

The Impact of Childhood Trauma on Cognitive Abilities: A Comparative Study of 9–12 Year-Olds in Algeria

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Abstract:

Childhood trauma is a major public health concern, yet its cognitive and educational consequences remain understudied in North Africa. This study examined 95 Algerian children aged 9–12 years, divided into trauma and non-trauma groups using Childhood Trauma Questionnaire cut-offs. Global cognition was assessed with a child-adapted Montreal Cognitive Assessment, and academic achievement with an Algerian adaptation of the Columbia Test of Educational Achievement. Trauma-exposed children showed significantly lower cognitive and academic scores than their non-trauma peers. Higher trauma scores predicted poorer outcomes after controlling for age and sex. Findings support trauma-informed screening, school-based intervention, and longitudinal research on resilience in Algerian youth. Policy implications are outlined.

Keywords: *childhood trauma; cognitive impairment; executive function; memory; MoCA.*

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I. INTRODUCTION

1.1 Childhood Trauma and Global Public Health

Childhood trauma encompasses a broad spectrum of adverse experiences, such as physical abuse, sexual abuse, emotional neglect, physical neglect, and exposure to domestic or community violence. These events fundamentally undermine a child's sense of safety and belonging (Bernstein & Fink, 1998; Kavanaugh, Dupont-Frechette, Jerskey, & Holler, 2017). According to the World Health Organization (WHO, 2025), an estimated 40 million children under the age of 15 worldwide are subjected to violence each year. Although reliable data on childhood trauma in Algeria remain limited, existing global literature has established that such adverse experiences pose severe risks not only to mental health outcomes such as depression, anxiety, and posttraumatic stress disorder, but also to long-term cognitive and educational trajectories (Cross, Fani, Powers, & Bradley, 2017; McLaughlin, Sheridan, & Lambert, 2014). Early adversity significantly raises the likelihood of academic failure, high dropout rates, unemployment, and broader social difficulties (Romano, Babchishin, Marquis, & Fréchette, 2014; Yeo, Lansford, Hirshberg, & Tong, 2024). The present investigation addresses this research gap by examining how early traumatic experiences affect the cognitive development of Algerian children, thereby situating these findings in relation to broader global insights.

1.2 Why Study Childhood Trauma in Algeria?

Algeria's sociocultural landscape offers distinct conditions that may shape both exposure to childhood trauma and its developmental consequences. Extended family networks often provide a cohesive support system that can buffer psychological distress (LaBrenz et al., 2020) yet economic hardship, insufficient mental health resources, and postcolonial sociopolitical instability exacerbate the risk of childhood adversity (Sabah, A., Hammadi et al., 2025). Existing research also suggests that childhood maltreatment might be substantially underreported in North African societies, where cultural norms and stigma discourage open discussions of abuse (Abbasi, Maryam & Saeidi, Masumeh & Khademi, Gholamreza & Hoseini, Bibi, 2015). These circumstances underscore the importance of studying childhood trauma in Algeria specifically, so that regionally appropriate interventions and policies can be devised. A more nuanced understanding of local protective mechanisms—such as intergenerational caregiving—and the barriers to care, including economic constraints and social taboos, is essential for effectively addressing the cognitive and educational needs of trauma-affected youth.

1.3 What Is Childhood Trauma? What Are Cognitive Abilities?

1.3.1 Definition and Types of Childhood Trauma

Childhood trauma refers to adverse life events that surpass a child's coping capacity, causing significant emotional distress and physiological dysregulation (Pynoos et al., 1999). These events are commonly classified as acute, involving a single overwhelming incident such as a natural disaster; chronic, referring to repeated stressors like continuous abuse or prolonged neglect; and complex, encompassing multiple traumatic experiences often occurring in a caregiving environment (Cook et al., 2005). Common types of childhood trauma include physical harm, sexual exploitation, emotional maltreatment, neglect of basic necessities, witnessing violence between caregivers, losing a parent or primary guardian through abandonment or death, and being raised in conflict zones or other violent environments (Felitti et al., 1998). Such conditions, especially when prolonged, activate the child's stress response system, leading to potential biological, psychological, and cognitive impairments (Danese & Widom, 2024).

1.3.2 Cognitive Abilities: Definition, Components, and Developmental Importance

Cognitive abilities comprise the mental processes that facilitate knowledge acquisition, information processing, and problem-solving (Neisser, 1967). These functions underpin daily learning, decision-making, and adaptation, evolving gradually from infancy into adulthood as a result of genetic, environmental, and experiential factors (Piaget, 1952). Several core domains constitute the building blocks of cognition (Thomas, D. C et al., 2008). Memory involves encoding, storing, and retrieving information in short-term, long-term, or procedural forms (Baddeley, 2012). Executive functioning encompasses higher-order processes such as shifting attention, regulating impulses, and devising strategies for complex tasks (Diamond, 2013).

Attention refers to the capacity to maintain focus, filter out extraneous stimuli, and reorient concentration when necessary (Posner & Petersen, 1990). Processing speed captures the rate at which

these cognitive operations are executed (Kail & Salthouse, 1994), while language/verbal abilities and visuospatial skills pertain to communication and spatial reasoning, respectively (Vygotsky, 1978; Uttal et al., 2013). These domains are interlinked and collectively determine an individual's academic performance, social interactions, and later professional prospects. However, persistent childhood trauma can derail the typical maturation of these domains, giving rise to enduring cognitive deficits that may compromise overall developmental trajectories.

1.4 The Impact of Trauma on Cognitive Development

Childhood trauma can severely disrupt normative cognitive maturation, particularly when adverse experiences occur during critical developmental windows or persist over lengthy periods. Chronic exposure to high-stress environments is associated with rewiring key neurobiological networks crucial for sustaining attention, encoding memories, and solving complex problems. By probing these mechanisms, researchers gain insights into why children subjected to traumatic experiences encounter profound social and academic challenges, and why early, targeted interventions that account for both biological and psychosocial dimensions are of paramount importance.

