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Neurobiological and psychological effects of reciting the Quran from the Mushaf

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Abstract

Background This study aims to examine the acute neurobiological effects of reciting the Quran from the Mushaf on salivary BDNF, Apelin, and Cortisol levels and their relationship with emotional state.

Methods The study employed a randomized pre-test post-test control group design conducted in Türkiye. The sample consisted of 100 healthy theology students (50 females, 50 males) aged 18–25, proficient in reciting the Quran in accordance with *Tajweed* rules. Participants were randomly assigned to either the experimental group (reciting the first nine verses of Surah Al-Imran, $n = 50$) or the control group (standardized passive resting, $n = 50$). Salivary BDNF, apelin, and cortisol levels were measured using the ELISA technique before and after the intervention. Emotional states were assessed using the Mood Scale and the Psychological Well-being Scale.

Results The experimental group exhibited a statistically significant increase in mean salivary BDNF and apelin levels and a significant decrease in cortisol levels following recitation compared to the passive control group ($p < 0.05$). In terms of gender, no statistically significant differences were observed in biomarker responses ($p > .05$). Correlation analysis revealed a significant “biological reciprocity,” where cortisol showed a negative correlation with apelin ($r = -0.436, p < 0.001$) and BDNF, while correlating positively with negative emotions.

Conclusions Reciting the Quran aloud acts as a rapid psychophysiological intervention that downregulates the HPA axis (reduced cortisol) and upregulates neurotrophic factors (increased BDNF and apelin). These findings suggest that structured recitation functions as a restorative neuroplasticity practice, promoting biological stress resilience associated with psychological well-being.

Highlights

- Structured Quran recitation induced acute increases in salivary BDNF and apelin levels.
- A significant downregulation of the HPA axis (reduced cortisol) was observed in the experimental group.
- A “biological reciprocity” was identified between stress hormones (cortisol) and neurotrophic factors.
- Neuroendocrine responses showed significant correlations with subjective mood and psychological well-being scores.



Keywords Brain-Derived Neurotrophic Factor (BDNF), Apelin, Cortisol, Quran reciting, Psychoneuroimmunology, Neuroplasticity

1 Background

Religion has historically served as a significant source of support for individuals navigating life's challenges, offering solace and hope [1]. Within this context, religious practices, the obligatory rituals prescribed to adherents, are crucial in enhancing religious efficacy. In this context, religion influences mood through various aspects such as individual differences, the nature of religious beliefs, the type of religious practices, and so on [2].

From the perspective of Mind-Body Medicine, religious practices such as recitation are increasingly recognized not merely as spiritual rituals but as potent psychophysiological interventions. Within the framework of Psychoneuroimmunology (PNI), these practices are hypothesized to trigger 'top-down' neural regulation [3, 4], where focused cognitive attention and rhythmic vocalization modulate the hypothalamic-pituitary-adrenal (HPA) axis [5]. This modulation effectively reduces stress responses and promotes a neuroendocrine environment conducive to neuroplasticity and immune health. Therefore, analyzing Quran recitation through this bio-behavioral lens offers a unique opportunity to understand how spiritual engagement translates into measurable neurobiological alterations, specifically involving stress hormones (cortisol) and neurotrophic factors (BDNF, apelin).

In Islam, practices primarily encompass prayer (Salah), fasting (Sawm), almsgiving (Zakat), and pilgrimage (Hajj). Furthermore, learning, reciting, and memorizing the Quran, Islam's central religious text, constitute both an act of worship and a prerequisite for the performance of Salah [6]. These practices not only enable a person to fulfil their religious obligations but also have significant effects on their mood. The Quran, the fundamental religious text of Islam, consists of 114 chapters and a total of 6,236 verses. Revealed by Allah to the Prophet Muhammad, it guides in all areas of life such as moral, legal, social, etc. and its reciting is an act of worship. The Quran is considered to offer psycho-spiritual therapeutic benefits to those who recite or listen to it [7, 8, 9, 10]. Quranic reciting is purported to stimulate alpha brainwave activity, increase endorphin release, elevate stress thresholds, mitigate negative emotions [11, 12, 13].

