared as the second prevalent adversity in 88.6%. Sexual abuse came as the least adverse experience in 3.5% of the studied population.

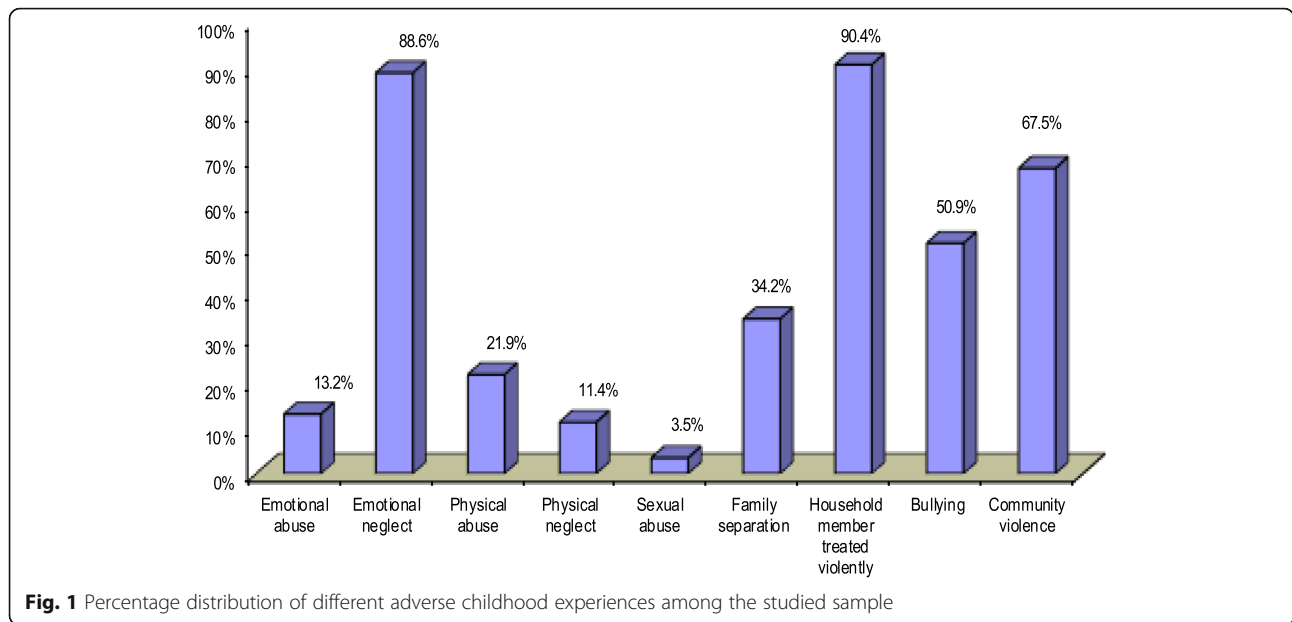
There was non-significant statistical difference between both sexes as regards exposure to different types of adversities, except exposure to bullying which was more predominant in boys (*P* < 0.001) (not shown).

Median and range of PSCL scores and different IQ scales are shown in Table 2.

Table 1 Characteristics of the studied sample

Age in (years)	Mean ± SD	9.39 ± 0.93
	Min.–max.	7.58–11.0
Parameter		N (%)
Sex	Males	53 (46.5%)
	Females	61 (53.5%)
Socioeconomic level	Above average	5 (4.4%)
	Average	9 (7.9%)
	Below average	50 (43.9%)
	Low	38 (33.3%)
	Very low	12 (10.5%)
Exposure to adverse experiences	Not exposed	3 (2.6%)
	Less exposed (1–2 adversities)	55 (48.2%)
	Highly exposed (3 or more adversities)	56 (49.1%)
Verbal IQ	Average	93 (81.6%)
	Below average	21 (18.4%)
Performance IQ	Average	40 (35.1%)
	Below average	74 (64.9%)
Full-scale IQ	Average	70 (61.4%)
	Below average	44 (38.6%)
PSCL total score	Non-affected	60 (52.2%)
	Affected	54 (47.8%)
Attention	Non-affected	67 (58.8%)
	Affected	47 (41.2%)
Internalizing behavior	Non-affected	73 (64.0%)
	Affected	41 (36.0%)
Externalizing behavior	Non-affected	77 (67.5%)
	Affected	37 (32.5%)

PSCL Pediatric Symptoms Checklist; IQ score is considered average if it ranged 90–110 and below average if it ranged 70–89



Odds ratio for the risk of below-average intelligence in relation to multiplicity of adversity exposure is shown in Table 3. The highly exposed children are more likely to have below-average performance IQ, 2.5 times more than the less exposed group ($P = 0.03$). On the other hand, the increased odds of below-average verbal IQ and full-scale IQ in the highly exposed children do not reach a statistically significant level ($P > 0.05$).

The association between socioeconomic level and performance IQ is studied in Table 4.

