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RISK FACTORS FOR THE DEVELOPMENT OF METABOLIC SYNDROME AMONG EMPLOYEES OF RIVER TRANSPORT OF YAKUTIA

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ABSTRACT

221 employees of river transport of Yakutia at the age 20-49 years old were examined simultaneously. Metabolic syndrome (MS) was verified in 7.7% of employees of non-indigenous nationality.

One of the most significant risk factor for MS was the age (F = 8.24, p = 0.005), 58.8% of people with MS belong to the age group from 40 to 49 years old. A sign of disadaptation of an organism - metabolic disorder was observed among people with the experience of 10 and more years. The degree of disorder of metabolic processes is mostly noticed among employees of non-indigenous nationality with an experience of residence in Yakutia of 15-20 years. Revealed age, severe arterial hypertension and the degree of dyslipidemia among river transport employees with MS in comparison with the population with MS indicate the acceleration of mechanisms of metabolic disorder in Yakutia.

Keywords: metabolic syndrome, river transport, Yakutia.

Introduction. WHO experts described the metabolic syndrome (MS) as a «pandemic of 21st century". Prevalence of MS is 20-40%. It is more common among middle-aged and older people (30-40%). Cardiovascular morbidity and mortality among people with MS are significantly higher than among those without MS. The presence of MS in 3-6 times increases the risk of developing both 2 type of diabetes and hypertension. MS is associated with a subclinical lesion of vital organs. MS is characterized by an increase of visceral fat, a decrease in the sensitivity of peripheral tissues to insulin and hyperinsulinemia, which cause the development of violations of carbohydrate, lipid, purine metabolism and arterial hypertension [8].

As in conditions of the Far North discomfort factors act continuously, depleting the adaptive reserves of the body, the risk of developing metabolic disorder increases, it leads to the formation of pathology [4, 6]. The formation of a specific "polar metabolic type" [5] among northerners are postulated, which is characterized by a complex restructuring of the hormonal-metabolic profile, active use of lipid energy carriers, a decrease of carbohydrates as energy substrates and a change in the need for vitamins. It is shown that there are significant differences in metabolic processes among migrants unadapted to the North and natives of the North, which can manifest themselves in the specific features of migrants and natives [1].

The specific nature of the operation of the floating structure of river vessels has stringent requirements for the health of workers in the fleet. The shortcomings in the organization of the regimes of labor, life, food, habitation on ships, etc., have a significant effect on the morbidity of crews. The leading factors in this are the impact of occupational hazards - noise, vibration, high humidity, various climatic and geographical and meteorological factors. In addition, the employees of water transport have high psychoemotional load [13]. According to Petrova T.B. and co-authors [2] in addition to climatic and geographic factors, there are specific occupational and socio-environmental factors, which influence on the floating crew of the Northern water basin, which doubles the probability of disturbances in metabolic processes, especially carbohydrate and lipid metabolism, among ship specialists. Due to increasing age and work experience, the activity of cholesterol esterification decreases, imbalance of lipid transport system and carbohydrate metabolism is increased, more noticeable among seamen, river birds and fishermen. According to the comparative analysis of the main causes of mortality in the Republic of Sakha (Yakutia) at the working age of 2005-2011, it was shown that the former population died more often than indigenous people from diseases of the circulatory system, including acute myocardial infarction and malignant neoplasms. According to the results of studies conducted in the Republic of Sakha (Yakutia), the frequency of metabolic syndrome (MS) is higher in non-indigenous residents than in indigenous ones [9]. The intensification of the lipid metabolism necessary for adaptation to the climatic and geographic conditions of the North with insufficient replenishment of body reserves, can lead to pre-pathological changes in the body. Thus, the study of the characteristics of metabolic processes of the newcomers who are working in the water transport industry of Yakutia is an urgent task for the development of therapeutic and preventive measures for early detection of risk groups. **The aim** of this study was to estimate the features of metabolic syndrome among river transport workers of Yakutia, depending on the medical and social factors, ethnicity and length of stay.

