Local inhomogeneity of the magnetic field as a possible factor of influence on the human

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ABSTRACT

The results of expeditionary studies in August 2013 at the Chui region of the earthquake epicenter (2003), in the area, characterized by an abnormal performance of the spatial distribution of the geomagnetic field vector values are presented. The adaptive response of the human body by analyzing the variability of the cardiovascular system activity in a short stay in the area of natural character geomagnetic anomalies is investigated. It is shown that a person entering the zone with abnormal magnetic field gradient levels can disrupt adaptive human body reaction that is accompanied by an increased level of the cardiovascular system functioning after visiting zone and increasing the power spectral density of oscillations several RR intervals of heart rate in the range of 0,04 -0,15 Hz and 0,5-1 Hz while in a zone.

Keywords: geomagnetic field, magnetic field gradient, human cardiovascular system, heart rate variability, spectral analysis.

1. INTRODUCTION

Cardiovascular and nervous system of the human body are universal "indicator" of adaptive reactions of the human body, quickly reacting to any external influence, including a change in the physical fields of the environment. Variations of the geomagnetic field of the Earth can have a significant impact on the state of the body as a healthy and, to a greater extent, weakened in some human disease [1]. At the same time there is the specificity of the response to various nosological manifestations [2].

Geomagnetic anomaly natural character is one of the least studied environmental risk factors for human. At the same time these geomagnetic anomalies - not uncommon. On the territory of the Russian Federation there are a fairly large number of such zones. Located in the places of residence of people and cities (district of the Kursk magnetic anomaly, Altai Republic, and others.), taking into account the increasing anthropogenic load, areas of geomagnetic anomalies are a significant risk factor for the health and life of the population [3]. Studies carried out in 2011-2012 in the epicentral area of the Chuya earthquake (2003), in areas with a complete anomaly of the magnetic field, we showed that the cardiovascular system is able to respond to changing environmental conditions within the zone of active-fault [4].

2. EXPERIMENTAL

The following are the results of expeditionary studies August 1-2, 2013. The investigated region is a plain area (within a few tens of square meters) with a centrally located boulder gneiss rocks. In connection with the processes of dynamic metamorphism domains containing magnetic minerals in it have gained a clear orientation that led strong gradient magnetic field inhomogeneity within clumps (the order of tens thousands nT/m). Thus, in contrast to previous studies, the magnetic anomaly occupies a limited portion of the terrain. During the expedition was recorded all possible complex heliogeophysical and climatic parameters during the measurement. Total geomagnetic activity was low (Kp = 1-2) for the entire period of measurement.

Each of the volunteers participating in the experiment lived in the camp away from the magnetic abnormal zone, passed through the same route finding in the area for 15-20 min., then return to the camp by the same route (fig. 1).

The study involved six volunteers with no significant deviations nosology. Four volunteers were equipped with Holter "Valenta" to record the electrocardiogram, two – monitor noninvasive blood oxygenation and pulse WristOx registration. Next, the four volunteers (two volunteers per day) – visited magnetic abnormal area, the other two (one per day) served as "background", being at that time in the camp. On the first day as the volunteers were women aged 20-23 years, on the second day – men, one aged 23 and two aged 40-50 years.

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For the analysis of human body reactions to environmental conditions variability have been used the time series of the heartbeat period (R-R intervals), derived from the analysis of the electrocardiogram and pulse data recording and the series of values of blood oxygenation.