Neurotrophic factors are a family of biomolecules, consisting almost entirely of peptides or small proteins, that support the growth, survival, and differentiation of both developing and mature neurons [14]. As a member of the neurotrophin family, Brain-Derived Neurotrophic Factor (BDNF) is a protein that plays a significant role in the survival, growth, and differentiation of neurons [15]. BDNF is widely expressed in the central and peripheral nervous system, with particularly high levels in the hippocampus, cortex, and basal forebrain [16]. BDNF exerts its effects primarily through a receptor tyrosine kinase called tropomyosin receptor kinase B (TrkB) [15]. The binding of BDNF to TrkB leads to dimerization and autophosphorylation of the receptor. This event triggers the activation of intracellular signaling pathways, such as PI3K/Akt, MAPK/ERK, and PLC γ , ultimately resulting in changes in gene expression, protein synthesis, and modulations in neuronal survival, neuronal growth and differentiation, synaptic plasticity, and neurotransmitter release functions [14]. Alterations in BDNF levels and function are associated with various neurological and psychiatric disorders. It is thought that

there is a relationship with low BDNF levels in diseases such as Alzheimer's disease [17], depression [18] and Parkinson's disease [19].

Apelin, a peptide hormone, is a recognized member of the adipokine family. It is widely accepted that adipose tissue is not merely an energy storage depot but also functions as an active endocrine organ [20]. Apelin is widely expressed in central and peripheral tissues and has many physiological functions [21]. Its main functions include regulation of the cardiovascular system [22, 23] fluid homeostasis [24], energy metabolism [25] and the immune system [26, 27]. Additionally, it modulates the nervous system by influencing neurotransmitter release, neuronal plasticity, and neuroprotection, and it plays a role in various neurological processes [28].

Cortisol is a steroid hormone secreted from the outer layer of the adrenal glands, called the cortex. As a member of the glucocorticoid class, cortisol plays a key role in the body's stress response and is also known as the "stress hormone" [29, 30]. Cortisol has a wide range of important functions in the body; it affects glucose metabolism (de Leon et al., 1997), protein metabolism [31] and lipolysis [32], regulates the stress response [33], the immune system, and plays an important role in cognitive functions such as memory formation and retrieval [34].

In the literature review, no study was found that investigated the relationship between Quran reciting (from Mushaf) and mood and salivary BDNF, apelin, and cortisol levels. In this context, this study aimed to examine the relationship between Quran reciting and mood and salivary BDNF, apelin, and cortisol levels.

2 Methods

2.1 Participants and procedures

The study employed a randomized pre-test post-test control group design conducted in Türkiye. The study population consisted of theology students aged 18–25. An a priori power analysis using G*Power (v3.1.9.7) indicated that a total sample size of 100 participants would be sufficient to detect a medium effect size ($f = 0.25$) with 80% power and a 5% margin of error ($\alpha = 0.05$).

Inclusion and Exclusion Criteria: The study included 100 healthy volunteers (50 females, 50 males). The primary inclusion criterion was proficiency in reciting the Quran in accordance with Tajweed (phonetic) rules. Exclusion criteria were rigorously applied to prevent confounding factors affecting salivary biomarkers. Participants were excluded if they had any history of psychiatric or neurological disorders, chronic systemic diseases, or were currently using any medication. To ensure sample integrity, participants were instructed to attend the sessions fasting (no food or drink), to abstain from smoking on the morning of the test, and to avoid brushing their teeth for at least two hours prior to sampling to prevent gingival micro-bleeding which could contaminate saliva samples.

Randomization and Procedure: Eligible participants were randomly assigned to either the experimental group ($n = 50$) or the control group ($n = 50$) using a simple randomization method (drawing lots). This process ensured a balanced gender distribution (25 males, 25 females per group). Data collection spanned a period of 20 days. To minimize the impact of circadian variations in cortisol secretion, all sessions were strictly conducted between 08:00 and 09:00 am. To strictly control for the Cortisol Awakening Response (CAR) and ensure that measured levels reflected the acute impact of the

intervention rather than natural diurnal surges, all participants were instructed to wake up at least 120 min (2 h) prior to their scheduled 08:00 am session. This timing ensured that salivary sampling (08:00–09:00 am) occurred during the post-awakening cortisol plateau, thereby minimizing the confounding influence of the rapid cortisol rise typically observed immediately after awakening. Furthermore, the strict requirement to abstain from smoking, food, and oral hygiene for at least two hours prior to the session further standardized the physiological state of the participants.

Experimental Group: Participants were seated comfortably and recited the first nine verses of Surah Al-Imran directly from the Mushaf. They were instructed to use the ‘Tar-til’ style (a slow, measured, and rhythmic recitation) while strictly adhering to Tajweed rules. The recitation lasted approximately 5–7 min.

