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HYGIENE, SANITATION, EPIDEMIOLOGY AND MEDICAL ECOLOGYAND MEDICAL ECOLOGY

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OPTIMIZATION OF THE SYSTEM OF PLANNING MEASURES FOR EPIDEMIOLOGICAL CONTROL OF THE INCIDENCE OF TICK-BORNE ENCEPHALITIS AND SIBERIAN TICK TYPHUS IN REGIONS WITH COMBINED FOCI OF THESE INFECTIONS

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The article presents the results of the multidimensional factor analysis, with the help of which the leading factors influencing epidemic processes of tick-borne viral encephalitis and Siberian tick-borne typhus in the territories of Altai Krai with combined foci of these natural focal infections in the period from 2000 to 2019 were determined. The relationships between individual predictors have been established, allowing them to make a significant contribution to the formation of the incidence rate as a single factor. The degree of influence of each of the leading factors on the morbidity level according to these nosologies in the studied territories was identified. The results of multiple and dual regression are presented carried out for the purpose of estimating the perspective value of the analyzed controlled factors necessary for the subsequent optimization of the planning system for the measures of epidemiological control of morbidity of tick-borne viral encephalitis and Siberian tick-borne typhus in the studied territory, which will also allow to form a planned trend of morbidity dynamics towards a decrease in its indicators.

Keywords: combined foci, natural focal infections, tick-borne viral encephalitis, Siberian tick-borne typhus, endemic territories, determination of leading factors, multidimensional factor analysis.

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Introduction. The incidence of Siberian tick-borne typhus (STT) and tick-borne viral encephalitis (TVE), as well as other tick-borne infections, is currently high and depends on multiple influence of a large number of factors characterizing epidemic processes of these vector-borne natural focal infections [1, 2, 3, 9, 10]. Such factors may be expressed as an independent phenomenon beyond the control of others or may consist of a different number of predictors forming a general, meaningful impact on the epidemic process of these infections [5, 6, 7, 11].

The multidimensional factor analysis of the effects of various predictors on the TVE and STT incidence will allow inducing the “latent” relationship between individual predictors acting as a single factor, while the effect of each predictor individually on the resulting trait was considered as statistically insignificant [4, 8, 12]. Identification of leading factors with determination of predictors in their structure allowed assessing each factor by its contribution to formation of incidence rate of these infections in the territory of the endemic region by means of the multidimensional factor analysis [13, 14, 15].

The **aim of the study** was to optimize the system for planning measures of epidemiological control of tick-borne viral encephalitis and Siberian tick-borne typhus incidence in regions with combined foci of these infections.

Materials and methods. The study was conducted using the data of the of-

ficial sources: statistical reporting forms No. 2 "Information on infectious diseases" in Altai Krai for 2000–2019, data of the Federal Statistics Service for Altai Krai for 2000–2019, information from the State reports "On the state of sanitary and epidemiological well-being of the population in Altai Krai" for 2000–2019. The study was carried out in Statistica 12.0, during which the absolute, relative and average indicators were calculated, as well as the coverage errors (±m). The calculation of significance of differences was carried out using the Fisher test (f). The multidimensional factor analysis was carried out using the principal component method with the rotation of factor loads Varimax. Leading predictors were determined using the Kaiser criterion.

Results and discussion. A set of predictors was selected empirically characterizing the territories of Altai Krai with combined foci of STT and TVE annually differing in the region's high incidence rates of these infections among the local population. After selection, all predictors were systematized into three groups according to their ability to influence the trend in the dynamics of incidence rates of current infections. **Group 1** included predictors consisting of data reflecting the frequency of contacts of population of endemic territories with causative agents of these infections: these are indicators of the prevalence of ticks with rickettsia (STT pathogens), infected ticks, the number of ticks per 1 km of the way, as well as indicators of the population at risk: children up to the age of 17, working-age population and older, occupational risk cohort. **Group 2** was formed from predictors designed to ensure a change in the direction of the trend in the incidence rate of current infections towards its decrease: these are data reflecting the level and availability of medical care in the study territory (the number of medical institutions of various levels), as well as data of such preventive measures as indicators of areas of acaricide treatment, indicators of emergency seroprevention and preventive vaccination of TVE.

