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EFFECT OF WATER-SOLUBLE OMEGA-3 PREPARATION ON CARDIOVASCULAR AND RESPIRATORY SYSTEM PARAMETERS

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The impact of a new water-soluble Omega-3 drug on the functional state of the cardiovascular and respiratory systems was determined using the example of residents of the ecologically disadvantaged Donetsk region (Mariupol) during military operations (conducting the Joint Forces Operation). The study was conducted on 131 healthy female volunteers aged 18 to 30 who did not have bad habits. Volunteers were divided into 2 groups. 68 people of the main group received a water-soluble Omega-3 drug in addition to their diet for 3 months. 63 persons in the control group did not take the drug. Before and after the Omega-3 course, the condition of the cardiovascular and respiratory systems was determined in the control subjects and main groups using functional tests: Ruffier, Serkin, Stange, Genchi, and active orthostatic test. The research established that the initial indices of the heart and respiratory system state, both in the control and main groups, did not correspond to the norm. After the water-soluble Omega-3 preparation, the results of functional tests in the subjects of the main group indicated recovery or a significant tendency to recover to the normal level of the function of the cardiovascular and respiratory systems.

Key words: ecologically adverse conditions**,** functional tests, water-soluble drug “V-Omega-3”, respiratory system, cardiovascular system, recovery.

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ВПЛИВ ВОДОРОЗЧИННОГО ПРЕПАРАТУ OMEGA-3 НА ПОКАЗНИКИ СЕРЦЕВО-СУДИННОЇ ТА ДИХАЛЬНОЇ СИСТЕМ

Визначено вплив нового водорозчинного препарату Omega-3 на функціональний стан серцево-судинної та дихальної систем на прикладі мешканців екологічно неблагополучної Донецької області (м. Маріуполь) під час військових дій (проведення Операції Об’єднаних сил). Дослідження проводилось у 131 здорового волонтера жіночої статі віком від 18 до 30 років, що не мали шкідливих звичок. Волонтерки були об’єднані у 2 групи. 68 осіб основної групи додатково до раціону харчування протягом 3 місяців отримувала водорозчинний препарат Omega-3. 63 особи контрольної групи не приймали препарат. До та після курсу Omega-3 у осіб контрольної та основної групи визначали стан серцево-судинної та дихальної систем за допомогою функціональних проб: Руф’є, Серкіна, Штанге, Генчі та активної ортостатичної проби. В результаті проведених досліджень було встановлено, що вихідні показники стану серцевої та дихальної системи, як в осіб контрольної, так і основної групи не відповідали показникам норми. Після курсу водорозчинного препарату Omega-3 результати функціональних проб в осіб основної групи свідчили про відновлення або значну тенденцію до відновлення до рівня норми функції серцево-судинної та дихальної систем.

Ключові слова: екологічно несприятливі умови**,** функціональні проби, водорозчинний препарат «V-Omega-3», дихальна система, серцево-судинна система, відновлення.

The study is a fragment of the research project “Restoration of the hematoimmunological, neurological and psychoemotional state of the population of the Donetsk region during the Joint Forces Operation”, state registration No. 0119U001445.

The current ecological situation in Ukraine can be described as a crisis that has developed over a long period due to the disregard of the laws of development and reproduction of natural resources in the country. The economy was severely deformed in the previous Soviet period, and priority was given to developing resource and energy-generating industries, which were the most ecologically dangerous types of production [15]. As a result, the anthropogenic and artificial load on the environment in Ukraine exceeds the corresponding indicators in developed countries by 4–5 times. The low level of environmental awareness of society has led to significant degradation of Ukraine's natural environment, excessive pollution of surface and underground water, air and land, and accumulation of vast quantities of harmful (including highly toxic) production waste. These adverse environmental factors have led to the deterioration of people's health and an increase in mortality, which threatens not only a decrease in the country's population but also changes in the body at the genetic level. Today, the environmental situation has become a problem of national importance that requires a priority solution both in Ukraine and around the world. Studies conducted showed that in several regions of Ukraine, the anthropogenic load on nature is approaching the limit of its ecological sustainability [7]. The consequences of man-made influence in large urban agglomerations, where negative environmental factors are exposed to wide strata of the population, are especially dangerous. In particular, in the Donetsk region of Ukraine, many cities were