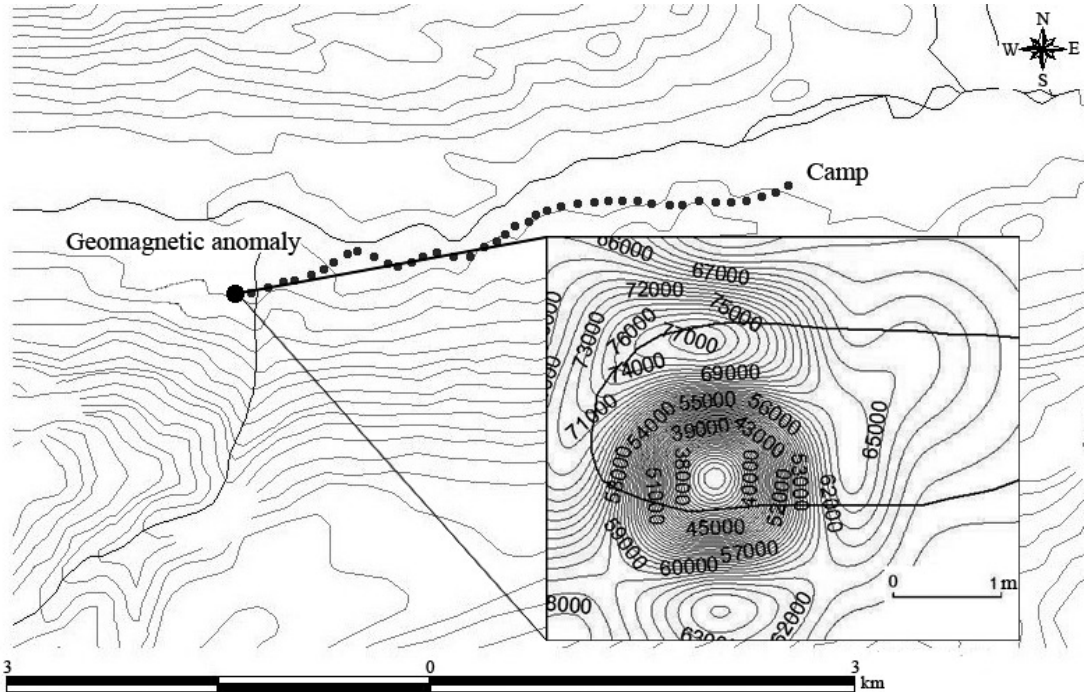

Figure 1. The route of the experiment with a dedicated magnetic anomalous zone (value of the magnetic field in the nT).

3. RESULTS

Fig. 2a shows the temporal dynamics of the average heartbeat period (index mRR) and standard deviation (index SDNN) volunteer ZYA in the first day of the study, averaging period – three minutes. Because of noise source data to see the general trend observed variables used filtering of input data based on the Hamming filter. Fig. 2b – the dynamics of the average oxygen content in the blood of volunteers (index meanO2) and standard deviation (index sdO2). The arrows here and below in the illustration: 1 – the beginning of the route, 2 – stay in the gradient of the magnetic field zone, 3 – arrival in the camp.

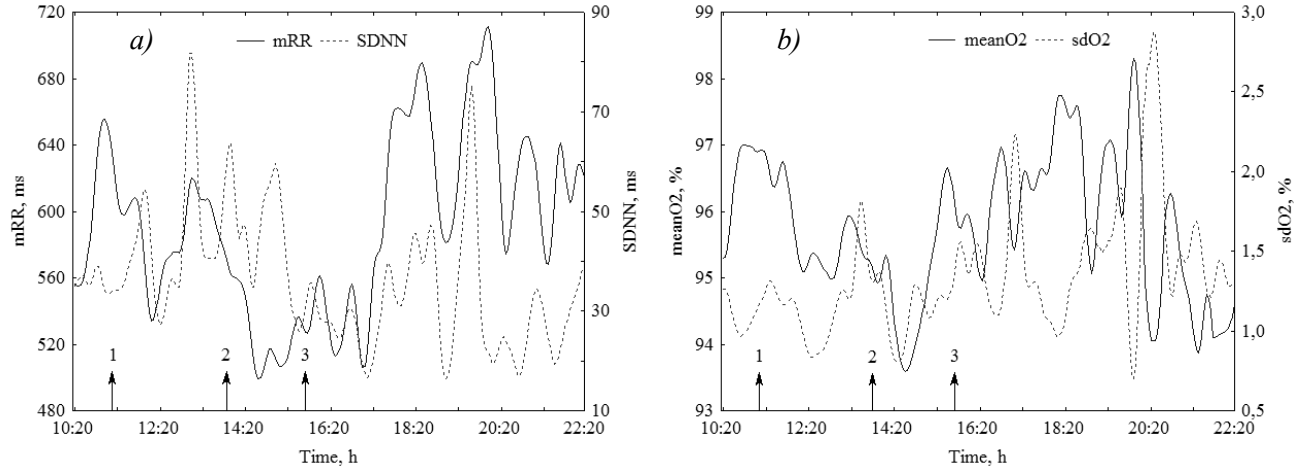

Figure 2. Temporal dynamics of heartbeat period (a) and blood oxygenation (b) variability of volunteer ZYA.

