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STRESS HORMONES IN MEN WHOSE PROFESSIONAL ACTIVITIES ARE EITHER OFFICE-BASED OR OF AN EXTREME EMERGENCY NATURE

ABSTRACT

In this study we investigated cortisol, dehydroepiandrosterone sulfate and testosterone concentrations in the serum blood of healthy young (up to 40 years old) and mature (over 40 years old) men, and whose professional activities are either office-based or of an extreme emergency nature. We revealed a significant age-dependent decrease in hormonal parameters in those working in office conditions. In the group of men whose professional activity is of an extreme emergency nature, significant age-dependent changes in hormonal parameters were not found. Comparison of men of different working conditions showed significant changes in all three studied hormones only in the second age group (over 40 years old).

Keywords: cortisol, dehydroepiandrosterone sulfate, testosterone, stress, office-based employees, an extreme emergency nature of work.

Introduction. The endocrine system plays a key role in the regulation of the compensatory response mechanisms to extreme factors affecting the organism. The hypothalamic-pituitary-adrenal system is equally important in the development of stress reactions [7, 8, 16]. The active substances of this system (glucocorticoids) activate the processes of long-term adaptation in the organism. Excessive, prolonged exposure to damaging factors results in desadaptive disorders.

Thus, a persistent increase in cortisol concentration under stress causes various physiological, cognitive, and behavioral changes that are crucial for successful adaptation [5, 11]. The endogenous steroid dehydroepiandrosterone (DHEA) has an antiglucocorticoid activity. The buffer form of DHEA (dehydroepiandrosterone sulfate - DHEAS) at certain concentrations prevents the development of psychological disability and stress-induced diseases [14]. However, other systems of endocrine regulation (gonadal, thyroid) play a significant role in the maintenance of adaptive responses induced by stress [4, 9]. Extreme factors induce changes in the ratios of sex hormone concentrations result in enhanced catabolic processes [10]. Given the role of the endocrine system in the implementation of the stress response, one might expect significant changes in the endocrine system in people whose professional activity is closely associated with exposure to extreme stressors. In particular, a distinctive feature of the service of the employees of the Ministry of the Russian Federation for Civil Defense, Emergencies and Elimination of Disaster Consequences is the presence of a large number of stress factors, emotional stress and constant dealing with danger – i.e. with life-threatening situations for themselves as well as for others. These circumstances in most cases have a negative impact on the health of those performing operational tasks and create conditions for the development of occupational stress [12].

In this regard, it is important to assess the functional state of people whose professional activity is of an extreme and stressful nature. The **purpose** of this study was a comparative investigation of the stress hormones concentrations in men whose professional activities are office-based or of an extreme emergency nature.

Materials and methods of the research. The study was carried out in accordance with the Code of Ethics of

Table 1

Concentration of cortisol, DHEAS, and testosterone in healthy male office workers, Me (25%Q-75%Q)

Hormone	< 40 years old (n=33)	> 40 years old (n=14)	p-value
Cortisol (nmole/l)	601.04 (449.16-762.08)	453.92 (386.51-569.44)	P=0.048
DHEAS (μg/ml)	2.5 (2.08-3.14)	1.86 (1.37-2.24)	P=0.03
Testosterone (nmole/l)	19.5 (15.9-22.87)	11.53 (9.39-16.3)	P=0.03

* - p <0.05 statistically significant by Mann-Whitney criteria

Table 2

Concentration of cortisol, DHEAS, and testosterone in healthy male employees of EMERCOM, Me (25%Q-75%Q)

Hormone	< 40 years old (n=117)	> 40 years old (n=27)	P по критерию Манна-Уитни
Cortisol (nmole/l)	567.12 (420.8-750.67)	615.37 (409.08-833.54)	P=0.176
DHEAS (μg/ml)	2.52 (2.09-3.56)	2.46 (1.69-2.91)	P=0.254
Testosterone (nmole/l)	16.08 (12.06-21.93)	18.66 (12.55-21.56)	P=0.675

the World Medical Association established for experiments involving humans (Declaration of Helsinki, revised in 2013 (World Medical Association, 2013)). Each person provided written informed consent after the study was approved by the Local Bioethics Committee of the Mental Health Research Institute in Tomsk. The total sample comprised 191 healthy men aged 19 - 60 years. Of these 47 were employees of higher educational and research institutions, so called office workers (the first group) and the second group consisted of 144 men, whose professional activity is of extreme emergency nature (employees of the EMERCOM of Russia in Tomsk region). Exclusion criteria were the presence of any mental disorders and somatic pathology in the acute stage.

Hormonal status was studied taking into account the age factor. According to previous research, the DHEAS and testosterone concentrations increase up to 40 years old, and decrease after 40 years old. For these reasons we divided the subjects into 2 age groups: of young (up to 40 years old) and mature age (over 40 years old) (Alcor Bio, product catalog 2018).

