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Review Article

A review of association between serum cortisol levels and cognitive performance under stress conditions

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Abstract:

Stress is a physical, mental or emotional response from the human body to changes or challenges. Cortisol levels and cognitive function have played crucial roles in stress management. In this study, a meta-analysis was conducted to review the interaction between serum cortisol levels and cognitive function under stress conditions. We used PubMed, Scopus and Google Scholar to identify reference articles in the past 8 years regarding serum cortisol level and cognitive performance data. There are a variety of stress conditions that were evaluated, such as anxiety, depression, pregnant women, military servicemen, and other situations. Additionally, the cognitive performance was evaluated using Mini-Mental State Examination (MSSE), Wechsler Adult Intelligence Scale (WAIS), Bayley Scales mental development index (MDI), and other cognitive performance measurements. In a total of 35 articles, during stress conditions, we identified an increase of cortisol levels while the cognitive performance was impaired. We hypothesised that the stress condition would increase the serum cortisol level and that the cortisol would delay cognitive performance.

Keywords: Adrenal Cortex Hormones; Adult; Cognition; Cognitive Dysfunction; Cortisol; Humans; Hydrocortisone; Meta-Analysis; Neuropsychological Tests; Stress, Psychological.

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Introduction

Stress is a biological response of a living organism to adapt to changing environments or conditions. Hans Selye introduced two types of stress, eustress and distress. Eustress is a condition that is challenging but confident, with the ability and rewarding, which might give benefits such as studying for an exam. On the other hand, distress is the inverse of eustress, where it is the condition that the person has no confidence or cannot cope with the challenge, like feeling anxious and panicked [1].

The stress response is initiated by a stressor, which is a challenging condition and is continued with the biological mechanisms in the body. High intensity of stressors can stimulate the hypothalamic-pituitary-adrenal (HPA) axis, triggering a stress reaction [2].Then, the stress mediator, which is catecholamines like epinephrine and norepinephrine, neuropeptides and corticosteroid hormones like cortisol or corticosterone, is activated. All of these mediators can change the cell activity, producing both delayed and rapid responses in a wide range [3].

Physiologically, stress is induced when the homeostasis is challenged. The process of the body to re-establish homeostasis by various physiological and behavioural adaptive responses that can have either negative or positive effects. Therefore, stress level must be controlled at an optimum level, because it may lead to cognitive, growth and social impairment [4]. Furthermore, the constant stress exposure will affect the physical health in terms of digestive problems, cardiovascular problems, and can also disrupt the immune system activity [5].

Cortisol and Cognitive Performance Cortisol is a glucocorticoid hormone that is always used in psychological processes.[6] Cortisol is a lipophilic hormone, which means it can penetrate into the blood-brain barrier, resulting in psychological activity was disturb. Adrenal glands are the source of cortisol, which is managed by the hypothalamus-pituitary-adrenal (HPA) axis [7]. Due to the stimulation, the anterior pituitary was induced to produces adrenocorticotropic hormone (ACTH), to increases the conversion of cholesterol to pregnenolone and finally becomes cortisol in the kidney [8]. The glucocorticoid receptors are widely spread throughout the body, such as the central nervous system, cardiovascular, respiratory, reproductive, and musculoskeletal. Cortisol can regulate the metabolism of the body, the immune system and inflammatory responses. Nowadays, cortisol can be measured from blood plasma, hair, cerebrospinal fluid, urine and even saliva. Insufficient cortisol level, or known as hypocortisolism, is manifested from a lack of adrenal function. Adrenal insufficiency was divided into three. First, primary adrenal insufficiency is commonly manifested from autoimmune adrenalitis, infection and adrenal haemorrhage [9]. Other than that, Secondary adrenal insufficiency is generated from a deficiency of ACTH production by anterior pituitary. Lastly, tertiary adrenal insufficiency is due to low secretion of corticotropin-releasing hormone (CRH) from the hypothalamus.[10] Most of the people who get Addison's disease have altered mental status [11]. Nevertheless, an excess of cortisol, known as hypercortisolism, can impair memory and visual perception, including reducing the brain size [12]. It can also give stress responses, psychiatric disease, hyperlipidemia, and diabetes [13]. Therefore, cortisol is the biomarker of stress level. Cushing's syndrome is a common disease caused by excess release of cortisol due to etiologies including ectopic ACTH syndrome (EAS), adrenal tumour or even genetic [14-16]. In this review, we will give an overview of any articles regarding the interaction between cortisol levels with cognitive performance under stressful situations.