1.4.1 Neurobiological Mechanisms Explaining Trauma-Induced Cognitive Deficits

Neuroimaging evidence consistently demonstrates significant structural and functional alterations in the hippocampus, prefrontal cortex, and amygdala among children who have endured maltreatment (Ireton, Hughes, & Klabunde, 2024). The hippocampus, normally critical for memory formation and recall, may undergo volume reductions, limiting a child's ability to consolidate and retrieve new information. The prefrontal cortex, responsible for executive functions such as regulatory control, strategic organization, and planning, sometimes displays cortical thinning in trauma-exposed youth (Kim et al., 2013). The amygdala often becomes hyperreactive, perpetuating cycles of emotional dysregulation and continuous threat perception, which impedes a child's capacity for reflective thinking or calm problem-solving. Beyond these regional changes, some trauma-affected children experience ongoing dysregulation of the default mode network (DMN), making it challenging to concentrate on current tasks and resist intrusive, stress-related memories (Cross et al., 2017; McLaughlin et al., 2014).

1.4.1.1 Structural and Functional Changes in Critical Brain Regions

Prolonged or severe adversity can remold the architecture and capabilities of the developing brain (Teicher et al., 2016). The hippocampus tends to shrink when exposed to unremitting cortisol elevations, reducing a child's ability to encode autobiographical data and retrieve academic concepts (Hanson et al., 2015). The prefrontal cortex, vital for impulse control and mental flexibility, may become less capable of adapting to novel situations, leading to suboptimal decision-making processes. Meanwhile, the amygdala's alarm system can be so sensitive that children remain on high alert, even in benign settings, contributing to frequent emotional outbursts and difficulties concentrating in the classroom.

1.4.1.2 Chronic HPA Axis Dysregulation and Its Effects on Cognition

The hypothalamic–pituitary–adrenal (HPA) axis orchestrates the body's physiological reactions to stress by modulating cortisol levels (McEwen & Gianaros, 2011). In children exposed to persistent adversity, elevated cortisol levels can undermine the structural integrity of brain areas involved in memory and executive functioning, primarily the hippocampus and prefrontal cortex (Hanson et al., 2015; Kim et al., 2013). Excessive amygdala activation further augments anxiety, mistrust, and hypervigilance (Teicher et al., 2016). Such endocrine and neural changes commonly translate into diminished academic performance, reduced emotional self-regulation, and an increased need for specialized interventions (McLaughlin et al., 2014).

1.5 Trauma's Impact on Specific Cognitive Domains

Chronic stress stemming from childhood adversity frequently disrupts multiple cognitive domains, including attention, processing speed, language skills, and executive functions. Children residing in environments marked by high levels of stress often find it difficult to conform to academic demands or assimilate new information. These challenges become more pronounced in complex learning scenarios necessitating sustained concentration, impulse management, and the capacity to process multiple data points in tandem.

1.5.1 Memory Impairments in Children Exposed to Trauma

Memory generally emerges as one of the most vulnerable cognitive domains in the face of chronic adversity (Bremner, 2006). Clinical and observational studies note pronounced weaknesses in working memory, limiting a child's ability to hold and manipulate transient information (Danese et al., 2020). Episodic memory can also deteriorate, eroding the details and coherence of personal recollections as well as newly learned academic material (Sheridan et al., 2017). Semantic memory might weaken, leading to slower retrieval of knowledge and difficulties mastering novel concepts (Cross et al., 2017). Empirical work consistently reports moderate to large effect sizes (Cohen's d ranging from 0.65 to 0.80) for such deficits (Op den Kelder et al., 2018), illustrating how repeated stress can significantly constrain children's long-term academic and social development.

1.5.2 Executive Functioning Deficits

Executive functions integrate higher-order skills—cognitive flexibility, inhibitory control, and planning—that guide goal-oriented behavior (Teicher et al., 2016). In trauma-exposed children, reduced cognitive flexibility manifests as difficulty transitioning between assignments or adhering to new rules, often fostering heightened frustration in dynamic learning contexts. Inhibitory control deficits foster impulsive behavior, undermining a child's capacity to pause and reflect before responding. Weakened planning and problem-solving skills limit systematic approaches to tasks, whether in school or everyday settings, reflecting a diminished ability to strategize effectively (Dauvermann & Donohoe, 2018). These problems frequently correlate with subpar academic outcomes and difficulties in social functioning, as children struggle to cope with the self-regulatory demands inherent in both the classroom and peer relationships.

1.5.3 Attention and Processing Speed Impairments

Children subjected to chronic stress often display marked distractibility and slower cognitive throughput, both of which impede their ability to complete daily academic tasks (Kim et al., 2013). Objective measures of sustained attention reveal that trauma-exposed youth frequently fail to filter out irrelevant inputs and sustain focus under typical classroom conditions (Posner & Petersen, 1990). In parallel, diminished processing speed can manifest as delayed responses on exams or a constant need for extended time, thereby affecting overall academic achievement (Romano et al., 2014). Targeted support, such as structured routines or teacher-led scaffolding, may partially mitigate these impairments, though effective interventions often require a holistic view that addresses emotional, cognitive, and environmental challenges simultaneously.

1.6 The Educational Consequences of Childhood Trauma

The cognitive deficits rooted in early traumatic experiences commonly translate into substantial declines in academic performance (Johnson, 2018). Researchers have shown that trauma-exposed children are at significantly higher risk of repeating grade levels, reflecting ongoing struggles to meet core curricular standards (Romano et al., 2014). Underperformance on standardized tests in subjects such as reading and mathematics can limit later educational and professional opportunities (Stokes & Brunzell, 2019). Socioeconomic adversities further compound these obstacles, leading to elevated dropout rates in disadvantaged areas and reinforcing cycles of poverty (Yeo et al., 2024). Despite the gravity of these patterns, emerging trauma-informed initiatives have begun to demonstrate positive results. Structured classroom models that prioritize consistency and routine, alongside programs targeting executive functions and social-emotional learning, can enhance academic engagement and improve resilience (Stokes & Brunzell, 2019). Recognizing the breadth of trauma's impact allows educators, policymakers, and mental health professionals to adopt a more integrated approach, striving to create school environments conducive to healing and cognitive recovery.