No significant statistical difference could be detected on comparing means of performance IQ in different social classes. However, the highest means of performance IQ scores were recorded in students belonging to the average and above-average social levels (Table 4).

Odds ratio for the risk of behavioral troubles in relation to multiplicity of adversity exposure is presented in Table 5. The highly exposed children were nearly 3 times at risk to develop symptoms of behavioral problems more than the less exposed group ($P = 0.003$), 2.5

times more likely to develop attention deficit ($P = 0.02$), and nearly 5 times more likely to develop externalizing behavior ($P = 0.0003$). On the other hand, the highly exposed group is 1.6 times more susceptible to develop internalizing behavior more than the less exposed group, but this difference did not reach the significant level as $P > 0.05$.

Discussion

Early experiences are important public health issue, as positive and negative childhood experiences have a tremendous impact on future physical and mental health [22].

The current study was conducted to test the effect of exposure to different adverse experiences in childhood on the risk of developing early behavioral and cognition abnormalities. The studied sample was chosen from public school to minimize the confounding effect of socioeconomic position on behavior and cognitive functions. They were in the pre-pubertal age to avoid the effect of puberty on psychological status. It was awful to find that all the recruited children were exposed to daily life adversities except for three. Accordingly, the researchers imposed to classify the sample into two groups according to multiplicity of adversity exposure. It was notable that witnessing household member treated violently came as the most encountered adversity with prevalence rate of 90.4%, and emotional neglect was coming after by 88.6 %, while sexual abuse came at the last with a prevalence of 3.5%. Other types of adversities encountered in this study were emotional abuse, physical abuse, physical neglect, family separation, bullying, and community violence.

In comparison to the current findings, a Brazilian study found that physical violence was the most prevailing form

Table 2 Median and range of different IQ scales and Pediatric Symptom Checklist scores

Parameter	Median (IQR)
Verbal IQ	100 (94–111)
Performance IQ	85 (75–93)
Full-scale IQ	92 (83–101)
PSCL score	14 (10–20)
Attention	6 (4–8)
Internalizing behavior	4 (2–5)
Externalizing behavior	5 (3–7)

PSCL Pediatric Symptom Checklist

Table 3 The risk of below-average intelligence in relation to exposure to multiple adversities

Exposed groups	Children with below-average IQ	Children with average IQ	OR (95% CI)	Z	P value
Full-scale IQ					
Highly exposed (56)	24	32	1.54 (0.7–3.34)	1.098	0.272
Less exposed (55)	18	37			
Verbal IQ					
Highly exposed (56)	12	44	1.39 (0.53–3.63)	0.682	0.490
Less exposed (55)	9	46			
Performance IQ					
Highly exposed (56)	42	14	2.50 (1.12–5.59)	2.232	0.03*
Less exposed (55)	30	25			

*Significant at $P < 0.05$; IQ score is considered average if it ranged 90–110 and below average if it ranged 70–89

of maltreatment, as it was encountered in 58% of investigated population, followed by neglect and psychological abuse [23]. Another study conducted in Taiwan revealed that psychological neglect was the most prevalent (69%), followed by physical neglect (66.5%), paternal physical abuse (15%), maternal physical abuse (14.7%), and sexual violence (9.2%) [24]. There is a wide variation in the prevalence rate of different types of adversities between studies that could be explained by different cultures, varied definitions of maltreatment, using of diverse research methodologies, and varying characteristics of studied populations.

The current study hypothesized that highly exposed children to multiple adversities would perform lower than the non-maltreated group in different neurocognitive domains. Results supported this hypothesis and provided additional evidence for the growing pediatric literature linking maltreatment to neurocognitive functions. It was found that the highly exposed group was 2.5 times more likely to have below-average performance IQ than the less exposed one, while the increased odds of below-average verbal IQ and full-scale IQ did not reach significant level.

There were notable similarities between the current findings and other prior researches such as studies of De Bellis et al. [25] and Goodman et al. [26] who found that

child maltreatment could be linked to global cognitive deficit, including impaired intelligence. They recorded troubles with school-based learning and a susceptibility to ongoing risk for neurodevelopmental challenges in neglected children, especially in memory and attention/executive function. In accordance, De Bellis and Zisk [27] proved the effect of exposure to maltreatment on the growth of specific areas of the brain concerned with executive and cognitive functions such as the prefrontal cortex and cerebellum, leading to adverse cognitive development.

These findings could be explained by the persistent high level of stress hormones that harm the brain architecture, particularly in the areas that have many glucocorticoid receptors such as the prefrontal cortex, orbitofrontal cortex, amygdala, and hippocampus. Consequently, there will be alterations in their functions such as executive functions, learning, and memory [28].

Recently, Piccolo et al. [29] raised the contribution of socioeconomic standard (SES) to performance IQ. That was explained by poor stimulation and lack of access to materials and activities that favor cognitive development in families of low socioeconomic status. However, in the current study, this effect of SES was not obvious. This could be explained by the homogenous SES among the studied sample. The majority of the sample belonged to the below-average and low socioeconomic standard (77%), and just few number of the children were from the average (7.9%) and above average (4.4%) levels.