Control Group (Standardized Passive Control): To establish a physiological baseline and control for the effects of the experimental environment, this group underwent a standardized passive resting session (quiet wakefulness). Participants were seated in the same isolated, temperature-controlled room for approximately 7 min, matching the experimental duration. They were strictly instructed to keep their eyes closed, remain silent, and avoid any deliberate cognitive engagement or physical movement.

2.2 Measures

Prior to the physiological sampling, socio-demographic data were collected using a Personal Information Form. Participants’ emotional states and psychological health were assessed as baseline measures using a cross-sectional protocol to investigate the correlation between initial psychological status and biological responses. No post-intervention psychological scales were administered.

Saliva Collection: To avoid the potential interference of cotton or synthetic swabs on protein markers (BDNF/apelin), the “unstimulated passive drool” method was utilized instead of Salivettes. Participants were instructed to pool saliva in the floor of their mouths and gently drool into sterile, polypropylene tubes (5 mL).

Biochemical Analysis: Immediately after collection, samples were centrifuged at 2000 × g for 20 min using a refrigerated centrifuge (NF 1200R, Ankara, Türkiye) and stored at -80 °C until analysis. To ensure methodological objectivity and eliminate potential detection bias, the laboratory personnel performing the ELISA assays were completely blinded to the participants’ group assignments, sampling time points (pre/post), and the specific study design. All biochemical analyses were performed in a single session to minimize inter-assay variability. Salivary levels were measured using human-specific Enzyme-Linked Immunosorbent Assay (ELISA) kits (SinoGeneclon, China) in accordance with the manufacturer’s instructions. The specific kits used were: Human BDNF (Cat.No: SG-10200), Human Apelin (Cat.No: SG-10252), and Human Cortisol (Cat. No: SG-00111). The intra-assay and inter-assay coefficients of variation were <8.0% and <10.0%, respectively. Absorbance values were read at 450 nm using a microplate reader.

The Mood Scale: Scale developed by Yıldırım and Tabak, is a 19-item instrument designed to measure both positive and negative affect. Specifically, the scale comprises 9 items assessing positive emotions and 10 items assessing negative emotions. Furthermore, the MS measures both the frequency and intensity of experienced emotions separately. Frequency of experience is assessed using a 5-point Likert-type scale with the following response options: (1) Never, (2) Rarely, (3) Sometimes, (4) Often, and (5)

Always. Intensity of experience is assessed using a 3-point Likert-type scale, offering the following responses for each item: (1) Low, (2) Moderate, and (3) High. The reliability coefficient of the Mood Scale was determined as 0.820 [35]. In this study sample, KMO and Bartlett's Test value was found to be 0.842 the Cronbach Alpha reliability coefficient was found as 0.777.

Psychological Well-being: The scale adapted to Turkish by Telef was developed to measure socio-psychological well-being. The scale consisting of 8 items has a 7-point Likert-type rating: (1) Strongly Disagree, (2) Disagree, (3) Slightly Disagree, (4) Undecided, (5) Slightly Agree, (6) Agree and (7) Strongly Agree are answered between 1 and 7 and all items are expressed positively. The sum of the Cronbach alpha internal values obtained from the reliability version of the scale was calculated as 0.800 [36]. In this study sample, KMO and Bartlett's Test value was found to be 0.801, and Cronbach's Alpha reliability coefficient was found to be 0.834.

2.3 Data analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (Armonk, NY: IBM Corp.). Numerical data are presented as mean $\pm$ standard deviation (SD). The normality of data distribution was verified using the Shapiro-Wilk test. To examine the effects of the intervention while accounting for gender differences, a Three-Way Mixed ANOVA (2 Groups [Experimental, Control] $\times$ 2 Genders [Female, Male] $\times$ 2 Time Points [Pre-test, Post-test]) was conducted. In this model, "Time" was defined as the within-subject factor, while "Group" and "Gender" were treated as between-subject factors. Where significant main effects or interactions were observed, Bonferroni-corrected post-hoc tests were performed to identify specific differences. Effect sizes were calculated using Partial Eta Squared (η^2_p) and classified as small (0.01), medium (0.06), and large (0.14). Correlations between numerical parameters were analyzed using Pearson's correlation test, while Spearman's rho was used for non-numerical parameters. A p-value of <0.05 was considered statistically significant.