Material and methods of investigation. During the planned medical examination, we examined 221 water transport workers of the Republic of Sakha (Yakutia) at the age of 20 to 49 years (mean age 35.03 ± 7.95 years) (men - 184, women - 37). There were 25 people of the indigenous nationality (Yakut people - 21, indigenous people of the North -

4). The non-indigenous population was represented by 196 people (Russians, Ukrainian, Tatar and many others), 85 of them turned out to be born in Yakutia. 111 people arrived from other regions of Russia and the CIS. Depending on the length of stay in Yakutia, they were distributed as follows: up to 1 year - 3 people; up to 5 years - 13; from 5 to 10 years - 15; from 10 to 15 years - 12; from 15 to 20 years - 17; more than 20 years - 51 people.

To identify the features of the metabolic syndrome among river transport workers, a comparative analysis was carried out with selective allocation (Lensky District, Republic of Sakha (Yakutia)), consisting of alien men (n = 20).

Blood for biochemical research was taken from the ulnar vein in the morning on an empty stomach. Laboratory research was conducted in conditions of constant internal and external quality control. Activity of aspartate and alanine aminotransferases (asAT, ALAT), alkaline phosphatase, gamma-glutamyltransferase (γ-HT), lactate dehydrogenase (LDH), creatine kinase, glucose levels, total cholesterol (cholesterol), high-density lipoprotein cholesterol (HDL-C), triglycerides were performed by the enzymatic method on the automatic biochemical analyzer CobasMiraPlus by LaRoche (Switzerland) using Biocon reagents (Germany). The levels of low-density lipoprotein cholesterol (LDL-C) and cholesterol of very low density lipoproteins (C-VLDL) were calculated by the formula Friedewald et al. [14]. The coefficient of atherogenicity was calculated by the formula proposed by Klimov A.N. [3]: Ka = (C-C-HDL) / HDL-C. For hypercholesterolemia, the level of total cholesterol ≥ 5.0 mmol / L was taken, elevated LDL cholesterol level ≥ 3.0 mmol / L, reduced level of HDL-C ≤ 1.0 mmol / L among men and HDL-C ≤ 1.2 among women. To hypertriglyceridemia, the level of TG ≥ 1.7 mmol / l was referred. The presence of the MS among the examined individuals was verified according to the criteria of the Russian Scientific Society of Cardiology (2010).

The main sign of the diagnosis of metabolic syndrome was abdominal obesity, in which the waist circumference is more than 80 cm among women and more than 94 cm among men. Additional criteria for our study were: arterial hypertension (BP ≥130 / 85 mmHg) and an increase in the level of TG> 1.7 mmol / l.

The study was approved by the decision of the local ethical committee at the Federal State Budget Scientific Institution "Yakut Scientific Center of Complex Medical Sciences" and carried out from the consent of the subjects in accordance with the ethical norms of the Helsinki Declaration (2000). In the process of conducting the statistical analysis, test for the distribution of the quantitative indicators was carried out according to the Kolmogorov-Smirnov test. The data are presented in the form of M ± m, where M is the mean value, m is the standard error of the mean value.

When comparing the quantitative indicators of the groups, the significance of the differences was assessed using the Student's t-test for the normal distribution and the Mann-Whitney test for the abnormal distribution. To compare the frequencies of qualitative characteristics in unrelated groups, the χ2 criteria were applied. The results were considered to be statistically significant with the values of the achieved significance level p <0.05.