On the other hand, the present study hypothesized that maltreatment during early childhood would adversely affect different psychosocial aspects. It was proved that children from the highly exposed group are 3 times at risk to develop symptoms of behavioral disorders, 2.5 times to develop inattention problems, and 5 times to develop externalizing behaviors more than the less exposed group. As regards internalizing behavior, the highly exposed group was 1.6 times at risk more than the less exposed one but this difference did not reach a significant level.

Table 4 Mean, minimum, and maximum of performance IQ scores in different socioeconomic levels

Socioeconomic level	Performance IQ value	
	Mean ± SD	Min.–max.
Above average	93.6 ± 12.681	78–111
Average	94.33 ± 11.99	68–106
Below average	83.08 ± 11.168	62–104
Low	84.58 ± 15.397	65–121
Very low	80.25 ± 14.201	65–104
F	2.308	
P value	0.063	

Table 5 The risk of behavioral problems in relation to exposure to multiple adversities

	Affected students	Non-affected students	OR (95% CI)	Z	P value
Any behavioral abnormality					
Highly exposed (56)	36	20	3.32 (1.51–7.24)	3.006	0.003*
Less exposed (55)	19	36			
Attention deficit					
Highly exposed (56)	30	26	2.58 (1.19–5.61)	2.392	0.02*
Less exposed (55)	17	38			
Externalizing behavior					
Highly exposed (56)	28	28	5.11 (2.12–12.39)	3.610	0.000*
Less exposed (55)	9	46			
Internalizing behavior					
Highly exposed (56)	24	32	1.68 (0.77–3.65)	1.300	0.193
Less exposed (55)	17	38			

*Significant at $P < 0.05$

This was consistent with previous study of Milot et al. [30] who found a significant relation between maltreatment and development of externalizing problems in 3 to 6 years old children raised in economically disadvantaged families. In addition, Holmes et al. [31] revealed that children who were physically abused were 1.5 times more likely to demonstrate clinical levels of aggressive act relative to children who were not physically abused. The study suggested that early behavioral adaptations could determine either enhanced or disrupted behavioral functioning during later life. Intimate relationship was found between adverse childhood experiences and impairment of social functioning with increased risk of externalizing behaviors that was explained by the impacts of past experiences on emotions generation and regulation which are controlled by complex interplay between cortical and limbic brain regions [32].

In contrast with our findings, other studies documented that history of child maltreatment was significantly related to internalizing behaviors [30, 32, 33]. The masked significance of internalizing behavior in the current study could be explained by the low educational and socioeconomic level of the majority of mothers “who were the reporters of their children’s behavior.” These mothers usually emphasize on the most pressing symptoms such as aggressive reactions or learning problems, but when the child is introverted or depressed, he will not attract the attention of the mother as long as he or she is not a troublemaker.

As regards inattention problems and its relation to childhood adversities, our findings were matched with database analytical study of Irigaray et al. [34] that was done to evaluate the influence of child maltreatment on cognitive functioning. It showed that maltreatment during childhood had deleterious effects on attention and cognitive functioning. In the same context, Beers and De

Bellis [35] documented that maltreated children performed more poorly on measures of attention and abstract reasoning.

Study limitations

During design of the current study, researchers tried to minimize confounding variables affecting cognitive and psychosocial status. Therefore, students were recruited from public schools with nearly the same social standard, and this resulted in lack of unexposed individuals to be compared with the exposed group. The consequences of childhood adversities were studied only in relation to the number of adversities. The small sample size restricted the ability to study the effect of each type of adversities on behavior and intelligence.

Conclusion

Children exposed to multiple adverse experiences are more likely to develop behavioral problems, attention deficit, externalizing behavior, and low-performance IQ. The study highlights the need for urgent policy and intervention programs to raise the public awareness about the damaging effects of daily-life stressors on children’s mental health and upcoming productivity. It is preferable in future studies to involve an un-exposed children as a control group, estimate a biological marker of chronic stress such as hair cortisol, and studying its association with cognitive and behavior consequences.

Abbreviations

ACE-IQ: Adverse Childhood Experiences International Questionnaire; ACEs: Adverse childhood experiences; HPA: Hypothalamic pituitary adrenal; PSC-17: Pediatric Symptom Checklist-17; SES: Socioeconomic standard; WISC-R: Wechsler Intelligence Scale for Children

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Authors' contributions

EMS, EME, and HHE conceived and designed the experiments. AEW, SI, and AAE performed the experiments. EMS, MAS, and AAE analyzed the data. EMS, AEW, and SI contributed reagents/materials/analysis tools. EMS, MAS, and AAE were major contributors in writing the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The Ethical Committees of the National Research Centre approved the study with the number (13-038). Written informed parental consents were obtained.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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