3 Results

Table 1 presents the descriptive statistics (Mean and Standard Deviation) for serum BDNF levels across groups, gender, and time points. At baseline (Pre-test), the Experimental ($M = 5.65$, $SD = 2.55$) and Control ($M = 5.70$, $SD = 2.55$) groups exhibited remarkably similar BDNF concentrations, indicating homogeneity prior to the intervention.

Following the intervention, a distinct divergence was observed. The Experimental group, which engaged in Quran recitation, demonstrated a substantial increase in BDNF levels, rising to a post-test mean of 8.59 ($SD = 3.66$). In contrast, the Control

Table 1 Descriptive statistics of BDNF Levels by group and gender

Group	Gender	N	Pre-test (M $\pm$ SD)	Post-test (M $\pm$ SD)
Experimental (Quran Recitation)	Male	25	5.41 $\pm$ 2.56	8.18 $\pm$ 3.08
	Female	25	5.90 $\pm$ 2.58	9.03 $\pm$ 4.23
	Total	50	5.65 $\pm$ 2.55	8.59 $\pm$ 3.66
Control (Passive Rest)	Male	25	5.33 $\pm$ 2.58	5.41 $\pm$ 2.58
	Female	25	6.04 $\pm$ 2.52	6.13 $\pm$ 2.52
	Total	50	5.70 $\pm$ 2.55	5.78 $\pm$ 2.55

Values are presented as Mean $\pm$ Standard Deviation (SD) The baseline and post-intervention aggregate values of these biomarkers, which provide the foundational descriptive context for these correlational dynamics, are highlighted in bold

Table 2 Results of the 2 × 2 mixed design ANOVA for BDNF levels

Source	SS	df	MS	F	p	η^2
Between-subjects						
Gender	24.02	1	24.02	1.52	0.221	0.016
Group (Exp./Control)	98.76	1	98.76	6.25	0.014*	0.061
Gender × Group	0.03	1	0.03	0.00	0.964	0.000
Error	1517.75	96	15.81			
Within-subjects						
Time	114.83	1	114.83	155.62	< 0.001*	0.618
Time × Gender	0.43	1	0.43	0.58	0.447	0.006
Time × Group	102.57	1	102.57	139.01	< 0.001*	0.592
Time × Gender × Group	0.39	1	0.39	0.53	0.469	0.005
Error(Time)	70.84	96	0.74			

SS Sum of Squares, df Degrees of freedom, MS Mean Square. $p < .05$

Table 3 Descriptive statistics of apelin levels by group and gender

Group	Gender	N	Pre-test (M ± SD)	Post-test (M ± SD)
Experimental (Quran Recitation)	Male	25	2.32 ± 0.75	2.91 ± 0.67
	Female	25	2.34 ± 0.68	3.05 ± 0.54
	Total	50	2.33 ± 0.71	2.98 ± 0.61
Control (Passive Rest)	Male	25	2.01 ± 0.49	2.06 ± 0.58
	Female	25	1.87 ± 0.59	2.02 ± 0.49
	Total	50	1.94 ± 0.55	2.04 ± 0.53

Values are presented as Mean ± Standard Deviation (SD) The baseline and post-intervention aggregate values of these biomarkers, which provide the foundational descriptive context for these correlational dynamics, are highlighted in bold

group (passive rest) showed negligible change, with post-test levels ($M = 5.78$, $SD = 2.55$) remaining nearly identical to their baseline values.

Regarding gender, both male and female participants in the experimental group displayed comparable upward trends, suggesting that the intervention's effect on neurotrophic levels was not gender-dependent.

To assess the impact of Quran recitation on neurotrophic activity, a 2 × 2 Mixed Design ANOVA was conducted (see Table 2). The analysis revealed a significant main effect for Time, $F(1, 96) = 155.62$, $p < .001$, $\eta^2_p = 0.62$, indicating a general increase in BDNF levels across the aggregated sample. However, as shown in Table 2, this main effect was qualified by a statistically significant and robust Time × Group interaction, $F(1, 96) = 139.01$, $p < .001$. The partial eta squared (η^2_p) value of 0.59 indicates a large effect size, suggesting that approximately 59% of the variance in BDNF changes can be attributed to the specific intervention. This interaction confirms that the increase in BDNF levels was not uniform but was specifically driven by the experimental condition.

Furthermore, while a significant main effect was observed for Group ($p = .014$), the analysis yielded no significant main effects or interactions involving Gender ($p > .05$). This lack of significance in the Time × Gender × Group interaction ($p = .469$) reinforces the finding that the neurotrophic benefits of the intervention are consistent across both male and female participants.