The predictors included in **group 3** reflected the anthropogenic change in the natural system within the boundaries of the region's territories with combined foci of STT and TVE: these are indicators of the area of perennial plantings, seed cultures, indicators of the number of cattle and small ruminants in farm and personal subsidiary holdings, the length of auto-roads. This group of predictors contributed to the creation and maintenance of the activity of anthropurgic foci of these infections.

After the distribution of the selected predictors into groups, in the course of the multidimensional factor analysis, the "leading" predictors were determined in each of them. Establishment of the leading predictors in each group was carried out taking into account the Kaiser criterion, according to which, the "leading" predictors are those that are greater than or equal to 1.0 using the own calculated values of the analyzed predictors. If the own calculated values of the predictors turn out to be less than 1.0 in the course of factor analysis, they will be considered "background", i.e. unable to have a significant impact on the resulting sign; in this case, it is the incidence of STT and TVE in the study areas.

Further, using the multidimensional factor analysis and principal component method, the selected leading predictors were ranked taking into account the criterion of their share of total variance (%) and factor loads. Thus, the contribution of each of the analyzed predictors to the formation of the incidence rate of current infections was assessed. In addition, it was found that there is a hidden relationship between some of the analyzed predictors allowing them to influence the incidence rate as part of a single factor. Thus, **Factor 1** included predictors having a dependent effect on the incidence of current infections and reflecting the availability of medical care, as well as indicators of the population at risk. **Factors 2–7** consisted of one predictor independent of the others. Thus, two groups of factors were obtained: specific and non-specific. Specific **Factors 1–3** had the ability to simultaneously affect two infections of different nosologies: STT and TVE, while non-specific **Factors 4–7** had the ability to affect the incidence of only one nosology: either TVE or STT. The data are presented in the Table.

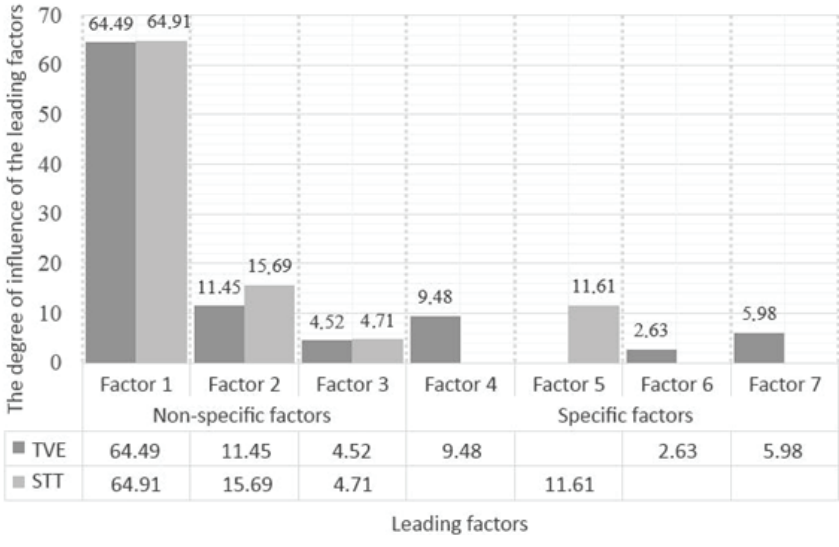
The degree of influence of each of the identified leading factors on the incidence of STT and TVE was heterogeneous, as the group of non-specific factors that simultaneously influence the incidence of both nosologies was characterized by the degree of influence on TVE in 80.5%, STT – 85.31%. This group of factors reflected the availability of treatment and prophylactic care for the population, the number of ticks per 1 km of the way, the area of acaricide treatment (ha), and the population at risk. The group of specific factors influencing the incidence rate of only one infection was characterized by the degree of influence on TVE – 18.09% (infected ticks, rates of vaccination of the population and emergency seroprevention), on STT – 11.61% (the prevalence of ticks with rickettsia).

