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## Changes in Athletes' Psycho-Emotional Stress in the Course of Annual Macrocycle

**Mihail A. Gamzin<sup>a</sup>, Kirill P. Bazarin<sup>b,c\*</sup>,  
Andrey A. Savchenko<sup>c,d</sup> and Alexandr D. Kakukhin<sup>e</sup>**

<sup>a</sup>*Wrestling Academy named DG Mindiashvili*

*88 Markovskogo Str., Krasnoyarsk, 660049, Russia*

<sup>b</sup>*Institute of Biophysics SB RAS, Federal Research Center*

*“Krasnoyarsk Science Center SB RAS”*

*50 Akademgorodok, Krasnoyarsk, 660036, Russia*

<sup>c</sup>*Federal Research Center «Krasnoyarsk Science Center»  
of the Siberian Branch of the Russian Academy of Sciences*

*“Research Institute for Medical Problems of the North”*

*3g Partizana Zheleznaya Str., Krasnoyarsk, 660022, Russia*

<sup>d</sup>*Siberian Federal University*

*79 Svobodny, Krasnoyarsk, 660041, Russia*

<sup>e</sup>*Reshetnev Siberian State University of Science and Technology*

*31 Krasnoyarsky Rabochy, Krasnoyarsk, 660037, Russia*

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*Emotions significantly influence physiological processes in the athlete's body. The level of his/her mental stress during training, competitions and recreation is obviously not the same. Taking into account the athletes' well-known predisposition to alexithymia, there is a need to search for objective ways of the level of psycho-emotional stress assessment. Using the calculated Stress Index (SI), based on electroencephalogram indicators and level of situational anxiety as per the standard Spielberger-Hanin test, our work assesses and compares the differences in the athletes' psycho-emotional state in various phases of the annual macrocycle. The study involved 155 athletes doing various sports. 96 athletes were males, their average age being  $24.34 \pm 3.54$  years; 59 athletes were females with the average age of  $23.12 \pm 2.3$  years. The control group consisted of 101 individuals who did not experience systematic high physical exertion, 53 of them being males with the average age of  $23.17 \pm 2.54$ , 48 — females with the average age of  $22.12 \pm 3.01$  years. The athletes' SI values are significantly different from those in the control group, as well as among themselves at various stages of the annual macrocycle. In the preparatory and transitional periods, the SI is significantly lower than in the control group. However, during the competitive period this index increases considerably. This is characteristic of a significant increase in the*

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\* Corresponding author E-mail address: kpbazarin@gmail.com

ORCID: 0000-0003-0597-9871 (Bazarin)

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*athletes' psycho-emotional stress. There is a high positive correlation ( $r = 0.81$ ) between the SI value and the number of points scored in the Spielberger-Hanin situational anxiety test.*

*Keywords: psycho-emotional stress, electroencephalography, athletes.*

*Research area: physiology; theory and methods of physical education, sports training, recreational and adaptive physical culture.*

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## **Introduction**

The athlete's attitude to competitions largely contributes to the competitive stress formation (Bazarin, Savchenko, 2016). On the one hand, this is due to a desire to win and show high results; on the other hand, there is uncertainty, non-guaranteed victory, and risk of injury. Generated by these factors, frustration is, as a rule, a dominant focus of activity in the athlete's nervous system. As a result, from 15 % to 74 % of qualified athletes have certain psychopathological conditions. In particular, 6 % of athletes have generalized anxiety disorder, 33 % — sleep disturbance, and 43 % — depressive symptoms (Rice, et. al., 2016; Wolanin, et al., 2016).

The athlete's level of mental stress during training, competitions and recreation is undoubtedly not the same. The level of situational anxiety, which is most likely typical for these states, usually increases as the competitive period approaches. It reaches its peak by the most responsible starts and then decreases quite quickly after the competitions are over. Thus, in the course of the preparatory period 52 % of athletes were diagnosed a low level of anxiety, 40 % — an average one and only 8 % showed a high level of anxiety. In the course of the competition period 53 % of athletes had a high level of anxiety. The level was average for 20 % of athletes and low for 17 % (Nosenko, Kholodova, 2014).

