

A Study on Relationship between Serum Cortisol and Serum Norepinephrine Levels and Sensation Seeking Trait among Iranian Male Staff

Hamidreza Pouragha¹, Seyed Jamaledin Shahtaheri^{2*}, Iraj Mohammadfam³, Hassan Ashayeri⁴, Abbas Rahimi Foroushani⁵ and Mahsa Naserpour⁶

¹Department of Occupational Health, Tehran University of Medical Sciences, International Campus, Tehran, Iran; ²Department of Occupational Health, International Campus, Tehran University of Medical Sciences, Tehran, Iran; ³Department of Safety Sciences, Hamadan University of Medical Sciences School of Public Health, Iran; ⁴Department of Neurology and Neuropsychology, Iran University of Medical Sciences, Iran; ⁵Department of Epidemiology and Bio-statistics, Tehran University of Medical Sciences, Iran; ⁶Department of Occupational Health, Tehran University of Medical Sciences Employees COHORT Study (TEC), Iran

Corresponding author:

Seyed Jamaledin Shahtaheri,
Department of Occupational Health,
International Campus, Tehran University of
Medical Sciences, Tehran, Iran, Arak, Iran
Tel: 00989121909095;
E-mail: shahtaheri@aftermail.ir

Abstract

Background: The sensation seeking trait as a personality element is the root of many risk taking behaviors. Behavioral biology theories consider this trait as acting under the command of genes and brains as the director. This research was conducted to study the relationship between sensations seeking trait with cortisol and norepinephrine transmitters. **Methods:** This study was conducted on 90 Iranian male Workers with an average age of 37.6±6.18 and an age range of 25 to 45 years old. In this study, blood serum cortisol and norepinephrine were measured and their association with the sensation seeking score was assessed by the fifth form of Zuckerman's Sensation Seeking Scale. Pearson correlation test and two-way ANOVA were used to analyze the data. **Results:** The mean sensation seeking score was 15.49 and the standard deviation was 5.69 and mean serum cortisol level was 14.65 µg / dl with SD 8.83. The mean serum norepinephrine level was 5.4 ng/ml with SD of 4.76. There was not a significant correlation between the overall sensation seeking scale and the serum cortisol concentration ($r = -0.243$, $p > 0.05$). Also the correlation between serum norepinephrine concentration and the overall SSS was not significant ($r = 0.247$, $p > 0.05$). Only a significant correlation was found between TAS subscale and cortisol concentration ($r = -0.266$, $p < 0.05$). **Conclusion:** This study supports the theory that the objective assessment of biomarkers related to the sensation seeking trait among Iranian man workers. The results showed an insignificant correlation between cortisol and norepinephrine concentration with sensation seeking trait. Since the correlation between serum cortisol concentration and TAS subscale of SSS was significant, based on the Zuckerman's Optimal Level of Arousal theory, according to our findings, it seems that more studies about the relationship between TAS subscale and relevant biomarkers, are require so we can conclude that TAS subscale can be used as a risky behavior predictor among workers. As such, it can be used as an introduction to predicting the sensation seeking status among employees as a contribution to their occupational and welfare status in order to select the right employer for a person's mental status.

Keywords: Sensation seeking; Cortisol; Norepinephrine; Risk taking; Iranian workers

Introduction

In recent decades, the sensation seeking theory developed by Marvin Zuckerman has been amazingly researched by scholars around the world. Zuckerman defines sensation seeking as the search for experiences and feelings that are "varied, novel, complex and intense and as the taking of various social risks. [1] He expressed sensation seeking as a personality trait inherent in the genes. For the people to reach the optimal level of arousal, they need to undergo experience. It was based on this idea that Zuckerman's sensation seeking scale was formed and developed. [2]

According to Marvin Zuckerman's sensation seeking theory, people have different personality traits and dimensions, especially in terms of sensation seeking. According to bio-behavioral theories, such personality traits are determined and guided by genes. [3]