formed around industrial enterprises built in the 19th and 20th centuries. The lack of protective and safety systems to preserve ecology at these enterprises causes toxic waste to enter the environment [12]. Among the old industrial cities of Donetsk region, Mariupol, where the metallurgical plants Illich Steel and Iron Works and Azovstal are located, occupied one of the first places in Ukraine in terms of the volume of harmful substances' emissions and polluted air and water in the coastal zone until February 24, 2022 [3, 15]. As a result of the war with the Russian Federation in 2014, the infrastructure of the Donetsk region began to deteriorate beyond repair. This caused additional pollution of drinking water sources, soil and air with heavy metals, increasing the level of gamma radiation [3, 10]. The military operations taking place close to the city caused tension in the psycho-emotional state and a shift in the psychoneuroimmune regulation of the body [3]. Thus, the living conditions of the population in Mariupol, before the hot phase of the war with the Russian Federation, can be considered an object for the study of complex interrelationships in the "society-nature" system. The development of means to protect the body from the adverse effects of the environment, especially regarding old industrial cities like Mariupol, of which there are quite a few worldwide, was and remains relevant. Food supplements, particularly vitamins and vitamin complexes, are most suitable.

Microelements and fat-soluble vitamins influence the body's development, functioning, and resistance to negative environmental factors [1]. Several studies have shown that Omega-3 fatty acids, including eicosapentaenoic (EPA) and docosahexaenoic acid (DHA), found in fish oil, are antioxidants. They reduce lipid peroxidation processes and strengthen cell membranes, which contribute to the normalization of the body's functioning, particularly its central systems: nervous, cardiovascular and respiratory [4, 6, 9, 11]. A new domestic fish oil preparation, "V-Omega-3", has appeared in Ukraine's pharmaceutical market. It is a dietary product, a water-soluble form of Omega-3 nanotechnology produces. One millilitre of the aqueous solution of the drug "V-Omega-3" contains 30 mg of Omega-3. It can be assumed that this Omega-3 drug is better metabolized in the body.

To find means of counteracting the impact of a complex of negative factors on the body, it was interesting to investigate the effectiveness of a water-soluble Omega-3 drug in restoring the cardiovascular and respiratory systems in the conditions of the combined effect of a complex of natural and man-made factors and significant psycho-emotional stress.

The purpose of the study was to evaluate the effectiveness of a water-soluble Omega-3 drug on the functional state of the cardiovascular and respiratory systems using the example of the Donetsk region (Mariupol), whose residents are constantly influenced by a complex of adverse natural, man-made and psycho-emotional factors during military operations (Joint Forces Operation).

Materials and methods. The study was conducted from 2019 to 2021 at the Department of Microbiology, Virology, Immunology, and Medical Biology of the Donetsk National Medical University. 131 female volunteers aged 18 to 30 took part in the study. Informed consent for the use of the drug and the examination was obtained from all the examined. According to the anamnesis, the subjects who participated in the study did not have acute or chronic diseases or bad habits and led a healthy lifestyle at the time of the study. No persons were registered in medical institutions with hidden cardiovascular or respiratory system insufficiency. At the time of the study, all the examined were conditionally healthy people (CHP). People who participated in the research were grouped into two groups: 68 people made up the main group (MG) who took the drug "V-Omega-3" and 63 women – the control group (CG), who did not take the drug. The drug "V-Omega-3" (VERBA, Ukraine) was taken, according to the instructions, once after the morning meal in a dose of 30 mg (1 ml), previously dissolved in 50–100 ml of water or juice. The study was conducted before and after using the water-soluble form of the drug "V-Omega-3". The course of taking the drug was 3 months.

Non-invasive methods in the form of functional tests were used to study the effect of the drug "V-Omega-3" on the cardiovascular and respiratory systems. The Ruffier Test and the active orthostatic test were used to assess the functional state of the cardiovascular system. To assess the functional state of the respiratory system, the combined Serkin test with three-phase respiratory retention, the Stange test with breath retention on inspiration, and the Genchi test with breath retention on exhalation were used. The study used well-known methods [2, 5, 8, 9, 13, 14]. The obtained results were processed using variational statistics and rank correlation using PCL: the Statistica 6.0 for Windows program (No. BXXR109F096230FAN10) and a package of relevant measurement programs regarding the reliability of values according to the Student's t-test.