Results of the study and its discussion. MS was diagnosed among 17 patients, (16 men and 1 woman), which was 7.69% of the total sample (n = 221) of the examined individuals. It should be noted that among the representatives of the indigenous nationality, MS was not identified; all 17 people were representatives of the newcomers. 7 men were born in Yakutia, 8 people had a length of residence in Yakutia for more than 20 years, 1 person was from 15 to 20 years old and 1 person was from 5 to 10 years old. There was only one 48-year-old woman with MS, native of Yakutia, who was of non-indigenous nationality. Analysis of the frequency of MS, depending on the position and the profession, did not reveal any significant differences. This pathology was detected among 4 steering motorists (8.8% of all 49 steering motorists); 3 captains (15% out of 20); 3 mechanics (20% out of 15), 2 administrative and management personnel (10.5% out of 19), 1 gas electric welder (33.3% out of 3), 1 skipper (33.3% out of 3), 1 cooker (5.88% out of 17), 1 coast worker (7.7% out of 28).

Single-factor variance analysis showed significant dependence of MS frequency on age (F = 8.24, p = 0.005), married life (F = 7.98, p = 0.005), duration of occupational hazard (F = 6.25, p = 0.013), as well as on housing conditions, i.e. MS is more common among people living in comfortable apartments (F = 4.65, p = 0.032). Comparative analysis found that the mean age (40.41 ± 7.67 years) of people with MS (n = 17) was statistically significantly higher (p = 0.005) than of those without MS (34.58 ± 7.82 years) (n = 204). As it can be seen from the presented figure 1, the highest frequency of MS was found in the age group from 40 to 49 years old and constituted 13.5% (n = 10) of all people of this age group; in the group of people from 30 to 39 years old - 4.82% (n = 4), in the group from 20 to 29 years old - 4.68% (n = 3). It should be noted that 58.8% of people with MS (10 people out of 17) were in the age group from 40 to 49 years old.

For further analysis of the features of the formation of MS among river transport workers, we excluded indigenous residents and women from the general sample (n = 221), MS was detected in 100% of cases among the newcoming population and in 94% of cases in men.

To study the metabolic characteristics, depending on the length of stay, four comparison groups were formed according to the age: group 1 - 11 men with a residence period from 1 to 5 years old (mean age 33.63 ± 1.97); group 2 - 12 men from 5 years to 10 years old (31.83 ± 1.91); group 3 - from 10 to 15 years old (32.40 ± 2.77) and group 4 - from 15 to 20 years (33.06 ± 1.43). In these comparison groups we did not include arrivals from other regions and people who were born in Yakutia (n = 67), because adaptation mechanisms to the conditions of the North will to some extent be formed and may have significant differences; people who lived in Yakutia for up to 1 year (n = 3) due to the small sample size; people who have lived more than 20 years (n = 43) as the mean age (40.27 ± 1.05 years) was statistically higher than in other comparison groups.

It is known that the main task of the organism in the process of adaptation to the climatic and geographic conditions of high latitudes is the mobilization

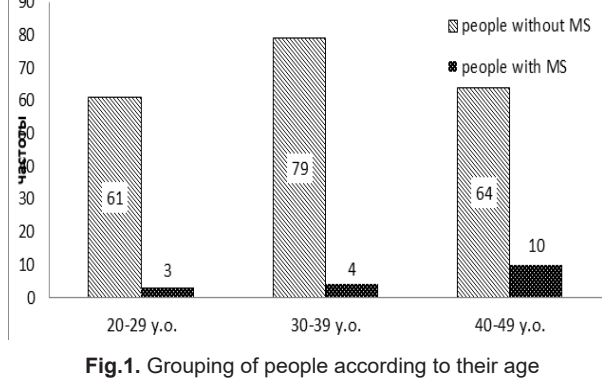

Fig.1. Grouping of people according to their age

of resources and the enhancement of energy metabolism in general, and the activity of the organism participating in metabolic reactions can be judged on the functional state of the organism [11]. The comparative analysis of biochemical parameters, depending on the length of stay in Yakutia, showed that the activity of the main enzymes (creatine phosphokinase, lactate dehydrogenase and alkaline phosphatase) is significantly more pronounced among men of the second group than among other groups indicating the intensity of biochemical processes.