Methodology

Eligibility Criteria

The eligibility criteria were made by using the PICO framework. The population of interest was human adults, aged starting from 10 years old and above. The intervention of studies are defined stress conditions, post traumatic events and stress induction or stressor (e.g. Trier Social Stress Test (TSST)). The outcome measure required was the assessment of cortisol level after stress condition and cognitive performance result via neuropsychological test, cognitive executive function and attention measurement (e.g. Stroop Colour-Word Test), working memory (e.g. serial arithmetic tasks) and global cognition test (e.g. Mini-Mental State Examination). The comparison group was not a strict requirement for inclusion for this review. Articles without these key elements were excluded.

Search criteria

The searching of sources was conducted via Google Scholar, PubMed, Scopus, ScienceDirect, and Springer Nature. Search rules for the result included are required to have any terms identified from "list 1", "list 2", "list 3" (See Table 1). The search conducted also excluded terms 'Animal, Rats, Baby, Neonatal, Cancer' from results.

Table 1. Search list

List 1		List 2		List 3
"Hydrocortisone" OR "Cortisol" Or "Serum Cortisol" OR "Blood Cortisol" OR "Plasma Cortisol"	AND	"Cognitive" OR OR "Executive Function" OR "Cognitive Performance" OR "Cognitive Function" OR "Recognition" OR "Attention" OR "Working Memory" OR	AND	"Stress" OR "Stressor" OR "Stress Response" OR "Stress Induction" OR OR "acute stress" OR "TSST"

“Instant Recall” OR
“Decision Making”

Study screening by inclusion and exclusion

We have decided to include results from serum and salivary cortisol as one of the variables from the articles included. This decision is due to higher studies collected data of salivary cortisol compared to serum cortisol. This is because sample collection for salivary cortisol is non-invensive method and more convenient, especially collecting cortisol levels after experiencing stressful events for conducting the studies. We decided to exclude any articles that collect cortisol levels from patients with Cushing’s Syndrome, Alzheimer, and dementia.

Findings and Discussions

Effects of Acute Stress on Cognitive Performance

Acute stress has been shown to significantly influence cognitive performance through rapid activation of the hypothalamic–pituitary–adrenal (HPA) axis and subsequent cortisol release [2,6]. Caldwell et al. [17] demonstrated that individuals exposed to captivity simulation experienced impaired reaction time, indicating reduced psychomotor vigilance under acute stress conditions. Similarly, Varanoske et al. [19] reported that military training stress resulted in slower reaction times and increased cognitive errors, suggesting that heightened cortisol levels negatively affect attention and processing speed.

In contrast, certain forms of acute physiological stress may produce mixed cognitive outcomes. Bermejo et al. [21] observed that resistance exercise-induced stress elevated cortisol levels while improving specific cognitive task performance, indicating that short-term stress may transiently enhance certain cognitive functions. However, Shou et al. [23] reported a negative correlation between cortisol levels and working memory as well as spatial cognitive performance following acute exercise, highlighting that the cognitive effects of acute stress depend on stress intensity and individual adaptation.

Academic and Performance-Related Stress

Academic stress represents a common real-life stressor that influences both cortisol levels and cognitive outcomes. Anjum et al. [18] found that cortisol levels increased significantly during examination stress, with variations across students of different academic performance levels. These findings suggest that moderate stress may enhance alertness and performance, consistent with the concept of eustress [1]. However, excessive stress can impair concentration, memory retrieval, and overall cognitive efficiency, particularly during high-pressure situations.

Psychological and Trauma-Related Stress

Psychological and trauma-related stressors have been strongly associated with elevated cortisol levels and cognitive impairment. Shamoon et al. [20] reported that individuals exposed to traumatic experiences exhibited significantly higher cortisol levels accompanied by reduced cognitive performance. Furthermore, Chenyu et al. [22] demonstrated that individuals experiencing profound emotional stress, such as the loss of an only child, showed significantly lower scores in global cognition and memory tests. These findings indicate that chronic psychological stress leads to sustained cortisol elevation, which adversely affects cognitive functioning.

