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## O.M. Zhurba, A.V. Merinov, A.N. Alekseenko, I.V. Kudaeva STUDY OF THE PARAMETERS OF ESTERI-FIED FATTY ACIDS IN BLOOD PLASMA IN PERSONS WITH VIBRATION PATHOLOGY

**Objective**: to study the spectrum of esterified polyunsaturated fatty acids in the blood of persons with vibration pathology.

**Materials and methods**. 97 people were examined, of which 2 groups were formed: the main group I included 52 workers with an established diagnosis of vibration disease (average age  $49.0 \pm 0.8$  years), group II (comparison group) consisted of 45 conditionally healthy men (average age  $-52.0 \pm 0.8$  years), who had no contact with vibration. The determination of esterified fatty acids was carried out by gas chromatography-mass spectrometry on a gas chromatograph Agilent 7890A with a mass-selective detector Agilent 5975C. The data were processed in the program Statistica 6.1.

**Results**. The distribution of parameters of polyunsaturated fatty acids (PUFA)  $\omega$ -3 and  $\omega$ -6 in the examined groups was studied. In the group of persons with vibration disease, a statistically significant increase in the level of  $\omega$ -3 docosahexaenoic acid was noted. The  $\omega$ -3 index was calculated, according to which the representatives of the cohorts were divided into 4 subgroups (less than 2.5%, 2.5 - 5%, 5 - 7.5%, more than 7.5%). The main group was dominated by persons with an  $\omega$ -3 index in the intervals of 2.5-5% and 5-7.5%, while in the comparison group there was a uniform distribution of persons between 4 subgroups ( $\chi$ 2 = 11.2, p = 0.011). Comparison of the sums of the main representatives of  $\omega$ -3 PUFAs (eicosapentaenoic and docosahexaenoic acids) and  $\omega$ -6 (arachidonic and linoleic acids) showed that the sum of the main  $\omega$ -6 PUFAs was statistically significantly higher than the sum of the main  $\omega$ -3 PUFAs in both groups.

**Conclusion**. The conducted study of esterified fatty acids parameters in blood plasma in persons with vibration disease revealed a higher content of C22:6 $\omega$ 3. It was found that the  $\omega$ -3 index in both groups and varied in the range: 2.0–9.2% in persons with vibration disease and 1.3–12.7% in the comparison group.

Keywords: polyunsaturated fatty acids, omega-3 index, chromatography-mass spectrometry, vibration disease.

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Introduction. In the structure of occupational morbidity, vibration disease (VD) occupies one of the leading places [3, 13]. The factors that aggravate the harmful effects of vibration on the body include unfavorable climatic conditions of carrying out production activities and living, especially low temperature of environment. It is known that cold enhance the negative exposure of vibration on the organism and increases the risk of developing vibration disease due to increased vascular reactions [1]. It should be borne in mind that one of the key roles in its pathogenesis is played by endothelial dysfunction, which, along with changes in the nervous system. leads to the formation of systemic microangiopathies [6]. It is believed that these disorders are caused both by the direct exposure of vibration on the vascular endothelium. and by an imbalance of redox processes, neurohumoral, neuroimmune mechanisms, metabolic disorders [2]. As the latter, changes in lipid metabolism of a proatherogenic orientation are noted. At the same time, the study of lipid profile indicators does not always answer the question of the possible mechanisms of the development of these disorders.

One of the approaches to solving this problem is study blood lipids in terms of their primary components, namely fatty acids, assess the balance of their various fractions for the diagnosis, prognosis and treatment of dyslipidemia, cardiovascular pathology and other diseases [5, 8, 12]. One of the fractions of blood fatty acids are esterified polyunsaturated fatty acids (PUFAs), the ratio between the components of which can play an important role in the development of vascular disorders caused, among other things, by exposure to vibration.

In this regard, the aim of the work was to study the spectrum of esterified polyunsaturated fatty acids in the blood of persons with vibration pathology.