The main structure of Zuckerman sensation seeking scale is based on four main factors: Thrill & Adventure Seeking or TAS, the items of this subscale include unusual physical activities, sensations and experiences such as climbing, parachuting, free fall, sky diving and diving. Often, these activities are known as relatively risky activities, and are avoided by the people with low risk seeking levels. The advantage that attracts sensation seekers is the very feeling of excitement rather than the risk associated. Experience Seeking or ES; this subscale describes

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new experiences that are perceived by the senses and the mind (music, art, excursion and travel) and that are usually sought by pursuing an unusual life style. Disinhibition or DIS, this subscale consists of seeking sensation through other people. The hedonistic lifestyle and participating in brutal parties and the diversity of sexual activities and whining are among the behaviors comprised by this subscale. Boredom Susceptibility or BS This subscale represents the frustration and discontent with any monotonous condition.^[1]

Risk seeking behaviors are closely related to sensation seeking trait, which include smoking, alcoholism and drug abuse, driving a vehicle while drunk, hazardous activities, gambling and unprotected sex.^[4-14] Another negative consequence of risky behaviors is dangerous driving, which can lead to accidents.

Many studies show that there is a relationship between risky behaviors, especially dangerous driving, with the sensation seeking. These studies indicate that the TAS sub-scale is the best predictor of risky driving behaviors.^[15-22] Many believe that inheritance and genes play a role in the transfer of sensation seeking personality traits. Biological research on identical twins indicate that sensation seeking trait, especially TAS and ES, are relatively largely hereditary.^[23-25]

Further, various studies have shown that aging reduces sensation seeking, especially in terms of TAS trait.^[4,7] TAS and DIS scores halve, especially over the age of 60 years, however this trend is less visible in the case of ES. In the case of BS, the increase in age does not significantly change its trend. Race doesn't affect the scoring.^[1] The socio-economic status, however, have a small effect on SSS.^[26]

Other biological correlations found in the sensation seeking scale indicate that those who seek more sensation have lower levels of monoamine oxidase and endorphin in their cerebrospinal fluid.^[27] The amplitude in visual or auditory evoked potentials is positively correlated with sensation seeking scale.^[28] Holmes et al. also found a significant correlation between cortical activity of the brain and sensation seeking. They said sensation seeking is associated with a reduction in the thickness of the cortical cortex of the brain.^[29] Ballenger et al. analyzed the levels of cerebrospinal fluid norepinephrine in male and female participants and found that these levels were negatively affected by sensation seeking.^[30]

There is also a similar negative correlation between sensation seeking and the concentration of dopamine hydroxylase (DBH), an enzyme involved in formation of norepinephrine.^[31]

One of the metabolites of norepinephrine in the urine is 3-methoxy-4-hydroxyphenylglycol (MHPG). It is generally thought to be derived from the epinephrine in the brain and therefore the reflector of its activity. Despite the diversity of the hypotheses in this regard, it can be stated that sensation seeking has a positive correlation with urinary levels of MHPG.^[32]

The relationship between sensation seeking behaviors and cortisol has been the subject of many studies. This steroidal substance, which is secreted by the cornea of the adrenal gland, increases under the conditions of physical and psychological stress and follows the regular rhythm of the circadian.^[33,34] These studies have shown a correlation between cortisol concentration and sensation seeking trait.^[34,35]

Another study in 2001 found that cortisol was not related to sensation seeking behaviors in both sexes and cortisol concentration in males had a negative correlation with their sensation seeking, but that in women, cortisol and the sensation seeking score were not related.^[36]

In 1996, Netter conducted a three-part study on the effects of neurotransmitters on the serotonergic system through hormonal responses (cortisol and prolactin). The study found that the activity of the dopamine and serotonin system is associated with the sensation seeking subscale of Zuckerman scale, and that there is a negative relationship between DIS and ES subscales of sensation seeking and the serotonergic system.^[37]

RUEGG et al. examined the relationship between cortisol and the three personality dimensions. They observed a correlation between cortisol and harm avoidance trait, but they did not see a correlation between the novelty seeking trait and cortisol.^[38] However, TYRKA stated that novelty seeking has a negative correlation with plasma cortisol concentration.^[39,40] Also, in 1999, GERRA et al. found no correlation between sensation seeking scores and cortisol concentrations.^[41]