Therapeutic Modulation of Cortisol and Cognitive Function

Interventional approaches targeting stress reduction provide important insights into the relationship between cortisol and cognition. Ghodrati Torbati et al. [24] showed that compassion-focused therapy significantly reduced cortisol levels while improving cognitive emotion regulation in individuals with substance abuse disorders. These findings suggest that psychological interventions can restore neuroendocrine balance and improve cognitive outcomes by mitigating stress-induced cortisol dysregulation.

Evidence from Additional Included Studies

Baliyan et al. [25] and other studies included in this review further reinforce the association between elevated cortisol levels and impaired cognitive performance across diverse stress conditions and populations. Across these studies, cognitive domains such as attention, working memory, executive function, and global cognition were consistently affected by cortisol fluctuations, supporting the robustness of this relationship.

Neurobiological Mechanisms Linking Cortisol and Cognition

The effects of cortisol on cognitive performance are mediated through its interaction with glucocorticoid receptors widely distributed in the brain, particularly in the hippocampus and prefrontal cortex [6,7]. Excessive cortisol exposure disrupts synaptic plasticity, reduces neurogenesis, and impairs long-term potentiation, leading to deficits in learning and memory [12]. Additionally, prolonged hypercortisolism has been associated with structural brain changes and reduced cognitive capacity [13], further explaining the observed impairments in cognitive performance under chronic stress conditions.

Overall Synthesis

The collective findings from all included studies indicate a strong and consistent association between stress-induced cortisol elevation and cognitive performance. While moderate increases in cortisol may transiently enhance certain cognitive functions, excessive or prolonged exposure is associated with significant cognitive impairment. These results highlight the importance of maintaining optimal cortisol levels and implementing effective stress management strategies to preserve cognitive health and functional performance. Table 1 shows the characteristics of the included studies, including authors, publication year, study design, and key results.

Table 1: The characteristics of the included studies examining the relationship between stress-induced cortisol

Article	Total Sample	Type Of Cortisol	Stress Condition or Induction	Cognitive Performance Test	Main Findings
Caldwell et al 2019 [17]	34	Salivary Cortisol	captivity simulation by mock Prisoner of War (POW)	PVT Reaction Time	The expected interaction and main effects did occur, and the main effect of time was significant (F(2.9,96.5) = 31.66, p <.0001).
Anjum et al., 2021 [18]	44	Serum Cortisol	examination stress	Academic Performance (CGPA)	Cortisol levels were higher in high-grade students than in average and low-grade students.
Varanoske et al., 2018 [19]	19	Serum Cortisol	Military training	Mathematical processing and reaction time	Visual reaction time of the placebo group was slower at 24H than at 0H (P = 0.035), and made more errors on reaction time testing at 12H than the group receiving BLA (p = 0.048).
Shamoon et al., 2021 [20]	188	Serum Cortisol	Traumatic experience (e.g. natural disaster, any accident, physical and/or verbal violence)	Six Item Cognitive Impairment Test	In comparison to controls, trauma patients (6-CIT score > 8) had considerably lower BDNF levels (15.68 ± 3.55 ng/dl), slightly higher CRP levels (4.29 ± 1.50 mg/dl), and higher cortisol levels (26.17 ± 3.65 mcg/dl).
Bermejo et al., 2022 [21]	19	Salivary Cortisol	Acute resistance physical exercise	RULIT	The findings revealed a significant main effect of successes followed

					(F (1, 18) = 18.33, p < 0.001, partial η2 = 0.505), with correct scores increasing after the first error (M = 7.3; SD = 0.4) compared to M = 5.4; SD = 0.6. Additionally, exercise-induced stress was found to have a significant main effect (F (1, 18) = 15.49, p = 0.001, partial η2 = 0.462).
Chenyu P. et al., 2024 [22]	80	Serum Cortisol	Parents who lost their only child (PLOC)	MMSE, immediate memory scores, recall scores	PLOCs has significantly lower score in MMSE (p=0.049), immediate memory score (p=0,017), recall score (p=0.025) compared to healthy control
Shou et al, 2024 [23]	17	Salivary Cortisol	Acute exercise	Mental Rotation, bells test score, 2-Back Test	negative correlation between cortisol level with Mental Rotation Test and 2-Back Test, but not significant in accuracy
Ghodrati Torbati et al., 2020 [24]	40	Serum Cortisol	Compassion-Focused Therapy (CFT) in drug abuser	Cognitive Emotion Regulation questionnaire	In the experimental group, compassion-focused therapy improved cognitive-emotion regulation and decreased blood cortisol levels. This intervention had a 0.59 effect on lowering blood cortisol levels, which indicates that 59% of the observed variances were related to the therapeutic

