

Psychological Status of Freshmen with Different Levels of their Regulatory System Activity

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The index of regulatory system activity (IRSA) was previously proposed to assess the functional state of a human organism. The association of mental activity parameters of college freshmen with IRSA levels was not studied before. The objective of our study was to compare the parameters of mental functions in university freshmen with different IRSA levels. A comparative assessment of the state of mental processes in 150 college freshmen with different IRSA levels was carried out. All subjects were pooled into four groups: Group 1 (n=60; IRSA =1-3), Group 2 (n=35; IRSA =4-5), Group 3 (n=37; IRSA =6-7), and Group 4 (n=18; IRSA =8-10). Statistically significant ($p<0.05$) differences from Group 1 in the level of emotional strain and the index of psychological stress were found in Groups 3 and 4. Such differences from Group 1 in the effectiveness of mental operations of classification and analysis were observed in Group 4. We established that all male freshmen with different levels of regulatory system activity in our study had high rates of psychological stress and emotional strain, which could ultimately lead to a significant decrease in the effectiveness of their mental operations and adaptation failure.

Keywords: Freshman Year at College; Healthy Students; Heart Rate Variability; Mental Processes.

The higher education is associated with stress^{1,2}, especially in freshmen^{3,4}, against the background of memory, attention, thought processes, and changes in living conditions. It is well known that stress leads to changes in nervous system functions and behavior⁵, as well as to endocrine, cardiovascular, and psychosomatic disorders^{6,7}.

The functional state of the cardiovascular system, evaluated by the heart rate variability (HRV) parameters, may be considered an indicator of the regulatory system activity in human

organism⁸. The index of regulatory system activity (IRSA) was proposed in early 1980s to assess the functional state of human organism⁹⁻¹² and turned out to be sufficiently effective for differentiating the levels of the regulatory system strain and assessing the adaptive potential of a human body. Later on, its computation algorithm underwent some improvements^{11,12}. This index uses a specific algorithm involving statistical indicators, histogram data and interval spectral analysis calculated. This indicator is often used by Russian authors¹³⁻¹⁵

and is actively employed in medical computer appliances, developed in the RF. However, it has been successfully used by some foreign research teams as well^{16, 17}.

The association of mental activity parameters of college freshmen with IRSA levels was not studied before. Hence the objective of our study was to compare the parameters of mental functions in freshmen with different IRSA levels.

MATERIALS AND METHODS

Subjects

The study included 150 healthy young men 19.0 (19.0, 20.0) years of age (data presented as median with lower and upper quartiles). The criteria for inclusion into the study were as follows: 1) written consent to participate in the study, 2) absence of chronic somatic and mental pathology in anamnesis, 3) lack of traumatic brain injuries and other nervous disorders, 4) verification of relative health at the time of the survey, and 5) male gender. Exclusion criteria involved refusal of examined subjects to participate in the study, positive responses to the second and third inclusion criteria, and confirmation of acute illness at the time of examination.

Ethical approval

The design of our study was approved in 2019 by the Ethics Committee of the Saratov State Medical University (Saratov, Russia). Informed consent was obtained from all participants. All procedures performed in the studies, involving human participants, were in accordance with the ethical standards of the institutional research committee, as well as with the 1964 Declaration of Helsinki and its later amendments, or comparable ethical standards.

Evaluating the functional state based on IRSA values

IRSA was calculated using the computer appliance VNS-Spectrum (Neurosoft LLC, Ivanovo, Russia; <https://neurosoft.com/ru/catalog/hrv-analysis/VNS-spectrum>). Contemporary IRSA algorithm incorporates the following five criteria^{11, 12}

Criterion A (Total regulatory effect) is computed from the heart rate (HR); Criterion B (Overall regulatory activity) is computed based on total power of HRV spectrum (TP) and SDNN,

i.e. standard deviation of normal-to-normal RR-intervals, where R is the peak of a QRS complex on an electrocardiogram (heartbeat); Criterion C (Autonomic balance) is computed on the basis of the straining index (SI) values, square root from the sum of squared differences of sequential normal RR-intervals (root mean square of the successive differences, or RMSSD), power in a high-frequency range (0.15-0.4 Hz) of HRV spectrum (HF), and index of centralization (IC); Criterion D (Vasomotor center control of vascular tone) is computed from the power in a low-frequency range (0.04-0.15 Hz) of HRV spectrum (LF); Criterion E (Activity of the cardiovascular subcortex nervous centers, or suprasegmental regulation) is computed from the power in a very-low-frequency range (less than 0.04 Hz) of HRV spectrum (VLF).

The IRSA value is calculated as the sum of the scores (their absolute values) of the above five criteria. IRSA values are expressed in numbers between 1 and 10. Depending on the IRSA values, four functional states of a study subject's organism are distinguished¹¹: i) a state of norm, or a state of satisfactory adaptation (IRSA = 1-3); ii) a state of functional strain (IRSA = 4-5); iii) a state of over strain, or a state of unsatisfactory adaptation (IRSA = 6-7); and iv) a state of regulatory system depletion, or an adaptation failure (IRSA = 8-10).

