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VARIABILITY OF HELIOCLIMATE FACTORS AND APPLICABILITY TO THE EMERGENCY SERVICE POPULATION OF THE NORTHERN REGION

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ВАРИАБЕЛЬНОСТЬ ГЕЛИОКЛИМАТИЧЕСКИХ ФАКТОРОВ И ОБРАЩАЕМОСТЬ В СЛУЖБУ «СКОРАЯ МЕДИЦИНСКАЯ ПОМОЩЬ» НАСЕЛЕНИЯ СЕВЕРНОГО РЕГИОНА

Abstract. The purpose of this study was to study the influence of the variability of weather and heliophysical factors on the appeal to the "Ambulance" service for different groups of nosologies in the population of the Russian North. Information about calls to the emergency medical service of Khanty-Mansiysk was obtained from the database of calls for the period from 2001 to 2021 by disease classes (ICD-10). To assess the dynamics of weather factors, data from the All-Russian Research Institute of Hydrometeorological Information and materials from the weather station of Khanty-Mansiysk were used. The dynamics of air temperature; barometric pressure; relative humidity; baric trend; maximum wind speed; weight oxygen content in the air are analyzed. Data on the relative daily number of sunspots are obtained from the materials of the Royal Observatory of Belgium. The average daily values of the level of planetary geomagnetic activity, expressed by the Ap index, are copied from the website of the National Center for Geophysical Data of the USA (Boulder). Mathematical processing was carried out using wavelet analysis. The graph of temperature fluctuations for the period from 2001 to 2021 shows a significant circadian cyclicity and a semi-annual rhythm with a high level of trend. Significant rhythms of barometric pressure with a period of 5 years, 1 year and rhythms close to semi-annual, seasonal and near-monthly are observed. Humidity changes significantly in the circadian and intra-annual rhythms. The baric tendency has significant rhythms: 3 years, 1 year, 6, 3, 2 months. Changes in the maximum wind speed do not have a circadian rhythm, but intra-annual monthly variations are observed. The value of the weight oxygen content has circadian; two-year, five-year; two- and near-

Аннотация. Целью данного исследования явилось изучение влияния вариабельности погодных и гелиофизических факторов на обращаемость в службу «Скорой медицинской помощи» по разным группам нозологий населения российского Севера. Информация об обращениях в службу «Скорой медицинской помощи» г. Ханты-Мансийска получена из базы данных вызовов за период с 2001 по 2021 гг. по классам заболеваний (МКБ-10). Для оценки динамики погодных факторов использованы данные Всероссийского НИИ гидрометеорологической информации и материалы метеостанции г. Ханты-Мансийска. Проанализирована динамика температуры воздуха; барометрического давления; относительной влажности; весового содержания кислорода в воздухе. Данные об относительном ежедневном числе солнечных пятен получены из материалов Королевской обсерватории Бельгии. Среднесуточные значения уровня планетарной геомагнитной активности, выраженные Ap-индексом, выкопированы с интернет-сайта Национального центра геофизических данных США (Боулдер). Математическая обработка проведена при помощи вейвлет анализа. График колебаний температуры за период с 2001 по 2021 годы показывает значимую окологодовую цикличность и полугодовой ритм с высоким уровнем тенденции. Наблюдаются значимые ритмы барометрического давления с периодом 5 лет, 1 год и ритмы, близкие к полугодовым, сезонным и околомесячным. Влажность значимо изменяется в окологодовом и внутригодовых ритмах. Величина весового содержания кислорода имеет окологодовой; двухлетний, пятилетний; двух- и околомесячный ритмы. Относительное число солнечных пятен (W) за период с 2001 по 2021 годы характеризуется пяти-, двухлетними и окологодовым ритмом. При