In general, the time of the visit of the fault zone does not show a significant change in the variability of the observed indicators. After leaving the zone heart rate acceleration is observed (decrease mRR) compared to the interval before the visit, and a reduced level of oxygen in the blood. This result can be interpreted as a violation of adaptive reactions of the body after being in the zone of magnetic anomaly, which is in good agreement with literature data. The second volunteer NGM involved simultaneously with the first in the campaign to the test zone, and detects heart palpitations after leaving the area on the way to the camp (fig. 3). For background volunteer at the camp such dynamics is not observed.

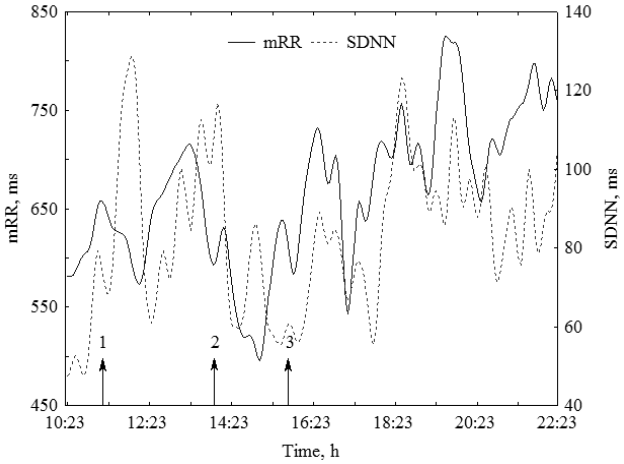

Figure 3. Temporal dynamics of heartbeat period variability of volunteer NGM.

In addition, we analyzed the spectral power density fluctuations of a number of R-R intervals. The discrete Fourier transform makes it possible to obtain spectra of variability interval R-R sinus rhythm. These spectra are further divided in the frequency subbands to the following amplitude: VLF – 0,005-0,04 Hz; LF – 0,04-0,15 Hz; HF – 0,15-0,4 Hz; HF2 – 0,5-1 Hz. Fig. 4 shows the results of spectral analysis of heart rate variability volunteer NGM. It can be seen that at the time of stay inside the magnetic anomaly zone appears peak LF frequency bands (fig. 4a) and HF2 (fig. 4b).