1.7 Theoretical Underpinnings: From Toxic Stress to Attachment Disruption

Childhood adversity affects cognition and socioemotional well-being through multiple, complementary theoretical lenses. Toxic stress theory posits that prolonged activation of the hypothalamic–pituitary–adrenal (HPA) axis causes chronically elevated cortisol levels, ultimately constraining neural plasticity and undermining learning and emotion regulation (Shonkoff, Boyce, & McEwen, 2009; Teicher, Samson, Anderson, & Ohashi, 2016; Kim et al., 2013; Danese & Widom,

2024). Over time, these hormonal imbalances can reduce hippocampal volume, disrupt prefrontal cortical functioning, and weaken the neural networks essential for higher-order cognitive processes.

Biological embedding theory (Danese & McEwen, 2012) further explains that repeated early-life stressors can become physiologically ingrained, leading to lasting modifications in immune, endocrine, and epigenetic mechanisms. This process renders children more susceptible to cognitive deficits and emotional maladaptation, as their bodies recalibrate to cope with persistent threat at the expense of adaptive development.

Latent vulnerability theory (McCrory, Gerin, & Viding, 2017) underscores how exposure to adversity prompts subtle shifts in neural processing that can remain hidden until triggered by future stressors or life transitions. These adaptations may not always manifest in overt clinical signs during childhood, yet they create a latent risk for psychopathology and compromised cognitive performance later in life.

From a relational standpoint, attachment theory emphasizes the protective function of stable, supportive caregiver bonds for children's exploration and cognitive expansion (Sheridan, Peverill, Finn, & McLaughlin, 2017). When neglect, abuse, or conflict erodes this caregiving foundation, vigilance often supplants curiosity, draining the cognitive resources children need for learning and exploration (Hanson, Hariri, & Williamson, 2015). Taken together, these theoretical perspectives—spanning toxic stress, biological embedding, latent vulnerability, and attachment disruption—illuminate the converging physiological and relational pathways by which chronic adversity reshapes a child's cognitive profile and long-term developmental trajectory.

1.8 Cultural and Socioeconomic Context in North Africa

Research findings on childhood trauma have predominantly emanated from Western samples, yet North African cultural, economic, and educational frameworks can modulate the impact of adversity in distinct ways (Abbasi, Maryam & Saeidi, Masumeh et al., 2015). In Algeria, the extended family structure often provides additional emotional and practical support that can cushion some of the negative effects of maltreatment (LaBrenz et al., 2020). However, conditions of high unemployment, underresourced mental health services, and ongoing political uncertainties can increase family tensions and elevate the risk of exposure to violence (Johnson, 2018). Local communities like in Algeria exemplify these intersecting forces. On one hand, strong kin networks present a potential protective factor; on the other, a shortage of specialized mental health professionals and a paucity of targeted interventions may exacerbate the consequences of unaddressed trauma. Children who exhibit developmental or behavioral red flags frequently lack formal assessments or therapeutic services, potentially compounding the lasting impact of adverse experiences.

1.8.1 Protective Factors in Algerian Communities

Many Algerian families rely on intergenerational caregiving models that allow multiple adults—such as grandparents, aunts, uncles, or older siblings—to participate in child-rearing. This communal approach can prevent any single caregiver's vulnerabilities from severely compromising a child's well-being (LaBrenz et al., 2020). Religious and spiritual frameworks, deeply ingrained in many Islamic societies, can also serve as effective coping strategies. Communal prayers, religious gatherings, and an overarching emphasis on spiritual resilience may bolster children's capacity to manage stress, promoting a sense of stability even in the face of adversity. Together, these cultural resources can provide a partial buffer against the detrimental outcomes of traumatic events.

1.8.2 Risk Factors Unique to the Algerian Context

Despite these strengths, economic instability—shaped by historical, structural, and geopolitical factors—remains a pervasive challenge (Johnson, 2018). Households under financial strain may experience heightened conflict, increasing the likelihood of physical or emotional maltreatment. Furthermore, a critical shortfall of professionals trained in child psychology and therapeutic interventions leaves many traumatized youth without the formal support they need (Abbasi, Maryam & Saeidi, Masumeh et al., 2015). Stigma around discussing domestic abuse or neglect can also perpetuate underreporting, making it difficult to measure the true extent of childhood trauma. In this landscape, rigorous investigations into how these factors interact to shape cognitive and educational outcomes

become pivotal for crafting effective, culturally informed strategies to identify, support, and treat children who have faced significant adversity (Berliner, L., Meiser Stedman, R., & Danese, A., 2020).

1.9 Clinical and Educational Assessments in Trauma

Within clinical psychology, instruments such as the Childhood Trauma Questionnaire (CTQ) and structured interviews offer a means to classify the type, severity, and frequency of childhood maltreatment (Bernstein & Fink, 1998). By capturing data on different abuse domains—physical, emotional, and sexual—these assessments enable a nuanced view of which specific adversities might exert the strongest impact on cognitive function. To evaluate cognitive abilities, broad batteries like the Wechsler Intelligence Scale for Children (WISC-V) remain standard, but researchers increasingly deploy targeted measures for executive function, memory, and attention. The Montreal Cognitive Assessment (MoCA) has gained prominence as a concise, sensitive screener for mild to moderate deficits, and its adaptability makes it viable for populations enduring prolonged psychosocial stress (Nasreddine et al., 2005; Dautzenberg, G. M. F. C., Lijmer, J. G., & Beekman, A. T. F., 2022).

