Psychological characteristics of the Heliomed 2 project volunteers and geomagnetic disturbance at high latitudes

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Abstract. The purpose of the study: to determine the psychoemotional characteristics of the inhabitants of subpolar latitudes participating in one of the stages of the Heliomed-2 project (2019, March), depending on the changes in the geomagnetic disturbance. For achieving this goal 20 male and female volunteers, with an average age of 42.5 (39.2; 45.3) years were examined using Ch. Spielberger-Yu. Hanin, E. Heim and psychogeometric tests; the indicator of a global geomagnetic disturbance – the daily Kp-index-was determined daily; a total of 420 measurements were made. It was found that among the volunteers, persons without psychological sensitivity to changes in geomagnetic disturbances prevailed (60%). The group effect among the respondents of the group I (carriers of the psychological sensitivity to the action of geomagnetic factors) was 57.14%, and among the respondents of the group II (without such sensitivity) – 14.29%. Among volunteers with psychological sensitivity to changes in geomagnetic perturbation, contradictory intrapersonal tendencies were established and the least effectiveness in constructing the stress-overcoming behavior (than among persons without this sensitivity) [p <0.05], and therefore it is advisable to conduct psychological correction of the changes detected in them to reduce the risk of developing neuroses and psychosomatic pathology.

1. Introduction

The functional state of the human body, which is an open system and carries out the exchange of energy with the environment, is determined by a variety of external factors. One of these factors is changes in the geomagnetic disturbance which is a complex of phenomena associated with processes on the Sun and in interplanetary space. Now, a lot of knowledge and information has been accumulated that describes the biotropic effects of geomagnetic disturbances: the effect on the rheological properties of blood, the development of endothelial dysfunction, fluctuations in blood pressure as well as on the heart rate, the development of thrombosis and arrhythmias. It was found that the psychoemotional state of a person is also affected by geomagnetic disturbances, which can have a negative impact on the background of the minimal solar activity [1-5].

The increasing number of scientific publications devoted to the study of the influence of geomagnetic disturbances on the state of the human body in combination with its psychological component emphasizes the relevance of these phenomena [3, 5, 6, 7]. This topic was previously relevant, but now it is in demand more than ever because cases of psychoemotional dependence on geomagnetic factors are becoming more frequent including at high latitudes.
In this regard, the purpose of our study was to determine the psychoemotional characteristics of residents of subpolar latitudes participating in one of the stages of the Heliomed-2 project depending on changes in geomagnetic disturbances.

2. Materials and methods
We observed 20 male (8 people) and female (12 people) volunteers [average age – 42.5 (39.2 – 45.3) years] living in the city of Yakutsk (subpolar latitudes). The obtained results were taken during the first half of the next stage of observations of the Heliomed-2 multi-latitude monitoring which took place in 2019.

The project participants were examined using tests of Ch.Spielberger – Yu. Hanin, E. Heim and psychogeometric ones. The questionnaire of Ch.Spielberger in the modification of Yu.Hanina [8] consists of 40 statements, the first 20 of which make it possible to model anxiety as a state, the remaining 20 make it possible to accept anxiety as a disposition, and these levels of anxiety are measured in points. The E. Heim test [9] provides an opportunity to compare the distinctive features of coping behavior in three areas: emotional, cognitive and behavioral. In the projective psychogeometric test by S. Delinger [10, 11] the respondents were given the opportunity to make a consistent preferred choice of 5 geometric shapes which allows them to find out the type of personality of the volunteers in a short period of time and present their behavior in template situations. To assess the activity of space weather factors, the global heliogeomagnetic disturbance index was used; it is the Raman index that was formed during the entire stage (including March 2019) on a daily basis. The tests were provided to the subjects once at the very beginning of this monitoring period, and the questionnaire for assessing reactive anxiety was provided daily. A total of 420 measurements were made. All volunteers living in subauroral latitudes signed a voluntary informed consent before starting the study.

Statistical processing of the obtained results was carried out using the application software package "STATGRAF Plus for Windows 6.0". The programs "Origin" and "Medstat" were also used for plotting graphs and statistical calculations. In accordance with the law of normal distribution, based on the calculation of the Shapiro-Wilko criterion, the discrepancy between the studied indicators and the law described above was revealed, i.e. the order of variables in this sample was incorrect, so modern nonparametric methods of mathematical statistics were used. The obtained results were presented in the image of the median with the values of the quartile range for the sample. For the analogy of variables the Wilcoxon pair comparison test was used, and for the comparison of groups the Mann – Whitney U-test was used. Conditions with values of at least 94% were accepted as reliable.