Table 3 presents the means and standard deviations for serum Apelin levels across groups and time points. At baseline (Pre-test), the Experimental group ($M = 2.33$, $SD = 0.71$) and the Control group ($M = 1.94$, $SD = 0.55$) exhibited moderate variability. Post-intervention measurements revealed a distinct divergence in trajectories. The Experimental group, following the Quran recitation regimen, showed a marked elevation

Table 4 Results of the 2 × 2 mixed design ANOVA for apelin levels

Source	SS	df	MS	F	p	η^2
Between-subjects						
Gender	0.003	1	0.003	0.007	0.932	0.000
Group (Exp./Control)	22.094	1	22.094	48.185	< 0.001*	0.334
Gender × Group	0.369	1	0.369	0.804	0.372	0.008
Error	44.018	96	0.459			
Within-subjects						
Time	6.967	1	6.967	24.917	< 0.001*	0.206
Time × Gender	3.758	1	3.758	13.439	< 0.001*	0.123
Time × Group	0.174	1	0.174	0.621	0.433	0.006
Time × Gender × Group	0.001	1	0.001	0.003	0.954	0.000
Error(Time)	26.842	96	280			

SS Sum of Squares, df Degrees of freedom, MS Mean Square. $p < .05$

Table 5 Descriptive statistics of cortisol levels by group and time

Group	Gender	N	Pre-test (M ± SD)	Post-test (M ± SD)
Experimental (Quran Recitation)	Male	25	2.01 ± 0.12	1.88 ± 0.17
	Female	25	2.09 ± 0.15	1.93 ± 0.16
	Total	50	2.05 ± 0.14	1.90 ± 0.17
Control (Passive Rest)	Male	25	2.08 ± 0.19	2.28 ± 0.19
	Female	25	2.06 ± 0.25	2.38 ± 0.20
	Total	50	2.07 ± 0.22	2.33 ± 0.20

Values are presented as Mean ± Standard Deviation (SD) The baseline and post-intervention aggregate values of these biomarkers, which provide the foundational descriptive context for these correlational dynamics, are highlighted in bold

in apelin levels, reaching a mean of 2.98 (SD = 0.61). Conversely, the Control group (passive rest) displayed a minimal increase, with post-test levels (M = 2.04, SD = 0.53) remaining largely comparable to their baseline values.

When stratified by gender, the data indicates a consistent pattern; both male and female participants in the experimental condition demonstrated similar upward trends in apelin concentration, suggesting a uniform physiological response to the intervention independent of gender.

To examine the differential effects of Quran recitation on apelinergic activity, a 2 × 2 Mixed Design ANOVA was conducted (see Table 4). The analysis yielded a significant main effect for Time, $F(1, 96) = 24.92$, $p < .001$, $\eta^2_p = 0.21$, suggesting a general increase in apelin levels from pre-test to post-test.

However, this temporal trend was significantly modulated by the group assignment, as evidenced by the significant Time × Group interaction, $F(1, 96) = 13.44$, $p < .001$. The effect size ($\eta^2_p = 0.12$) indicates that the intervention accounts for a substantial portion of the variance in apelin changes. This interaction confirms that the significant elevation in apelin levels was specific to the experimental group, while the control group showed a comparatively flat trajectory.

Furthermore, a significant main effect of Group was observed ($F(1, 96) = 48.19$, $p < .001$), indicating higher overall apelin concentrations in the experimental condition. Consistent with the analyses of cortisol and BDNF, no significant main effects or interactions were found for Gender ($p > .05$), demonstrating that the apelin response to the intervention is robust and independent of biological sex.

As detailed in Table 5, the baseline (pre-test) salivary cortisol levels were statistically similar between the Experimental (2.05 ± 0.14 µg/dL) and Control (2.07 ± 0.22 µg/dL)

Table 6 Results of the 2 × 2 mixed design ANOVA for cortisol levels

Source	SS	df	MS	F	p	η^2
Between-subjects						
Gender	0.164	1	0.164	3.309	0.072	0.033
Group (Exp./Control)	2.402	1	2.402	48.314	< 0.001*	0.335
Gender × Group	0.007	1	0.007	0.147	0.702	0.002
Error	4.772	96	0.050			
Within-subjects						
Time	0.171	1	0.171	9.406	0.003*	0.089
Time × Gender	0.028	1	0.028	1.525	0.220	0.016
Time × Group	2.093	1	2.093	115.274	< 0.001*	0.546
Time × Gender × Group	0.076	1	0.076	4.197	0.043*	0.042
Error(Time)	1.743	96	0.018			

