Chronobiological potential of human resources as a condition for ensuring socially safe activities in the development of the North

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Abstract. This paper presents an analysis of Russian scientific research in the field of the chronobiological potential of human resources as a condition for ensuring socially safe activities in the development of the North. The analysis of literary sources revealed that mainly works are devoted to characterization, including comparative, of individual physiological indicators. Most of the literature studied on the problems of human adaptation to the conditions of the north is devoted to the study of the functional state of the physiological systems of the indigenous and alien population to the harsh climatic conditions. Extreme north of the European, West Siberian, and less, East Siberian part of Russia. In connection with the development of natural resources, where there is no permanently resident population, such a non-traditional form of labor as a shift began to be used effectively. The time of the watch is determined by the conditions. Since newcomers will take part in the development of the Arctic latitudes, it is extremely important, from this point of view, information about seasonal exacerbations of functional systems of a pathological nature and disorders of the circadian chronorhythms of melatonin production resulting from changes in photoperiodism. In the analyzed works it is emphasized that the obtained information about the adaptation resources of various labor groups operating in the development of the Arctic latitudes, testifies not to the benefit of their health in comparison with the genetic potential of Aboriginal people. The results of the analysis of literary sources showed that the study of the potential of the human body from the point of view of determinism is not enough, since we can only register linear indicators. A look at this problem of the chronobiological potential of human resources from the point of view of fractal determinism is not well understood.

1. Introduction

The penetration of a person into higher latitudes is a difficulty for the permanent residence of the human population for many reasons. However, the desire of society for territorial development can lead to changes in the natural system of the Arctic, and may affect the health of those who will develop these territories. The clash of two global problems requires a reasonable, expedient solution.

The concept of human resources has been widely used as a scientific term, not only in sociology, but in other sciences. In the biomedical and psychological sciences, it is advisable to use it in the complex characteristics of the adaptive capabilities of both a particular person and groups of people in various environmental conditions. In the literature it is noted that the human factor is determined by the phylogenesis of the psycho-physiological reserves of a person. With the development of a
synergistic methodology, human resources are considered as a self-developing dissipative system, in which case the influence of external factors on adaptation to extreme conditions and situations should be considered on the basis of fractal determinism. At the present stage of development of the fundamental science of man and earth, the natural system of the Arctic and its influence on man is a “white spot” in science.

We have analyzed more than 140 literary sources aimed at studying the peculiarities of human adaptation to the rhythmic features of the Arctic latitudes. This paper presents an analysis of some aspects of this problem according to Russian studies.

First of all, it is advisable to pay attention to the monograph of V.I. Evdokimova “Scientometric analysis of scientific articles on medico-biological problems among specialists of extreme professions in the Far North of Russia (2005–2016) in the Russian Scientific Citation Index (RISC)”, which presents a statistical analysis of Russian scientific publications. In general, they analyzed 2606 articles on 02.03.2016. The author found that medical and biological issues in military personnel were investigated in 41% of articles, clinical medicine - in 13%, preventive medicine - in 39%, psychology - in 7% of articles, in shift workers - in 25, 20, 34 and 22% articles, respectively [9]. From the above example, it is not difficult to understand that the problem of studying the potential of human resources is being investigated, but it is not noted that the system is expressed systematically, which emphasizes the need to systematize data on human resources precisely in the chronobiological aspect.

2. Main part
Of great scientific interest is the individual potential of human resources in the socio-psychological aspect, since labor activity is associated with group interactions. In domestic and foreign literature sources, the results of human resources research to a complex of stress factors of various nature, including the Arctic latitudes, are not sufficiently reflected.

The coordinated activity of various functional systems that determine individual indicators of the internal environment is an expression of the biological expediency and physiological integrity of the organism. One of the leading indicators of the normal functioning of systems of any level is its stability. The manifestation of such stability can be directed preservation of chronoarchitecture of biorhythms [2; 12].