Thus, the concentrations of creatine phosphokinase (p = 0.043), γ-HT (p = 0.029), and ALT (p = 0.05) among men of the 2 group were significantly higher than among men of group 1 (Table 1).

There are low values of the enzyme level among men of the 1st group in comparison with other groups indicating signs of an emergency phase of adaptation. In this phase, the molecular processes in the cells and membranes of the body do not change; it is required significantly more time for their thorough restructuring. The increased activity of key enzymes among men of the 2nd group corresponds to the transition phase of adaptation, for which the intensity of metabolic processes is typical for increasing the energy, plastic and protective maintenance of the organism. Considering the fact that creatine phosphokinase is considered to be an absolutely stress-dependent enzyme and an indicator of the realized energy potential due to the synthesis of a unique endogenous membrane protector of creatine phosphate [11], it can be assumed that non-indigenous men of the 2 group with a residence period of 5-10 years experience a strain of metabolic processes in the greatest degree in comparison with other groups. With different intensity of metabolic processes, one can judge the prevalence of catabolic and anabolic metabolic pathways by the De Ritis coefficient (the ratio of ASAT to ALAT), the adaptation range of which varies from 1.2 to 1.6, its reference value is 1.5. In our study, the de Ritis coefficient was significantly different among compared groups, so in men of the 1st group and of the 3rd groups its value exceeded 1.8. In the 1st group, this indicator was increased due to a low value of ALAT, i.e. decrease in anabolic processes, and in 3 groups - due to increase of ASAT, i.e. catabolic processes. There is an increased content of γ-HT enzymes among non-indigenous men of the 3rd group with an experience

Table 1

Biochemical parameters of blood in non-indigenous men - river transport workers, depending on the length of stay in Yakutia

Index, reference values	Group				The Importance of Differences
	1 1-5 y.o. n=11	2 5-10 y.o. n=12	3 10-15 y.o. n=10	4 15-20 y.o. n=15	
Age, y.o.	33.63±1.97	31.83±1.91	32.40±2.77	33.06±1.43	
Lactate dehydrogenase, (225-450 U / l)	335.9±15.9	376.5±22.5	366.0±20.7	374.0±11.59	0.006##
Creatine phosphokinase, (< 190 U / l)	110.8±11.1	150.2±13.91	116.8±13.96	117.7±20.0	0.043*
Alkaline phosphatase, (< 258 U / l)	193.2±15.28	205.6 ±12.08	187.8±17.7	194.20± 13.8	
Gamma-glutamyltransferase, (11 to 50 U / l)	23.00±2.42	45.4±8.25	53.6±23.58	45.6±5.23	0.029* 0.002##
ALT, (< 30 U / l)	11.81±1.12	22.2 ± 4.53	20.8±4.43	24.46±5.6	0.05* 0.044##
AsAT, (< 40 U/l)	20.36±1.28	28.20±6.43	34.88±8.9	26.53±53	
Coefficient de Ritis, (the norm is 1.3 - 1.5)	1.81±0.13	1.37±0.14	1.87 ± 0.26	1.30±0.14	0.042* 0.048** 0.019##
Glucose, (3.3 to 5.5 mmol / l)	4.95±0.14	4.64±0.12	5.00±0.16	5.18±0.2	0.082#
Triglycerides, (0.5-1.7 mmol / l)	1.26±0.24	1.10±0.15	1.55±0.25	1.27±0.12	
Cholesterol, (3.6-6.5 mmol / l)	4.27±0.26	4.52±0.14	5.05±0.28	5.27±0.28	0.002## 0.028 ° 0.036°°
HDL-C, (0.78-2.2 mmol / l)	1.13±0.14	1.18±0.12	1.18±0.08	1.34±0.09	
LDL-C, (1.68-4.53 mmol / l)	2.79±0.29	2.82±0.15	3.40±0.27	3.49±0.25	0.085# 0.087## 0.04°
HS-VLDL, (0.8-1.5 mmol / l)	0.63±0.11	0.50±0.07	0.65±0.11	0.61±0.10	
The coefficient of atherogenicity, (< 3)	3.47±0.52	3.22±0.27	3.46±0.47	3.60±0.47	