SS Sum of Squares, df Degrees of freedom, MS Mean Square. $p < .05$

Table 7 Relationship between BDNF, apelin, cortisol, mood scale and psychological well-being

		BDNF	Cortisol H.	Apelin	M. S. Positive E.	M. S. Negative E.	P. Well-Being
BDNF	r	1	−0.216*	0.320**	0.117	−0.211*	0.085
	p		0.012	0.001	0.244	0.035	0.398
Cortisol	r	−0.216*	1	−0.436**	−0.202*	0.285*	−0.313*
	p	0.012		0.000	0.043	0.022	0.013
Apelin	r	0.320**	−0.436**	1	0.161	−0.106	−0.114
	p	0.001	0.000		0.263	0.464	0.431
M. S. Positive E.	r	0.117	−0.202*	0.161	1	−0.369**	0.515**
	p	0.244	0.043	0.263		0.000	0.000
M. S. Negative E.	r	−0.211*	0.285*	−0.106	−0.369**	1	−0.347**
	p	0.035	0.022	0.464	0.000		0.000
P. Well-Being	r	0.085	−0.313*	−0.114	0.515**	−0.347**	1
	p	0.398	0.013	0.431	0.000	0.000	

N = 100

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed)

groups, indicating a balanced starting point. However, following the sessions, a distinct divergence was observed: while the cortisol levels in the passive control group increased to 2.33 ± 0.20 $\mu\text{g/dL}$, the levels in the Quran recitation group decreased to 1.90 ± 0.17 $\mu\text{g/dL}$. This descriptive data suggests a stress-reducing trend specifically in the experimental group.

The statistical significance of these changes was confirmed by the Three-Way Mixed ANOVA results presented in Table 6. The analysis revealed a highly significant Time × Group interaction [$F(1, 96) = 115.27$, $p < .001$]. The effect size for this interaction was substantial ($\eta^2_p = 0.546$), indicating that the intervention accounted for approximately 54.6% of the variance in cortisol changes.

Although a marginally significant three-way interaction (Time × Gender × Group) was detected [$F(1, 96) = 4.20$, $p = .043$], its effect size was small ($\eta^2_p = 0.042$). This suggests that while there were minor variations in the magnitude of response between males and females (e.g., control females showed a slightly steeper increase than males), the primary stress-reducing effect of the recitation was consistent across both genders.

Pearson correlation analysis was conducted to investigate the interrelationships between biological markers (BDNF, apelin, cortisol) and psychological measures (Mood and Well-being) (see Table 7).

Biological Interactions: The analysis revealed a significant “biological reciprocity” between stress hormones and neuroprotective factors. Cortisol levels exhibited a moderate, negative correlation with apelin ($r = -.436, p < .001$) and a significant negative correlation with BDNF ($r = -.216, p = .012$). Conversely, a significant positive correlation was observed between the two neurotrophic markers, BDNF and apelin ($r = .320, p = .001$), suggesting a synchronized neuroprotective response. The baseline and post-intervention aggregate values of these biomarkers, which provide the foundational descriptive context for these correlational dynamics, are highlighted in bold within Tables 1, 3, and 5.

Psycho-Biological Associations: Regarding psychological outcomes, cortisol emerged as the primary physiological correlate of subjective well-being. A significant inverse relationship was found between cortisol and Psychological Well-being ($r = -.313, p = .013$) and Positive Mood ($r = -.202, p = .043$), while a positive correlation was observed with Negative Mood ($r = .285, p = .022$). Additionally, BDNF showed a significant inverse correlation with Negative Mood ($r = -.211, p = .035$), indicating that higher neuroplasticity is associated with reduced negative affect. Apelin, while strongly linked to biological stress markers, did not show significant direct correlations with the self-reported psychological scales ($p > .05$).

4 Discussion

The present study provides the first empirical evidence regarding the acute neurobiological effects of structured Quran recitation from the Mushaf on salivary BDNF, apelin, and cortisol levels. Our findings demonstrate that a brief session of recitation, performed with adherence to *Tajweed* rules (rhythmic vocalization) and cognitive focus, leads to a significant reduction in salivary cortisol and a concurrent elevation in neurotrophic factors (BDNF and apelin). These physiological alterations showed significant correlations with baseline subjective mood and psychological well-being scores.

