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DOI 10.25789/YMJ.2022.79.24

УДК 572.79

RELATIONSHIP OF PERSONALITY TRAITS AND STRESS WITH FUNCTIONING OF THE HYPOTHALAMIC-PITUITARY-ADRENAL AXIS

The aim of this study is to test the hypothesis that personality traits (neuroticism, extraversion/introversion) and stressful life events in childhood could be related to HPA axis reactivity. We studied 121 healthy adult men of Yakut ethnicity aged 18–25 years. High neuroticism and introversion have been found to be associated with lower blood cortisol. Stressful life events have been positively associated with neuroticism, but we failed to detect a significant correlation with ACTH and serum cortisol levels in young people.

Keywords: personality traits, cortisol, adrenocorticotropin (ACTH), HPA-axis, neuroticism, extraversion, introversion, stressful events in childhood, Yakuts.

Introduction. The neurobiological response to stress is coordinated by the hypothalamic-pituitary-adrenal (HPA) axis through changes in cortisol levels. HPA axis reactivity represents a potential marker of sensitivity for various neuropsychiatric disorders. The prospective studies of individuals without depression have demonstrated that such personality trait as neuroticism, which can be characterized by a tendency to experience negative emotions, is a risk factor for the subsequent development of depression [1; 19]. Moreover, the results of behavioral and molecular genetic studies showed that neuroticism and depression had common genetic risk factors [2; 6; 8; 29]. However, it is still poorly understood whether there is a relationship between personality trait measures (neuroticism, extraversion/introversion) and the level of HPA hormones. The results of several studies attempted to identify associations between these variables are conflicting [9; 12; 17; 20; 23; 24; 26 - 28].

It is known that HPA axis functioning is affected by several factors, including stress at an early age [5; 11; 14; 15; 31; 33], as well as anxiety disorders, but these potential predictors have been rarely systematically assessed or controlled for. However, there is some evidence that stress and trauma at an early age can be associated with hypocortisolemia and a weakened cortisol response to stress [5; 14; 15; 33]. Stressful life experiences, apparently, can trigger the development of depression, anxiety and mental disorders [4; 18]. Animal and human studies showed that early exposure to stress could cause persistent changes in HPA axis functioning that reflect some of the neuroendocrine abnormalities commonly associated with depression and various post-traumatic stress disorders [16; 31].

The aim of the present study is to test the hypothesis that personality traits (neuroticism, extraversion/introversion) and childhood stressful events are associated with HPA axis reactivity.

Materials and methods. The study sample consisted of 121 apparently healthy young men (21.5±2.25 years), the Yakuts from the Republic Sakha (Yakutia). All individuals were students or employees of Universities without a hereditary burden of mental illness. To form the sample, we have considered the fact that the hormonal background in men is more stable than in women. Hormonal disruptions in men often occur when the level of sex hormones falls after the age of 30, so young men under the age of 30 were included in the sample to minimize this factor. The ethnicity of the subjects was determined on the basis of a questionnaire survey. At the same time, ethnic self-identification was taken into account mainly up to the third generation.

Hormonal levels were assessed by determining the levels of serum cortisol and adrenocorticotropic hormone (ACTH) in EDTA-plasma. Blood sampling was carried out in the morning on an empty stomach, in the appropriate vacutainers. The analysis was carried out by enzyme-linked immunosorbent assay (ELISA) using standard kits from Diagnostics Biochem Canada Inc. (Canada) and Biomerica (USA) on the Victor X5 multifunctional plate analyzer.

The Eysenk Personality Inventory (EPI) was used to diagnose extraversion/introversion and neuroticism. EPI is one of the most common tests for assessing the basic personality traits, proposed by G. Eysenck and S. Eysenck in 1964. Despite the fact that the questionnaire evaluates personality traits, actually they comprise of temperament traits, since in foreign psychological studies the concept of personality includes the concept of temperament. The EPI contains 57 questions, 24 of which assess extraversion/introversion, the other 24 - evaluate

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emotional stability/instability (or neuroticism), the remaining 9 form a control group of questions designed to assess the sincerity of the subject, his attitude to the examination and the reliability of the results. Diagnostics according to G. Eysenck is a classic technique and serves as a reliable tool in modern psychology.