In educational contexts, standardized achievement tests help quantify the extent to which cognitive impairments compromise real-world learning (Stokes & Brunzell, 2019). This study employs the Columbia Test of Educational Achievement, adapted for Algerian students, to measure competencies in reading comprehension, math fluency, and problem-solving. Unpublished pilot validation data from 2019 by the Algerian Ministry of Education reported moderate to high reliability (Cronbach's α of 0.85–0.90) as well as strong correlations with teacher-assigned grades. Incorporating such culturally and linguistically adapted measures offers a richer understanding of how childhood trauma echoes across various domains of functioning, from core cognitive processes to day-to-day classroom performance. By capturing both the psychological and scholastic dimensions of trauma, researchers and educators alike can better design interventions that address the complex web of factors influencing children's developmental outcomes.

1.10 Study Objectives and Hypotheses

Building on the preceding sections, the present study seeks to:

- a. Assess differences in global cognitive function (MoCA) between children with and without reported trauma in Algeria.
- b. Examine specific deficits in memory, executive function, attention, and processing speed, core domains implicated in trauma-related neurocognitive models.
- c. Evaluate educational performance via the adapted Columbia Test of Educational Achievement, focusing on reading comprehension and basic math skills.
- d. Determine whether trauma severity (CTQ scores) correlates with MoCA and Columbia test results, emphasizing potential dose-response patterns.
- e. Explore contextual moderators, such as communal child-rearing practices and parental education, to glean insights into resilience factors.

It is hypothesized that trauma-exposed children will perform significantly worse on MoCA total and memory/executive function subdomains, as well as on academic measures (reading comprehension, math tasks). Additionally, higher CTQ scores are expected to correlate with lower cognitive and educational achievement scores, reflecting a dose-response relationship between adversity and developmental outcomes.

II. Methods

2.1 Study Design

This research employed a cross-sectional, comparative group design to investigate the relationship between childhood trauma and cognitive abilities in 9–12-year-old children residing in Algeria. Two groups were formed based on Childhood Trauma Questionnaire (CTQ) scores. A trauma exposure group ($n = 48$) was identified using a CTQ cutoff score of ≥ 50 (indicating moderate-to-severe maltreatment), while a non-trauma (control) group ($n = 47$) included children whose CTQ total scores were below 50. Both groups underwent standardized cognitive and educational evaluations using the Montreal Cognitive Assessment (MoCA) and the adapted Columbia Test of Educational Achievement. The study aimed to compare cognitive functioning between these groups, identify specific trauma-related cognitive

deficits, and examine the correlation between trauma severity and academic outcomes. As data collection occurred at a single point in time, the cross-sectional design limits causal interpretations yet offers a detailed snapshot of how varying trauma severity may coincide with cognitive and educational functioning in a North African context.

2.2 Participants and Setting

A total of 95 children between the ages of 9 and 12 were recruited from local schools, community centers, and non-governmental organizations in Algeria. Parental consent and child assent procedures conformed to guidelines set by the Algerian Ministry of Health and the Declaration of Helsinki. Out of these participants, 48 children who reported significant traumatic experiences (CTQ ≥ 50) were assigned to the trauma group, while 47 children scoring below this threshold formed the non-trauma group. Inclusion criteria required that participants be within the specified age range (9–12), currently enrolled in local schools or community programs, and free of any known neurodevelopmental disorders such as autism or global intellectual disability. Children with severe physical ailments requiring hospitalization or uncorrected sensory impairments were excluded to minimize confounding variables that could compromise test results.

2.3 Measures

2.3.1 Childhood Trauma Questionnaire (CTQ)

The CTQ (Bernstein et al., 1994) is a 28-item self-report inventory evaluating five dimensions of childhood maltreatment: emotional abuse, physical abuse, sexual abuse, emotional neglect, and physical neglect. Respondents indicate frequency on a scale from 1 (Never True) to 5 (Very Often True). Prior research in diverse cultural contexts, including preliminary Algerian samples, suggests high internal consistency (Cronbach's $\alpha = 0.91\text{--}0.94$) for this measure. In line with existing literature, a CTQ total score of ≥ 50 served as the cutoff for moderate-to-severe trauma (Kim et al., 2013).

2.3.2 Montreal Cognitive Assessment (MoCA)

Global cognitive functioning was assessed using the MoCA (Nasreddine et al., 2005), a 30-point screening instrument for mild cognitive impairment that evaluates several domains: memory (delayed recall of word lists), executive function (trail-making and abstraction), attention (digit span and serial subtraction), and processing speed (rapid naming tasks). Given the pediatric focus, a cutoff score of 21 was employed to flag possible impairments in children aged 9–12, consistent with existing adaptations (Dautzenberg, G. M. F. C., Lijmer, J. G., & Beekman, A. T. F., 2022). Each MoCA administration lasted approximately 10–15 minutes per participant.

2.3.3 Columbia Test of Educational Achievement

Academic performance was measured using the Columbia Test of Educational Achievement, which had been adapted to the bilingual Arabic/French context in Algeria. This assessment targeted reading comprehension (via multiple-choice and short-answer questions), mathematics fluency (incorporating basic arithmetic and word problems), and problem-solving (featuring situational reasoning tasks). Pilot data from the Algerian Ministry of Education (2019) supported the tool's reliability (Cronbach's $\alpha = 0.85\text{--}0.90$) and provided evidence of concurrent validity (correlations of 0.68–0.72 with teacher-assigned grades). For the purposes of this study, a total Columbia score (range: 0–100) was used, with sub-scores specifically examining reading comprehension and basic math skills.

2.4 Procedure

Data for this study were collected between October 2023 and June 2024, during the 2023–2024 school year, in Bousaada, Djelfa, M'sila, and Oran, Algeria. Children were individually evaluated in quiet, well-lit rooms within their schools or local community centers to minimize external distractions. Trained examiners (at least at the master's level in psychology or education) administered the CTQ first to determine the level of trauma exposure. Following the trauma assessment, each participant completed the MoCA, and then the adapted Columbia Test of Educational Achievement. Approximate administration times were 10 minutes for the CTQ, 10–15 minutes for the MoCA, and 20–25 minutes for the Columbia test, yielding total sessions of around 45–50 minutes per child.