monthly rhythms. The relative number of sunspots (W) for the period from 2001 to 2021 is characterized by a five-, two-year and circadian rhythm. When considering the variations of the number W for the period from 1818 to 2017, in addition to the classic eleven-year, annual and near-monthly, rhythms with a period of 42.5 years, 18.1 years and 2.1 years are found. The index of planetary geomagnetic activity (Ar) has a rhythm with a period of 4 years, two-year and near-annual. The significance of all rhythms is p=0.001. When analyzing fluctuations in geomagnetic activity from 1932 to 2016, long-term rhythms are added: 35.00 years; 16.06 years; 10.88 years; semi-annual and three-month rhythms. Despite numerous hypotheses of the search for cosmobiological harmony in the form of "evolutionary synchronisms", "rhythmic cascades", "golden section", the problem of the interaction of exogenous natural rhythms and endogenous rhythms of the human body remains largely unresolved. Comparison of the results of various studies is difficult due to methodological and mathematical approaches. With observation periods of 100-200 years or more, a long-period component is monitored, and in clinical studies (from a day to a week), short-period components are detected. Changing the background in the form of helioclimatic and social variations also does not add accuracy. The use of various methods of time series analysis involves obtaining information of different resolution levels (Fourier transform, SWANN, wavelet analysis). Nevertheless, the results obtained track the classical rhythms of solar and geomagnetic activity with periods of about eleven years, a year and a month. There is also a 35-year-old rhythm, a 42.5-year-old rhythm close to the 44.16-year rhythm identified by Bezrukova A.Ya., at 18.1 years (long-period components of the lunar tide) and other intra-annual rhythms with periods from two weeks to 9 months. The effect of helioclimatic factors on human health indicates the absence of constant coherence (in our case, the consistency of these processes over time, manifested when they are combined), due to the presence of a large number of mega- and mesorhythms, which is manifested by amplitude and phase desynchronization of heliogeophysical indicators and health status.

Keywords: rhythms of health disorders, variability of weather factors, solar and magnetic activity, northern region.

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рассмотрении вариаций числа W за период с 1818 по 2017 гг., кроме классических одиннадцатилетнего, годового и околомесячного, обнаруживаются ритмы с периодом: 42,5 года; 18,1 года и 2,1 года. Индекс планетарной геомагнитной активности (Ap) имеет ритм с периодом 4 года, двухлетний и окологодовой. Значимость всех ритмов p=0,001. При анализе колебаний геомагнитной активности с 1932 по 2016 годы добавляются многолетние ритмы: 35,00 лет; 16,06 года; 10,88 лет; полугодовой и трехмесячный ритмы. Несмотря на многочисленные гипотезы поиска космобиологической гармонии в виде «эволюционных синхронизмов», «ритмокаскадов», «золотого сечения», проблема взаимодействия экзогенных природных ритмов и эндогенных ритмов организма человека остается во многом нерешенной. Сопоставление результатов различных исследований затруднено, вследствие методологических и математических подходов. При периодах наблюдений 100-200 лет и более, отслеживается длиннопериодный компонент, а при клинических исследованиях (от суток до недели) выявляются короткопериодные составляющие. Изменение фона в виде гелиоклиматических и социальных вариаций также не добавляет точности. Применение различных методов анализа временны̀х рядов предполагает получение информации различного уровня разрешения (преобразование Фурье, СВАН, вейвлет анализ). Тем не менее, в полученных результатах отслеживаются классические ритмы солнечной и геомагнитной активности с периодами около одиннадцати лет, года и месяца. Так же присутствуют 35-летний ритм, ритм в 42,5 года, близкий к ритму 44,16 года, выявленному Безруковой А.Я., в 18,1 года (долгопериодические компоненты лунного прилива) и другие внутригодовые ритмы с периодами от двух недель до 9 месяцев. Воздействие гелиоклиматических факторов на здоровье человека указывает на отсутствие постоянной когерентности (в нашем случае – согласованности этих процессов во времени, проявляющаяся при их сложении), ввиду наличия большого количества мега- и мезоритмов, что проявляется амплитудной и фазовой десинхронизацией гелиогеофизических показателей и состояния здоровья.