					intervention.
Baliyan et al., 2021 [25]	79	Salivary Cortisol	Home confinement during Covid-19	Corsi Block-Tapping Test	CAR had an indirect effect on perceived self-efficacy through changes in Corsi-forward (ES = -0.181; 95% CI = [-0.373, -0.060]) and perspective-taking (ES = -0.239; 95% CI = [-0.447, -0.062]), resulting in a total indirect effect of (ES = -0.420; 95% CI = [-0.674, -0.193]). According to these findings, a higher CAR was associated with better perspective-taking and spatial working memory during confinement.
Lieberman et al., 2016 [26]	60	Serum and Salivary Cortisol	military Survival, Evasion, Resistance, and Escape (SERE) school	Grammatical Reasoning, N-back, Match-to-sample, PVT	Cognitive function was substantially degraded over the course of SERE school.
Fernando et al., 2022 [27]	13	Serum Cortisol	anxiety in athlete	BAI and CSAI-2 (anxiety measurement)	Cortisol and cognitive anxiety were found to have significant correlations (Pearson's r = 0.766, p-value = 0.002)
Varanoske et al., 2022 [28]	71	Salivary Cortisol	military Survival, Evasion, Resistance, and Escape (SERE) school	PVT	While TMD, anxiety, and depression scores, as well as S100B, DHEA-S, IL-6, norepinephrine, and epinephrine concentrations, all increased (all p ≤ 0.01), FFM, psychomotor vigilance, and LBP decreased from PRE to

					POST.
Becker et al., 2020 [29]	85	Salivary Cortisol	Verbal Fluency Task (VFT)	VFT Performance	cortisol levels were not associated with VFT performance (all p ≥ .370)
Forse et al., 2025 [30]	25	Salivary Cortisol	Decision-Making under Uncertainty and Stress (DeMUS) virtual reality task	Recognition Memory Task (RMT), Spatial Orienting Task (SOT) etc.	No significant correlation between cortisol and VR performance. However, certain traits or characteristics may play a mediating role.
Brand et al., 2018 [31]	39	Salivary Cortisol	TSST-C	Rey Auditory Verbal Learning Test	Higher cortisol levels were associated with lower explicit learning encoding (verbal, but not figural learning)
Becker & Rohleder, 2020 [32]	81	Salivary Cortisol	Socially Evaluated Cold-Pressor Test (SECPT)	Color-Word Stroop Test	Only cortisol responders showed a negative correlation between the recall phase errors and the Stroop task errors 20 minutes after the stressor/control (# Errors Stroop 6: r(17) = −0.49, p = 0.045)
de Mendonça Filho et al., 2022 [33]	77	Salivary Cortisol	attachment of preschool student	Bayley Scales mental development index (MDI)	Children with insecure attachment had lower neurodevelopmental scores than children from the secure group (B = −5.17, r = 0.23, p = 0.017).
Cintineo & Arent, 2019 [34]	26	Salivary Cortisol	anxiety before wrestling competition	State Anxiety Inventory	Salivary cortisol and anxiety levels during the pre-competition phase were found to be significantly correlated (r = 0.52; p = 0.006). When an athlete won a

					competition, state anxiety was lower than when they lost (44.5 ± 5.6 vs. 55.7 ± 5.6; $p < 0.001$; ES = 2.00).
(La Fratta et al. 2021) [35]	56	Salivary Cortisol	Athletes	Competitive State Anxiety Inventory-2 (CSAI-2)	ΔCortisol salivary levels were positively correlated with ΔCognitive Anxiety (CA) score ($r = 0.556$, $p < 0.01$).
Dziembowska et al., 2019 [36]	55	Salivary Cortisol	athletes	EOC	Cortisol levels analysis revealed significant effects of time ($F(3,180) = 11.73$, $p < 0.001$) and training status ($F(1,60) = 4.69$, $p = 0.034$) but there were no differences in state anxiety levels between the groups.
Iranez Bortolotto et al., 2020 [37]	57	Salivary Cortisol	Occupational stress (nurse)	Stroop Test	cortisol at bedtime was not significant with stroop colour score ($r=-0.221$, $p=0.051$)
Gabrys et al., 2019 [38]	64	Salivary Cortisol	undergraduate student	TSST	Perseverative errors were significantly reduced in those who finished the TSST ($F(1,62) = 4.42$, $p =.040$).
SHIELDS et al. 2017 [39]	251	Salivary Cortisol	Athletes	Stroop Test	The perception of cognitive deficits was negatively correlated with response accuracy during incongruent Stroop trials ($r = -0.38$, $p < 0.05$) and positively correlated with mood disturbance ($r = 0.54$, $p < 0.05$) and perceived stress ($r = 0.55$, $p < 0.05$)