The Life Events Checklist (LEC) is a short questionnaire used to identify potentially traumatic events (PTEs) such as spouse's death, parental divorce, substance use by a spouse, accidents, relatively low levels of family income or poor living conditions, disasters, sexual or physical abuse, or other effects associated with the impact on the nervous system [3]. The original English version was recently tested for reliability and validity and showed good psychometric properties and is therefore recommended for use in trauma assessment. Our study used a modified version of the original Blake et al. [3]. Our modified LEC consists of 16 items, and each item reflects a potentially traumatic event.

Statistical analysis and data processing were performed using the STATISTICA software package (version 10.0, StatSoft, Inc., USA, 2011). To identify the significance of intergroup differences in personality traits and hormone levels, the nonparametric Mann-Whitney U test and the Kolmogorov-Smirnov test were used. For the quantitative indicators of the G. Eysenck questionnaire, a comparative analysis of the mean group values was carried out, the mean rank values were derived using the Student's t-test. The analysis of the relationship of individual personality traits (extraversion, neuroticism) was carried out accounting for the results obtained on the level of cortisol and ACTH via correlation analysis with linear correlation and correlation ratio algorithms. Direct and inverse relationships were taken into account determining weak, medium, and strong correlations. Correlation coefficients have been calculated via Spearman rank correlation coefficient - a measure of linear relationship between random variables.

The study was conducted in compliance with the principle of informed consent. All participants were informed about the plans, methods and aims of the study and gave written consent to participate in it. The design of the study was approved by the local committee on biomedical ethics of the YSC CMP (Protocol No. 41 of November 12, 2015).

Results. The average level of plasma ACTH and serum cortisol in the total sample of young Yakut men was 31.92 pg/ml and 10.01 μg/dl, which corre-

Table 1

ACTH and cortisol levels in the groups of individuals with high and low neuroticism

Hormones	Average levels of hormones in the group		p	
	Low neuroticism (n=46)	High neuroticism (n=75)	Mann-Whitney test	Kolmogorov-Smirnov test
ACTH, pg/ml	34.09	30.52	0.09	< 0.10
Cortisol, μg/dl	11.04	9.02	**0.05**	**<0.01**

Table 2

ACTH and cortisol levels in the groups of individuals with high extraversion/ introversion

Hormones	Average levels of hormones in the group		p	
	Extraverts (n=63)	Introverts (n=58)	Mann-Whitney test	Kolmogorov-Smirnov test
ACTH, pg/ml	32.42	32.15	0.80	>0.10
Cortisol, μg/dl	11.20	9.01	**0.04**	**<0.05**

Table 3

Levels of ACTH, cortisol, extraversion and neuroticism in groups of individuals with high and low LEC scores

	Group with low LEC levels (n=78)	Group with high LEC levels (n=43)	p	
			Mann-Whitney test	Kolmogorov-Smirnov test
ACTH	32.24	31.35	0.69	> 0.10
Cortisol	9.97	10.35	0.66	> 0.10
Neuroticism	11.7	13.8	**0.024**	> 0.10
Extraversion	11.96	12.51	0.41	> 0.10

Table 4

Correlations of ACTH and cortisol levels with personality traits (extraversion and neuroticism) and stressful life events (LEC)

	Extraversion(n=121)	Neuroticism (n=121)	LEC
ACTH	r= 0.01 p>0.05	r= -0.14 p>0.05	r= -0.03 p>0.05
Cortisol	r= **0.19*** **p<0.05**	r= -0.07 p>0.05	r= 0.04 p>0.05

Table 5

Correlations of ACTH and cortisol levels between subscales (levels) of extraversion/ introversion and neuroticism

	Extraverts (n=63)	Introverts (n=58)	High Neuroticism (n=75)	Low Neuroticism (n=46)
	Neuroticism		Extraversion	
ACTH	r= **-0.42*** **p<0.05**	r= 0.05 p>0.05	r= -0.19 p>0.05	r= **0.23*** **p<0.05**
Cortisol	r= -0.08 p>0.05	r= -0.07 p>0.05	r= 0.07 p>0.05	r= **0.30*** **p<0.05**

sponds to the manufacturer's indicated average high ACTH levels and average low cortisol level. The concentrations of ACTH and cortisol depending on neuroticism and extraversion / introversion are presented in tables 1 and 2.