For analyzing and visualizing the results of the study of synchronization of medical parameters with space weather parameters, an original method was used using a specially developed interactive software package in the Python programming language which allows for the classification of volunteers [12].

3. Results
As a result of comparing the daily determined indicators of the anxiety as a state according to Spielberger-Yu. Khanin and the integral index of geomagnetic perturbation of the Kr-index, all volunteers living in subauroral latitudes during this period of observations of the Heliomed-2 multi-latitude monitoring were graded into two groups taking into account the coincidence of these indicators. The first (I) group of respondents who have 66.7% matches of the peak values of the Cr-index and reactive anxiety; the second (II) group: persons who do not have or have a smaller number of marked matches.

The volunteers of the group I were classified as psychologically sensitive to changes in geomagnetic disturbances, and the representatives of the group II were not carriers of this sensitivity.

Analyzing the group effects (Figures 1-2), the following drew attention to itself.
On the monthly profile of the Kr-index indicators for the observation period (March 2019), both absolute and relative peak-like increases were revealed, as well as trends towards peak formation of geomagnetic disturbance values. These changes were marked by the following days: 1, 4, 6, 12, 16, 19, 28 observations. On the average profile of the values of reactive anxiety in volunteers who are carriers of psychological sensitivity to changes in geomagnetic disturbances (for March 2019), both relative peak-like increases in the indicator of situational anxiety and trends to its peak formation were also revealed. Similar fluctuations in anxiety as a condition were established on the 4, 7, 12, 19, 28 days of monitoring. When comparing the deviations of the Kr-index and reactive anxiety in March 2019, five complete coincidences were revealed (March 4, 12, 19, 28) and in one case (March 6-7) – a "delay" of a day in the relative increase in situational anxiety. Thus, the group effect among the volunteers who were psychologically sensitive to changes in the geomagnetic disturbance was 57.14% (Figure 1).

Figure 1. Indicators of the averaged reactive anxiety of the group I of volunteers when the geomagnetic disturbance changes. 

Note: Kp - the indicator of the global geomagnetic disturbance; RT - the reactive anxiety.

Figure 2. Indicators of the averaged reactive anxiety of the group II of volunteers when the geomagnetic disturbance changes. 

Note: RT – reactive anxiety.
Among volunteers who do not have psychological sensitivity to changes in geomagnetic disturbances during the observation period on the average profile of anxiety indicators such as states, relative and peak-like increases (including trends to peak formation) in the values of the reactive anxiety were noted on 5, 10, 14, 19, 22, 26 days of the project stage (March 2019). Accordingly, the group effect was 14.29% (since the coincidence with the peak increase in the Kr-index was detected only on the 19th day of monitoring) (Figure 2).

The features of the personal response of the volunteers of both groups I and II, identified using the psychological methods chosen by us, were illustrated in Figures 3-7.

**Figure 3.** Features of the construction of the stress-overcoming behavior in the cognitive sphere in volunteers living in subauroral latitudes (in %).

Note: 1) Forms of coping reactions: C – constructive, N-non-constructive, R-relatively constructive. 2) Designation of groups: Group I-volunteers who are psychologically sensitive to changes in geomagnetic disturbances; group II-project participants who do not have such sensitivity.

**Figure 4.** Features of the construction of the stress-overcoming behavior in the emotional sphere of volunteers living in subauroral latitudes (in %).

Note. The forms of coping reactions and group designations are the same as in Figure 3.

**Figure 5.** Features of the construction of the actual stress-overcoming behavior of volunteers living in subauroral latitudes (in %).

Note: the forms of coping reactions and group designations are the same as in Figure 3.