Ключевые слова: ритмы нарушений здоровья, вариабельность погодных факторов, солнечная и магнитная активность, северный регион.

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Introduction. Heliogeophysical and climatic factors quite seriously affect human health [19; 22; 26]. Meteotropic reactions are observed in diseases of the heart, blood vessels, bronchi and lungs, digestive organs, joints, skin, nervous and mental pathologies [16; 23; 27].

In the northern region, conditions are created for the disruption of the temporal organization of the psychological and physiological functions of the body, due to climatic and geographical features and the characteristic heliophysical status of the circumpolar regions [8; 11; 12; 18]. The *human organism* is constantly in a state of mismatch in the phase of its own endogenous rhythms and fluctuations of helioclimatic factors [6; 10], which can lead to the development of various pathologies [7; 20; 25].

Purpose of the research is studying the influence of the variability of weather and heliophysical factors on the ambulance service appeals for different groups of nosologies in the population of the Russian North.

Objects and methods of research. Information about the ambulance service appeals in Khanty-Mansiysk was obtained from the electronic database of calls for the period from 2001 to 2021, on average per day by class, in accordance with ICD-10 (https://clck.ru/32oJRk): Certain infectious and parasitic diseases (AB); Neoplasms (CD); E*ndocrine diseases* (E); Mental and behavioural disorders (F); Diseases of the nervous system (G); Diseases of the circulatory system (I); Diseases of the respiratory system (J); Diseases of the digestive system (K); Diseases of the

musculoskeletal system (M); Diseases of the genitourinary system (N); Pregnancy, childbirth and the puerperium (O); Injuries (ST). The length of the time series is 7665 measurements.

To assess the dynamics of weather factors, long-term meteorological data of the All-Russia Research Institute of Hydrometeorological Information were used – World Data Center (ARRIHI – WDC) (http://meteo.ru). The observation period was from 2001 to 2021. The dynamics of the following parameters was analyzed: ambient air temperature (°C); barometric pressure (kPa); relative humidity (%); partial pressure of oxygen in the air (g/m^3). The partial pressure of oxygen in the air is directly proportional to atmospheric pressure minus the partial pressure of water vapor and inversely proportional to air temperature: O2 (g/m^3) = 83 * (P-e) / T, where P and e in kPa, T in °K, another definition – partial density, which correlates with the partial pressure of oxygen in the inhaled and alveolar air, depending on the physical characteristics [15].

Data on the relative daily number of sunspots (Wolf number – W) were obtained from the materials of the Royal Observatory of Belgium (Brussels) [33]. To track the short period component of rhythms and possible correlation with weather data and chronopathology rhythms, the period from 2001 to 2021 was analyzed. To analyze the long-period component, we analyzed a time series consisting of 72635 observations for the period from 1818 to 2017 (199 years).

The daily average values of the level of planetary geomagnetic activity, expressed by the Ap-index, were copied from the Internet site of the US National Geophysical Data Center (Boulder) (http://www.sidc.be/silso/datafiles).

The period from 2001 to 2021 was analyzed to track the short period component of rhythms and possible correlation with weather data and chronopathology rhythms. To analyze the long-period component, a time series consisting of 31025 observations was used for the period from 1932 to 2017 (85 years).

Statistical data processing. To test the assumption about the presence of many cyclical parameters of contacting the emergency medical service, weather factors, and heliogeophysical indicators, a program was used using wavelet analysis to identify the rhythms of the estimated indicators and evaluate their correlation [17]. Wavelet is a mathematical function that allows you to analyze various frequency components of data [9; 13; 14]. Based on the results of the wavelet transform, we can judge how the spectral composition of the time series changes over time. The statistical significance of the rhythms was assessed by multiple (5000) random permutation of the levels of the initial time series. The reduced p shows the proportion of cases when the energy of the selected frequency component in the original series exceeded the corresponding energy in a random permutation.