When examining the level of ACTH in the subjects with low neuroticism, we observed a tendency for high plasma ACTH level compared with individuals with high neuroticism (p=0.09) (Table 1). In the group of men with low neuroticism, the average cortisol level was 11.04 μg/dl, while in the group of men with higher neuroticism, the level of serum cortisol was significantly lower - 9.02 μg/dl (p = 0.05)

There were no significant differences in mean ACTH levels between the extravert and introvert groups (p=0.80) (Table 2). When conducting a comparative analysis of cortisol level, it was found that the average level of cortisol in the blood serum was 11.20 μg/dL in the group of extraverts, while it was significantly lower - 9.01 μg/dL (p=0.04) in the group of introverts.

Table 3 demonstrates a comparative analysis of individuals with high and low levels of stressful life events (based on LEC). As a result of comparing hormonal levels, no significant differences in both cortisol and ACTH between low- and high-LEC groups were revealed. When comparing mean neuroticism scores, it was detected that in low-LEC group they were statistically significantly lower than in high-LEC group (11.7 and 13.8, respectively, p=0.024) (Table 3). This observation allows to characterize the men from high-LEC group as emotionally unstable than from low-LEC group.

When conducting a correlation analysis of ACTH and cortisol levels with extraversion, neuroticism and the number of stressful life events, we observed no correlation between cortisol level in the total sample of Yakut men and neuroticism; however, a weak correlation was determined with extraversion (r = 0.19, p<0.05) (Table 4). According to ACTH level, no significant correlations with these indicators were found.

When searching for correlations in the subgroups of extraverts and introverts, a significant persistent negative correlation between ACTH and neuroticism was characteristic for extraverts (r=-0.42, p<0.05), whereas no such correlation was reported for introverts (Table 5). In low neuroticism scoring individuals, a positive correlation was found between cortisol and ACTH levels and extraversion (r=0.30, r=0.23, p<0.05) (Table 5).

Discussion. Neuroticism reflects a tendency to experience negative emotions, and people with emotional instability show increased levels of anxiety, apprehension, and negative emotions [22]. Previous studies report contradictory findings on the relationship between neuroticism and cortisol levels. In some studies of young subjects separated into high or low neuroticism groups measured with the Eysenck Personality Inventory, it was reported that high levels of neuroticism predicted lower cortisol levels [12; 17; 20; 26]. In other studies neuroticism has been frequently associated with elevated cortisol levels, or a lack of association between these variables was shown [9; 23; 24; 28; 27]. In our sample a negative relationship was observed between neuroticism and cortisol (Table 1), which is consistent with the results of the first group of researchers [12; 17; 20; 26].

The neuroendocrine correlates of extraversion/introversion have not been systematically examined, but it has been suggested that HPA axis hormones are involved. Some studies indicated that higher extraversion was associated with increased cortisol levels [20; 23; 25]. According to Oswald et al., lower extraversion in men is associated with a reduced cortisol response to stress, and introverts can be expected to cope better with stress and, therefore, have lower activation thresholds for their HPA axis [25]. Oppositely, extraverted individuals may have higher thresholds for physiological arousal. This effect may be mediated by aggressive interactions causing peer rejection, which can represent a powerful social stressor [13]. Several other studies reported an opposite tendence (higher extraversion associated with lower cortisol levels) [33], or the absence of associations [28]. The underlying reason for such discrepancy between the results of various studies remains unclear, but our result is consistent with previous suggestion that extraverts are characterized by higher levels of cortisol (Table 2), and there is a weak positive correlation between cortisol levels and extraversion (Table 4).