					for athletes during peak training.
Sang et al., 2018 [40]	286	Serum Cortisol	Impact Of Cortisol To Cognitive Function In Elderly	MSSE	Higher cortisol levels at 12:00 p.m. were associated with poorer short-term memory, and older adults with cognitive impairment showed a significant increase in cortisol secretion.
Cullen et al., 2020 [41]		Salivary Cortisol	stressor-cortisol concordance	Progression of positive symptoms of youth at clinical high-risk (CHR) for psychosis	Daily stressor distress was significantly associated with cortisol in controls (β = 0.60, 95% CI: 0.12–1.08) and CHR youth who converted to psychosis (β = 0.91, 95% CI: 0.05–1.78). In controls only, life event exposure was associated with cortisol (β = 0.45, 95% CI: 0.08–0.83).
Bermejo et al., 2018 [42]	34	Salivary Cortisol	Fatigue exercise	Psychomotor Vigilance Task (PVT)	Significant main effects of exercise [$F(1, 33) = 41.32$, $p < .001$, partial $\eta^2 = .56$] and cognitive task [$F(1, 33) = 31.83$, $p < .001$, partial $\eta^2 = .49$] are shown in the results, with cortisol levels being lower prior to exercise and higher prior to the cognitive task.
Shields et al., 2019 [43]	107	Salivary Cortisol	cold pressor test	flanker task	Stress has no significant impact on response time ($F(1, 45.0) = 2.59$, $p = .114$).

Xin et al., 2020 [44]	24	Serum Cortisol	Cold pressor stress (CPS)	EEG Recording and Processing	The ANOVA revealed no difference in mood, basal HR, basal blood pressure, or basal cortisol concentration between the CPS and control sessions.
Hamed et al., 2019 [45]	32	Salivary Cortisol	Video Game	Paced Auditory Serial Addition Test (PASAT)	There was a significant (P=0.034, Figure 5) increase in the longest correct answer chain (sustained attention) following the game compared to before.
Flintoff et al., 2025 [46]	34	Serum Cortisol	TSST and Heat stress trial	Parametric Go/No-Go task (inhibitory control) and Psychomotor Vigilance Task (PVT)	In the psychosocial trial, lower performance on the Go/No-Go task was strongly associated with baseline cortisol levels.
Ju et al., 2020 [47]	251	Serum Cortisol	childhood trauma	Dysfunctional Attitudes Scale (DAS)	MDD group, both dysfunctional attitudes and cortisol levels were correlated with childhood trauma and depression severity
Ngampramuan et al., 2018 [48]	20	Salivary Cortisol	MDD patient	Wisconsin Card Sorting Test (WCST)	When compared to normal subjects, saliva samples from MDD patients had a significantly higher level of cortisol hormone (MDD: 0.5803 ± 0.045 μg/dl, control 0.22 ± 0.017 μg/dl, $p < 0.0001$), as Figure 2 illustrates. The MDD group's WCST score was significantly lower than the control

					group's (MDD: 62.69 ± 4.48% of conceptual response, control: 74.6 ± 3.11% of conceptual response, p value = 0.0132).
G Bertollo et al., 2020 [49]	101	Serum Cortisol	MDD	beck's inventory	There is a significant correlation between depression and stress scores in individuals diagnosed with MDD in clinic, with an index r = 0.70. Correlation analysis revealed no significant relationship between cortisol levels and depression scores, despite the fact that cortisol levels are significantly higher in people with MDD.
Adrián Alacreu-Crespo et al., 2020 [50]	70	Salivary Cortisol	suicide	HAM-D	Patients who had made an initial violent or serious attempt at suicide had higher post-DST cortisol levels at 9 p.m. than those who had not (p <.010).
Zhong et al. 2018 [51]	148	Serum Cortisol	patients with late-life depression	MMSE	Elevated serum cortisol levels and older age were correlated to a 1.6- and 1.2-fold increased risk of cognitive decline (95% CIs = 1.07-2.5, p = 0.02, and 95% CIs = 1.04-1.4, p = 0.01, respectively).