Results. The graph of the initial series of temperature fluctuations for the described period from 2001 to 2021 (tabl. 1) shows a significant (p=0.0001) annual cycle with a high rhythm amplitude and a semi-annual rhythm with a high trend level (p=0.065). Intra-annual seasonal (period of 96.6 days) and lunar (period of 23.7 days) are present, but unreliable. In decreasing power, rhythms of barometric pressure are observed with a period of 5 years, 1 year, and rhythms close to semi-annual, seasonal and circa-monthly: 173.4 days; 109.3 days; 37.2 days, with the significance of the detected rhythms (p=0.001). The value of humidity regularly changes in the circumannual rhythm (395.6 days), the

intra-annual dynamics is as follows; 6, 4 and 2 months. All rhythms are significant (p=0.001). The value of the partial pressure of oxygen, being calculated, retains the main rhythm of such components of the formula as temperature, barometric pressure and humidity, namely: circannual (p=0.001); two years (p=0.001), five years (p=0.042); two- (p=0.001) and about-monthly (p=0.002) rhythms. Rhythms are arranged in descending order of power.

The relative number of sunspots (W) for the described period from 2001 to 2021 (tabl. 2) changes with the following pattern. The most stable and powerful is the rhythm with a period of 5 years (p=0.001), followed by two-year and circannual rhythms. The following low-amplitude components reveal a rhythm with periods of 9, 4 months and circa-monthly rhythms.

When considering the variations in the number W for the period from 1818 to 2017, wavelet analysis shows, in addition to the classic eleven-year, annual and circa-monthly, rhythms with a period of: 42.51 years; 18.10 years and 2.14 years.

Table 1

Consistency of fluctuations in weather factors and calls to the EMS by groups of diseases of the population of Khanty-Mansiysk for the period from 2001 to 2021

Weather factors	Period of rhythms										
	6 years	5 years	3 years	2 years	1 year	6 months	4 months	3 months	2 months	1 month	3 weeks
	Groups of diseases										
T					AB; CD; F; G;I; J; K; M; N; O	AB; G; I		AB;J; N		E;F	
P	G; N				AB; CD; F; G; I; J; K; M; N; O	AB; G; I	G;M			E;F	
RH					AB; CD; F; G; I; J; K; M; N; O	AB; G; I	G;M		AB; CD; F; G; N		
P_{O2}		CD; F; I; M; O; ST		AB; E; I; J; M; O; ST	AB; CD; F; G; I; J; K; M; N; O				AB; CD; F; G; N	E;F	

When conducting a wavelet analysis of the index of planetary geomagnetic activity (Ap), attention is drawn to a larger number of significant rhythms (tabl. 2), which can be explained by the sum of the effects of various sources, which are complex systems of currents flowing in the ionosphere and in the Earth's magnetosphere.

Table 2

Consistency of fluctuations in heliomagnetic activity and calls to the EMS by groups of diseases of the population of Khanty-Mansiysk for the period from 2001 to 2021

Solar and magnetic activity	Period of rhythms										
	5 years	4 years	2 years	1 year	9 months	6 months	4 months	3 months	2 months	1 month	2 weeks
	Groups of diseases										
W	CD; F; I; M; O; ST		AB; E; I; J; M; O; ST	AB; CD; F; G; I; J; K; M; N; O	N; ST		G; M			E;F	
Ap		AB; G	AB; E; I; J; M; O; ST	AB; CD; F; G; I; J; K; M; N; O		AB; G; I		AB; J; N	AB; CD; F; G; N	E; F	CD; M

The most powerful is the rhythm with a period of 4 years, the next multi-year, two-year and circannual. Intra-annual cycles: six-, three-, two- and circa-monthly. Significance of all rhythms is p=0.001.