According to the results of the construction of the stress-overcoming behavior according to E. Heim it was found that in the cognitive sphere among psychologically sensitive volunteers living in high latitudes, non-constructive (confusion and dissimulation, on a parity basis) prevailed, and among persons without this sensitivity constructive coping cognitions prevailed (a problem analysis) (Figure 3, p <0.05). In the emotional sphere, constructive responses prevailed in both groups (optimism), but among representatives without psychological sensitivity to changes in geomagnetic disturbances, it was possible to speak of their dominance (Figure 4, p <0.05). Among the unconstructive emotional coping forms, the representatives of the group of psychologically sensitive volunteers showed
suppression of emotions, and the respondents without this sensitivity showed a self-accusation. When building the actual coping behaviors among project participants from the group I the choice was mainly for non-constructive coping styles (retreat), and the absence of psychological sensitivity to geomagnetic disturbances volunteers most often chose constructive (cooperation) than non-constructive coping responses (Figure 5, p <0.05).

The level of anxiety as the disposition in both groups was average, but individuals who do not have psychological sensitivity was slightly higher (38.75 points in the group I; 42.83 points in the group II), however, differences were not significant.

Working with the stimulus material of the psychogeometric test it was shown that the volunteers of the Heliomed-2 project are residents of subauroral latitudes and at this stage of the observation chose mainly a triangle (persons with psychological sensitivity to geomagnetic disturbances) and a circle (those who did not have such sensitivity); representatives of both groups rejected the zigzag (Figures 6-7).

4. Discussion of the results

It was noteworthy that it was during this period, when the study was conducted (2019), that the minimum level of the solar activity was observed in its next 11-year cycle. It was shown that under these conditions, the influence of heliogeomagnetic factors on the state of the cardiovascular system of the inhabitants of the North increases [13]; it would be interesting to clarify whether this is true for the psychoemotional status of the inhabitants of high latitudes in our study.

I would like to note that during this period of observations of one of the stages of the multi-latitude monitoring "Heliomed-2" (March 2019), among the volunteers living in subpolar latitudes, people who do not have psychological sensitivity to changes in geomagnetic disturbances prevailed (60%) compared with those who had this psychological sensitivity was detected (40%).

The group effect when comparing the indicators of anxiety as a state and the integral indicator of geomagnetic disturbance in the group of persons who are carrier of psychological sensitivity to changes in the action of geophysical factors was 57.14%, and in those who did not have such sensitivity it was 14.29%.

The group I of individuals more rarely than the group II of individuals choose constructive forms in all three areas of coping behavior, and more rarely choose non-constructive forms.

The psychological profile of the volunteers participating in this stage of the project "Heliomed-2" living in sub-auroral latitudes and having psychological sensitivity to changes in heliomagnetic
disturbances, includes the following features with contradictions: despite their optimism, purposefulness, the presence of leadership traits, in cases where they are confused in difficult situations, they try to hide their psychological and somatic problems and actively suppress their emotions, fearing possible changes and conflicts and as a result of this it is the retreat before difficulties.

As for the representatives of the group without this psychological sensitivity, they are characterized by benevolence, the desire to avoid conflicts and analyze the causes of problems, to be optimistic about their own resources and the outcome of current events, to blame themselves for possible failures in difficult situations and to seek a way out of them by cooperating with people important to them.

Thus, representatives of the group of participants of the project "Heliomed-2", who have psychological sensitivity to changes in geomagnetic disturbances, have polar intrapsychic tendencies which in certain situations can reach the degree of intrapersonal conflict increasing their level of anxiety and the risk of developing neuroses and psychosomatic diseases, since increased anxiety is recognized as an independent risk factor for these pathological conditions. In addition, their desire to suppress their emotions (for example, aggressiveness) can also lead to the somatization of affect and the emergence of psychosomatic pathology [14-16]. Therefore, they need psychological correction of the identified changes in personal response in contrast to those volunteers who do not have this sensitivity.

5. Conclusion

Among the volunteers participating in the first half of the Heliomed-2 project phase (March 2019), persons without psychological sensitivity to changes in geomagnetic disturbances predominated (60%). The group effect among individuals who are carriers of psychological sensitivity to the action of geophysical factors was 57.14%, in contrast to the respondents who do not have this sensitivity, their number is 14.29%. Volunteers with psychological sensitivity to changes in geomagnetic disturbances had polar tendencies in the personality radical and were less constructive in constructing stress-overcoming behavior in all its areas (compared to those who did not have such sensitivity), which makes it advisable to psychologically correct the changes identified in them to reduce the risk of developing neuroses and psychosomatic pathology.

6. References

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