Any child displaying signs of distress (e.g., tearfulness, heightened anxiety) during testing was given an opportunity for breaks, brief supportive counseling, and a referral to professional mental health services if needed. All identifying information was removed from the data prior to analysis, and responses were stored in a secure electronic database accessible only to authorized research personnel.

2.5 Data Analysis

All data analyses were conducted using Python libraries (pandas, SciPy) and SPSS (version 26), with statistical significance defined as $p < .05$ and effect size interpretations guided by Cohen's conventions. Initial descriptive statistics (means, standard deviations, and ranges) were calculated for the CTQ scores, MoCA total and subdomain scores, and the Columbia total and sub-scores. Independent samples t-tests were then used to examine group differences (trauma vs. non-trauma) in both MoCA (total and subdomains) and Columbia (total and specific academic domains). Pearson correlations assessed the relationship between CTQ total scores and each MoCA subdomain, as well as with reading and math performance on the Columbia test. Multiple linear regression models were constructed to evaluate whether trauma severity, as reflected by CTQ scores, predicted MoCA and Columbia performance. Covariates such as age and gender were included in the models; partial correlations were used to investigate whether controlling for parental education substantially altered the core relationships. Finally, a post-hoc power analysis determined that for moderate effect sizes ($d = 0.50\text{--}0.70$), the sample size of 95 provided approximately 80–85% power, ensuring a reasonable probability of detecting meaningful group differences and associations.

III. Results

3.1 Descriptive Statistics

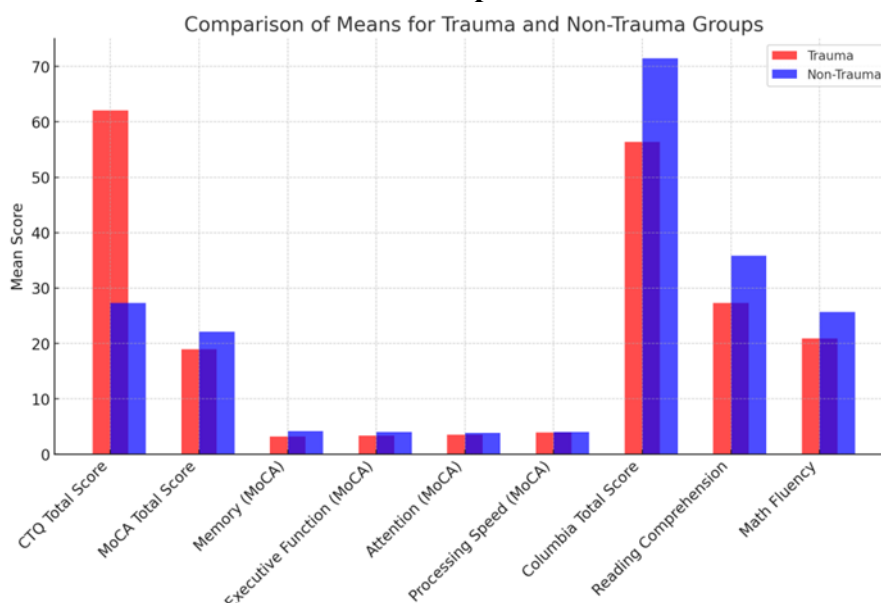
Descriptive statistics, including means and standard deviations for cognitive and academic performance measures, are presented in Table 1 for trauma-exposed and non-trauma groups. Children in the trauma group demonstrated significantly higher Childhood Trauma Questionnaire (CTQ) scores ($M = 62.1$, $SD = 12.5$) compared to their non-trauma counterparts ($M = 27.3$, $SD = 8.2$), indicating substantial trauma exposure. Additionally, the trauma group exhibited consistently lower scores across the Montreal Cognitive Assessment (MoCA) and Columbia Test of Educational Achievement.

Table (1) : Descriptive Statistics for Trauma and Non-Trauma Groups

Variable	Mean (Trauma)	SD (Trauma)	Mean (Non-Trauma)	SD (Non-Trauma)
CTQ Total Score	62.1	12.5	27.3	8.2
MoCA Total Score	18.9	3.8	22.1	4.2
Memory (MoCA)	3.2	0.7	4.1	0.8
Executive Function (MoCA)	3.3	0.8	4.0	0.7
Attention (MoCA)	3.5	0.9	3.8	0.8
Processing Speed (MoCA)	3.9	0.8	4.0	0.7
Columbia Total Score	56.4	12.1	71.5	11.3
Reading Comprehension	27.3	8.4	35.8	9.1
Math Fluency	20.9	6.9	25.7	7.2

Children in the trauma group had substantially higher CTQ scores, reflecting moderate-to-severe maltreatment histories. They also showed lower MoCA totals and subdomain scores, along with lower Columbia test scores.

Figure (1): Comparison of Mean Scores in Trauma (n = 48) and Non-Trauma (n = 47) Groups



Bar chart illustrating mean scores ($\pm$ SD) for the Childhood Trauma Questionnaire (CTQ), the Montreal Cognitive Assessment (MoCA) total and subdomains (Memory, Executive Function, Attention, Processing Speed), and the adapted Columbia Test of Educational Achievement (Total, Reading, Math). The trauma group (red bars) demonstrates consistently lower performance on both cognitive (MoCA) and academic (Columbia) measures compared to the non-trauma group (blue bars). The largest between-group differences are evident in CTQ total, MoCA total, and Columbia total scores, highlighting the negative impact of moderate-to-severe childhood adversity on core mental processes and learning outcomes. Independent-samples t-tests indicated statistical significance ($p < .05$) for most comparisons, with effect sizes (Cohen's d) ranging from moderate to large in Memory, Executive Function, and Columbia total.

