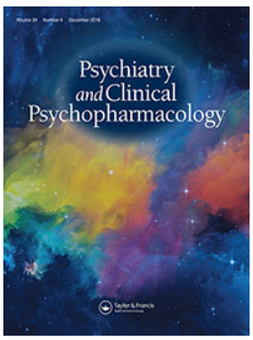

Psychiatry and Clinical Psychopharmacology

ISSN: 2475-0573 (Print) 2475-0581 (Online) Journal homepage: https://www.tandfonline.com/loi/tbcp21

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To cite this article: Zeynep Baran Tatar & Alparslan Cansız (2019) Childhood physical neglect may impair processing speed in adults with ADHD: a cross-sectional, case–control study, Psychiatry and Clinical Psychopharmacology, 29:4, 624-631, DOI: 10.1080/24750573.2018.1522714

To link to this article: https://doi.org/10.1080/24750573.2018.1522714

Published online: 19 Sep 2018.

PSYCHIATRY AND CLINICAL PSYCHOPHARMACOLOGY
2019, VOL. 29, NO. 4, 624–631
https://doi.org/10.1080/24750573.2018.1522714

Childhood physical neglect may impair processing speed in adults with ADHD: a cross-sectional, case–control study

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ABSTRACT

AIM: Higher rates of childhood trauma have been reported in both children and adults with adult attention deficit hyperactivity disorder (ADHD) than in healthy individuals. The association between childhood trauma and deficiency in cognitive functions in adults has been reported. One of the aims of our study was to compare childhood trauma reporting between adults with ADHD and healthy individuals. The second aim was to assess the difference in the cognitive function performance between traumatized and non-traumatized individuals in ADHD group as well as in the control group. Finally, the association between childhood trauma exposure and cognitive function in adults with ADHD was assessed.

METHODS: Fifty adults with ADHD and age, sex and years of education matched 50 healthy controls were administered a sociodemographic data form, Wender Utah rating scale (WURS), adult attention deficit hyperactivity disorder self-report scale (ASRS), childhood trauma questionnaire (CTQ), the structured clinical interview form for DSM-IV-TR Axis I Disorders (SCID-I). Both groups were also assessed by neuropsychological tests.

RESULTS: On the CTQ, patients with ADHD had a higher mean overall score than the control subjects, $t(98) = -4.977$, $p < .001$). Furthermore, ADHD patients reported significantly higher levels of childhood emotional abuse ($t(98) = -4.986$, $p < .001$), emotional neglect ($t(98) = -5.105$, $p < .001$) and physical neglect ($t(98) = -2.663$, $p < .001$) compared to controls. ADHD patients with a history of physical neglect performed worse in TMT-A than ADHD patients without a history of physical neglect. Based on correlation analysis, TMT Part A time had a significant positive relationship with emotional abuse and physical neglect ($r = .382$, $p < .01$; $r = .281$, $p = .048$) in ADHD group.

CONCLUSION: Adults with ADHD report higher rates of childhood trauma than healthy control individuals. Processing speed was slower only in the adults with ADHD who suffered from physical neglect than those who did not. A significant association was found between physical neglect and emotional abuse with processing speed in ADHD group. These findings could reflect the idea that both physical neglect and ADHD are related with processing speed weakness, with those who have both of these conditions having significantly greater problems on such measure than those with ADHD alone.

ARTICLE HISTORY
Received 27 June 2018
Accepted 9 September 2018

KEYWORDS
Adult ADHD; childhood trauma; neurocognitive measures; processing speed; neglect

Introduction

Adult attention deficit hyperactivity disorder (ADHD) is a psychiatric disorder that starts in childhood and continues into adulthood [1]. It is known as a heterogeneous neurodevelopmental disorder, and its possible etiology are biological and environmental factors. It is important to know the early risk factors because ADHD is associated with various behavioural, social, familial, and mental disorders [1]. Several studies have reported an association between childhood trauma with ADHD, and some studies support a bidirectional association: the trauma may cause ADHD symptoms by inducing neurochemical alterations in the brain [2] or children with ADHD may get exposed to relatively more physical and emotional trauma than healthy individuals as they are hard to discipline and may also have behavioural problems [3]. Initially, it was determined that ADHD symptoms could occur in children following a trauma [4], and ADHD was diagnosed twice as much in abused children compared to healthy individuals [5]. Moreover, in a sample of sexually abused children, ADHD prevalence rate of 46% was found [6]. A recent study has revealed that childhood abuse is associated with ADHD symptoms that worsen in adulthood [7].