The material for the study was blood serum. Blood samples from all examined individuals were drawn after an 8-h overnight fast into tubes with a clot activator (CAT) to isolate the serum (BD Vacutainer).

The cortisol, dehydroepiandrosterone sulfate (DHEAS) and testosterone concentrations were measured in serum by enzyme immunoassay (ELISA) using reagent kits from AlcorBio. Reactions were carried out according to the manufacturer's instructions with the obligatory control of the standard positive and negative samples included in the test systems. The ELISA results were evaluated on the Epoch BioTek Instruments (USA) automatic microplate spectrophotometer at a wavelength of 450 nm.

Statistical analysis was carried out using the SPSS 22.0 for Windows software package. The normality of the distribution of the values of the variables was checked by the Kolmogorov-Smirnov criterion. Data were expressed as medians, upper and lower quartiles. The statistical significance of differences between groups was determined by Mann-Whitney criteria (for two independent samples). Differences were considered significant at p <0.05.

Table 3

Concentration of cortisol, DHEAS, and testosterone in healthy men over 40 years old whose professional activities are either office-based or of an extreme emergency nature, Me (25%Q-75%Q)

Hormone	Healthy male office workers	Healthy male employees of EMERCOM	P по критерию Манна-Уитни
Cortisol (nmole/l)	453.92 (386.51-569.44)	615.37 (409.08-833.54)	P=0.017
DHEAS (µg/ml)	1.86 (1.37-2.24)	2.46 (1.69-2.91)	P=0.05
Testosterone (nmole/l)	11.53 (9.39-16.3)	18.66 (12.55-21.56)	P=0.02

* - p <0.05 statistically significant by Mann-Whitney criteria

Results and discussion. Our study showed significant age dependent changes of hormonal levels in male office workers. In this group the cortisol concentration was statistically lower in men aged 40 years or more compared to men younger than 40 years old (p = 0.048) (Table 1). DHEAS concentrations in the mature age group were significantly lower compared to the young age group (p = 0.03). The testosterone level in male office workers also decreased significantly with age (p = 0.03).

Another pattern was observed in the employees of EMERCOM of Russia in the Tomsk region. We did not find any age-dependent significant differences in the concentrations of the studied hormones in men whose professional activity is of an extreme emergency nature (Table 2). Though the cortisol concentration was slightly higher in men over 40 years old in comparison to those under 40 years old, the difference did not reach statistical significance (p = 0.176).

The lack of significant changes in endocrine indices in different age groups among employees of extreme emergency professions is probably related to the main physiological functions of the studied hormones. Cortisol is the main adaptive hormone that mediates the physiological response of the organism to various extreme factors [5]. Its increase under conditions of prolonged and repeated stress provides optimal adaptive changes of the body. According to previous research, changes in the level of cortisol and testosterone in law enforcement officers and rescuers are associated with the level of professional stress and length of work, which is associated with disturbances of the pituitary regulation [1-3].

The comparative analysis of groups of men under the age of 40 whose professional activity is of an office or extreme emergency nature did not reveal any significant differences.

Significant changes in all three studied hormones were observed when results from the two groups of men aged 40 years or more were analyzed. In the older age group, cortisol (p = 0.017), DHEAS (p = 0.048) and testosterone (p = 0.02) were significantly higher in employees of EMERCOM of Russia in the Tomsk region compared with the office workers (Table. 3).

Such age-related features of hormonal regulation in men whose professional activity is of an extremely stressful nature can be explained by the theory of allostasis. With age, the mechanisms and driving forces of mental development change, primarily due to changes in the brain's energy and neurodynamic parameters of mental activity in the form of a shift in the balance of neurodynamic parameters of mental activity towards the predominance of inhibitory processes [6]. As a result, hormonal changes those are protective when young (allostasis) become non-adaptive later. Allostatic stress, manifested in over-activation of regulatory systems, with age makes a person less able to additionally respond to adaptive stress, which leads to vulnerability, and not to sustainability [13, 15]. Another explanation could be quite opposite. Employees of EMERCOM are actually fitter with more physical activity than the more sedentary office workers. Changes with time in office workers might be seen as age-related deterioration which is not seen in the group of rescuers.

Conclusion

1. In the group of healthy men whose professional activity is office based, a significant decrease in the concentration of cortisol, DHEAS and testosterone in the blood serum with age was found.

2. In the group of healthy men whose professional activity is of an extreme emergency nature, there were no significant age dependent changes in the concentration of the blood serum cortisol, DHEAS, and testosterone.