All examined subjects were pooled into four groups, based on their IRSA values: Group 1 (n=60) – subjects with 1-3 IRSA points, Group 2 (n=35) – subjects with 4-5 IRSA points, Group 3 (n=37) – subjects with 6-7 IRSA points, and Group 4 (n=18) – subjects with 8-10 IRSA points.

Psychological analysis

The study of mental activity parameters was performed using the computer appliance NS-Psychotest (Neurosoft LLC, Ivanovo, Russia; <https://neurosoft.com/ru/catalog/psycho/expert>).

To measure an information stress impact in students as the basis for development of psychosomatic disorders, we used the College Schedule of Recent Experience-Modified (CSRE-M)^{18, 19}.

To assess the index of psychological stress, the questionnaire for evaluating neuropsychiatric stress by T.A. Nemchin [20] (Supplement A) was used.

To determine an effectiveness of mental operations of classification, analysis and an ability

Table 1. Comparative assessment of the psychological status in male freshmen with different IRSA levels

Parameters	Group 1 (n=60)	Group 2 (n=35)	Group 3 (n=37)	Group 4 (n=18)
Emotional strain, points	349.0 (199.0, 420.5)	393.2 (226.4, 546.0), p=0.561	465.3 (330.0, 571.7), p=0.055	477.6 (416.2, 585.5), p=0.045
Index of psychological stress, points	47.0 (45.0, 53.5)	49.3 (45.6, 54.7), p=0.482	63.4 (52.5, 72.5), p=0.048	67.0 (53.0, 78.6), p=0.036
Effectiveness of mental operations, points	14.0 (12.0, 15.0)	15.0 (12.2, 15.0), p=0.344	12.5 (11.0, 14.0), p=0.128	9.0 (8.7, 11.2), p=0.046

The statistical significance (p-values) of paired differences among indicators in Groups 2-4 with Group 1 is presented

to identify the essential features of objects, we employed a verbal version of the Exclusion of Irrelevant Items technique (Supplement B), which is very popular among Russian psychologists.

Statistical analysis

We reported continuous variables as medians with lower and upper quartiles – Me (LQ, UQ). Binary variables were presented by us as frequencies and percentages – n (%). We applied the Shapiro–Wilk test to check whether the values were normally distributed. Since most variables were not normally distributed, further analysis was carried out using nonparametric statistical methods. We used the Mann–Whitney test to compare the values of continuous variables between the groups of study subjects. The results were considered statistically significant if the p-value was less than 0.05.

RESULTS

The results of assessing the level of emotional strain, the index of psychological stress, and effectiveness of mental operations of classification and analysis in freshmen with different IRSA scores are presented in the Table 1. Statistically significant differences from Group 1 in the level of emotional strain and the index of psychological stress were found in Groups 3 and 4. Group 4 exhibited significantly different effectiveness of mental operations of classification and analysis, compared with the Group 1.

DISCUSSION

We discovered that male freshmen in all groups, differing by their IRSA scores, had a high degree of emotional strain with a high risk of developing psychosomatic disorders, while those with unsatisfactory adaptation (Group 3) and adaptation failure (Group 4) had a significant increase in the average values of their emotional strain and an increase in psychological stress to a moderate level. All subjects exhibited a high level of effectiveness of mental operations on comparison and generalization. However, students with a failure of adaptive mechanisms (Group 4) demonstrated a significant decrease in the effectiveness of their mental processes.

The prospects for using HRV indicators to assess the resilience of mental processes have already been discussed in the context of modern scientific data²¹. At the same time, HRV indices of vagal activity (specifically, HF, RMSSD, along with a widely used measure of HRV – pNN50) are of particular importance for adults. Changes in HRV parameters are also known in patients with depressive mental disorders²². Analysis of the association of mental status with HRV indicators has been very actively studied among young people, including students²³⁻²⁶. Summarizing the published data, we should point out that individuals with different states of their mental functions have characteristic differences in HRV indicators, although the research data are somewhat different. Difficulties in studying such relationships could

be due to the fact that different HRV assessments among people with certain mental status features are often studied simultaneously.

In our research, we attempted to go the opposite way: first, to divide the subjects according to their HRV specificities, and then to compare obtained characteristics of mental status among the groups. It should be noted that for such task, an integral HRV indicator is required, taking into account all its properties as much as possible; in our opinion, IRSA can be considered a suitable indicator for this purpose. As a result, the association of the autonomic regulation of heart function with properties of mental status was reconfirmed, and potentially important additional information was obtained.

CONCLUSION

We conclude that all male freshmen with different levels of regulatory system activity in our study have high rates of psychological stress and emotional strain, which ultimately leads to a significant decrease in the effectiveness of their mental operations and adaptation failure.

Conflict of interest

All authors declare no potential conflict of interest.

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