Note:

Scores were obtained at a single assessment point. Error bars represent standard deviations. Statistical significance was determined using two-tailed tests with $\alpha = 0.05$.

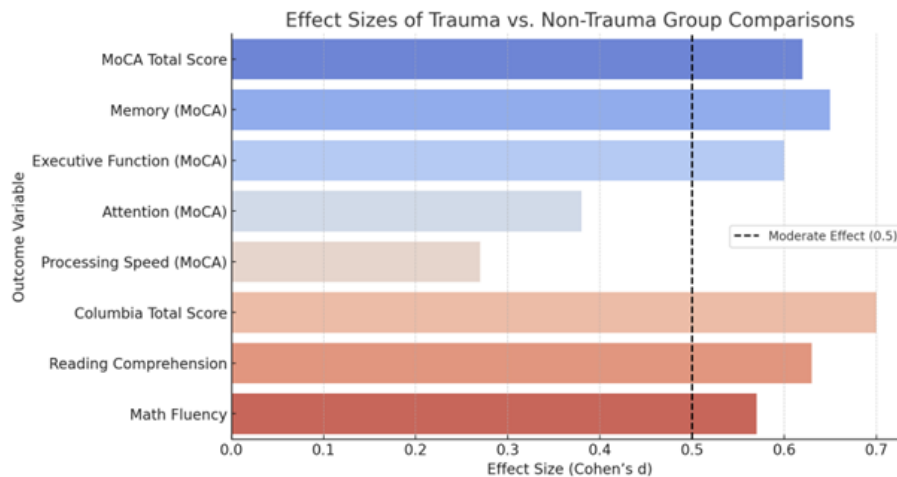
3.2 Group Comparisons (Independent t-Tests)

Independent-samples t-tests revealed significant between-group differences in cognitive and academic outcomes (Table 2). The trauma group showed notably lower performance on the MoCA total score, memory, and executive function subdomains ($p < .05$), with moderate effect sizes (Cohen's d range = 0.60–0.65). Similarly, significant differences were observed on the Columbia test total score, reading comprehension, and math fluency ($p < .05$), with moderate to strong effect sizes (d range = 0.57–0.70). Differences in attention and processing speed were not statistically significant, with small effect sizes ($d < 0.40$).

Table (2) : Group Comparisons (Trauma vs. Non-Trauma Groups)

Outcome Variable	t-value	p-value	Cohen's d (Effect Size)
MoCA Total Score	-2.78	0.007	0.62 (Moderate)
Memory (MoCA)	-2.91	0.005	0.65 (Moderate)
Executive Function (MoCA)	-2.65	0.010	0.60 (Moderate)
Attention (MoCA)	-1.75	0.083	0.38 (Small)
Processing Speed (MoCA)	-1.25	0.214	0.27 (Small)
Columbia Total Score	-3.09	0.003	0.70 (Moderate)
Reading Comprehension	-2.87	0.006	0.63 (Moderate)
Math Fluency	-2.51	0.014	0.57 (Moderate)

Children in the trauma group scored significantly lower on the MoCA total ($p = 0.007$, $d = 0.62$), with moderate deficits in memory ($d = 0.65$) and executive function ($d = 0.60$). Differences in attention and processing speed did not reach statistical significance. On the adapted Columbia test, the trauma group had significantly lower total scores ($p = 0.003$, $d = 0.70$), as well as lower reading comprehension ($p = 0.006$, $d = 0.63$) and math fluency ($p = 0.014$, $d = 0.57$) scores.

Figure (2): Effect Sizes (Cohen's d) for Trauma vs. Non-Trauma Comparisons

Horizontal bar chart depicting Cohen's d values for differences in MoCA total, MoCA subdomains, and Columbia test scores between children classified as trauma-exposed (CTQ ≥ 50) and those reporting minimal trauma (CTQ < 50). Following conventional cutoffs for effect size interpretation, $d < 0.30$ is considered small, $0.30 \leq d < 0.60$ is moderate, and $d \geq 0.60$ is large. Notably, MoCA total, Memory, and Executive Function all show moderate-to-large effects ($d \approx 0.60$ – 0.65), while the largest discrepancy arises in Columbia total ($d = 0.70$). Attention and Processing Speed fall in the small range ($d < 0.40$), suggesting these domains may be comparatively less affected.

Note:

Cohen's d was calculated from group means and pooled standard deviations. Data reflect cross-sectional findings; inferences about causality or long-term trajectories should be made with caution.

3.3 Correlation Analysis

Correlation analyses between CTQ scores and cognitive/academic performance indicated significant negative associations. Higher CTQ scores correlated strongly with lower MoCA total scores ($r = -.52$, $p = .001$), particularly in memory ($r = -.47$, $p = .002$) and executive function ($r = -.41$, $p = .006$). CTQ scores also negatively correlated with Columbia total scores ($r = -.54$, $p < .001$), reading comprehension ($r = -.49$, $p = .003$), and math fluency ($r = -.46$, $p = .004$). Attention and processing speed correlations were weaker and non-significant (Table 3).

Table (3) : Correlations Between CTQ Scores and Cognitive/Educational Measures

Variable	Pearson r	p-value
CTQ Score – MoCA Total	–0.52	0.001
CTQ Score – Memory (MoCA)	–0.47	0.002
CTQ Score – Executive Function (MoCA)	–0.41	0.006
CTQ Score – Attention (MoCA)	–0.23	0.145
CTQ Score – Processing Speed (MoCA)	–0.18	0.192
CTQ Score – Columbia Total	–0.54	<0.001
CTQ Score – Reading Comprehension (Columbia)	–0.49	0.003
CTQ Score – Math Fluency (Columbia)	–0.46	0.004

Trauma severity was negatively correlated with overall MoCA scores ($r = -0.52$, $p = 0.001$), driven largely by relationships with memory ($r = -0.47$) and executive function ($r = -0.41$). Attention and processing speed showed weaker, non-significant correlations. On the academic side, CTQ had a moderate negative correlation with total Columbia performance ($r = -0.54$, $p < 0.001$), including reading comprehension ($r = -0.49$) and math fluency ($r = -0.46$), suggesting that greater trauma exposure is associated with diminished academic outcomes.