The Stress-Reducing Effect: Psychoneuroimmunological Mechanism The significant reduction in cortisol observed in the experimental group aligns with the growing body of literature on the restorative effects of spiritual practices. Recent studies have demonstrated that group chanting and rhythmic vocalization can effectively reduce cortisol levels and alleviate stress [37, 38]. Our findings suggest that Quran recitation operates through a similar but distinct psychoneuroimmunological (PNI) pathway [39] (as illustrated in Fig. 1).

The regulated breathing and rhythmic vocalization required by *Tajweed* likely stimulate the vagus nerve, inducing a “Relaxation Response” that downregulates the Hypothalamic-Pituitary-Adrenal (HPA) axis [5]. This finding is particularly significant when interpreted alongside our recent research. In a previous study, we demonstrated that dysfunctional metacognitive beliefs and high stress levels were strongly associated with increased cortisol secretion and disrupted CREB levels [40]. The current study suggests that Quran recitation may act as a potent “psychological buffer” that reverses this maladaptive pathway, effectively lowering the cortisol load even in the presence of academic or daily stressors.

Neuroplasticity and the BDNF Response A critical finding of this study is the acute increase in salivary BDNF levels following recitation. This corroborates the very recent findings of Adriani et al. (2025), who reported that Quran memorization activities

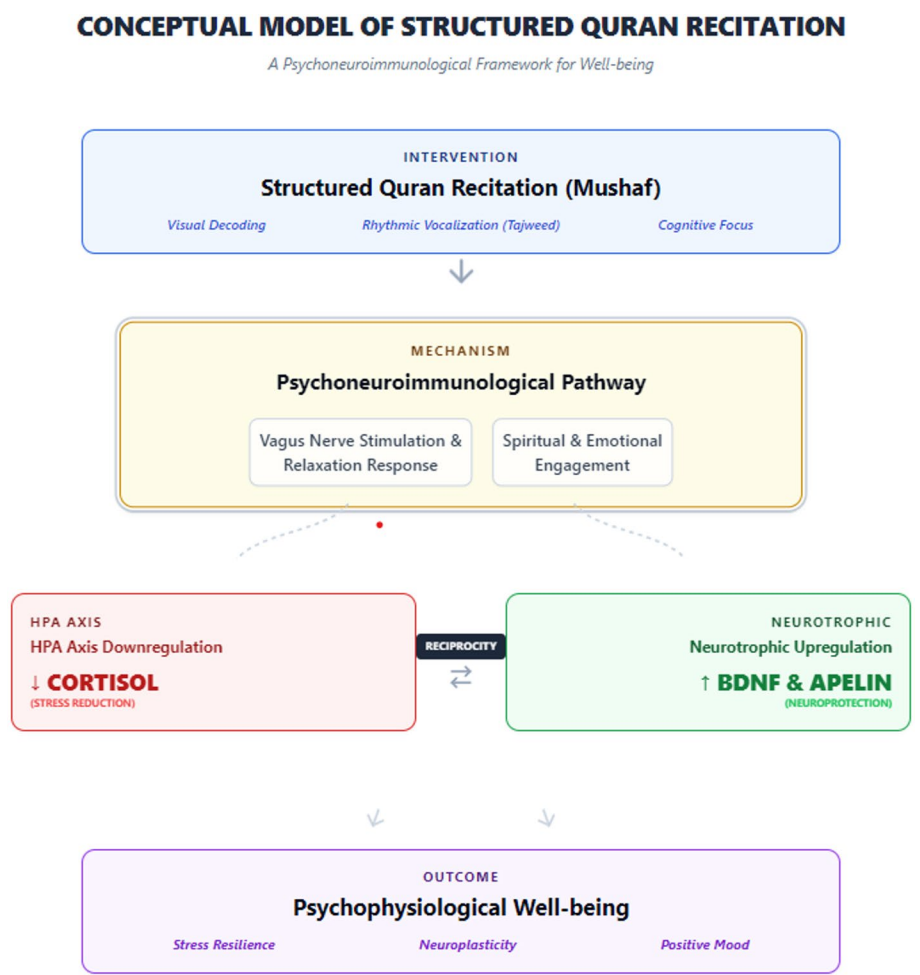


Fig. 1 Conceptual model of the psychoneuroimmunological framework of structured Quran recitation. The intervention acts as a multi-modal stimulus (visual, rhythmic, cognitive) triggering vagal modulation. This leads to a synchronized biological response characterized by HPA axis downregulation (stress reduction) and neurotrophic upregulation (neuroprotection), connected via biological reciprocity. The outcome is enhanced psychophysiological well-being. *HPA* Hypothalamic-Pituitary-Adrenal, *BDNF* Brain-Derived Neurotrophic Factor