In a survey of a large national adult population, it was reported that childhood physical abuse was associated with increased rates of many adult psychiatric disorders, with ADHD showing the strongest association [8]. Indeed, it has been determined that the history of

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abuse predicts psychopathology in the adult life [9]. In a large study of adult Canadians, diagnosis of ADHD by a health professional was reported 6 times higher in physically abused than non-abused adults [10].

Higher rates of childhood trauma have been reported in both children and adults with ADHD than in healthy individuals, which supports the bidirectional association between trauma and ADHD [11–14]. Emotional abuse was found significantly associated with ADHD in children [11], and also in adults with ADHD emotional abuse and neglect had found more occurred during childhood than in healthy adults [12–14].

Children, adolescents [15], and adults [16] who have been maltreated during childhood show deficits in cognitive functions. Cognitive flexibility has been associated with sexual abuse, whereas significant attention and working memory dysfunction have been identified in children with emotional abuse [17]. The relationship between physical neglect and physical abuse with decrease in cognitive flexibility performance has also been demonstrated in adolescents without psychiatric condition [18]. In a study of adults with a history of childhood maltreatment and without a psychiatric disorder, emotional abuse and physical neglect have been found to be associated with working memory deficits [16].

In a recent meta-analysis, moderate deterioration in attention and working memory and small deterioration in executive functions and processing speed have been detected in adults who were abused in childhood [19].

In addition, regardless of trauma history, neuropsychological deficits both in children and adults diagnosed with ADHD have been well documented utilizing various neuropsychological tests [20]. However, to our knowledge, neuropsychological functions between individuals with ADHD with childhood trauma and those without childhood trauma have not been compared yet.

Childhood trauma predicts future psychopathology, such as increased risks of depression, anxiety disorders, and post-traumatic stress disorder [2]. These psychopathologies adversely affect the neuropsychological functions [21,22]. Therefore, it is important to conduct studies particularly on individuals with no additional major psychiatric diagnosis to understand the effects of trauma on cognitive functions in individuals with ADHD.

The study had three major aims. The first aim of our study was to compare childhood trauma reporting between adults with ADHD (ADHD group) and healthy individuals (control group). The second aim was to assess the difference in the cognitive function performance between traumatized and non-traumatized individuals in ADHD group as well as in the control group. In addition to second aim, the ADHD group was evaluated in terms of cognitive functions by classification according to the type of their individual trauma. Finally, association between childhood trauma exposure and cognitive function in adults with ADHD was assessed. With respect to the earlier findings, we expected childhood trauma was more common in ADHD individuals compared to controls. Based on the association between childhood abuse and cognitive function deterioration in healthy adolescents and adults with no psychopathology, it is predicted that individuals with ADHD with trauma history differentiated in at least some cognitive aspects than individuals with ADHD without trauma history [16,18]. In terms of association between childhood trauma and neuropsychological functions, we had no clear predictions because of the lack of previous research findings.

Materials and methods

Participants

This case–control study was conducted in the Adult ADHD Outpatient Clinic, Bakirkoy Training and Research Hospital. Fifty adults with ADHD and 50 healthy adults matched for sex, age, and educational level were included in this study. Our ADHD sample comprised help-seeking patients who were referred to the Adult ADHD Outpatient Clinic by other psychiatrists for further evaluation. ADHD was diagnosed in accordance to the Diagnostic Manual of Mental Disorders (DSM-IV-TR) criteria [23]. All study participants were interviewed by using Structured Clinical Interview Form for DSM-IV-TR Axis I Disorders (SCID-I) [24]. The form allowed the identification of conditions that could be considered as exclusion criteria, while also allowing the formation of a control group without any psychopathology. Clinical interviews were held with the patients' spouse, parents, or close family member to confirm the ADHD diagnosis. The healthy participants consisted of psychology students and workers recruited from Bakirkoy Training and Research Hospital.