White et al. observed a correlation between TAS and cortisol concentration.^[42] Couture et al. found a direct relationship with risk seeking behaviors in people with hypothalamic-pituitary-adrenal (HPA) axis dysregulation.^[43]

Shabani et al. examined 57 male volunteers and found a correlation between salivary cortisol and serum serotonin on the one hand and the sensation seeking scales on the other hand. They stated that there was only a negative correlation between the overall sensation seeking score and the concentration of salivary cortisol.^[44]

In this cross-sectional study, we intend to examine the correlation between two neurotransmitters, norepinephrine and cortisol with sensation seeking trait using the fifth form of Zuckerman's sensation seeking scale among Iranian male workers.

This study can be an introduction to the objective examination of the worker's sensation seeking status in order to provide optimal job and welfare conditions for them, and preventing many of the injuries caused by conflicts of occupational status and personality.

The aim of this research was clarifying the relationship between sensation seeking trait and its subscales and risk taking behaviors with cortisol and norepinephrine, using SSS questionnaire among Iranian workers and also we examined the relationship between cortisol and norepinephrine.

At the beginning, we assumed that cortisol has a reverse relation with risk taking and also there is a contrary relation between cortisol and norepinephrine. Our assumption was that all SSS subscales have direct relation with each other, either the relationship between norepinephrine and sensation seeking. According our hypothesis the relationship between age and risk taking was invers.

It should be noted that it was the first time that cortisol and norepinephrine were studied at the same time among Iranian population.

Methods

Objective

According to the theories, the effects of genes on the behaviors of many biomarkers play a role in sensation seeking. This paper examined the relationship between cortisol and norepinephrine on sensation seeking behaviors among Iranian male workers. Such risky behaviors can lead to unsafe acts, especially in high risk job and tasks, which can lead to industrial-scale human-induced incidents.

Participants

This study was conducted among 90 Iranian male Workers with an average age of 37.6 ± 6.18 years, with maximum and minimum age of subject being 45 and 25 years, respectively. The protocol of the study was approved by the Ethics Committee of Tehran University of Medical Sciences. Based on the ethical committee's approval, all participants were informed of the whole study process before the study and signed the informed participation consent form. All participants were also free to leave the study at each stage of the study process. Participants were also assured that their personal information was examined confidentially and we ensured the confidentiality of the participants' information using a coding system.

Subjects

In this study, healthy Iranian men employed in the industries were included. The maximum age of subjects was 45 years. Samples from 7 different factories were selected randomly. Participation in this study was voluntary. At first, 103 were selected. After initial analysis, 13 subjects were excluded because they didn't meet the inclusion criteria including non-smoking, non-alcoholism, no drug abuse and no medicine abuse and mental and physical health. Analysis was then performed on the remaining samples of 90. 33% had university education and 67% had secondary education.

The participants first completed the demographic and general information questionnaire and then completed the GHQ-28 questionnaire. The items of demographic information questionnaire covered inter alia physical and psychological disorders, history of drug use, alcohol, tobacco and drug use, exercise BMI, and diet. At this stage, after the examinations, those who did not have full health or used certain medications were excluded from the study. Those who had a history of smoking, alcoholism, drug abuse and medicine abuse were excluded from the study. The participants were psychologically and physically monitored on a regular and annual basis and had physical and mental health records, and only healthy people were included in this study. Table 1 presents the demographic indices of the participants.

Procedure

Every participant provided a letter of informed consent for participation in the study. 9cc venous blood samples of subjects were taken at a time between 10:00 and 12:00 by means of Multi-Sample Luer Adapter in serum blood clotting tube (Clot Activator evacuated tubes) for isolating the serum from the blood. Samples were centrifuged at 3000 rpm for 15 minutes and immediately after separation, blood serum was isolated and placed in icepack at 4°C for transfer to the lab. In the laboratory, the samples that were marked with a special code were stored in a negative 20°C freezer for collection and reaching the set level for the analysis. The samples remain stable up to 3 Month at this temperature. After two weeks, the samples collected were isolated and purified by ELISA method and the concentration of samples was read by ELISA reader. Based on the calibration curve drawn by the standard solution provided by the kits manufacturer, calculations were carried out on the biomarker concentrations.

