Article

Predictors of the formation of pathological conditions of landing participants in the Arctic latitudes considering the trans-latitudinal flight along ultradian rhythms

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Abstract The article looks at what causes landing participants in the Arctic to develop health problems during trans-latitudinal flights that last 28 hours, focusing on ultradian rhythms. Landing performed from a height of 10 km to the territory of the Russian islands in the Arctic Ocean. Holter monitoring used in the studies. Predictors were determined by normalized indicators of heart rate variability. The identified violations are typical for classes 06, 07, 11 of ICD-11 (International Classification of Diseases).

Keywords: ultradian rhythms, predictors, pathological conditions, trans-latitudinal flight, heart rate variability, desaturation, dyschronism.

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1. Introduction

Over the past ten years, scientists studying chronobiology have focused on biological rhythms such as ultradian. Ultradian rhythms during periods of active work of the human body in various conditions of its activity have not been studied enough. This applies not only to labor activity but also to educational, sports and others.

The term “ultradian rhythms” is aperiodic [1]. To describe the biological phenomena of life more accurately [2], some call them "episodic ultradian events" while in physiology, they referred to as "basic rest-activity cycle" (BRAC) [3]. Studying ultradian rhythms can show how the body works during busy times, like work. Such studies can provide the key to understanding the formation of pathological conditions and disease [4].

2. Patients and Methods

HOLTERLIVE hardware complex was used to analyze heart rate variability in ISCIM6.0. Spectral analysis indicators were of the greatest interest: HF, LF, VLF, ULF (m/s2 and % ratios), their amplitudes (A), stress index (SI). The drawings of the phase portraits make using the ISCIM6.0 software. Phase portraits show the body's state, including normal, before illness, and when the body can't adapt to illness. To study ultradian rhythms in the active physical phase of a person, it is most expedient to use the method of heart rate variability. The method has over 40 indicators that are sensitive to spatio-temporal physical and cognitive loads, including extreme conditions.

The psychological state of Arctic landing participants evaluated with the SAM method (well-being, activity, and mood). This technique is valid and widely used in biomedical research.

Eight men participated in the study. They were aged 28 to 50 and had experience in landing on limited sites in extreme conditions due to their parachute training (from 300 to 15 thousand jumps).

The uniqueness of the study lies because the Arctic landing conducted for the first time in the world from a height of 10 km to the islands of the Arctic Ocean. The flight crossed one time zone, but the temperature shifted from mild to Arctic.

The measurements were performed: from the moment of installing Holter monitoring devices when boarding the plane, landing on the islands and returning to the original base. The air temperature of the airfield at the time of departure was +17o, the air temperature at the time of leaving the aircraft was -60o, and landing - 5o. Recording of ultradian rhythms of heart rate variability conducted for 20 hours.

3. Results

3.1. Heart rate variability.

The data received indicate that, regardless of age, there is an overstrain of functional systems. What is typical of the disruption of adaptive reactions and corresponds to the formation of a pathological condition. It was revealed that the range of these differences in terms of AHF amplitude was 93%, and SI -89%. Between the amplitudes of ALF and AVLF dense areas of scattering observed, VLF did not exceed 280 ms2/Hz (Fig.).

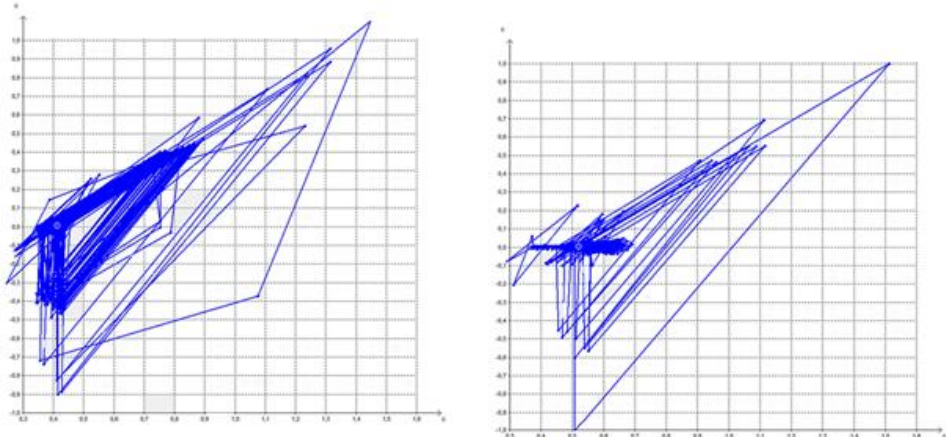

Figure. Phase portrait and HRV values in specialists aged 33 and 50 after landing in arctic conditions

The data received indicates that the activity of the vagus nerve increases with age in extreme situations. Which indicates parasympathicotonia, which characterized by a decrease in the response of the sympathetic department during stress; there is a need for urgent adaptation of the body. Accordingly, the activity of the autonomous circuit increases. Synchronization of heart rate control processes occurs.