3. A comparative analysis in groups of men aged 40 years and more showed significantly higher concentrations of cortisol, DHEAS, and testosterone in the blood serum of men whose professional activity takes place in extreme emergency conditions compared to men whose professional activity is of an office nature.

Acknowledgements

This work was carried out within the framework of Tomsk Polytechnic University Competitiveness Enhancement Program.

References

1. Бойко И.В. Соотношение содержания кортизола и артериального давления у сотрудников силовых ведомств в зависимости от уровня профессиональной напряженности. Актуальные проблемы военной и экстремальной медицины: Сборник научных статей IV Интернет-конференции с международным участием. 2016:65-74. [Boyko I.V Cortisol and arterial pressure relation at enforcement person in de pendence from professional load. Actual problems of military and extreme medicine. Collection of scientific articles of the IV Internet conference with international participation. 2016:65-74. (In Russ.).]

2. Апчел А.В., Кубасов Р.В., Барачевский Ю.Е., Иванов А.М., Сидоренко В.А. Влияние профессиональной нагрузки на секрецию адренокортикотропного гормона и кортизола у сотрудников органов внутренних дел. Медицинский вестник МВД. 2015;4(77):56-58. [Apchel A.V., Koubassov R.V., Barachevsky Yu.E., Ivanov A.M., Sidorenko V.A. The effect of occupational stress on the secretion of adrenocorticotropic hormone and cortisol from employees of the internal affairs bodies. Medical Herald MIA. 2015; 4(77):56-58. (In Russ.).]

3. Оприщенко А.А., Донченко Л.И., Кравченко А.В., Штутин А.А., Вдовиченко М.Д., Павловец Л.С. Влияние экстремальных факторов на нейроэндокринную регуляцию и иммуно-биохимические показатели военнослужащих в условиях боевых действий в Донбассе. Университетская клиника. 2018;2(27):30-34. [Oprishchenko A.A., Donchenko L.I., Kravchenko A.V., Shtutin A.A., Vdovichenko M.D., Pavlovec L.S. Influence of extreme factors on the neuroendocrine regulation and immuno-biochemical indicators of servicemen in the conditions of hostilities in the Donbas. University Hospital. 2018; 2(27):30-34. (In Russ.).] DOI: https://doi.org/10.26435/uc.v0i2%20(27).211

4. Горобец Л.Н. Нейроэндокринные дисфункции и нейролептическая терапия. М.: Медпрактика. 2007:312. [Gorobets L.N. Neuroendocrine dysfunctions and neuroleptic therapy. M.: Medpraktika. 2007:312. (In Russ.).]

5. Козлов А.И., Козлова М.А. Кортизол как маркер стресса. Физиология человека. 2014; 40(2):123. [Kozlov A.I., Kozlova M.A. Cortisol as a Marker of Stress. Human physiology. 2014; 40(2):123. (In Russ.).] DOI: 10.7868 / S013116461402009X

6. Корсакова Н.К., Московичюте Л.И. Клиническая нейропсихология. М.: Издательство Юрайт. 2018:165. [Korsakova N.K., Moskovichyu L.I. Clinical neuropsychology. M.: Yurait Publishing House. 2018:165. (In Russ.).]

7. Стояк В.А., Жернова Е.В., Бохан Н.А., Иванова С.А. Кортизол, дегидроэпиандростерон сульфат и их соотношение у больных алкоголизмом. Сибирский вестник психиатрии и наркологии. 2010;4(61):88-90. [Stoyak V.A., Zhernova E.V., Bokhan N.A., Ivanova S.A. Cortisol, dehydroepiandrosterone sulphate and their correlation in alcoholic patients. Siberian Bulletin of Psychiatry and Narcology. 2010;4(61):88-90. (In Russ.).]

8. Кубасов Р.В., Барачевский Ю.Е., Иванов А.М. Гипофизарно-надпочечниковая и тиреоидная секреция у сотрудников МВД при различных уровнях профессиональной напряженности. Вестник РАМН. 2015;1:101-105. [Koubassov R.V., Barachevsky Yu.E., Ivanov A.M. Pituitary-adrenal and thyroid secretion at Law Order Staff Depending on professional Loading. Bulletin of the Russian Academy of Medical Sciences. 2015; 1:101-105. In Russ.).]

9. Кубасов Р.В. Гормональные изменения в ответ на экстремальные факторы внешней среды. Вестник РАМН. 2014;9:102-109. [Koubassov R.V. Hormonal Changes in Response to Extreme Environment Factors. Bulletin of RAMS. 2014;9:102-109. In Russ.).]