In this study, ELISA kits with the following specifications were used to purify and measure serum cortisol and norepinephrine: Human Cortisol ELISA kit ZellBio® GmbH (Germany) Cat No: ZB-11003H-96 and Human Norepinephrine ELISA kit ZellBio® GmbH (Germany) Cat No: ZB-12099-H96

Zuckerman sensation seeking scale

This research was based on Zuckerman's theory of sensation seeking. Scientists like Zuckerman believe that the main personality traits are rooted in genes and biological mechanisms and have sustained interactions with the surrounding environment.

The fifth version of Zuckerman's sensation seeking scale is a shortened version of Zuckerman's Fourth Scale, designed in 1971.

The fifth version of the Zuckerman sensation seeking scale is the most popular measure of sensation seeking trait in the study of risky behaviors. The fourth edition of SSS contained 47 items, which were shortened in its fifth edition. For each of the 4 subscales, 10 of the best items were selected and the resulting form was 40-factor form, which is used to measure the overall sensation seeking.^[26]

One aspect of the personality that Zuckerman introduced in his new division is the topic of impulsive sensation seeking. Zuckerman also points out that there is a very strong relationship between this index and sensation seeking in personality.

Zuckerman^[3] acknowledged that SSS-V sensation seeking scale was still valid and reliable. SSS sensation seeking questionnaire is a self-contained 40 items questionnaire with mandatory

Table 1: Demographic indices.

Statistics	Age	BMI ¹	work experience (year)	monthly income \$	GHQ-28 Score ²	Job Satisfaction %
Mean	37.6	26.15	13.72	557	18.76	68.76
SD	6.18	3.66	6.9	263.15	6.83	20.33
min	25	19.59	1	222	7.00	10.00
max	45	36.33	25	1389	48	100.00

¹Body Mass Index - ²General Health Questionnaire

responses. Participants must answer all the questions. In this study, a Persian version of the questionnaire was used, whose validity and reliability has been established by Mahvi Shirazi.^[45]

Statistical analysis

In this study, Pearson correlation test was used to analyze the correlation between the results of serum norepinephrine and cortisol concentrations, sensation seeking scores, sensation seeking subscales. The significance level in this study was set at 0.05. Also, two-way analysis of variance was used to confirm the significance of the results. Statistical analyzes were performed using SPSS version 24 software.

Results

Participants in this study were 90 Iranian healthy men aged 25 to 45 years. The average age of participants was 37.6 ± 6.18 . The mean sensation seeking score for these 90 people was 15.31 and the standard deviation was 5.74. The minimum and maximum sensation seeking scores were 4 and 28, respectively.

The mean serum cortisol level was $14.65 \mu\text{g/dl}$ with a standard deviation of 8.83 and a range of $2.1 \mu\text{g/dl}$ to $47.9 \mu\text{g/dl}$. The mean serum norepinephrine level was also 5.4 ng/ml with a standard deviation of 4.76 and a range of 0.09 ng/ml to 16.3 ng/ml .

Cortisol and sensation seeking

There was not a significant correlation between the overall score on Zuckerman sensation seeking scale and the serum cortisol concentration ($r = -0.243, p > 0.05$).

Figure 1 shows that there is an inverse, not significant correlation between serum cortisol concentration and the score on Zuckerman sensation seeking scale, which means that the increase in serum cortisol concentration correlates negatively with the sensation seeking score.

Regarding the correlation between the four subscales of Zuckerman sensation seeking scale with serum cortisol concentration, only a significant correlation was found between TAS subscale and cortisol concentration as shown in Figure 2 ($r = -0.266, p < 0.05$). Table 2 shows the correlation results of serum cortisol concentration with the sensation seeking scale.