When analyzing fluctuations in geomagnetic activity over a longer time interval (from 1932 to 2016), multi-year rhythms are added: 35.00 years; 16.06 years; 10.88 years; semi-annual and three-monthly rhythms.

Discussion. If we take a mechanistic approach to the influence of heliophysical and weather factors on biosystems, then there are coincidences in the periods of parameters of solar, magnetic activity, weather factors, the occurrence and exacerbation of diseases of various groups (tabl. 1 and 2). The annual rhythm W coincides with the frequency of calls to the EMS by groups of diseases: AB; CD; F; G; I; J; K; M; N; O, and the period of rotation of the Sun – with exacerbations of groups of diseases E; F; fluctuations of Ap are similar with the indicated groups of diseases and most weather factors.

Synchronicity is also observed in rhythms with periods of 5 years (secondary geophysical rhythm) and 2 years, and the injury rate is added, as well as intra-annual rhythmic activity with periods of 9 and 4 months. Coincidences in the two-year rhythm are also observed with the Ap index (groups of diseases AB; E; I; J; M; O; ST), but geomagnetic activity also has a four-year rhythm (synchronized with AB; G) and intra-annual low-amplitude rhythms (six-, three-, two-month and two-week), nevertheless coinciding with the rhythms of fluctuations of exacerbations of pathology in groups AB; G; I; CD; J; F; M; N.

The correlation analysis between the time series of appeals for diseases, weather factors, solar and geomagnetic activity did not show significant relationships, which is quite natural, given the polycyclic nature of the analyzed parameters, and is confirmed by the dynamics of the in-phase index. That is, despite the high index of synchronicity, there is a change in the phase difference of the analyzed pairwise time series.

Conclusion. Despite the numerous hypotheses of the search for cosmobiological harmony in the form of “evolutionary synchronisms”, “rhythm cascades” [2; 3], “golden section” [4; 28], the problem of interaction between exogenous natural rhythms and endogenous rhythms of the human body remains largely unresolved [23; 24]. Comparison of the results of various studies is difficult due to methodological and mathematical approaches. With observation periods of 100-200 years or more, a long-period component is monitored, and in clinical studies (from a day to a week), short-period components are detected. Changing the background in the form of helioclimatic and social variations also does not add accuracy. The use of various methods for analyzing time series involves obtaining information of various levels of resolution (Fourier transform, STAN, wavelet analysis). Nevertheless, the results obtained trace the classical rhythms of solar and geomagnetic activity with periods of about eleven years, a year, and a month. There is also a 35-year rhythm, a rhythm of 42.51 years, close to the rhythm of 44.16 years, identified by A.Ya. Bezrukova [1], at 18.1 years (long-period components of the lunar tide) and other intra-annual rhythms with periods from two weeks to 9 months [5]. It is shown that the impact of helioclimatic factors on human health indicates the absence of constant coherence (in our case, the consistency (correlation) of these processes in time,

which manifests itself when they are added), due to the presence of a large number of mega- and meso-rhythms, which is manifested by amplitude and phase desynchronization of heliogeophysical indicators and health status.

The authors declare no conflict of interest.

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REFERENCES

1. Bezrukova, A.Ya. (1950). Kharakter tsirkulyatsii zemnoi atmosfery i solnechnaya aktivnost'. *Byulleten' komissii po issledovaniyu Solntsa,* (5-6), 12–18. (In Russ).

2. Budanov, V.G. (1996). Printsipy garmonii kak evolyutsionnye sinkhronizmy nachala demistifikatsii. In *Matematika i iskusstvo: Trudy mezhdunarodnoi konferentsii,* Suzdal', 23-27. (In Russ).

3. Budanov, V.G. (1998). Vremennaya fraktal'nost' v zadachakh s prioritetami. Ritmokaskady ierarkhicheskikh sistem. In *Problemy teoreticheskoi biofiziki. Mezhdunarodnaya shkola MGU.* (In Russ).