The preparatory period is a sort of a “game” in which the process is more important than the result. Specific achievements at each training are deprived of the component of super-value that they acquire by the competitive period, when the need to win the desired victory is literally getting a matter of life and death, a matter of survival, and the body passes to a state of combat, responding to an imaginary danger. At this stage, a massive release of stress hormones — cortisol, catecholamines (CA) — takes place at the periphery (Li, et. al., 2015). The dopaminergic processes, which order to anticipate the victory and to be afraid of defeat, will be the main central driver of the phenomena mentioned. As shown in the research (Roelands,

et. al., 2013), dopamine reuptake inhibition leads to a significant increase in the maximum load power mainly due to an increase in motivation to perform the task. One can trace the correlation between the work of the dopaminergic system and changes in the power and frequency characteristics of the electroencephalogram. So, according to a number of researchers, there is a correlation between D1- and D2- dopamine receptors and characteristic changes in the EEG profile. D1-dopamine receptor blockade by SCH 23390 causes an increase in EEG power across the entire frequency spectrum (Chen, et. al., 2013; Avila-Luna, et. al., 2015). The influence of the selective D1-dopamine receptor agonist SK&F 38393 causes desynchronization and an overall decrease in EEG power. The effect is reversible under the influence of D1 SCH 23390 antagonist. It is characterized by an isolated power increase in the EEG alpha-1 activity range (D'Aquila, Galistu, 2012). The alpha rhythm activation is associated with the involvement of D2 receptors (Chen, et. al., 2013). Such stimulation is also characteristic of beta-endorphin, an endogenous mu-opioid receptor agonist. Thus, the above data allows the use of electroencephalogram power indicators for an objective analysis of the athletes' mental state in various phases of their annual training and competitive macrocycle.

### **Objective**

The objective of the research is to study the changes in objective and subjective indicators of the level of the athletes' psycho-emotional stress during the annual macrocycle.

### **Materials and methods**

The research involved 155 athletes doing various sports. 96 of them were males with the average age of  $24.34 \pm 3.54$  years; 59 were females with the average age of  $23.12 \pm 2.3$  years. The control group consisted of 101 individuals who did not experience systematic physical exertion. These were 53 males with the average age of  $23.17 \pm 2.54$  and 48 females with the average age of  $22,12 \pm 3,01$  years. This research was approved by the local ethics committee, the subjects giving voluntary informed consent for their participation in the experiment.

The dynamics of the athletes' EEG changes in various phases of the annual training and competitive macrocycle was studied using "BOSLAB" hardware and software complex developed by the Institute of Molecular Biology and Biophysics of the Siberian Branch of the Russian Academy of Medical Sciences. The study was conducted at the

end of the preparatory, competitive and transitional periods. Based on the obtained values of the Fz-Cz lead, the Stress Index (SI) was calculated as the ratio  $\beta_2 / \alpha_2$ , where  $\alpha_2$  (alpha2) is the EEG power indices in the range from the maximum alpha peak frequency (APF) as per the reaction to opening of the eyes to the  $\alpha$ -range upper limit (14 Hz);  $\beta_2$  (beta2) is the EEG power indices in the range of 19–22 Hz. The calculation was based on the obtained values of the Fz-Cz lead. This index is an objective indicator of the emotional stress, anxiety degree. The SI value above 1.0 reflects the excessive emotional stress (Tishakin, Dzhafarova, Grebneva, 2010).

The level of situational anxiety was assessed by the standard Spielberger-Hanin test (Dermanova, 2002).

### **Results and discussion**

Despite the fact that great anxiety and neuroticism are classically described as peculiar to the female sex (Il'in, 2010), it has long been known that these differences are not true for the athletes (Hanin, 1997). We also found no statistically significant differences in the dynamics of the male and female athletes' psycho-emotional state at different stages of the annual macrocycle. No great differences in these parameters were found among the athletes doing various sports either. Considering the above, the data without differentiation by sex and sports are summarized below.