Serum norepinephrine and sensation seeking

In this study, there was not a significant correlation between serum norepinephrine concentration and the overall score of Zuckerman sensation seeking ($r = 0.247, p > 0.05$). The direct insignificant correlation between norepinephrine concentration and the overall score of sensation seeking scale is shown in Figure 3.

As for the relationship between the four subscales of Zuckerman sensation seeking scale with serum norepinephrine concentrations, the results reflect any correlations between them ($r = 0.266, p < 0.05$). The results of the correlation of Zuckerman sensation seeking subscales with serum norepinephrine concentrations are shown in Table 2. As shown in Figure 4 in contrast, there was a significant correlation between Cortisol and TAS, the correlation between TAS and Serum norepinephrine was not significant.

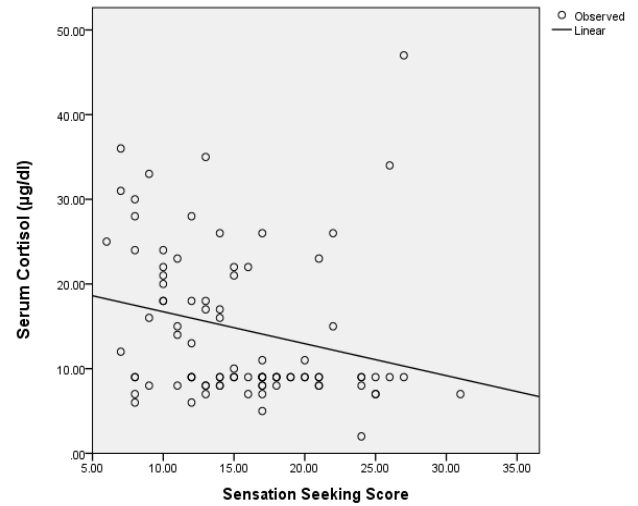


Figure 1: Correlation between SSS and serum cortisol.

Table 2: Statistical results.

	Serum Cortisol		Serum Norepinephrine	
	Sig	r	Sig	r
SSS	P>0.05	-0.243	P>0.05	0.247
TAS	P<0.05*	-0.266	P>0.05	0.266
BS	0.18	-0.139	0.238	0.126
DIS	0.208	-0.134	0.235	0.126
ES	0.323	-0.105	0.188	0.14

*Correlation is significant at the 0.05 level (2-tailed). SSS: Sensation Seeking Scale, TAS: Thrill & Adventure Seeking, BS: Boredom susceptibility, DIS: Disinhibition, ES: Experience seeking.

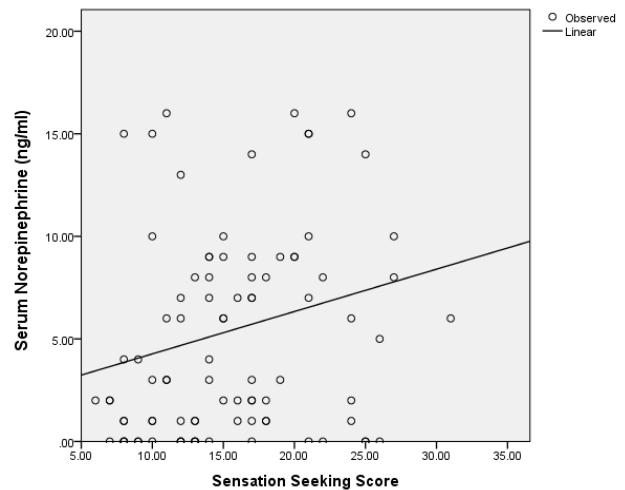


Figure 2: Correlation between SSS and serum norepinephrine.