Exclusion criteria in both groups were the presence of psychosis, bipolar disorder, severe neurological pathology (e.g. stroke, epilepsy) or physical diseases, current major depression, current substance and/or alcohol abuse, posttraumatic stress disorder, major anxiety disorders, severe suicidal ideations, pervasive developmental disorders, mental retardation, conduct disorder, and unwillingness to participate. Individuals diagnosed with ADHD were also excluded from the control group. A total of 53 patients from the ADHD outpatient clinic who had already been diagnosed as having ADHD were initially invited to the study; two of these patients were excluded due to a diagnosis of major depression, one patient refused to participate in the study. Two of 52 individuals who were invited to join the control group were excluded from the

study due to a diagnosis of major depression. According to DSM-IV-TR, 31 patients in the ADHD group fulfilled the criteria for the predominantly inattentive subtype, and 19 patients were of the combined subtype. 10 of the patients had a diagnosis of "anxiety disorder not otherwise specified," "depressive disorder not otherwise specified," obsessive compulsive disorder, dysthymia, or specific phobia. Adults with ADHD on stimulant medication suspended their treatment for at least 48 hours before neuropsychological testing.

Measures

Sociodemographic data form

The sociodemographic data form is a semi-structured form prepared by the researchers. This form was used to record the patients personal information, address, telephone number, age, sex and level of education. The hand preference of the patients was also indicated on this form; information regarding the handedness of the patients was learned verbally, by directly asking the patients.

The structured clinical interview form for DSM-IV-TR Axis I Disorders (SCID-I)

SCID-I is a diagnostic interview that was adapted for the DSM-IV-TR by First et al. [24]. In this study, the SCID-I was used to evaluate and identify possible exclusion criteria among the patients and control. The validity and reliability studies for Turkish adaptation of the SCID-I were previously performed by Corapcioğlu et al. [25].

Wender Utah rating scale

The WURS is a self-administered scale that measures childhood ADHD symptoms and behaviours in order to support ADHD diagnoses for adults. It is a five-point Likert-type scale including 25 items which is scored between 0 and 4 (0 = not at all, 4 = very much) [26]. A validity and reliability study for the Turkish adaptation of the WURS was previously performed, and the cutoff score for the scale was determined as 36 [27].

Adult attention deficit hyperactivity disorder self-report scale

The ASRS is a 18-item self- rating scale that was developed by the World Health Organization to screen adults for current ADHD [28]. The scale is a five-point Likert-type scale in which every item is scored between 0 and 4. The scale is further divided into two sub-scales "attention deficit" and "hyperactivity/impulsivity," each consisting of nine items. The validity and reliability study for the Turkish adaptation of the ASRS was previously conducted [29].

Childhood trauma questionnaire

The CTQ is a standardized 28-item self-report retrospective inventory developed by Bernstein et al. [30]. It is a key tool for the assessment of childhood abuse and neglect experiences. CTQ contains five subscales each comprised of five items: Emotional Abuse, Physical Abuse, Sexual Abuse, Emotional Neglect, Physical Neglect. Each item is a 5-point Likert scale ranging from never true = 1 to very often true = 5, producing scores of 5 to 25 for each trauma subscale. The reliability and validity study for Turkish population was done by Sar et al. In the present study, the CTQ cut-off scores were as follows: physical abuse >5, sexual abuse >5, emotional abuse >7, physical neglect >7 and emotional neglect ≥10 [31].

Trail-Making Test part A and part B (TMT)

In the Trail-Making Test part A, 25 circles are numbered from 1 to 25 and participants are asked to draw lines to connect these numbers in ascending order. This part measures processing speed. In the Trail-Making Test part B, participants are instructed to join 25 randomly arranged numbers and letters. This part is considered as a test of executive functions regarding working memory, set-shifting ability, and cognitive flexibility. The participant is evaluated on the duration of time (seconds) required to connect the trail [32].

Continuous performance test

The continuous performance test (CPT) is used to measure sustained attention and response inhibition. In the present study, a computer-based CPT adapted by Zaimoglu et al. was used [33]. This test is administered by using letters that appear and disappear on a computer screen. Subjects are instructed to press a button only when the letter A is followed by the letter Z. The evaluated parameters include the total number of correct answers, the number of omissions (i.e. failing to press the button when the target is presented), and the number of commissions (i.e. pressing the button when a non-target is presented). The omission score is related to sustained attention, and high commission scores are indicative of problems relating to response inhibition and impulsivity.