The average stress index for the control group and athletes at different phases of the annual macrocycle are presented in Fig. 1. The athletes' SI values are significantly different from those in the control group, as well as among themselves at various stages of the annual macrocycle. In the preparatory and transitional periods, the SI is significantly lower than in the control group. However, during the competitive period this index increases significantly that is typical for a significant increase in the athletes' psycho-emotional stress. It should be noted that on its average the Stress Index in this case does not reach the critical values ( $> 1$ ). Yet, it significantly exceeds the indicators of a comfortable emotional state.

The dynamics of the situational anxiety level as per the Spielberger-Hanin test generally corresponded to the dynamics of the Stress Index (Fig. 2).

The obtained results correspond to other authors' data (Nosenko, Kholodova, 2014). Thus, in this respect the group of athletes under the research is a representative reflection of the general population.

There is a high positive correlation ( $r = 0.81$ ) between the Stress Index value and the number of points as per the Spielberger-Hanin situational anxiety test.

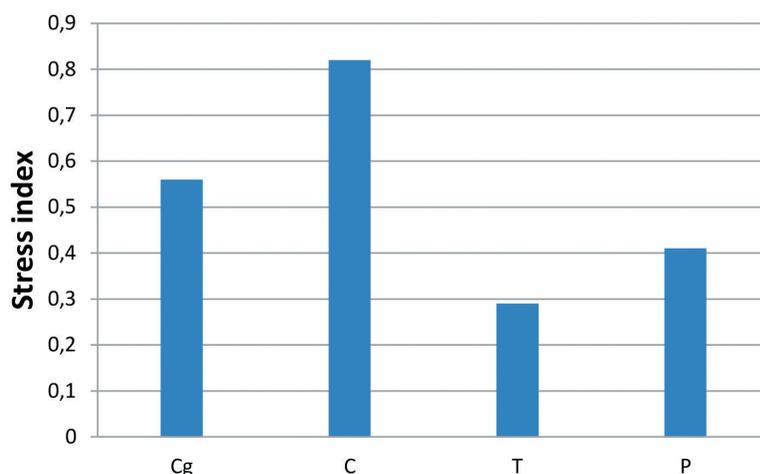


Fig. 1. The value of the athletes' and control group individuals' Stress Index at different stages of the annual training and competitive macrocycle. Cg — control group, C — competitive period, T — transition period, P — preparatory period

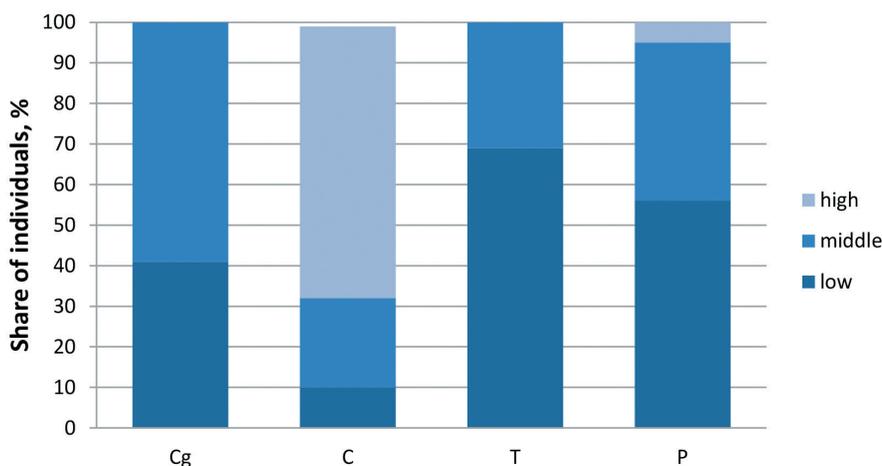


Fig. 2. The athletes' and control group individuals' situational anxiety at different stages of the annual training and competitive macrocycle. Cg — control group, C — competitive period, T — transition period, P — preparatory period

It is worth while noting that there were 12 athletes in the examined group. The level of their situational anxiety remained low in the course of the competitive period. Yet, the SI analysis showed that, according to test results, low anxiety corresponded to an electroencephalographic picture only in 10 cases. The preparatory period revealed the opposite situation — for three cases the results, obtained in accordance with the answers to the test questions and indicating high anxiety, did not correspond to the electroencephalographic results. In these cases, when answering the test questions, the

examined athletes apparently failed to adequately assess their psycho-emotional state. In general, this corresponds to the data obtained by other authors (Chukhrova, et al. 2009).