There were a high level of individual differences in the group. Comparison of the maximum and minimum values in terms of AHF was 79%, SI - 86%, ALF - 75%. According to the AVLF, all participants had dense areas of scattering, and the VLF exceeded 400 ms2 /Hz.

It was also found that the higher the VLF, the lower the RMSSD (r= ¬0.929; P<0.001) and SDNN (r= ¬0.898; P<0.001). The body's autonomous circuit is regulating the heart rhythm, which leads to an increase in the sympathetic branch and a desire for self-regulation.

Health risks like vasodilatation and cardiogenic collapse can occur if people over 50 try to overcome the challenges of the Arctic such as time zones, high altitude, low temperatures, and other factors.

Normative indicators of heart rate variability such as SDNN, HF%, LF%, VLF%, and TP m/s2 were used to identify the pathophysiological state of Arctic landing participants during their trans-latitudinal flight along ultradian rhythms.

Mathematical modeling using SDNN suggests that the trans-latitudinal Arctic flight participants could have microcirculatory disorders in their brain tissue. The examined patients have a chronotropic reaction, obvious violations of the innervation of the conduction system of the heart.

The obtained data of correlation analysis characterizes dysfunction of heart rate regulation and decrease in resistance associated with desaturation. This can be seen as internal dyschronism. [5]. Internal dyschronism occurs between the biological rhythms of the body. Human factors like lack of sleep, disrupted routines, and mental health issues can cause various disorders. In the absence of obvious nosological changes, it can serve as a sign of premorbid conditions [5, 6]. The body reacts to Arctic conditions during the trans-latitudinal flight.

4. Discussion

During a flight in the Arctic with technical support for critical infrastructure, participants experience external dyschronism and individual adaptation to unfavorable factors based on heart rhythm control. External dyschronism occurs between external environmental rhythmic factors and the body's own rhythms. Flights across time zones or latitudes cause these changes. The results obtained indicate a stable formation of pathological conditions.

It has been established that under conditions of high-altitude hyperoxia-hypoxia up to 10,000 m, accompanied by desaturation followed by the use of oxygen apparatus for breathing: the resistance decreases, the activity of the parasympathetic link increases, which is typical for a violation of the function of regulating the regulation of the heart rhythm. This considered as an internal dyschronism and a sign premorbid state of the body. There is also a cross-adaptation to a complex of adverse factors.

According to the GSAM method, during the training camp, all the subjects noted good health and mood. At the same time, 87% felt tension, drowsiness, a desire to rest, lack of attention and efficiency, which negatively affected the cognitive reactions of the landing participants.

5. Conclusions

Thus, the analysis of the results of the study showed that the predictors of the formation of pathological conditions according to ultradian rhythms of heart rate variability in landing participants on the Arctic islands, considering trans-latitudinal flight, were both psychological indicators and cardiovascular indicators of heart rate variability: HR, MxDMn, RMSSD, SDNN; SI spectrum power: HF, LF, VLF, ULF TP; ULF / HF are reflected in classes 06, 07, 11 of ICD 11. The method of heart rate variability in the study of ultradian rhythms is the most practical and scientifically based method for determining the predictors of the formation of pathological conditions of the human body under the influence factors of stress of various natures.

To ensure the safety of landing in arctic conditions and prevent the occurrence of the human factor, it is necessary to consider the health of specialists and their adaptive capabilities. Based on the results of the study, it is recommended that it is advisable to approach the selection of specialists to perform complex tasks in extreme conditions of professional activity. Particular attention should be paid to the formation of group synchronization. It should be emphasized the importance of the organization of nutrition, sleep and rest for the successful completion of tasks, in conditions that are especially dangerous for human life. When professionals train for extreme situations, a doctor or psychophysiologist should supervise them. This helps with rehabilitation, monitors their health and mental state, and regulates work and rest.

Application of artificial intelligence:

The article is written without the use of artificial intelligence technologies.

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