Factors reflecting preventive measures (preventive vaccination and seroprevention of TVE, acaricide treatment of territories) have a degree of influence on the TVE incidence in 13.13%. For STT, there was a factor in the section of preventive measures that included an indicator of the area of acaricide treatment with a degree of influence on the incidence of this infection of 4.71%. The data are shown in the Figure.

The degree of influence of measures

List of analysed predictors forming factors

Factor group	Factor name	List of predictors included in the factor
Non-specific factors	Factor 1	- the number of children under 17; - the number of occupational risk cohort; - the number of population older than the working age; - the number of medical organizations
	Factor 2	the number of ticks per 1 kilometer of the way
	Factor 3	the area of acaricide treatment (ha)
Specific factors	Factor 4	infected ticks (%)
	Factor 5	the prevalence of ticks with rickettsia (%)
	Factor 6	vaccination rate against TVE
	Factor 7	emergency seroprevention of TVE in affected individuals from a tick bite



Influence of the leading factors on the trend of the dynamics of the STT and TVE incidence typical for the local population of Altai Krai territories with their combined foci (%).

of specific and non-specific prevention on the formed level of TVE and STT incidence characteristic of region's territories with combined foci may have been due to the insufficient volume of measures carried out.

For the studied period of 2000–2019, the average long-term incidence rates of TVE and STT in certain territories of Altai Krai characterized by the presence of combined foci of these infections significantly exceeded similar incidence rates in the region as a whole; for TVE, this difference was 1.5 times (reaching 4.3±1.09 0/0000, while corresponding figures in Altai Krai were within 2,86±0,34 0/0000); for STT, indicators exceed 2.8 times (reaching 87,8±4,90 0/0000, while the same indicator in the region was 31,77±1,11 0/0000) (p≤0,001).

In order to from the tendency to decrease in the STT and TVE incidence in areas with combined foci, the assessment of the perspective values of measures of epidemiological control of the incidence rate of these nosologies was carried out using the method of multiple regression. Using this method, it was possible not only to confirm the existence of a connection between the resulting trait (TVE and STT incidence) and the factors affecting it, which are implemented as measures of epidemiological control (the indicator of preventive vaccination and emergency prevention with immunoglobulin against TVE, the area of acaricide treatment), but also to assess the perspective value of the analyzed factors necessary for formation of a planned trend of incidence dynamics.

Thus, the coefficient of the multiple regression equation for the preventive vaccination factor was -0.00074, which means a decrease in the TVE incidence rate by 0.74 0/0000 (p<0.001) with an increase in the preventive vaccination level by 1000 0/0000, i.e. 33.6% (to 3979.1 0/0000) compared to the previous year. The coefficient of the multiple regression equation for the factor of emergency prevention with immunoglobulin was -0.0085, which means a possible decrease in the TVE incidence rate by 0.85 0 /0000 in case of an increase in the emergency immunoprophylaxis level by 100.0 0/0000, i.e. by 24.6% compared to the previous year (to 507.0 0/0000 (p<0.001)). The coefficient of the multiple regression equation for the area of acaricide treatment factor regarding TVE was -0.00016, which means a possible decrease in the incidence rate by 0.16 0/0000 as a result of an increase in the area of acaricide treatment by 1000 ha, i.e. 45.4% (up to 3203 ha) compared to the previous year (p<0.001). For STT, this dual regression coefficient for this factor was -0.0156, indicating a possible decrease in the STT incidence by 15.60 0/0000, i.e. 15.74% (p<0.001) compared to the previous year with the same increase in the volume of acaricide treatment (by 1000 ha, i.e. by 45.4% up to 3203 ha) within the areas with combined foci of these infections.

The identified leading factors characterizing epidemic processes and ensuring formation of the TVE and STT incidence rate in areas of the region with combined foci of these infections show the significant contribution of indicators of the population at risk (children under 17, population older than the working age, and occupational risk cohort) to the positive trend in incidence dynamics. A large number of cases of TVE and STT in the areas under study is recorded in these population groups due to the higher susceptibility to infections (children under 17, population older than the working age) and the high frequency of contact with natural and anthropogenic foci among persons from the occupational risk group. The unidirectional effect on the incidence indicators trend provided by a predictor reflecting the availability of medical care together with predictors of risk groups among the population is explained by a higher level of diagnosis and laboratory confirmation of the disease.