At the end of the 1980s-1990s, brilliant studies were conducted aimed at studying the adaptation and health of the population of the Far North of Russia, whose territory stretches for thousands of kilometers from west to east. Human labor in high latitudes is subject to the influence of a complex set of factors, both social and geophysical. In this connection, the elucidation of the specific mechanisms of systemic chronobiological rearrangement of body functions is a necessary condition for the effective development of control devices, as well as: a) the possibility of scientific prediction of their remote effects; b) prevention of the development of pathology; c) monitoring individual health; d) the optimal organization of labor for the preservation of occupational health of a person, associated with a long or short stay (shift and expeditionary shift) in extreme climatic and seasonal conditions of the north. Research in this area has its own history and is associated with the socio-economic development of the northern latitudes of our country [15].

The analysis of literary sources revealed that mainly works are devoted to characterization, including comparative, of individual physiological indicators. Most of the studied literature on the problems of human adaptation to the conditions of the north is devoted to the study of the functional state of the physiological systems of the indigenous and alien population to the harsh climatic conditions of the far north of the European, West Siberian, and less Eastern Siberian part of Russia. In connection with the development of natural resources, where there is no permanently resident population, such a non-traditional form of labor as a shift began to be used effectively. The time of the watch is determined by the conditions.

Of great interest are medical and biological studies of rotational and expeditionary rotational labor activity in the Far North. Thus, it has been established that directly in the extreme conditions of the Polar region, the prevalence of arterial hypertension is observed among people engaged in
expeditionary-shift labor work [13]. The obtained fundamental biomedical information of studying adaptation resources of “shift workers” revealed the development of significant morphological and functional changes in the body of workers associated with incomplete adaptation (S.G. Krivoschekov, 1998) [3; 5; 17].

The concept of ”unfinished adaptation” allowed to substantiate the mode of work and rest for the population of extreme northern latitudes. Thus, studies indicate that the physiological level of response and changes in psychoemotional status in the case of expeditionary labor is of particular importance, since the activities of workers are associated with a dynamic change of climatic zones, time zones and conditions of life activity [13]. It was revealed that in conditions of high latitudes a certain regulatory background is needed, which establishes complex psychosomatic interrelations, as well as the conjugacy and heterochronicity of the inclusion of individual systems that ensure the efficiency of the human body [20].

Of particular interest are the works of N.M. Fateeva. Based on the works of domestic and foreign researchers (Bykov V.A., Katinas G.S., 1977; Zaslavskaya R.M., 1994-2001; Kolpakov V.V., 1987-1995; Sorokin A.A. et al., 2000; Anderson S., 1989; Hilman D.C., 1993; Otsuka K., Cornelissen G., Halberg F., 1997; Rusak, 1977; Rossi A., 1988; Ikonomow O., 1991; Wang Z., 1993, etc.) she emphasizes that the chrono-physiological diagnosis of the state of the body, both in normal conditions and in various forms of production activity, in different environmental conditions is the most informative in assessing and deciphering the physiological mechanisms of adaptation and disruption compensatory adjustment positive reactions. The most promising at present is the complex characterization of biorhythms [10]. She has established extremely important relationships of the systemic organization of biorhythms (ultradian, circadian, seasonal) hemostasis, hemodynamics, blood phospholipid content, structural and functional state of platelet membranes in mid-latitude conditions and in intensive production activities in the Far North with periodic change of climatic environment (watch 2 type). The author of the work identified the criteria for desynchronosis of varying severity when moving from middle latitudes to the conditions of the Far North and the action of climatic contrast. N.M. Fateeva notes that during shuttle flights from mid-latitudes to conditions of the Far North, shift workers maintain seasonal dynamics of physiological functions with the manifestation of individual-typological reactions of the body to shuttle meridional movements [ibid].

Various ultradian and infradian components of the diurnal rhythm are established in a wide range of physiological functions. In particular, a complete description of the spectral composition of the biorhythms of the cardiovascular system at various stages of ontogenesis is given [8]. The hemostasis system is one of many systems that ensure the normal functioning of the body. It is known that the hemostasis system is in close morphofunctional relationship with the cardiovascular system, in the problem of their joint functioning both in normal conditions and in conditions of intensive production activity.