Patients and controls were administered the sociodemographic data form, WURS, ASRS, SCID-I, CTQ after informed consent forms were read and signed. The WURS and ASRS were used to confirm the diagnosis of ADHD and better distinguish the groups. For viewing additional diagnosis SCID-I was applied,

and also for allowing the formation of a control group without any psychopathology. Both groups were administered neuropsychological tests consists of TMT Part A and B, and CPT.

Statistical analysis

Demographic variables, scores of rating scales, and neuropsychological tests were compared between ADHD group and control group using independent sample t test. When analysing categorical variables (e.g. sex, hand dominance, abuse, and neglect types), the chi square test was applied. The level of effect size, the Cohen's d, were determined in order to evaluate the differences between the ADHD patients and the controls. A value of $d = .2$ is considered as corresponding to a low-level effect size; a value of $d = .5$ is considered as corresponding to a moderate level effect size; and a value of $d = .8$ is considered as corresponding to a high-level effect size [34]. Childhood trauma was analysed both categorically (using the predefined thresholds for each subtype) and continuously.

Mann–Whitney U test was used to compare neurocognitive domains in subjects with a history of trauma versus those with no such history, separately into patients and controls.

ADHD participants were further split into groups according to childhood trauma subtype status and the neurocognitive tests' scores were evaluated in these groups. Similar analysis was not performed in the control group because there are not enough comparative samples in the trauma subtypes.

To identify the relationship of "CTQ subscale scores" and "CPT-omission, CPT-commission, TMT Part A time, TMT Part B time" in both the patient and control group, the Pearson correlation analysis was calculated.

The results were evaluated within a 95% confidence and by using a statistical significance level of $p < .05$, with $p < .01$ and $p < .001$ being considered to as indicating a high level of statistical significance. Data analysis was performed using SPSS 18.0 (Statistical Program for Social Sciences).

Results

The sample consisted of 25 men and 25 women. ADHD and control groups were similar in terms of age (21.56 ± 3.94 and 22.22 ± 3.11, $x^2 = .92$, $p = .161$), sex (ADHD group mean age was 21.56 (SD = 3.94) with mean level of education of 14.06 years (SD = 1.96). Table 1 provides age, gender, education, and hand preferences by group. The ADHD and control groups did not differ significantly in any of these areas.

As expected measurements of psychopathology revealed significant group differences with ADHD participants scoring higher WURS scores (mean = 45.52, SD = 15.59 and mean = 17.02, SD = 9.70, respectively; $t(98) = -10.99$, $p < .001$); the ASRS-Attention Deficit subscale scores (mean = 25.32, SD = 5.97 and mean = 11.28, SD = 4.18, respectively; $t(98) = -13.61$, $p < .001$); the ASRS-Hyperactivity/Impulsivity subscale scores (mean = 22.26, SD = 8.46 and mean = 11.12, SD = 3.80, respectively; $t(98) = -8.483$, $p < .001$); and the total ASRS scores (mean = 46.78, SD = 12.67 and mean = 22.50, SD = 7.21, respectively; $t(98) = -11.772$, $p < .001$) than the controls (Table 2). The comparison computed on scores in the CPT revealed that the adults with ADHD performed more poorly than the control group. In comparison to the control group, the ADHD group had a lower number of correct answers in the CPT (mean = 46.06, SD = 7.91 and mean = 51.86, SD = 3.79, respectively; $t(98) = 4.67$, $p < .001$), had higher omission scores (7.94 ± 7.91 and 2.16 ± 3.79, respectively; $t(98) = -4.656$, $p < 0.01$) and higher commission scores (5.82 ± 6.29 and 2.28 ± 2.841, respectively; $t(98) = -3.713$, $p < .001$). The effect size was determined to be high (Table 2). No group differences were found on Trail A time (28.11 ± 9.31 sec and 13.74 ± 8.10 s, respectively; $t(98) = -2.504$, $p = 0.249$) while significant differences were shown on Trail B time (78.81 ± 47.63 s and 48.40 ± 19.10 s, respectively; $t(98) = -4.190$, $p < 0.001$). The effect size was determined to be high (Table 2).