4. Butusov, K.P. (1978). Zolotoe sechenie v Solnechnoi sisteme. *Astrometriya i nebesnaya mekhanika. Ser. Problemy issledovaniya Vselennoi,* 7, 475–500. (In Russ).

5. Vladimirskii, B.M., Temur'yants, N.A., & Martynyuk, V.S. (2004). Kosmicheskaya pogoda i nasha zhizn'. Moscow. (In Russ).

6. Gorokhova, S.G., At'kov, O.Yu., Serikov, V.V., Muraseeva, E.V., & Pfaf, V.F. (2018). Bimodal'nyi khronotip u rabotayushchikh s nochnymi smenami. *Meditsina truda i promyshlennaya ekologiya,* (12), 59-63. (In Russ).

7. Gubin, D.G. (2015). Okolonedel'nye (tsirkaseptannye) ritmy v fiziologii (obzor). *Uspekhi sovremennogo estestvoznaniya,* (1(8)), 1268–1272. (In Russ).

8. Degteva, G.N. (2004). Sostoyanie sistemy krasnoi krovi pri ekspeditsionnom rezhime truda v Zapolyar'e: metodicheskie rekomendatsii. Arkhangelsk. (In Russ).

9. D'yakonov, V.P. (2004). Veivlety. Ot teorii k praktike. Moscow. (In Russ).

10. Zaripov, A.A., Yanovich, K.V., Potapov, R.V., & Kornilova, A.A. (2015). Sovremennye predstavleniya o desinkhronoze. *Sovremennye problemy nauki i obrazovaniya,* (3), 176-176. (In Russ).

11. Zenina, O.Yu. (2017). Khronofiziologiya i khronopatologiyaserdechno-sosudistoi sistemy (obzor literatury). *Ekologiya cheloveka,* (1), 25-33. (In Russ).

12. Karpin, V.A. (2018). Analiz vliyaniya geliogeomagnitnykh anomalii na zhitelei severnoi urbanizirovannoi territorii. *Ekologiya cheloveka,* (11), 10–15. (In Russ).

13. Malla, S. (2005). Veivlety v obrabotke signalov. Moscow. (In Russ).

14. Nagornov, O.V. (2010). Veivlet-analiz v primerakh. Moscow. (In Russ).

15. Ovcharova, V.F. (1981). Opredelenie soderzhaniya kisloroda v atmosfernom vozdukhe na osnove meteorologicheskikh parametrov (davleniya, temperatury, vlazhnosti) s tsel'yu prognozirovaniya gipoksicheskogo effekta atmosfery. *Voprosy kurortologii, fizioterapii i lechebnoi fizkul'tury,* (2), 29–34. (In Russ).

16. Orlova, K.N., Shafranova, L.N., & Bol'shanin, V.Yu. (2014). Vliyanie solnechnoi aktivnosti pri smene magnitnykh polyusov na magnitnoe pole Zemli. *Mezhdunarodnyi zhurnal prikladnykh i fundamental'nykh issledovanii,* (11-5), 863-863. (In Russ).

17. Ragozin, O.N. (2014). Programma issledovaniya biologicheskikh ritmov metodom veivlet-analiza. Svidetel'stvo o gos. Registratsii programmy dlya EVM № 2014611398, data gos. Registratsii v Reestre programm dlya EVM 03 fevralya 2014 g. (In Russ).

18. Radysh, I.V., Ragozin, O.N., & Shalamova, E.Yu. (2016). Bioritmy, kachestvo zhizni i zdorov'e. Moscow. (In Russ).

19. Revich, B.A., Khar'kova, T.L., & Kvasha, E.A. (2016). Demograficheskie protsessy, dinamika trudovykh protsessov i riski zdorov'yu naseleniya Evropeiskoi chasti arkticheskoi zony Rossii. Moscow. (In Russ).