**Materials and methods**. The present study involved 97 people who were examined at the clinic of our institute, of which 2 groups were formed: the main

group I included 52 workers with an established diagnosis of VD (average age 49.0±0.8 years), group II ( comparison group) consisted of 45 conditionally healthy men (average age - 52.0±0.8 years) who did not have contact with vibration in the professional route. The exclusion criteria from the study were the presence of acute and chronic non-infectious diseases in the exacerbation stage at the time of the examination, diagnoses established in the anamnesis of ischemic heart disease, stroke, myocardial infarction, cerebrovascular accident, as well as age over 65 years and the use of dietary supplements containing PUFA. All surveyed lived in the conditions of Eastern Siberia for at least 10 years. The studies were carried out in accordance with the principles of the Declaration of Helsinki of the World Association "Ethical principles of scientific medical research with human participation" (as amended in 2008), "Rules of clinical practice in the Russian Federation" (approved by the Order of the Ministry of Health of the Russian Federation of June 19, 2003, No. 266), all studies were carried out with the informed consent of the subjects, approved in accordance with the established procedure by the Committee on biomedical ethics of the FSBSI ESIMER. The studies conducted did not infringe on the rights, did not endanger the well-being of the research subjects, and did not harm their health

Vacutainers containing ethylenediaminetetraacetic acid were used to collect blood plasma samples. To obtain plasma, the collected blood was centrifuged for 15 min at 3000 rpm. Plasma samples were aliquoted into eppendorfs and stored at -20 ° C.

The determination of esterified fatty acids (EFA) was carried out by a twostage technique using extractive alkylation by gas chromatography-mass spectrometry [4] on a gas chromatograph Agilent 7890A with an mass-selective detector Agilent 5975C on an HP-5MS capillary column.

The results were statistically processed using the Statistica 6.1 software, using the nonparametric Mann-Whitney test. The normal distribution of quantitative indicators was tested using the Shapiro – Wilks test. Comparison of relative values was performed using the  $\chi^2$  test. In all cases, the differences were considered statistically significant at p <0.05. The results of the studies performed are presented as the median and interquartile range, mg/l.

Results and discussion. The distribution of quantitative indicators of PUFA

Parameter	Group with VD. n $= 52$	Comparison group. n = 45	р
$\omega 3 - Fatty acids$			
Eicosapentaenoic acid (C20:5ω3)	27.8 (19.9–48.4)	37.5 (24.8–54.9)	0.066
x- Linolenic acid (C18:3ω3)	13.6 (9.5–23.3)	14.4 (9.9–29.0)	0.820
Eicosatrienoic acid (C20:3ω3)	2.8 (0.2–3.3)	3.0 (0.2–3.3)	0.321
Docosahexaenoic acid (C22:6ω3)	110.1 (85.7–133.8)	89.4 (38.7–105.2)	0.003
Σω3 FA	151.5 (123.7–193.0)	139.4 (111.0–176.0)	0.154
$\omega$ 6 – Fatty acids			
- Linolenic acid (C18:3ω6)	8.7 (6.2–14.0)	10.2 (7.3–20.6)	0.063
Linoleic acid (C18:2ω6)	468.1 (414.8–559.2)	449.6 (380.7–643.8)	0.834
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184.4 (153.8–207.1)

96.3 (71.8-115.8)

15.6 (11.7-18.8)

761.9 (673.4-923.7)

4.7 (4.1-6.4)

181.6 (160.3-227.1)

85.8 (76.9-121.9)

12.5 (10.5-16.3)

746.5 (613.6-997.6)

5.4 (4.4-9.4)

0.546

0.919

0.096

0.868

0.114

## The content of esterified polyunsaturated fatty acids of the $\omega$ -3 and $\omega$ -6 families in the blood plasma of persons with vibration pathology. Me (Q25 – Q75). mg/l

of the  $\omega$ -3 and  $\omega$ -6 families in the examined groups was studied (table). In the group of individuals with VD, there was a st atistically significant increase in the level of  $\omega$ -3 docosahexaenoic acid.