Discussion

An objective approach to the underlying cause of the unsafe and risky acts that are considered in the sensation seeking trait context helps us to better understand how these behaviors occur. In recent years, this approach has devoted much research in the field of neuroscience. One of the important biological areas of behavior is the biochemical part. Cortisol and norepinephrine are challenging among biomarkers that are associated with emotional behaviors. So that different studies have shown different, sometimes counterproductive, results for the correlation of risky behaviors with these biomarkers. The

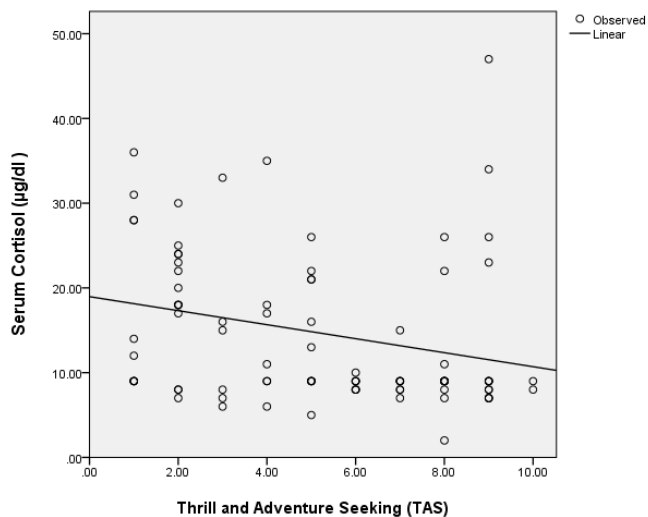


Figure 3: Correlation between TAS and serum cortisol.

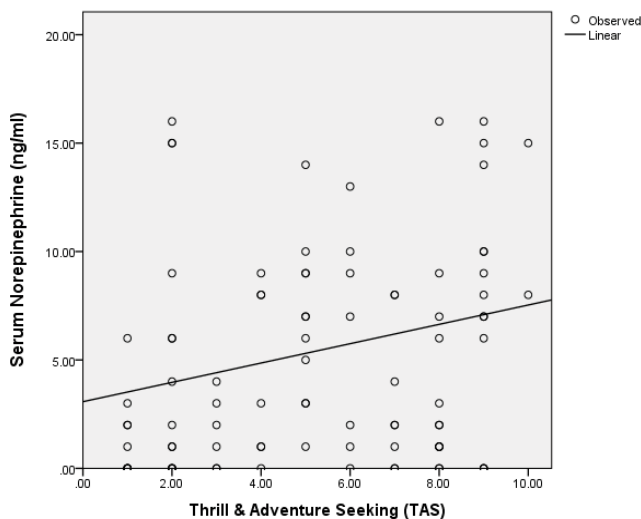


Figure 4: Correlation between TAS and serum norepinephrine.

findings of this study showed that serum cortisol concentration had only a significant, direct correlation with TAS subscale, but it's correlation with the overall score of Zuckerman sensation seeking scale was insignificant. Also, serum norepinephrine concentration had not significantly related to the overall score and none of subscales of sensation seeking.

The results of this study can be partly attributed to the results of earlier researches that cortisol, also known as the stress hormone, has a lower concentration in people with a stronger sensation seeking trait and thus inversely related with sensation seeking trait.

The findings of this study showed that serum cortisol concentration had a significant inverse correlation with only TAS subscale from Zuckerman sensation seeking scale. Although there was an inverse relation between cortisol and overall score of SSS, in our study the significance of this correlation is not proven. Also in this study norepinephrine concentration didn't have any significant correlation with none of subscales and overall scale of SSS Zuckerman.

Wang et al. using Cloninger Tridimensional Personality

Questionnaire (TPQ), studied relationships between Hormonal Profile and Novelty Seeking revealed that there was a significant, inverse correlation between urinary cortisol and novelty seeking, while this correlation about norepinephrin was direct and significant but in our study only the correlation between TAS subscale of SSS and serum cortisol was inversely significant. Also in a study was done by Tyrka, a significant correlation between Novelty seeking and plasma cortisol, was observed.^[39] While in another study the results implied on an inverse correlation between plasma cortisol and novelty seeking results of White's study pointed out a significant inverse relationship between cortisol and TAS subscale of SSS.^[35,37,39,40,42,44]

However, the results of this study are consistent with the results of previous studies such as Ruegg, Gerra and Rosenblitt, which indicates an insignificant correlation between cortisol concentration and the overall sensation seeking score.^[36,38,41] Also, the present study showed that serum cortisol concentrations had a significant correlation with only TAS sensation seeking subscale while it had no significant correlation with three other subscales; BS, DIS & ES. As said above, this is still a challenging topic, and this study, of course, rejects the studies showing a significant correlation between serum cortisol concentration and the overall sensation seeking score.