10. Алексанин С.С. Особенности патогенеза и профилактики синдрома хронического адаптивного перенапряжения как ключевого механизма развития соматической патологии у спасателей и пожарных МЧС России. Методические рекомендации. – СПб.: ВЦЭРМ им. А.М. Никифорова. 2016:34. [Aleksanin S.S. Features of pathogenesis and prevention of chronic adaptive overwork syndrome as a key mechanism for the development of somatic pathology in rescuers and firefighters of the Russian Emergencies Ministry. Methodical recommendations. SPb.: ARCERM named after A.M. Nikiforova, 2016:34. In Russ.).]

11. Левчук Л.А., Вялова Н.М., Симуткин Г.Г., Иванова С.А., Бохан Н.А. Уровень кортизола у пациентов с аффективными расстройствами: ассоциация с нозологической формой. Вестник Уральской академической медицинской науки. 2014;3(49):217-219. [Levchuk L.A., Vyalova N.M., Simutkin G.G., Ivanova S.A., Bokhan N.A. Level of cortisol in patients with depressive: association with nosological forms. Bulletin of the Ural Academic Medical Science. 2014;3(49):217-219. In Russ.).]

12. Ширванов А.А., Камнева Е.В. Факторы профессионального «выгорания» сотрудников МЧС России. Научные и образовательные проблемы гражданской защиты. 2016;2(29):105-108. [Shirvanov A.A., Kamneva E.V. Factors of professional "burnout" of EMERCOM of Russia employees. Scientific and educational problems of civil protection. 2016; 2(29):105-108. In Russ.).]

13. Ewen B.S. Brain on stress: how the social environment gets under the skin. Proc Natl Acad Sci USA. 2012; 109(2):17180–17185. DOI: 10.1073/pnas.1121254109

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PEROXIDATION INTENSITY IN YAKUTIA RESIDENTS IN ZONES WITH A HIGH RATE OF ONCOLOGICAL MORBIDITY

ABSTRACT

In order to study the peculiarities of free-radical processes in the organism of residents of the Republic of Sakha (Yakutia) living in areas with a high oncological diseases index, some indicators of lipid peroxidation and antioxidant system have been determined. We surveyed 75 rural residents of the Lensky district of the southern zone (high oncological diseases) and 88 rural residents of the Anabarsky district of the Arctic zone (growth of liver cancer) were examined. The intensification of lipid peroxidation in residents of the southern zone, especially in non-indigenous women, has been established. In the non-indigenous population, the intensification of free-radical processes causes the activation of low molecular weight antioxidants, and the indigenous population activates the enzymatic link of the antioxidant system. The reduced activity of antioxidant protection indicators was also noted in non-indigenous women, which puts them at risk of developing oxidative stress, as one of the main factors in the development of pre-pathologies and pathologies, including tumors.

Keywords: lipid peroxidation, antioxidant protection, disadaptation, cancer incidence.

Introduction. The severity of environmental stress can be determined by indicators of the increase in mortality of the working age population in a specific area [3]. According to the Ministry of Health of the Republic of Sakha (Yakutia), in the structure of causes of mortality, neoplasms rank third (15%) after circulatory system diseases and external causes of death. In 2018, the death rate from neoplasms increased by 4.4% and amounted to 143.1 per 100 thousand population (2017 - 137.5) [2]. Under the conditions of increasing anthropogenic and technogenic environmental pollution, the growth of environmentally caused diseases can be considered as a result of a decrease in the adaptive reserves of the body. One of the important factors in the impairment of adaptation and the development of many diseases is the activation of lipid peroxidation processes with impairments in the prooxidant-antioxidant system [5, 6]. Therefore, the assessment of the state of lipid peroxidation and antioxidant protection of the organism of the population living in areas with a high incidence of tumors, is an important task to find the reasons underlying the growth of cancer and the adoption of appropriate preventive measures.

The aim of the study was to identify and compare the features of free-radical processes in the inhabitants of the Southern and Arctic zone of the Republic Sakha (Yakutia) with a high rate of oncological morbidity.

Material and research methods. We carried out the determination of indicators of POL-AOS in a sample of 75 rural residents of the Southern zone RS (Ya), where a high oncological morbidity rate is registered (Lensky district). The average age of the investigated was 46.1 ± 0.25 years. In the Arctic zone, where the number of liver, respiratory organs, lymphatic and hematopoietic tissues cancer is growing, the sample was 88 rural residents (Anabarsky district), the average age was 44.1 ± 0.34 years. The intensity of free radical oxidation of lipids was determined spectrophotometrically by the accumulation of malonic dialdehyde (MDA) [8]. The antioxidant defense indicators of the body were determined by the total content of low molecular weight antioxidants (LMWA) [7], catalase (Kat) [4].

Statistical data processing was performed using the SPSS Statistics 17.0 applied statistical software package. Standard methods of variation statistics were used: calculation of averages, standard errors, medians, 95% confidence interval. The data in the tables are presented as M ± m, where M is the average, m is the average error. The significance of differences between the mean values was assessed using Student's t