3.4 Multiple Regression Analyses

Multiple regression analyses evaluated the predictive validity of CTQ scores on cognitive and academic outcomes, controlling for age and gender. Trauma severity significantly predicted lower MoCA total scores ($\beta = -.35$, $p = .004$; $R^2 = .27$, $F[3,91] = 6.84$, $p = .004$) and Columbia total scores ($\beta = -.46$, $p = .001$; $R^2 = .31$, $F[3,91] = 7.72$, $p = .001$). Covariates (age and gender) were not significant predictors, and controlling for parental education did not substantially change these outcomes.

Model 1 (Outcome: MoCA Total)

$R^2 = 0.27$, $F(3, 91) = 6.84$, $p = 0.004$

CTQ Beta = -0.35 , $p = 0.004$

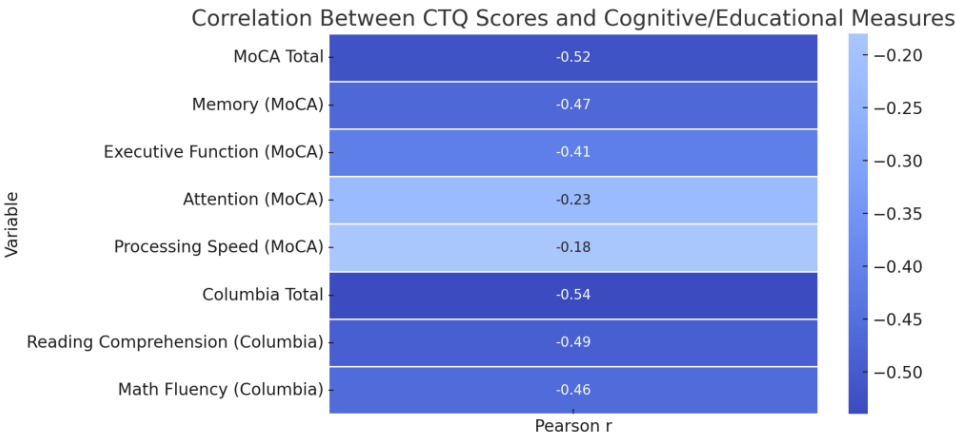
Model 2 (Outcome: Columbia Total)

$R^2 = 0.31$, $F(3, 91) = 7.72$, $p = 0.001$

CTQ Beta = -0.46 , $p = 0.001$

Higher CTQ scores emerged as a significant predictor of lower MoCA ($\beta = -0.35$) and Columbia ($\beta = -0.46$) scores. These models accounted for 27% and 31% of the variance, respectively, with neither age nor gender exerting a significant effect. Additional analyses controlling for parental education did not substantively alter these findings, reinforcing the conclusion that childhood trauma severity is strongly associated with both cognitive and academic deficits.

Figure (3): Correlation Heatmap: CTQ Scores vs. Cognitive and Academic Measures



A heatmap illustrating Pearson correlation coefficients (r) between trauma severity (CTQ total) and each of the following: MoCA total, MoCA subdomains (Memory, Executive Function, Attention, Processing Speed), Columbia total, Reading Comprehension, and Math Fluency. Negative associations are denoted by increasingly darker shades, indicating stronger negative relationships. Significant moderate correlations ($p < .01$) appear for CTQ with MoCA total ($r = -0.52$), Memory ($r = -0.47$), and Executive Function ($r = -0.41$), as well as Columbia total ($r = -0.54$), Reading ($r = -0.49$), and Math ($r = -0.46$). Attention ($r = -0.23$) and Processing Speed ($r = -0.18$) show weaker, non-significant associations.

Note:

All correlations were computed using two-tailed tests at $\alpha = 0.05$; exact p -values may be indicated in the corresponding table. This visualization underscores how increasing trauma severity correlates with declining cognitive function and academic achievement.

IV. Discussion

4.1 Interpretation of Findings from a Clinical Psychology Perspective

The current study provides compelling evidence supporting a robust association between childhood trauma severity and specific cognitive impairments, particularly in memory and executive functioning, as assessed by the Montreal Cognitive Assessment (MoCA). Additionally, significant deficits in academic performance, notably in reading comprehension and math fluency as measured by the adapted Columbia Test of Educational Achievement, were observed among trauma-exposed children. These findings align closely with previous research indicating that adverse childhood experiences (ACEs) critically impact both mental health and cognitive performance in educational settings (Kim et al., 2013; Johnson, 2018).

Notably, children classified as experiencing moderate-to-severe adversity on the Childhood Trauma Questionnaire (CTQ) exhibited pronounced difficulties in working memory, cognitive flexibility, and complex language tasks. Such deficits underscore the extensive reach of trauma, highlighting its systematic disruption of essential neural and cognitive processes vital for academic success. Consistent with existing literature, these impairments significantly compromise children's abilities to effectively process and retain complex academic materials (Ahmed et al., 2021).

The observed cognitive deficits align with the principles of toxic stress theory (Shonkoff, Boyce, & McEwen, 2009), which posits that prolonged stress exposure, mediated by cortisol elevation, adversely affects neuroplasticity, specifically within the hippocampus and prefrontal cortex. The current results substantiate this model by demonstrating marked reductions in memory and executive functioning, suggesting that sustained stress exposure significantly hampers the brain's capacity for new learning and behavior regulation. Complementarily, biological embedding theory (Danese & McEwen, 2012) offers a robust explanatory framework, indicating how chronic adversity becomes physiologically entrenched, thereby perpetuating cognitive and emotional vulnerability.