To assess a degree of experienced stress we used a modified version of the LEC questionnaire. The Life Events Checklist (LEC) was added to the list of Potentially Traumatic Events (PTEs) [7] and Post Traumatic Stress Disorder (PTSD) [35] after Gray et al. [10] showed that it was reasonably reliable. The LEC is the most widely used adult self-report tool to evaluate PTEs and is usually administered prior to a structured interview with the CAPS scale, which is the "golden standard" to diagnose PTSD. The results of our study indicate that severe adverse life events are significantly associated with neuroticism level; however, they insignificantly affect ACTH and cortisol levels (Table 3). Thus, it can be argued that such personality trait as neuroticism, which is traditionally considered as a risk factor for depression, depends on stressful events in the past.

On the other hand, within the framework of the present study, correlations between the level of HPA-axis hormones and personality traits were found only in extraverts and in emotionally stable individuals. Interesting data on the presence of a correlation between personality traits and the level of HPA-axis hormones were obtained depending on individual's specificity of sports activity. In particular, a positive correlation of cortisol levels with extraversion was observed only in bowmen, while such a relationship was not found for helmsmen [21]. It is known that the differentiation of athletes' roles in a team, among other things, is determined by a combination of certain personality traits: bowmen are characterized by high activity, socially oriented behavioral style and purposefulness, while helmsmen are characterized by a high degree of introversion [21]. Thus, our data indicating a positive correlation of cortisol (and ACTH) levels with extraversion, observed only for emotionally stable Yakut men (with low neuroticism) to a certain extent are consistent with the results of differential correlation in athletes. At the same time, similar findings were obtained without reference to sports activities: high cortisol levels positively correlated with self-esteem, endurance and emotional stability, as well as with reduced neuroticism and reduced depression in men [32]. Previous studies also indicated a positive correlation of extraversion with the level of pro-inflammatory cytokines (interleukin-6) [34], which may also indicate a general relationship between hyperactivity of the HPA axis and inflammatory response system in individuals searching for social contacts (i.e., extraverts). Another interesting finding of the present study is the negative correlation between ACTH levels and neuroticism, which was only significant in extraverts. This observation is congruent with the results of another research group, which demonstrated a decrease in adrenocorticotropic activity in individuals with a reduced sense of control (to some extent coinciding with an increase in neuroticism) [12]. At the same time, literature data indicate a difference in daily fluctuations in cortisol levels in extraverts and introverts. In particular, extraverts

are characterized by higher levels of cortisol during the day, while introverts are characterized by higher levels of cortisol during the nocturnal phase [30], which may to some extent explain the presence of a statistically significant correlation between the level of HPA-axis hormones and neuroticism only in extraverts.

This study is limited by a single-point assessment design, which does not allow to make conclusions regarding the stability of these associations. It should be noted that our sample is relatively homogeneous (it includes young individuals, Asians, high-school students), therefore, the results obtained may not reflect the processes occurring in adults and elderly, which limits the possibility of generalizing our results to a wider population. Despite these limitations, our study is the first one examining the associations of HPA axis activity with personality traits in more than a hundred informants using the stressful life events questionnaire. We also used a relatively large sample to detect associations with cortisol levels compared to other publications to more reliably assess HPA axis activity.

Conclusions. The results of this study confirm the link between two important personality traits (neuroticism, extraversion/introversion) and the activity of the HPA axis. Personality traits traditionally have been associated with greater risk for developing depression (high neuroticism) and introversion have been found to be associated with lower blood cortisol levels. It has been demonstrated that a greater number of experienced stressful events was associated with increased emotional instability (neuroticism), but insignificantly affected ACTH and serum cortisol levels in young individuals.

The work was supported financially by the Ministry of Education and Science, project No. FSRG-2020-0016 and by the megagrant from the Government of the Republic of Bashkortostan (Agreement No. 1, December 28, 2021).

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