20. Saltykova, M.M. (2018). Vliyanie pogody na patsientov s boleznyami sistemy krovoobrashcheniya: glavnye napravleniya issledovanii i osnovnye problemy. *Ekologiya cheloveka*, (6), 43–51. (In Russ).

21. Frolov, V.A. (2016). Obshchaya patofiziologiya. Moscow. (In Russ).

22. Tsandekov, P.A. (2017). Zavisimost' psikhoemotsional'nogo sostoyaniya i fiziologicheskikh sistem organizma ot solnechnoi aktivnosti. *Uchenye zapiski Krymskogo inzhenerno-pedagogicheskogo universiteta. Ser. Pedagogika. Psikhologiya*, (1(7)), 169–174. (In Russ).

23. Tsetlin, V.V., & Aptikaeva, O.I. (2013). Ritmy prirodnykh protsessov v variatsiyakh elektricheskikh tokov v mezhelektrodnom promezhutke. *Prostranstvo i Vremya: al'manakh, 3*(2), 9–11. (In Russ).

24. Chernykh, D.A., & Taseiko, O.V. (2017). Otsenka riska ot temperaturnykh voln, vliyayushchikh na povyshenie urovnya smertnosti naseleniya g. Krasnoyarska. In *Aktual'nye problemy aviatsii i kosmonavtiki, 2*, 678–680. (In Russ).

25. Chibisov, S.M., Katinas, G.S., & Ragul'skaya, M.V. (2013). Bioritmy i kosmos: monitoring kosmobiosfernykh svyazei. Moscow. (In Russ).

26. Chizhevskii, A.L. (1995). Kosmicheskii pul's zhizni: Zemlya v ob"yatiyakh solntsa. Geliotaraksiya. Moscow. (In Russ).

27. Shevelev, I.Sh., Marutaev, M.A., & Shmelev, I.P. (1990). Zolotoe sechenie. Tri vzglyada na prirodu garmonii. Moscow. (In Russ).

30. Danilenko, K. V., Kobelev, E., Semenova, E. A., & Aftanas, L. I. (2019). Summer-winter difference in 24-h melatonin rhythms in subjects on a 5-workdays schedule in Siberia without daylight saving time transitions. *Physiology & behavior*, *212*, 112686. https://doi.org/10.1016/j.physbeh.2019.112686

ЛИТЕРАТУРА

1. Безрукова А.Я. Характер циркуляции земной атмосферы и солнечная активность // Бюллетень комиссии по исследованию Солнца. 1950. №5-6. С. 12–18.

2. Буданов В.Г. Принципы гармонии как эволюционные синхронизмы начала демистификации // Математика и искусство: Труды международной конференции. Суздаль. 1996. С. 23-27.

3. Буданов В.Г. Временная фрактальность в задачах с приоритетами. Ритмокаскады иерархических систем // Проблемы теоретической биофизики. Международная школа МГУ. 1998.

4. Бутусов К.П. Золотое сечение в Солнечной системе // Астрометрия и небесная механика. Сер. Проблемы исследования Вселенной. 1978. Вып. 7. С. 475–500.

5. Владимирский Б.М., Темурьянц Н.А., Мартынюк В.С. Космическая погода и наша жизнь. М.: Век 2, 2004. 224 с.

6. Горохова С.Г., Атьков О.Ю., Сериков В.В., Мурасеева Е.В., Пфаф В.Ф. Бимодальный хронотип у работающих с ночными сменами // Медицина труда и промышленная экология. 2018. №12. С. 59-63.

7. Губин Д.Г. Околонедельные (циркасептанные) ритмы в физиологии (обзор) // Успехи современного естествознания. 2015. №1(8). С. 1268–1272.

8. Дегтева Г.Н. Состояние системы красной крови при экспедиционном режиме труда в Заполярье: методические рекомендации. Архангельск: СГМУ, 2004. 13 с.