*-between 1 and 2 group; # - between 2 and 3 group; **- between 3 и 4 group; ## - between 1 and 4 group; ° - between 2 and 4 group; °°- between 1 and 3 group

of 10-15 years in comparison with other groups, which provides energy-dependent amino acid transport to maintain the level of total protein. It is known that with the enhancement of adaptive mechanisms, glucose appears in the blood due to gluconeogenesis, in its turn, its intensification is possible only with the optimal supply of the necessary substrates for this - amino acids [11].

It should be noted that in the phase of stable adaptation, which is associated with constant voltage of the control mechanisms, the restructuring of the nerve humoral ratios, the formation of new functional systems, adaptive processes can be depleted. Depletion of control mechanisms, on the one hand, as well as cellular mechanisms associated with increased energy costs, leads to disadaptation [7]. With chronic effects on the body of sub-extreme and extreme factors, the role of lipids in energy supply of adaptation reactions increases. The fat-mobilizing effect and the formation of transport forms of fat-lipoproteins of all classes are intensified [12]. Taking into account the fact that it was revealed content of enzymes γ-HT, AST, glucose, total cholesterol, atherogenic fraction of LDL-C and atherogenicity coefficient among non-indigenous men of the 3rd group with the experience of 10-15 years it can be stated about the depletion of adaptive reserves and the development of disadaptation. Violations of carbohydrate and lipid metabolism are most pronounced among people the 4th group with a residence time of 15-20 years (Table 1).

Thus, the data obtained by us show that the length of stay in the North is one of the main risk factors for metabolic disorders, i.e. the higher the length of service, the greater the degree of violations.

To assess the characteristics of the metabolic syndrome among river transport workers, a comparative analysis was made between the data of non-indigenous men: river transport workers (n = 16) and population sampling (n = 20) with

MS. The population sample was chosen during a comprehensive medical survey in the expeditionary conditions of residents of the village of Vitim in the Lensk District, the Republic of Sakha (Yakutia).

The results of the comparative analysis indicate that the mean age (38.44 ± 2.12 years) among river transport workers is significantly (p = 0.001) lower than among population sample (53.40 ± 1.32 years), which may indicate the earliest formation of the metabolic syndrome among non-indigenous men working in the water transport industry. In terms of anthropometric parameters (height, weight, BMI, waist circumference, hips), a significant difference was revealed only by height (p = 0.026). The value of height among river transport workers (176.68 ± 1.26 cm) was higher than among population group (170.35 ± 2.21 cm).

The indices of arterial pressure among river transport workers were higher than among population group. Thus, the mean diastolic pressure among river transport workers was significantly (p = 0.001) higher (94.62 ± 2.09 mm Hg), and systolic blood pressure (142.00 ± 2.62 mm Hg) tended to an increase (p = 0.085) in comparison to the population sampling (82.00 ± 0.92 and 135.00 ± 2.94 mmHg, respectively) (Fig. 2).

There is a significant increase of triglyceride content (p = 0.001), total cholesterol (p = 0.023), and uric acid (p = 0.001) in the serum of river transport workers in comparison with the population sample. They also showed a significant reduction in the content of the antiatherogenic fraction - high-density lipoprotein (HDL-C) (p = 0.006) and the associated significant increase in the atherogenic index (p = 0.003). The average values of LDL-C and C-VLDL among river transport workers exceed those of the population sample although they do not have significant statistical differences. Thus, the obtained results of a comparative analysis of biochemical parameters indicate an unfavorable atherogenic background among river transport workers in comparison to the population sample (Table 2).