Results of the study and their discussion. Ruffier's test was performed as follows: the subject's pulse was determined in a sitting position for 5 minutes in 15 seconds (P1); then, within 45 seconds, the subject performed 30 squats. After the end of the load, the subject sat down, and his heart rate was again

counted for the first 15 s (P2) and then – for the last 15 s (P3) of the first minute of the recovery period. Heart performance was assessed using the formula: Ruffier index = (4 × (P1 + P2 + P3) – 200):10. The results were evaluated according to the value of the index from 0 to 15. Less than 3 was considered good performance, 3 to 6 – moderate, 7 to 9 – satisfactory, 10 to 14 – poor (moderate heart failure), and 15 and above (severe). The active orthostatic test was performed as follows: after staying in the "lying" position for 5 minutes, the subject's pulse rate was counted for 15 seconds, and the heart rate (HR) was determined in 1 minute by multiplying by 4. After that, the studied person (SP) was slowly (up to 3 seconds) brought up, and her heart rate was determined immediately and after 3 minutes in 1 minute. A normal response to this test is an increase in heart rate from 10 to 16 beats per minute. An increase to 18 beats is rated as satisfactory, and an increase to 19 beats and above is unsatisfactory, indicating insufficient cardiovascular system nervous regulation. Serkin's test was performed in three stages. After 5 minutes of rest, SP held her breath for the maximum possible period of time while inhaling calmly in a sitting position. The delay time was recorded by a stopwatch. Two minutes later, SP did 20 squats in 30 seconds, sat on a chair and held her breath while inhaling. The breath holding time was recorded similarly to the previous one. After resting in a sitting position for 1 minute, SP held a breath for the maximum period on a calm exhalation. The time of breath holding was recorded by a stopwatch. Then the data obtained from all three stages are compared with the norm. When carrying out the Stange test, after 5 minutes of rest in the "sitting" position, SP made 3 deep breathing movements, and then, after taking a deep breath, she held her breath as long as possible and pinched her nose with her fingers. The duration of the SP breath-holding time was recorded with a stopwatch. At the moment of exhalation, the stopwatch was stopped. The data obtained were compared with the norm. According to the Genchi test, after 5 minutes of rest in the "sitting" position, SP made several deep breathing movements. Then, after exhaling as deeply as possible, SP held her breath as long as possible. A stopwatch recorded the duration of the breath retention time. The stopwatch was stopped at the time of inhalation, and the data obtained were compared with the norm. For a healthy, untrained person, the norm is from 25 to 30 s, and for a trained person from 40 to 90 s.

Data on the results obtained are shown in Table 1.

Table 1

Results of the study of the state of assessment of the cardiovascular and respiratory systems before and after the course of the water-soluble drug Omega-3

Functional test	Before taking Omega 3		After taking Omega 3	
	Main group	Control group	Main group	Control group
Ruffier index (index)	12.6±0.4	12.4±0.6	6.6±0.2*	12.8±0.5
Orthostatic test (beats/min)	18.2±0.3	18.2±0.5	15.0±0.3*	17.7±0.4
Serkin test first phase (s)	42.3±0.6	42.3±1.6	46.0±0.7*	41.4±1.5
Serkin test second phase (s)	19.3±0.2	20.0±0.5	20.0±0.5	18.7±0.9
Serkin Test third phase (s)	38.0±0.9	38.3±0.9	41.2±0.6*	36.9±1.4
Stange test (s)	30.4±0.9	30.7±1.1	53.8±0.4*	32.7±0.8
Genchi test (s)	24.6±0.8	24.3±1.3	37.2±0.5*	25.0±1.1

* At $P<0.05$ between the main and control groups before and after applying the vitamin complex.

Studies of the physiological state of the body before the use of the Omega 3 drug showed that the level of functional reserve of the heart according to the Ruffier index in CHP of MG did not differ from the indices of the CG, which corresponded to the value of "satisfactory" (from 10.1 to 15) and moderate cardiovascular insufficiency [12, 14]. Conducting an orthostatic test before the use of the drug showed that the parameters of the orthostatic test in MG persons did not differ from those of CG. At the same time, in most of the examined MG and CG, when moving from a horizontal position to a vertical position, the heart rate was on the border between the values of "satisfactory" and "unsatisfactory" [5, 8, 13]. The obtained orthostatic samples also indicated the increased reactivity of the sympathetic part of the autonomic nervous system in CG and MG, which is characteristic of insufficiently trained individuals [5, 8, 13]. A study of the respiratory system using the Serkin test before taking the drug showed that in the first, second and third phases of respiratory arrest in MG and CG individuals, there were no likely deviations, and they corresponded to the state of the respiratory system of healthy, untrained individuals [5, 13]. According to the results of the Stange test in MG and CG individuals before taking the Omega 3 drug, the value of the indicator of this test, as in previous studies, was between the "Satisfactory" and "Unsatisfactory" indices [5, 13]. The indicators of Genchi's test in MG and CG individuals before the course of the Omega 3 drug also probably did not differ and testified to the low supply of oxygen to the body and the reduction of adaptive capabilities to transfer the hypoxic state of these contingents [5, 13]. The obtained results indicated