Adaptive reactions of the cardiorespiratory system in shift workers were studied by A.S. Sarychev (2011) [18]. The author has established that with an expeditionary type of organization, fatigue at shift workers occurs at different periods of the shift period: at sympathotonics — by 1–4, normotonics — by 20-30, and by vagotonics — for 35-40 days of rotation. With the expeditionary shift organization of labor in sympathotonics, fatigue occurs earlier than that of normative experts and vagotonics. Research indicates that the stress of the functioning of the external respiration system, regardless of the types and modes of rotational work, is manifested in hyperventilation, with a decrease in alvolar ventilation, which leads to an increase in the energy value of respiration [1; 14]. Strengthening of ventilation at rest, occurred while maintaining the maximum abilities of the external respiration system and reducing its reserve capabilities, which at the beginning and end of the watch were assessed as unsatisfactory for most oilmen. It was established that in the dynamics of night shifts a deterioration in the functional state of varying severity was recorded in the period from 19.00 to 23.00 and by 05.00. In all night shifts, regardless of the timing of the oil workers on duty, a deterioration in the functional state was noted, which is a prerequisite for emergency situations. The researchers of the rotational method recommends that when forming work teams for work on oil production, preference is given to
persons permanently residing in the Far North. However, the author does not specify the chronobiological and synergistic aspects of the study, which confirms the importance of the stated topic and the need for its continuation [4].

At the same time, in various environmental conditions and unresolved issues remain in different environmental conditions. In this regard, fundamental research on modern problems of adaptation and the establishment of criteria for the “price of adaptation” in the pathogenesis of environmentally determined human pathology is of great importance.

The system of chronobiological regulation of a person’s physical / mental activity directly depends on his biorhythmological status, which is determined by the activity of the body’s biological clock, i.e. pineal gland and its hormone messenger melatonin. It is known that melatonin is a hormone that preserves the circadian rhythm of the body. Russian and foreign researchers contributed to the study of the rhythmic role of melatonin for a living system in different years [7; 11].

Moreover, the adaptation of the organism at the cellular level is not well understood. So, in 2017, the Nobel Prize in Physiology and Medicine was awarded to Jeffrey Hall, Michael Rosbach and Michael Young for studying the molecular mechanisms of circadian rhythms. In connection with the active development of chronobiology, it became necessary to define such definitions as “desynchronosis” (a pathological condition of the body when coordination of the rhythms of the various components of the chronome is disturbed) and “dyschronism” (not a pathological condition arising under the influence of episodic factors of external and internal environment, previously synchronized oscillators).

The literature notes the features of the endocrine system in residents of the Arctic regions of the European North of Russia. It was revealed that during the polar night, signs of sensory deprivation develop, and depressive states occur. During the polar day, the central nervous system is more irritable, sleep disturbance, irritability, various autonomic disorders, etc. [6]. In the North, the development of psychosomatic pathology often occurs and plays an important role. Residents of the North showed a seasonal correlation of exacerbations of the pathological process of disturbance of the circadian chronorhythms of melatonin production, resulting from changes in photoperiodism, which is an essential condition for living in these territories [19]. It is noted that the change of accents of the influence of external factors with the predominance of social and the effects of urbanization over climate impacts will not contribute to the acquisition by functional systems of a person of a useful net effect. They emphasize that in conditions of instability and the need for re-adaptation to new combinations of environmental factors (often toxic and pathogenic for humans), functional systems can quickly exhaust the choice of strategy for stress response options. Accordingly, the safety margin of the system with parallel comparisons of population groups of alien and aboriginal populations at high latitudes will not be in favor of genetically adapted groups due to the rise in the “price of adaptation”.

3. Conclusion
In this paper, emphasis is placed on Russian studies of the chronobiological potential of human resources as a condition for ensuring socially safe activities in the development of the North:

- all researchers emphasize the problem of human adaptation to the natural, climatic, rhythmic conditions of northern latitudes. Since newcomers will take part in the development of the Arctic latitudes, it is extremely important, from this point of view, information about seasonal exacerbations of functional systems of a pathological nature and disorders of the circadian chronorhythms of melatonin production resulting from changes in photoperiodism.

- in the analyzed works it is emphasized that the obtained information about the adaptation resources of various labor groups, operating in the development of the Arctic latitudes, does not indicate the benefit of their health compared with the genetic potential of Aboriginal people.