### Conclusion

The following features of psycho-emotional state dynamics can be distinguished: in the course of the preparatory and transitional periods athletes demonstrate the lower level of anxiety and psycho-emotional stress than those in the control group. The competitive period is characterized by a significant increase in anxiety and tension. Thus, the preparatory period is characterized by large volumes of physical exertion, mainly of medium and high intensity against the background of a stable psycho-emotional state. Physical loads in the course of the competition period are smaller in volume but more intensive. They are accompanied by significant psycho-emotional stress. The level of physical exertion and psycho-emotional stress is minimum in the transition period.

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## **Изменения психоэмоционального напряжения у спортсменов в течение годового макроцикла**

**М. А. Гамзин<sup>а</sup>, К. П. Базарин<sup>б,в</sup>,  
А. А. Савченко<sup>б,г</sup>, А. Д. Какухин<sup>д</sup>**

<sup>а</sup>Академия борьбы имени Д.Г. Миндияшвили  
Россия, 660049, Красноярск, ул. Марковского, 88

<sup>б</sup>Институт биофизики СО РАН, ФИЦ КНЦ СО РАН  
Россия, Красноярск, 660036, Академгородок, 50

<sup>в</sup>Научно-исследовательский институт  
медицинских проблем Севера  
Россия, 660022, Красноярск, ул. Партизана Железняка, 3г

<sup>г</sup>Сибирский федеральный университет  
Россия, 660041, Красноярск, пр. Свободный, 79

<sup>д</sup>Сибирский государственный университет науки и технологий  
им. академика М.Ф. Решетнева  
Россия, Красноярск, 660037, пр. Красноярский рабочий, 31

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*Эмоции оказывают существенное влияние на физиологические процессы в организме спортсмена. Очевидно, что уровень психического напряжения спортсмена в ходе подготовки, участия в соревнованиях и отдыха не одинаков. С учетом известной предрасположенности спортсменов к алекситимии существует потребность в поиске объективных способов оценки уровня психоэмоционального напряжения. В нашей работе проводится оценка и сравнение отличий психоэмоционального состояния спортсменов в различных фазах годового макроцикла с помощью расчетного индекса напряжения (ИН), основанного на мощностных показателях электроэнцефалограммы, и уровня ситуативной тревожности по стандартному тесту Спилбергера-Ханина. В исследовании приняли участие 155 спортсменов, представителей различных видов спорта. Мужской пол — 96 человек, средний возраст —  $24,34 \pm 3,54$  лет; женский пол — 59 человек, средний возраст составил  $23,12 \pm 2,3$  лет. Контрольная группа состояла из 101 человека, не испытывающих систематических высоких физических нагрузок. Мужской пол — 53 человека, средний возраст  $23,17 \pm 2,54$  лет; женский — 48 человек, средний возраст  $22,12 \pm 3,01$  лет. Величины ИН у спортсменов достоверно отличаются от лиц контрольной группы, а также между собой на различных этапах годового макроцикла. В подготовительном и переходном периодах ИН достоверно ниже, чем в контрольной группе, однако в ходе соревновательного периода этот показатель существенно увеличивается, что характеризует значительный рост психоэмоционального напряжения у спортсменов. Имеется высокая положительная корреляция ( $r = 0,81$ ) между величиной ИН и количеством набранных баллов в тесте ситуативной тревожности Спилбергера-Ханина.*

*Ключевые слова:* психоэмоциональное напряжение, электроэнцефалография, спортсмены.

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