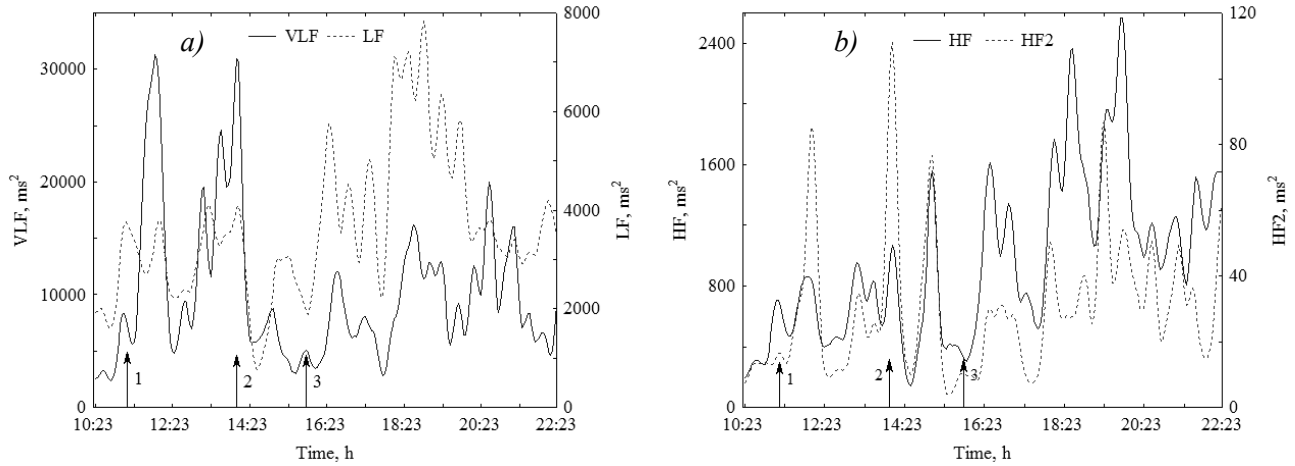

Figure 4. The spectral analysis results of R-R intervals time series of volunteer NGM.

Results obtained in the second study day, have a similar, though less pronounced trend. For example, fig. 5a shows the temporal dynamics of average and standard deviation of the heartbeat period volunteer SAV. This volunteer belongs to the age group 40-50 years, and finds brief palpitations both during entry into the magnetic anomaly zone, and on the path of return to the camp after visiting the area. As for the level of oxygen in the blood, throughout the campaign, it is stored at a low level, falling to its lowest level after returning to the camp (fig. 5b).

Another volunteer VDS (male, 23 years) who participated in the campaign for the second day of the study, does not show significant changes in the functioning of the registered activity indices of the cardiovascular system. The observed

differences may be associated with gender or age differences (on the first day involved only girls the same age group, the second – mens of different age groups), and the individual characteristics of the human body, its physiological state variations.

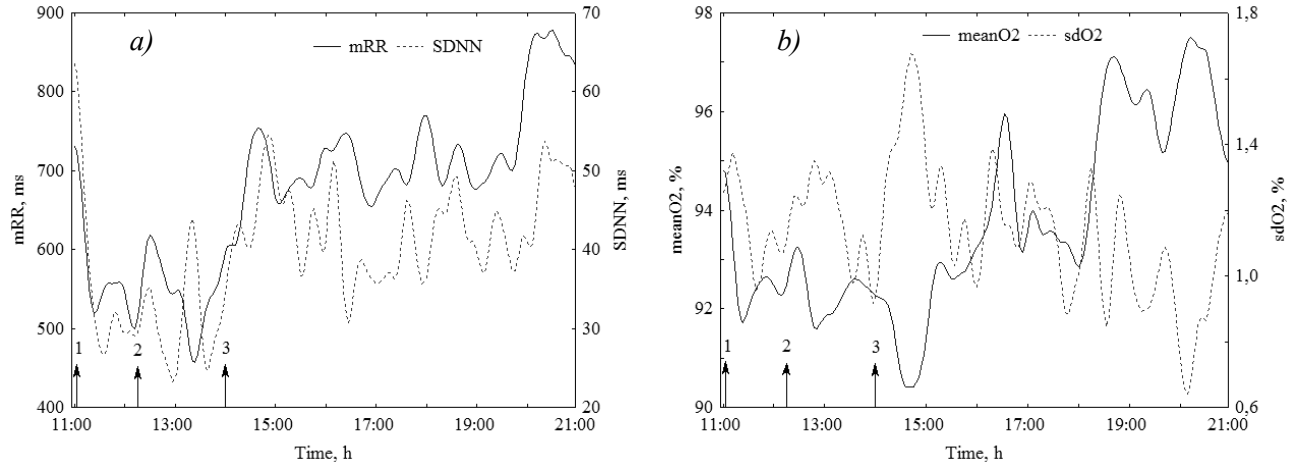

Figure 5. Temporal dynamics of heartbeat period (a) and blood oxygenation (b) variability of volunteer SAV.

4. CONCLUSION

Thus, as a result of studies of the effect of spatially limited natural geomagnetic anomalies of the human body found that short-term stay of the person within the zone may lead to the disruption of adaptation characteristics of the body, resulting in heart palpitations, and lowering the oxygen content in the blood after visiting the area, which regardless of the connection with the respiratory system can respond to specific environmental conditions. It is assumed that various gender and age groups have a specific response to the impact of abnormal values of the geomagnetic field. The results, due to poor statistics accumulated experimental data because of the specificity of research expeditions require verification through further experiments.

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