The relatively low degree of influence of leading predictors reflecting preventive measures against TVE and STT among the population of the studied territories may be due to the low volume of measures in Altai Krai in general, as well as specifically among the population of risk groups. It is the small amount of preventive measures in relation to these nosologies and their non-rational implementation among the population or territories that could be one of the main reasons for the existing level of morbidity.

Conclusion. Thus, thanks to the carried out multidimensional factor analysis, it was possible to establish the presence of leading factors having a significant impact on the formation of the incidence rate of STT and TVE, registered among the local population in the territories of Altai Krai with combined foci of these infections. A low degree of influence of factors reflecting preventive measures for specific and non-specific prevention of these infections was established, which could be due to the insufficient volume of these measures implemented in the areas of the region with combined foci. The insufficient amount of these measures in the study areas is also confirmed by the long-term average incidence of population of these areas, which is 1.5 times higher for TVE than the same indicator for the region in general making 4,3±1,09 0/0000 and 2,8 times higher for STT making 87,8±4,90 0/0000.

It was possible to establish the perspective value of the analyzed factors necessary for the formation of the planned trend of incidence dynamics. Thus, if to increase the volume of vaccination against TVE by 33.6%, increase the volume of emergency prevention with immunoglobulin against TVE by 24.6%, and increase the volume of acaricide treatment by 45.4% in the territories of the areas of Altai Krai with combined foci of TVE and STT, it will be a success to get a possible decrease in the incidence rate by 40.7% to 2.55 0/0000 for TVE and

15.74% to 83.5 0/0000 for STT among the population in these areas.

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MORTALITY ANALYSIS OF THE WORKING-AGE POPULATION OF YAKUTIA

The article analyzes the government statistics data on mortality of able-bodied population in the Republic of Sakha (Yakutia) in the period from 1995 to 2020, together with the structure of the main causes of death in this category. The dynamics of changes in the mortality structure of urban and rural residents with gender division is studied, the impact of the new coronavirus infection on the work of the health care system in Yakutia is shown. Mortality rate of the population of the Republic of Sakha (Yakutia) of working age decreased significantly during the study period, but the proportion of deaths in this group to the total number of deaths is still higher than the all-Russian figures. It is also shown that the mortality rate of men is 3.6 times higher than that of women. Since 2011, the mortality rate in rural areas has become significantly higher than that in urban areas, especially among the female population, which is largely determined by the reduction of bed capacity. The trend towards reducing the number of inpatient beds is certainly typical not only for Russia, but also for most European countries, but the negative consequences of this are largely offset by the opening of prevention and rehabilitation centers locally, where progressive treatment technologies are used. But this approach does not take into account the main regional peculiarities of Yakutia - its extensive territory and low population density. The problem is also exacerbated by environmental conditions, the negligent attitude of many citizens to their health and unfavorable socio-economic factors, especially pronounced in rural areas. But it must be recognized that in recent years the republic has carried out significant work to improve its healthcare system, including through the construction of new medical facilities, large-scale preventive work and the introduction of "Zemskiy Doctor" and "Zemskiy Feldsher" programs, thanks to which qualified personnel are sent to the remote corners of the republic to work. However, receiving quality and prompt medical care is still difficult for remote rural settlements.

Keywords: mortality; able-bodied population; main causes of death; coronavirus; Yakutia.

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Introduction. Increasing life expectancy is one of the national development goals of Russia until 2030. [1]. However, the achievement of this goal is still hindered by the high mortality rate of people of working age. According to even the average version of the UN forecast [6], calculated even before the COVID-19 pandemic, by 2050 the number of Russians aged 25-64 will decrease by 28% (from 82,808,000 to 59,623,000 people). This may cause a shortage of labor resources and lead to an increase in the demographic load factor.

Objective of the study. To conduct a comparative analysis of the mortality rate