On the CTQ, patients with ADHD had a higher mean overall score than the control subjects, $t(98) = -4.977$, $p < .001$). Furthermore, ADHD patients reported significantly higher levels of childhood emotional abuse ($t(98) = -4.986$, $p < .001$), emotional neglect ($t(98) = -5.105$, $p < .001$) and physical neglect ($t(98) = -2.663$, $p < .001$) compared to controls (Table 3).

The ADHD and control groups were significantly different from one another with respect to emotional abuse, $X^2(1) = 23.04$, $p < .001$; emotional neglect , $X^2(1) = 26.84$, $p < .001$ and physical neglect, X^2 (1) = 7.30, $p < .01$ according to cut-off point of CTQ. ADHD group was more likely to report emotional abuse (52.0%), emotional neglect (50.0%), physical neglect (32.0%), than the control group (8.0%, 4.0%, 10.0%, respectively). 32% of the female controls and 44% of the male controls reported childhood trauma while trauma was detected in 56% of women and 80% of men with ADHD. In ADHD group and control group trauma subtypes did not differ between genders.

Individuals with and without trauma in the ADHD group and control group did not differ in terms of neuropsychological tests. ADHD patients with a history of physical neglect performed worse than ADHD patients without a history of physical neglect in TMT-A (Table 4). Based on correlation analysis, it was observed that TMT Part A time had a significant positive relationship with emotional abuse and physical neglect ($r = .382$, $p < .01$; $r = .281$, $p = .048$) in ADHD

Table 1. The demographic characteristics of the ADHD and control groups.

		ADHD ($n = 50$)		Control ($n = 50$)			
		n	%	*n*	%	X^2	*p*
Sex	Female	25	50	25	50	0.00	0.579
	Male	25	50	25	50		
Hand preference	Left	2	6.7	3	3.3		
	Right	48	93.3	47	96.7	0.351	0.500
		Mn	Sd	Mn	Sd	t	p
Age		21.56	3.94	22.22	3.11	.92	0.161
Education (years)		14.06	1.96	14.18	0.81	.31	0.357

Note: Mn, Mean; Sd, Standard deviation.

Table 2. Comparison of the scales and test scores for the ADHD and control groups.

		ADHD ($n = 50$)		Control ($n = 50$)				Effect size
		Mean	Sd	Mean	Sd	*t*(98)	*p*	Cohen's *d*
WURS		45.52	15.59	17.02	9.70	−10.995	.000**	2.20
ASRS	Total score	46.78	12.67	22.50	7.21	−11.772	.001**	2.35
	The attention deficit subscale	25.32	5.97	11.28	4.18	−13.611	.000**	2.72
	The hyperactivity/impulsivity subscale	22.26	8.46	11.12	3.80	−8.483	.000**	1.70
CPT	Number of omissions (CPT)	7.94	7.91	2.16	3.79	−4.656	.005*	0.93
	Number of commissions (CPT)	5.82	6.29	2.28	2.41	−3.713	.000*	0.74
Trail-making test	Trail A time (seconds)	28.11	9.31	23.74	8.09	−2.504	.249	0.50
	Trail B time (seconds)	78.81	47.69	48.40	19.09	−4.190	.000*	0.83

Notes: ADHD, adult attention deficit hyperactivity disorder; WURS, Wender Utah rating scale; ASRS, adult attention deficit hyperactivity disorder self-report scale; CPT, continuous performance test.
*$p < .05$.
**$p < .001$.

Table 3. Group comparison concerning CTQ total and subdomain scores.

	ADHD ($n = 50$) *M* (SD)	Control ($n = 50$) *M* (SD)	*t*(98)	*p*	Cohen's *d*
CTQ emotional abuse	8.06 (3.07)	5.74 (1.17)	−4.986	.000**	.99
CTQ physical abuse	5.96 (1.95)	5.52(1.79)	−1.170	.138	.23
CTQ sexual abuse	5.88 (2.92)	5.44 (1.57)	−0.936	.104	.18
CTQ physical neglect	6.62 (1.99)	5.72 (1.30)	−2.663	.000**	.53
CTQ emotional neglect	11.60 (4.89)	7.82 (1.87)	−5.105	.000**	1.02
CTQ total	38.26 (10.68)	30.24(3.95)	−4.977	.000**	.44

Notes: ADHD, attention-deficit/hyperactivity disorder; CTQ, the childhood trauma questionnaire; *M*, mean; SD, standard deviation.
*$p < .05$.
**$p < .001$.

group (Table 5). There was no significant correlation between "CTQ subscale scores" and neuropsychological test results in control group.