 $\Sigma \omega 6 FA$ 

 $\omega 6/\omega 3$ 

Arachidonic acid (C20:4w6)

Eicosadienoic acid (C20:2w6)

Dihomo-y-linolenic acid (C20:3w6)

According to the literature, of all PUFA of the  $\omega$ -3 family. docosahexaenoic (DHA) and eicosapentaenoic (EPA) are significant, and of w-6 - arachidonic (AA) and linoleic (LA) [7]. For the first, the  $\omega$ -3 index was calculated as a percentage of the sum of eicosapentaenoic (C20:5ω3) and docosahexaenoic (C22:6w3) acids of the total amount of fatty acids (FA) in the blood. This index in the examined groups varied in a wide range: from 2.0 to 9.2% in patients with VD and from 1.3 to 12.7% in the comparison group. According to the obtained data of the  $\omega$ -3 index, the representatives of the co-







**Fig. 2.** The ratio of the sum of the concentrations of the main representatives of FA of the family  $\omega$ -3 and  $\omega$ -6 Note \*, \*\* - differences are statistically significant at p <0.05



horts were divided into 4 subgroups (less than 2.5%, 2.5 - 5%, 5 - 7.5%, more than 7.5%). The main group was dominated by persons with an  $\omega$ -3 index in the intervals of 2.5-5% and 5-7.5%, while in the comparison group there was a uniform distribution of persons between 4 subgroups ( $\chi$ 2 = 11.2, p = 0.011) (Figure 1).

The studied ω-3 index is currently proposed to determine the risk of cardiovascular diseases (CVD). It is believed that in individuals with an  $\omega$ -3 index <4%, the risk of CVD is 10 times higher than in patients with an index> 8% [14]. In our observation, in the main group, the number of patients with  $\omega$ -3 index> 7.5% was 11.5%, and in the comparison group - 22.2%, however, the intergroup differences were statistically insignificant ( $\chi 2 = 2.0$ , p = 0.157). Noteworthy is the fact that among the persons of the comparison group, the relative number of persons with an  $\omega$ -3 index less than 2.5 was statistically significantly higher  $(22.2\%, \chi 2 = 7.5, p = 0.006)$  than in the main group of subjects (3.8%).

Comparison of the sums of the main representatives of the  $\omega$ -3 PUFAs (EPA and DHA) and  $\omega$ -6 (AA and LA) showed that the sum of the main  $\omega$ -6 PUFAs was statistically significantly higher than the sum of the main  $\omega$ -3 PUFAs in both groups (Figure 2).

It is known that esterified fatty acids reflect the transfer of exogenous FAs from enterocytes to the liver and then to all cells [10]. Wherein,  $\omega$ -3 and some ω-6 FAs are essential, act as a substrate for energy production and for the synthesis of biologically active humoral regulators. Therefore, with a deficiency of their intake into the body, the regulation of physiological processes is disrupted. In the same time, a violation of the ratio between them in the direction of the prevalence of  $\omega$ -6 PUFA indicates the activation of pro-inflammatory processes. This is determined by the conversion of PUFA in the body. When oxidized with cyclooxvgenase, PUFAs are converted into prostaglandins (PGs): from ω-6 PUFAs PGs of classes 1 and 2 are formed, from ω-3 PUFAs PGs of class 3 are synthesized [15]. The transformation of PUFAs by the lipoxygenase pathway gives classes of leukotrienes (LT): 3 and 4 for  $\omega$ -6 acids, 5 for  $\omega$ -3 acids. With an increase in the class, the vasodilating and antiaggregatory effect of PG increases and the proinflammatory and atherogenic properties of LT decrease [9, 11].

Considering that one of the links in the

pathogenesis of VD is a dysfunction of the endothelium, the formation of vascular inflammation as a result of the prevalence of esterified  $\omega$ -6 over  $\omega$ -3 PUFAs in the organism can be considered as a mechanism of its development. It should be noted that the representatives of the comparison group have disorders of a similar nature in the metabolism of PUFA, which requires, on the one hand, studies to determine whether they have a metabolic syndrome, and, on the other hand, dictates the need to study the prevalence of such changes in the population as a whole.

**Conclusion**. Thus, the study of the quantitative parameters of EFA in the blood plasma of persons with VD revealed a higher content of C22:  $6\omega3$ . It was found that the  $\omega$ -3 index in both groups and varied in the range: 2.0–9.2% in persons with VD and 1.3–12.7% in the comparison group.

The work was performed within the framework of research work on a fragment of the laboratory of analytical ecotoxicology and biomonitoring of the FSB-SI ESIMER "Study of the mechanisms of metabolic disorders and their role in the formation of sensitivity to the exposure of production factors", state registration number AAA-A18-1180 2089005-6.

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