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PREDICTORS OF THE FORMATION OF PATHOLOGICAL CONDITIONS OF LANDING PARTICIPANTS IN THE ARCTIC LATITUDES CONSIDERING THE TRANS-LATITUDINAL FLIGHT ALONG ULTRADIAN RHYTHMS

Research article

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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. The landing participants faced desaturation and the possibility of hypoxia, but the entire group had experience in mountain climbing up to 4 km. This study aimed to examine physiological indicators using ultradian rhythms and identify predictors of pathological conditions in landing participants. 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.

ПРЕДИКТОРЫ ФОРМИРОВАНИЯ ПАТОЛОГИЧЕСКИХ СОСТОЯНИЙ УЧАСТНИКОВ ДЕСАНТИРОВАНИЯ В АРКТИЧЕСКИЕ ШИРОТЫ С УЧЕТОМ ТРАНСШИРОТНОГО ПЕРЕЛЕТА ПО УЛЬТРАДИАННЫМ РИТМАМ

Научная статья

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Аннотация

В статье обсуждаются предикторы формирования патологических состояний по ультрадианным ритмам (28 часов) участников десантирования в арктические широты с учётом трансширотного перелёта. Впервые в мире десантирование осуществлялось с высоты 10 км на территорию российских островов в Северном Ледовитом океане. Целью данного исследования явилось изучение физиологических показателей по ультрадианным ритмам и выявление тех предикторов, которые указывали бы формирование патологических состояний участников десантирования. В исследованиях использовано холторовское мониторирование. Предикторы определялись по нормированным показателям вариабельности сердечного ритма. Выявленные нарушения характерны для классов 06, 07, 11 МКБ-11 (международная классификация болезней).

Ключевые слова: ультрадианные ритмы, предикторы, патологические состояния, трансширотный перелёт, вариабельность сердечного ритма, десатурация, дисхронизм.

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 [7], [8], [12].

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], [9], [14], [18].

Ultradian rhythms are interesting because they happen during a person's active period and have not been studied enough [1], [5], [6], [15]. The complexity of such studies lies because not all species of work activities are available to the researcher and can be performed remotely. Another difficulty lies in the interests of the subjects, since workers do not express a desire to conduct the study.

The landing in the Arctic latitudes from a height of 10 km was prepared long before the event itself. A medical examination was conducted on the applicants, resulting in the formation of a group of experienced specialists with diverse ages and backgrounds in parachute training and landing from various heights [16]. The preparation occurred in several stages. It included a training period with leaving a turbojet transport aircraft at a minimum speed of 760 km/h from an altitude of 8 and 10 km. All participants expressed concern regarding the shift from desaturation to the subsequent utilization of personal breathing devices. Special parachute equipment, clothing, gloves, and shoes were also tested, since at the height of the drop object, the air temperature was down to -60º C.

The landing participants faced desaturation and the possibility of hypoxia, but the entire group had experience in mountain climbing up to 4 km. No one in the world has jumped from a height of 10 km, especially on the islands of the Arctic Ocean, and there is no information about such studies in literary sources [17]. Literary data exists on the physiological state of sailors who sailed in the Arctic Ocean's northern latitudes and shift workers in polar latitudes, as well as the potential for work-related pathological conditions [10], [11], [13].

Research methods and principles

The studies used non-invasive heart rate variability method. There were no other opportunities from nature of the tasks. The subjects wore specialized gear and uniforms that restricted the use of additional tools, such as pressure and saturation measurements. Only before departure, a few hours before landing, during a trans-latitudinal flight, was this information received. The HOLTERLIVE hardware systems were installed at the airfield before boarding the plane several hours before landing, considering the trans-latitudinal flight.

Heart rate variability indicators were analyzed using the HOLTERLIVE hardware complex in statistical processing ISCIM6.0. The most interesting were the spectral analysis indicators: HF (high frequency waves, 0.40-0.15 Hz), LF (low frequency waves, 0.15-0.04 Hz), VLF (very low frequency waves, 0.04-0.04 Hz). 0.0033 Hz), ULF (ultra-low frequency, less than 0.0033 Hz) in m/s2 and % ratios, their amplitude (A), stress (SI).

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 trans-latitudinal flight was performed from a temperate continental climate to a typical arctic one.

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.

Main results

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.

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 ($r= \neg 0.929$; $P<0.001$) and SDNN ($r= \neg 0.898$; $P<0.001$). 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. All participants showed high-altitude hyperoxia at the altitude of leaving the aircraft (10 km).

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 hypoxia and hyperoxia, 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.

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. Participants in trans-latitudinal flights and landings on Arctic islands in the Arctic Ocean may experience stable formation of pathological conditions, as specified by the containing results.

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 of 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.

Conclusion

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 of 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.

Конфликт интересов

Не указан.

Рецензия

Все статьи проходят рецензирование. Но рецензент или автор статьи предпочли не публиковать рецензию к этой статье в открытом доступе. Рецензия может быть предоставлена компетентным органам по запросу.

Conflict of Interest

None declared.

Review

All articles are peer-reviewed. But the reviewer or the author of the article chose not to publish a review of this article in the public domain. The review can be provided to the competent authorities upon request.

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