Discussion

One of the main purposes of this study was to compare the prevalence of childhood trauma between the ADHD group and the control group. Consistent with previous studies, childhood trauma as well as remarkably high prevalence of emotional abuse and emotional neglect have been reported more frequently in the ADHD group than in the control group [12–14]. The first study which investigated childhood history of abuse in adults with ADHD was held by Rucklidge et al. [12] with similar findings with our study. Another study found that depressive symptoms and traumatic experiences have effect on quality of life in adults with ADHD [13]. A recent study conducted by Semiz et al. [14] investigated the association between adult ADHD and childhood maltreatment, and they found significant correlation between adult ADHD scales, and emotional abuse. In addition, in our study, physical neglect was more frequent in patients with ADHD compared with controls. Compared with the control group, the ADHD group may be more prone to physical neglect, which is specified in CTQ-28 with "not having enough food," "parents abusing alcohol or drugs to the point of not being able to take care of their family," and "not seeing a doctor when needed." Higher rates of childhood trauma are

Table 4. Neuropsychological test results according to presence of physical neglect in ADHD group.

	ADHD physical neglect				
	Yes ($n = 16$)	No ($n = 34$)	*Z*	*p*	*r*
TMT-A time (seconds)	33.31	21.82	−2.600	0.009*	0.36
TMT-B time (seconds)	30.13	23.32	−1.539	0.124	0.21
CPT-omission	28.38	24.15	−0.959	0.337	0.13
CPT-commission	27.69	24.47	−0.731	0.465	0.10

Table 5. The Pearson correlation analysis between the CTQ subscales and neuropsychologic test results of the ADHD group.

		TMT-A	TMT-B	CPT-omission	CPT-commission
CTQ emotional abuse	*r*	.382	.096	.078	.175
	p	.006*	.506	.589	.225
CTQ physical abuse	*r*	.140	.175	.041	.024
	p	.331	.225	.779	.867
CTQ sexual abuse	*R*	.088	.189	-.123	.194
	p	.544	.188	.395	.177
CTQ physical neglect	*r*	.281	.110	.148	.116
	p	.048*	.445	.304	.422
CTQ emotional neglect	*r*	.201	−.191	−.061	−.102
	p	.162	.183	.673	.482

reported in males with ADHD than in females with ADHD. It may be that behavioural symptoms of ADHD are more frequent in male children than in female children [35]. So, difficulties experienced by caretakers in handling these types of behaviour may be a factor in increasing the exposure of male children with ADHD to derogatory, threatening verbal assaults and/or negligence.

The second aim was to assess the difference in the cognitive function performance between traumatized and non-traumatized individuals in ADHD group as well as in the control group. No difference was identified. In the ADHD group, among the childhood trauma subtypes, processing speed was slower only in the individuals who suffered from physical neglect than those who did not.

As the final aim, in the correlation analysis of the ADHD group we found positive association between physical neglect and emotional abuse with processing speed. Lack of association between the cognitive functions and trauma sub types in the control group may be an indicator that trauma in individuals with ADHD has an effect on their cognitive functions. These findings could reflect the idea that both physical neglect/emotional abuse and ADHD are associated with processing speed weakness, with those who have both of these conditions having significantly greater problems on such measure than those with ADHD alone. In line with this, it has been demonstrated that psychosocial functioning in children with ADHD who had experienced trauma was significantly worse than either ADHD children without trauma or traumatized children without ADHD [36]. Furthermore, quality of life is reported to be negatively affected in individuals with ADHD adults with childhood trauma, and psychiatric diagnoses are more frequent [13].

A recent meta-analysis has shown that processing speed is negatively affected in adults with childhood trauma ($g = -0.40$) [13]. Processing speed is a function that plays a key role in the execution of many cognitive tasks [37]. It is calculated by measuring the speed used in the execution of cognitive functions. Processing speed depends on the level of coordination and efficiency of neural networks and is affected by the changes in volume and integrity of white matter [38]. Decline in the integrity of the white matter following childhood trauma has been reported [39]. In individuals with ADHD, a decline in the integrity of the white matter has also been detected [40]. However, neuroimaging studies are needed to reach a clear inference regarding the association between processing speed and white matter anomalies.