9. Дьяконов В.П. Вейвлеты. От теории к практике. М.: СОЛОН-Пресс, 2004. 440 с.

10. Зарипов А.А., Янович К.В., Потапов Р.В., Корнилова А.А. Современные представления о десинхронозе // Современные проблемы науки и образования. 2015. №3. С. 176-176.

11. Зенина О.Ю. Хронофизиология и хронопатологиясердечно-сосудистой системы (обзор литературы) // Экология человека. 2017. №1. С. 25-33.

12. Карпин В.А. Анализ влияния гелиогеомагнитных аномалий на жителей северной урбанизированной территории // Экология человека. 2018. №11. С. 10–15.

13. Малла С. Вейвлеты в обработке сигналов. М.: Мир, 2005. 672 с.

14. Нагорнов О.В. Вейвлет-анализ в примерах. М.: НИЯУ МИФИ, 2010. 120 с.

15. Овчарова В.Ф. Определение содержания кислорода в атмосферном воздухе на основе метеорологических параметров (давления, температуры, влажности) с целью прогнозирования гипоксического эффекта атмосферы // Вопросы курортологии, физиотерапии и лечебной физкультуры. 1981. №2. С. 29–34.

16. Орлова К.Н., Шафранова Л.Н., Большанин В.Ю. Влияние солнечной активности при смене магнитных полюсов на магнитное поле Земли // Международный журнал прикладных и фундаментальных исследований. 2014. №11-5. С. 863-863.

17. Рагозин О.Н. Программа исследования биологических ритмов методом вейвлет-анализа. Свидетельство о гос. регистрации программы для ЭВМ № 2014611398, дата гос. регистрации в Реестре программ для ЭВМ 03 февраля 2014 г.

18. Радыш И.В., Рагозин О.Н., Шаламова Е.Ю. Биоритмы, качество жизни и здоровье. М.: РУДН, 2016. 458 с.

19. Ревич Б.А., Харькова Т.Л., Кваша Е.А. Демографические процессы, динамика трудовых процессов и риски здоровью населения Европейской части арктической зоны России. М.: ЛЕНАНД, 2016. 304 с.

20. Салтыкова М.М. Влияние погоды на пациентов с болезнями системы кровообращения: главные направления исследований и основные проблемы // Экология человека. 2018. №6. С. 43–51.

21. Фролов В.А. Общая патофизиология. М.: Практическая медицина, 2016.

22. Цандеков П.А. Зависимость психоэмоционального состояния и физиологических систем организма от солнечной активности // Ученые записки Крымского инженерно-педагогического университета. Сер. Педагогика. Психология. 2017. №1(7). С. 169–174.

23. Цетлин В.В., Аптикаева О.И. Ритмы природных процессов в вариациях электрических токов в межэлектродном промежутке // Пространство и Время: альманах. 2013. Т. 3. Вып. 2. С. 9–11.

24. Черных Д.А., Тасейко О.В. Оценка риска от температурных волн, влияющих на повышение уровня смертности населения г. Красноярска // Актуальные проблемы авиации и космонавтики. 2017. Т. 2. С. 678–680.

25. Чибисов С.М., Катинас Г.С., Рагульская М.В. Биоритмы и космос: мониторинг космобиосферных связей. М., 2013. 442 с.

26. Чижевский А.Л. Космический пульс жизни: Земля в объятиях солнца. Гелиотараксия. М., 1995. 768 с.

27. Шевелев И.Ш., Марутаев М.А., Шмелев И.П. Золотое сечение. Три взгляда на природу гармонии. М.: Стройиздат, 1990. 342 с.

28. Danilenko K.V., Kobelev E., Semenova E.A., Aftanas L.I. Summer-winter difference in 24-h melatonin rhythms in subjects on a 5-workdays schedule in Siberia without daylight saving time transitions // Physiology & behavior. 2019. Vol. 212. P. 112686. https://doi.org/10.1016/j.physbeh.2019.112686

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