the insufficiency of the function of the cardiovascular and respiratory systems in MG and CG individuals from the CHP who lived in the conditions of the environmental crisis of the old industrial city of Mariupol in the Donetsk region at the time of the study. On average, the examined subjects had a moderate degree of insufficiency of the pumping function of the heart, a decrease in the reserve of the body's resistance to hypoxia, autonomic dysfunction of the hypotonic type in response to the load, under which the heart does not work efficiently enough, with high energy expenditure.

The results of studies for the term after the end of the course of taking the new domestic water-soluble Omega-3 drug in MG showed that the Ruffier index, compared to the initial indicators and individuals of CG, in these individuals probably decreased ($P<0.05$) with a tendency towards normalization [5, 13, 14]. No changes in the Ruffier index were recorded in CG individuals. When performing an orthostatic test in MG individuals after taking the Omega-3 drug, a probable decrease in heart rate when moving from a horizontal position was recorded, compared to the initial data ($P<0.05$). In fact, according to the orthostatic test data, the MG indicators have returned to the limits of the physiological norm [5, 13]. In the subjects of the control group, the parameters of the orthostatic test before and after the end of the course of the Omega-3 drug in MG had no significant differences ($P>0.05$).

A study of the effect of a new domestic Omega-3 drug on the state of the respiratory system using Serkin's functional test showed that the duration of breath retention changed positively in MG patients after taking the medication. At the same time, the first and third phases of breath retention significantly increased compared to the initial data ($P<0.05$). CG indicators, unlike MG indicators, did not change. Indicators of the second phase of breath retention in the MG were within the normal range before taking the drug in the MG. They had a slight tendency to increase after Omega-3, and in individuals with CG, unlike MG, no positive changes were recorded. The results generally indicated that after taking the Omega-3 drug in MG individuals, respiratory function was restored to the average values of healthy, untrained individuals [5, 13, 14]. When carrying out the Stange test after a course of using the drug, it was established that inspiratory breath retention in MG individuals probably increased, in contrast to CG indicators ($P<0.05$), and returned to the normal indicators of healthy untrained individuals [5, 13]. When carrying out the Genchi test after a course of the Omega-3 drug, a probable increase in the exhalation delay time in MG, individuals was registered ($P<0.05$) to the normal indicators of healthy untrained individuals [5, 13]. In contrast to MG, the parameters of the control group probably did not change ($P>0.05$).

Thus, after 3 months of water-soluble Omega-3 preparation, the cardiovascular and respiratory systems' functional indices improved, and they tended to recover or recover. In particular, this was reflected in MG individuals by the acceleration of the speed of recovery processes of the cardiovascular system during exercise, the improvement of the pumping function of the heart to the limits of the physiological norm against the background of the restoration of the balance of the sympathetic and parasympathetic parts of the autonomic system. According to the indicators of functional tests characterizing the state of the respiratory system (Serkin, Stange, and Genchi tests), after a course of the Omega-3 drug, the body's supply of oxygen significantly improved, and resistance to hypoxia increased. At the same time, our previous studies [4] testified to its restorative effect on the nervous system and psycho-emotional state and, accordingly, the adjustment of psychoneuroimmune regulation of the body.

Based on this, it is appropriate to consider the water-soluble Omega-3 drug as a promising tool in the complex of developments aimed at protecting and improving the condition of the cardiovascular and respiratory systems in people living in conditions of combined action of a complex of natural man-made factors and a significant psychoemotional load, in particular, eco-crisis old industrial regions, such as the Donetsk old industrial region.

Conclusions

1. It has been established that the new domestic water-soluble Omega-3 preparation, when taken as a course for three months, accelerates the speed of recovery processes of the cardiovascular system under stress, improves the pumping function of the heart to the limits of the physiological norm, and restores the balance of the sympathetic and parasympathetic parts of the autonomic system.

2. Using a water-soluble Omega-3 drug improves the body's oxygen supply, increasing its resistance to hypoxia.

3. It is appropriate to consider the water-soluble Omega-3 drug as a promising tool in the complex of developments aimed at protecting and improving the condition of the cardiovascular and respiratory systems in people living in conditions of combined action of a complex of natural man-made factors and a significant psychoemotional load, in particular, eco-crisis old industrial regions, such as the Donetsk old industrial region.

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