significantly elevated serum BDNF levels, linking the practice to enhanced cognitive function [41]. Furthermore, meta-analytic evidence supports that mindfulness-based interventions can acutely enhance peripheral BDNF concentrations [42]. Our results offer a compelling physiological counter-narrative to the “stress-neurotoxicity” hypothesis. In our parallel investigation involving university students, we found that negative metacognitive beliefs were associated with suppressed BDNF levels, and low BDNF was linked to deficits in specific intelligence domains [43, 44]. The observed upregulation of BDNF in the current study suggests that structured recitation functions as a “neuroplasticity training,” combining the cognitive effort of decoding the text with the emotional engagement of worship to restore neurotrophic balance.

Apelin: A Novel Marker of Stress Resilience Perhaps the most novel contribution of this study is the identification of the apelinergic response to religious practice. Although historically viewed as a metabolic peptide, recent research has redefined apelin as a key neuro-regulator involved in stress adaptation [45]. Xu et al. (2025) recently highlighted the apelin/APJ system as a promising therapeutic target for countering oxidative stress

and neuroinflammation [46]. The strong negative correlation between apelin and cortisol observed in our study supports a “counter-regulatory” hypothesis: Apelin may be upregulated in response to the recitation to buffer the physiological effects of stress and promote homeostasis. This places Quran recitation not merely as a psychological comfort but as a practice potentially activating endogenous neuroprotective pathways, consistent with neural correlates of Quranic impacts on cognition [47].

4.1 Limitations and future directions

Several limitations of this study should be acknowledged, which also provide avenues for future research. The primary limitation represents the nature of the control group. While the “passive resting” protocol provided a valid physiological baseline to isolate the effects of the experimental environment, it did not control for the mechanics of vocalization. The experimental group engaged in a complex cognitive-motor task involving rhythmic vocalization, adherence to phonetic rules (*Tajweed*), and engagement with a spiritual text, whereas the control group remained silent. Consequently, it is difficult to determine whether the observed physiological changes are specific to the spiritual content of the Quran or are partially attributable to the physiological benefits of regulated breathing and vocalization. Future studies should employ rigorous “active control groups,” such as having participants recite a non-religious text with similar phonetic complexity, to better isolate the unique psychobiological effects of the Quran. Additionally, this study was conducted with a specific homogenous demographic (theology students). While this increased internal validity by minimizing lifestyle variables, it may limit generalizability. Future research could explore these effects in a more diverse population with varying levels of religious commitment.

5 Conclusion

This study provides empirical evidence that, compared to a passive resting baseline, the acute recitation of the Quran from the Mushaf triggers a distinct neuroendocrine response characterized by the upregulation of neurotrophic factors (BDNF and apelin) and the downregulation of stress hormones (cortisol). These physiological alterations were significantly correlated with better baseline subjective mood and psychological well-being, suggesting a synchronized mind-body mechanism. The findings support the hypothesis that structured Quran recitation functions as a psychophysiological intervention within the Psychoneuroimmunological (PNI) framework, potentially fostering stress resilience and neuroplasticity. Given the study’s methodological scope, further research utilizing active control designs and neuroimaging techniques is warranted to elucidate the precise neural causality of this relationship. Nevertheless, this study serves as a pioneering step at the intersection of the psychology of religion and neuroscience.

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Author contributions

S.O. and B.B. designed the study. S.O. and B.B. collected data. S.O. analyzed the data. B.B. prepared the draft plan. All authors contributed to writing the manuscript. All authors read and approved the final manuscript.

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Data availability

The corresponding author upon reasonable request will provide data supporting the findings of this study.

Declarations

Ethics approval and consent to participate

The study received ethical approval from the Bayburt University Research Ethics Committee (12.12.2024/Decision no: 361). Before data and sample collection, participants were informed about the study and their written/verbal consent was obtained in accordance with the Declaration of Helsinki. All methods were carried out in accordance with the relevant guidelines and regulations.

Consent for publication

Not applicable.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Competing interests

The authors declare no competing interests.

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