The results of the analysis of literary sources showed that the study of the potential of the human body from the point of view of determinism is not enough, since we can only register linear indicators.
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References
[1] Abubakirova O and Fateeva N 2009 Adaptation of the organism to the conditions of the Extreme North in the expeditionary rotational labor form Bulletin of Peoples' Friendship University of Russia. Series: Medicine 4 609–610 (in Russian)
[2] Agadzhanyan N 1989 Chronophysiological aspects of human adaptation to the conditions of the Arctic Polar Chronobiology and chronomedicine - Moscow Medicine 400 (in Russian)
[3] Agadzhanyan N et al 2001 Desynchronosis of systemic reactions of homeostasis and hemodynamics during the expeditionary shift organization of labor in the conditions of the Tyumen North Human Ecol og 2 8-10 (in Russian)
[4] Afonichkina E and Afonichkin A 2018 Synergies of the Economic Development of the Arctic Cluster System IOP Conference Series: Earth and Environmental Science 180 1 doi: 10.1088/1755-1315/180/1/012011
[5] Andreevsky M et al 2011 Features of circadian rhythms of the parameters of the functional systems of the body of workers of the railway Surgut in different seasons of the year Northern region: science, education, culture 2(24) 20-28 (in Russian)
[6] Boyko E and Bichkayeva F 2000 Phospholipid profile in residents of the European North of Russia Human Physiology 26(2) 105-110 (in Russian)
[7] Chronobiology and chronomedicine 2018 Ed C Chibisova, S Rapport, M Blagonravov Moscow PFUR 828 (in Russian)
[8] Entropy to assess the state of the human body Available from: http://www.marketjournal.com/voprosiupravleniya/17.html [Accessed 23.02.2019]
[9] Evdokimov V 2017 Scientometric analysis of scientific articles on biomedical problems among specialists of extreme professions in the Far North of Russia (2005–2016) All-Russian Center for Emergency and Radiation Medicine. A Nikiforova EMERCOM of Russia. (St.Petersburg : Polytechnic Service) 78 (in Russian)
[10] Fateeva N 2011 Temporary organization of physiological systems during human adaptation to the conditions of the Far North and expeditionary shift work Northern region: science, education, culture 2(24) 16-20 (in Russian)
[11] Fonzi S et al 1994 Melatonin and cortisol circadian secretion during ethanol withdrawal in chronic alcoholics Chronobiologia 21 109–112
[12] Gutma S and Teslya A 2018 Environmental safety as an element of single-industry towns' sustainable development in the Arctic region IOP Conference Series: Earth and Environmental Science 180(1) 012010 doi: 10.1088/1755-1315/180/1/012010
[13] Gubin D et al 2013 Chronobiological and standard analysis of the data of daily monitoring of blood pressure and heart rate at Yamal shift workers (Yamburg. Tyumen Oblast) Successes of Modern Natural Science 6 27–33 (in Russian)
[14] Gudkov A and Tedder Y 1999 Characteristics of metabolic changes in workers in the expeditionary shift work mode in the Arctic Human Physiology 25(3) 138-142 (in Russian)
[15] Kaznacheev S 1997 Modern Problems of Synthetic Ecology "Polar Voltage Syndrome" Bulletin SB RAMS 1 6-10 (in Russian)
[16] Kolpakov V et al 1984 Climatophysiological aspects of the expeditionary rotational organization of labor View and its productivity in April: Mat. 4th All-Union. meeting (April 3-7 1984) Sverdlovsk 65-66 (in Russian)
[17] Krivoschekov S 2012 Biorhythmic markers of dysadaptation in rotational work in the North Russian physiological journal named. THEM. Sechenov 98 (1) 57–71 (in Russian)
[18] Sarychev A et al 2011 Compensatory-adaptive external respiration reactions in the oil industry in the dynamics of the expeditionary labor regime in the Polar Region Human Ecology 3 7–13 (in Russian)
[19] Sukhanov S and Karmanova L 2014 Morphophysiological features of the endocrine system in residents of the Arctic regions of the European North of Russia. Arkhangelsk: Publishing House of the Northern (Arctic) Federal University named after M.V. Lomonosov 107 (in Russian)

[20] Vinogradova I and Anisimov V 2012 Light regime of the North and age pathology. Petrozavodsk: Petropress 128 (in Russian)