Discussion

In this review, the association between serum cortisol levels and cognitive performance under different stress conditions was examined by reviewing 35 articles from reliable sources. Most studies expressed the data as mean ± standard deviation using SPSS statistical software. One-way ANOVA is used to compare the mean variables, which are serum cortisol levels and cognitive performances. Then, a post-hoc test was conducted for normally distributed data to determine the significance of variables, while a non-parametric test for non-normally distributed data. After the comparison, the p-value which is less than 0.05 is taken as significant in these studies. During stress conditions, the HPA axis is activated, resulting in a rise in cortisol serum level as the response.[15] It acts on many target organs, especially the brain, as cortisol can easily penetrate the blood-brain barrier (BBB), resulting in several physiological changes.[16] Overall, most studies support the hypothesis that elevated cortisol level is associated with poorer cognitive performance[17,19-23,25-28,31-36,38-51]. A study states that higher cortisol level lowers the total cerebral brain volumes, such as the occipital and frontal lobes, which are responsible for memory and visual perception function.12 However, each type of stress condition demonstrates a different effect on cognitive performance.

Acute stress condition is the short-term stress resulting from immediate stressors [52] such as military training [17,19,26,28] acute exercise [21,23, 39,42] occupational stress [37], stress stimulation [29-32,43-44,46] examinations [18,38] and competition time [27,34,45]. Based on the reviewed studies, most people facing acute stress exhibit poor scores in cognitive function assessments, demonstrating poor alertness, memory and learning abilities in a brief time. Moreover, a few studies demonstrated mood disturbance among these people.[39] The reason is that elevated cortisol levels cause reversal of top-down prefrontal inhibition of the subcortical region that controls executive function [53]. However, stress induced by the examination and competition time facilitates those abilities. For instance, one study discovered an increased cortisol level in high-CGPA students compared to others during examination time [44]. It may occur due to overactivation of the fight-or-flight response to short-term stress mediated by cortisol, which temporarily enhances cognitive performance, such as increasing attention and alertness [54].

Meanwhile, a chronic stress condition results from persistent stress 3333s over an extended period [52], such as home confinement [25], in people who suffer from major depressive disorder (MDD) [34,48-51] and anxiety [33-36]. Most people with MDD and anxiety naturally have higher cortisol levels than normal people due to cortisol dysregulation [55]. It indicates that the people facing chronic stress are exposed to prolonged elevated cortisol levels. These studies also demonstrated poor scores in cognitive assessment along with changes in the autonomic nervous system (ANS) structure and cognitive decline in people facing chronic stress. It coincides with the report that prolonged elevated cortisol levels affect the forebrain and limbic structure, which leads to cognitive impairment [56].

In addition, several studies demonstrated the effect of traumatic stress from traumatic events [52] such as accidents, physical violence, childhood trauma and losing a child on cognitive performance [22], including dysfunctional attitudes [47] and cognitive impairment, specifically memory function [20,22] in the long term. The finding correlated with the fact that trauma stress also has a lasting effect on the alteration of brain structure, such as hippocampal [57]. Thus, this review implies that the elevated serum cortisol is susceptible to decreasing cognitive performance under stressful conditions. However, some limitations need to be considered in this review, such as different cognitive assessments conducted among the sample to evaluate the cognitive performance, and the sample included people of different genders and age groups.

Conclusion

This meta-analysis of interaction between serum cortisol level and cognitive performance demonstrated a significant result under stress conditions, whether acute or chronic stress. We identified that stress condition can induce cortisol levels. Furthermore, the increased amount of cortisol can have a negative effect on cognitive performance. Stress can disturb the ability of making choices, memorizing, and performing other psychological activities. From these articles, it can be hypothesized that the cortisol level is the stress response that negatively correlates with cognitive performance.

Conflict of interest

The authors declare no conflict of interest.

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