As for the association of sensation seeking score with norepinephrine concentration, the results of previous studies are even more controversial compared to cortisol as some studies have noted the sensation seeking score as being in direct relationship with norepinephrine and its metabolites.^[32] While others have noted an inverse relationship with norepinephrine.^[3,30,32]

Perhaps the main cause of these contradictions can be found in the Catecholamine system activity model (CAS); this model suggests that, under non-stimulated conditions, norepinephrine levels are much lower than their optimal levels, and these are the main reasons for the person being forced to perform risky behaviors in order to reach to the desired level of arousal and higher levels of norepinephrine.

Furthermore, the results of this study could not revealed any significant correlation between serum norepinephrine and none of SSS subscales and also overall score of Zuckerman sensation seeking scale.

The results of this study with serum Cortisol studied in relation to sensation seeking score supported Zuckerman's sensation seeking theory with the approach of biological structures of personality, which suggests a strong correlation between the concentration of neurotransmitters and the biochemical substances of the body and the appearance or absence of sensation seeking behaviors. This study, which was conducted among healthy Iranian male workers, supported Zuckerman's Optimal Level of Arousal theory.

According to the current study we can propose that more studies are require in order to gathering more evidences about the relationship between cortisol and TAS subscale or other biomarkers till based on enough evidences can make prediction about this matter. In other words, one can thus prevent the human-induced accidents being caused by unsafe acts of sensation seeking that are aimed at achieving higher levels

of arousal, especially in high risk industries and occupations. Further, extending the results of such studies to workplaces, it can be suggested that individuals with lower sensation seeking score and biomarker concentrations be chosen for the jobs requiring a high level of temerity or conservatism.

Therefore, it can be more firmly argued that the inherent and personality traits of individuals can be related to the occurrence of unsafe acts in industrial environments and the subsequent accidents and injuries.

Conclusion

Based on the results of this research, we can provide additional evidence on the Bio-psychological Theory of Personality's Biological Theory. According to this theory personality and behaviors have biological factor and are caused by internal biological factors. This research is one of the few studies among Iranian population that examine the relationship between risk taking trait with serum cortisol and serum norepinephrine by using neurotransmitter biologic deliberation. The results of this study revealed that only the total sensation seeking score and one of its subscales, TAS, have a reverse significant relation with serum cortisol and direct significant relation with serum norepinephrine. These results can help to sum up the similar results in examining the relationship between sensation seeking and various neurotransmitters especially since less study have been done on norepinephrine. Therefore, this study could be the opportunity for other studies in Iranian and non-Iranian populations.

Ethics approval and consent to participate

The Auto's assert all procedures contributing of this study were conducted in accordance with the guidelines and criteria of the Ethics Committee of Tehran University of Medical Sciences (TUMS), Tehran, Iran. Code of Ethics Committee approval: IR.TUMS.REC.1394.959

Consent for publication

We all authors approve that our consent for publication our manuscript titled "A Study on Relationship between Serum Cortisol and Serum Norepinephrine Levels and Sensation Seeking Trait among Iranian Male Staff" in journal of a mental health system.

Availability of data and materials

The authors approve that all data underlying the findings are completely accessible without limitation and also pertinent data are in the paper.

Conflict of Interest

The authors disclose that they have no conflicts of interest.

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Given that our country is developing, the authors do not have the financial means to pay for it, and it is apparent that this article will be published for free.

Author's Contributions

All authors were involved in the design of the study. Also, all authors contributed to the editing and writing of the article and approved the final version of the manuscript.

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