The obtained data to some extent confirm the data of Khasnulin V.I. and co-authors (2011) [12] indicating that lipid metabolism disorders among alien residents of the North, with the impossibility of switching to the northern type of metabolism, become one of the important links in the progression of arterial hypertension in high latitudes.

Dyslipidemia is one of the main and most frequently encountered diagnostic criteria for MS. With respect to MS and coronary atherosclerosis, the high levels of LDL-C and, especially TG, reduced levels of HDL-C are the dominant disturbances in the lipid transport system [9]. Hyperuricemia is one of the most important components of MS and is involved in the pathogenetic mechanisms of atherogenesis, activating the processes of lipoperoxidation with the formation of peroxide-modified LDL-C [9]. Oxidative stress and an increase in the oxidative modification of lipids in the wall of the arteries can play a significant role in the progression of atherosclerosis. It was also found that uric acid is capable to activate the adhesion and aggregation of platelets. These mechanisms demonstrate the active participation of uric acid in the processes of atherogenesis and confirm the significant role of hyperuricemia in the formation of a high risk of cardiovascular pathology in patients with MS.

Undoubtedly, the length of stay of an alien population in the North is one of the main risk factors for the formation of metabolic disorders and leading to prepathological conditions.

Conclusion. MS was verified in 7.7% of river transport workers, indicated data refer to non-indigenous residents of Yakutia. One of the significant risk factors for MS was the age (F = 8.24, p = 0.005) of the examined individuals. 58.8% of people with metabolic syndrome were in the age group from 40 to 49 years old.

Among non-indigenous people working in the river transport of Yakutia, the signs of disadaptation of metabolic processes (dyslipidemia, increase in blood glucose) begin to be observed among people with experience of residents of 10 years or more. The degree of disturbance of metabolic processes is most pronounced in newcomers with an experience of 15-20 years.

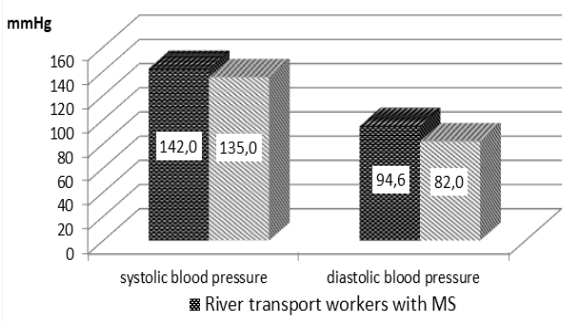

Fig.2. Indices of blood pressure among river transport workers and population sampling with metabolic syndrome

The average age of the river transport workers with MS (38.44 ± 2.12 years) was significantly lower (p = 0.001) than among the population sample with MS (53.40 ± 1.32 years), which probably indicates early formation of MS among the newcomers working in the branch of the river transport of Yakutia.

Comparative analysis of people with MS indicates that arterial hypertension and degree of dyslipidemia are more pronounced among river transport workers than among population sample, which may indicate a negative impact of working conditions of river transport workers, which provokes acceleration of metabolic disturbances in Yakutia.

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Table 2

Biochemical parameters of blood in people with metabolic syndrome

Biochemical parameters	River workers with MS (n=16)	Population sample with MS (n=20)	p= ....
Uric acid. mmol / l	443.92 ± 17.14	261.58 ± 21.2	0.001
Triglycerides. mmol / l	2.67 ± 0.32	1.24 ± 0.18	0.001
Cholesterol. mmol / l	6.03 ± 0.29	5.24 ± 0.13	0.023
HDL-C. mmol / L	0.99 ± 0.03	1.24 ± 0.07	0.006
LDL-C. mmol / L	3.69 ± 0.29	3.44 ± 0.23	
C-VLDL. mmol / l	1.26 ± 0.15	1.24 ± 0.18	
Atherogenicity index	5.01 ± 0.42	3.44 ± 0.23	0.003

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