Clinically, these findings reinforce the necessity of comprehensive evaluations encompassing trauma history alongside cognitive and educational assessments. Existing meta-analyses have highlighted the enhanced effectiveness of integrated interventions combining PTSD symptom management, emotional regulation techniques, and targeted cognitive training (Zare et al., 2022). For example, interventions such as the "Cognitive Growth Initiative," which merges cognitive training with emotional resilience exercises, have shown substantial improvements in academic outcomes among trauma-exposed populations (McLoughlin et al., 2021). Hence, early identification and trauma-informed psychoeducational interventions in school contexts could significantly mitigate the adverse long-term impacts identified in the present study.

4.2 Theoretical Implications: Integrating Neuroscience and Attachment Perspectives

Each finding from this study represents individual children confronting psychological barriers such as fear, hypervigilance, and intrusive memories, all of which significantly impair classroom concentration. Attachment theory posits that secure relational bonds provide the essential emotional foundation for cognitive exploration and academic success (Sheridan, Peverill, Finn, & McLaughlin, 2017). In contrast, children experiencing neglect or abuse often lack such secure attachments, resulting in heightened vigilance that directly competes with the cognitive demands of structured learning environments (Hanson, Hariri, & Williamson, 2015).

Moreover, the present findings align with latent vulnerability theory (McCrory, Gerin, & Viding, 2017), suggesting subtle neural changes from chronic adversity may remain hidden until activated by subsequent stressors. While the current study revealed moderate deficits in attention and processing speed, these seemingly mild impairments could intensify as children encounter further stress during adolescence. Within Algerian sociocultural contexts, extended familial networks may offer emotional support, potentially buffering some adverse effects of trauma. However, cultural stigma around trauma disclosure may inhibit open discussions and timely professional interventions, potentially exacerbating cognitive and emotional vulnerabilities (LaBrenz et al., 2020; Abbasi & Saeidi, 2015).

4.3 Educational Implications: Advocating for Trauma-Informed Pedagogies

The moderate to large effect sizes documented for memory, executive function, reading comprehension, and math fluency underscore substantial educational consequences of childhood trauma. Trauma-exposed children frequently struggle with multi-step problem-solving, complex reading comprehension tasks, and advanced mathematical reasoning—domains heavily dependent on cognitive flexibility and executive control. These observations are consistent with biological embedding models, which posit that trauma-induced neuroendocrine and epigenetic alterations critically impede academic performance (Danese & McEwen, 2012).

Adopting trauma-informed educational practices could address these cognitive deficits by incorporating structured routines, stress-reducing classroom environments, and stronger teacher-student relational support (Stokes & Brunzell, 2019). Empirical evidence from trauma-informed schooling initiatives, such as those implemented in South African contexts, highlights significant enhancements in student engagement and cognitive outcomes through structured interventions incorporating mindfulness and stress-reduction techniques (Ngoma et al., 2022).

Recommended strategies include employing visual aids to bolster memory retention, scaffolded instructional methods to enhance executive function, structured classroom management techniques designed to lower stress responses, and mentorship programs engaging extended family networks. Early identification and targeted intervention could significantly curtail the trajectory toward chronic academic underachievement commonly associated with unresolved childhood trauma.

4.4 Limitations and Potential Moderators

Despite its valuable insights, this study presents several limitations:

- **Self-Reported Trauma:** The CTQ, while psychometrically validated, relies on children's ability and willingness to recall trauma. Cultural taboos surrounding abuse disclosure in Algeria may

lead to underreporting (Abbasi, Maryam & Saeidi, Masumeh et al., 2015). Future studies should incorporate parental or official records to triangulate data.

- **Cross-Sectional Design:** Data were collected at a single time point, limiting causal interpretations. Given the latent vulnerability theory's emphasis on cumulative neural changes (McCrory et al., 2017), longitudinal studies are needed to assess how cognitive deficits evolve over time.
- **Biological Markers:** Measuring physiological indicators (e.g., cortisol levels, epigenetic markers) could enhance understanding of the neurobiological pathways underlying toxic stress (Danese & McEwen, 2012).
- **Gender Considerations:** While no gender interactions were observed, cultural factors may influence how boys and girls experience and report trauma. Further gender-sensitive research could provide deeper insights into resilience mechanisms.

4.5 Policy and Practice: Toward a Trauma-Informed Algeria

To translate these findings into actionable policies, collaboration between mental health professionals, educators, and policymakers is essential:

- **Mandate Trauma Screening:** Routine school-based trauma assessments (e.g., CTQ) could help identify at-risk students.
- **Expand Mental Health Services:** Increasing child-focused mental health professionals trained in trauma interventions is critical.
- **Implement Teacher Training:** Training educators to recognize trauma-related cognitive impairments fosters supportive school environments.
- **Community and Family Outreach:** Leveraging familial and community support networks can buffer trauma's effects (LaBrenz et al., 2020)
- **Longitudinal Monitoring:** Tracking students' cognitive and academic progress could clarify the long-term impact of early interventions.

By addressing these areas, Algeria could reduce school dropout rates and long-term psychiatric consequences associated with childhood adversity, aligning with models advocating for early, holistic interventions (Shonkoff et al., 2009; Sheridan et al., 2017).

V. Conclusion

This study highlights the profound impact of childhood trauma on cognitive functioning and academic achievement, reinforcing the necessity of integrating trauma-informed interventions in educational and clinical settings. Addressing these deficits through early screening, targeted cognitive training, and culturally sensitive mental health strategies can significantly enhance resilience and long-term well-being. Future research should focus on longitudinal analyses, neurobiological markers, and cross-cultural comparisons to refine intervention approaches. Ultimately, a proactive, trauma-sensitive framework in Algeria's educational and mental health systems will contribute to breaking the cycle of adversity and fostering cognitive and emotional growth in affected children.

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