Our study is a case–control study; therefore, it is not possible to establish any causality with respect to trauma experiences causing ADHD symptoms and individuals with ADHD being exposed to more trauma. Trauma during early childhood may cause alterations in brain functioning [2]. Animal researches have indicated that early exposure to stressful events, can influence brain regions involved in cognition. Hypothalamic–pituitary–adrenal HPA axis hyperactivation has been shown as a result of maltreatment. It has been stated that the hippocampus, amygdala, and the prefrontal cortex are the main brain regions affected in trauma which also involved in cognitive impairments [41]. In a previous study, it has been demonstrated that ADHD symptoms can emerge after exposing trauma in children [6]. In addition, difficulties in handling children with ADHD may result in the child being exposed to more trauma [42] This maltreatment may originate from families of ADHD children who also have the same diagnosis. Parents of ADHD children often show symptoms of ADHD, which can lead to parenting difficulties [43]. Less patience and impulsivity can lead to difficulties in parent–child relationships [44]. To conclude, there may be bidirectional relationship between childhood maltreatment and ADHD. By the results of our study, it can be assumed that patients with ADHD with specific childhood trauma may associated with more cognitive weaknesses, and these patients may present with a different cognitive nature compared to patients with ADHD without childhood trauma. Studies with a larger sample size with a longitudinal design and different neuropsychological tests comparing with control group will shed light on these assumptions.

There are some limitations of our study. First of all, since DSM-IV-TR does not allow a diagnosis of ADHD in adults, Diagnostic Interview for ADHD in Adults 2.0 (DIVA 2.0) which is a structured diagnostic instrument also available in Turkish language, could be preferred to select the patients [45]. Secondly, although a significant association between processing speed and physical neglect/emotional abuse in adults with ADHD and childhood trauma was demonstrated in our study, it is difficult to specify the direction of this association. Although we could not establish any causality because this is a case–control study, it was demonstrated that there was a different processing speed profile at least

in ADHD adults with physical neglect compared to ADHD patients without physical neglect. To establish the impact of physical neglect on this cognitive measure, it is important to include a control group with a comparable number of sample. Also, the number of sample is rather small in average to assume such a generalization of childhood traumas in ADHD. Although the discardation of comorbid cases increase the consistency of our results, this evolves another limitation because of high comorbidity in adults with ADHD. Future studies comparing ADHD patients plus comorbid psychiatric disorders with ADHD alone should be investigated in terms of childhood trauma.

Childhood trauma reports are retrospective and may include memory errors. Nevertheless, the clinical diagnosis of ADHD in adults is based on retrospective reporting, which is an ineluctable limitation. Although the individuals were matched in terms of age, sex, and educational status, there was no information regarding their intelligence level, which is a variable that may affect their performances in the tests. This is because of the lack of an intelligence test with validity and reliability that will ensure the gathering of accurate data in adults in Turkey. However, the fact that the ADHD group included high school and university graduates, which reduces the likelihood of mental deficiency, minimizes the effects of intelligence level on performance. A prospective study conducted from the childhood through adulthood will provide more information regarding the effect of childhood trauma on neuropsychological functions in individuals with ADHD. Lack of tests that examine different neuropsychological function areas is another methodological limitation of our study. Even though the effects of childhood trauma on neuropsychological functions have been studied in many psychiatric as well as healthy individuals, as per our knowledge, ours is the first study to examine adults with ADHD in this manner. However, neuroimaging studies may offer more insight regarding the relationship among childhood trauma, cognitive functions, and ADHD symptomatology.

In conclusion, the findings of our study show that adults with ADHD report higher rates of childhood trauma than healthy controls, processing speed is slower in ADHD patients with physical neglect when compared to ADHD patients without physical neglect, and significant correlation was found between physical neglect and emotional abuse with processing speed in ADHD group. When clinicians take into consideration that trauma experience is frequent in individuals with ADHD, they can perform psychotherapeutic interventions aimed at reducing the signs of continuing trauma, and these interventions can be helpful in the treatment of ADHD if included in pharmacotherapeutic interventions for ADHD.

Disclosure statement

No potential conflict of interest was reported by the authors.

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