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CONTEMPORARY TRENDS IN HARMONIZATION OF LEGAL GROUNDS FOR PROVIDING SAFETY OF ENVIRONMENTAL CHEMICAL CONTAMINAITON FOR HUMAN HEALTH

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Regulatory documents on environmental protection adopted in Russia and abroad often contradict each other as regards terms and requirements. It is even more so in case of subordinate legislation in Russia which often doesn't fully conform to international requirements and is not sufficient when it comes to legal protection of people and the environment from sources of chemical threats. Our research goal was to compare international and Russian documents on environment protection and validate our suggestions on their harmonization. Such a concept as a "target" is not a quantitative characteristic for those threats for health which are caused by contamination with chemicals. The MPC validating system existing in Russia as well as types of standards accepted in the country are not in full conformity with international practices. Abroad there are no MPCs for water objects used for fishery. In Russia, the Federal Law issued on January 01, 2002 No. 7-FL "On environmental protection" contains a term "standards for the quality of the environment"; however, such standards don't exist, and there are no techniques for their development either in Russia or abroad. But still, it is vital to give grounds for ecological-hygienic standards allowing for a lifecycle of chemicals. The greatest discrepancies occur in lists of chemicals which are subject to control in various environmental objects; these lists are to be adjusted significantly in order to create a unified document on control with recommendations on choice of priority indexes. International regulatory documents recommend a system of the best available technologies (BAT) as a way to reduce chemicals emissions into the environment. And they also state that in case it is impossible to meet safety requirements even with BAT application, then any permission to emit and discharge should contain a program on emissions reduction in future. However, there is no such requirement in Russian legislation; that is, MPC is replaced with technologies for emissions reduction. Therefore, it is necessary to work out a unified consistent system of laws and subordinate legislation on providing health safety and protection from chemical contamination of the environment.

***Key words**: chemical contamination, environment, targets, maximum permissible concentration, BAT, priority chemicals, harmonization.*

According to M.E. Dmitriev, the President of ‘New Economic Growth’ Partnership: "There are about 2.5 million regulatory documents in Russia…". Cur-

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rently, at least 10 federal laws[1] are devoted to the requirements for protecting human health from the effects of chemicals. All these documents are inconsistent and contradict each other in terms and requirements. This applies even more to by-laws, which, moreover, do not fully correspond to international requirements, and in some cases are insufficient in respect of legal protection of a human and environment from the sources of chemical danger. In the absence of a unifying legislative act, there are also no links between the main elements of legislation regulating the protection of health from chemicals effects. In this regard, the purpose of this study was to compare international and national documents in the field of environmental protection and substantiation of proposals for their harmonization in the following areas: terminology, the system of chemical standards, lists of indices under control, the best available technologies.

One of the most recent laws related to environmental protection is the Federal Law of 10.01.2002 No. 7-FZ (Ed., Dated December 31, 2017) "On Environmental Protection"[2]. In addition to the concept of "maximum permissible concentration" (MPC) of substances in the environment, it contains such terms as "limits", "best available technologies" (BAT), "technological" and "technical" standards. Therefore, it is advisable to consider the significance and applicability of these indices.

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[1] Vodnyi kodeks Rossiiskoi Federatsii № 74-FZ ot 03.06.2006 g. (red. ot 29.07.2017 g.) [Water Code of the Russian Federation of 03.06.2006 No. 74-FZ (as amended on July 29, 2017)]. *Konsul'tantPlyus.* Available at: http://www.consultant.ru/document/cons_doc_LAW_60683/ (11.03.2018) (in Russian).

Vozdushnyi kodeks Rossiiskoi Federatsii № 60-FZ ot 19.03.1997 g. (red. ot 31.12.2017) [Air Code of the Russian Federation of March 19, 1997 No. 60-FZ (as amended on December 31, 2017)]. *Konsul'tantPlyus*. Available at: http://www.consultant.ru/document/cons_doc_LAW_13744/ (11.03.2018) (in Russian).

Ob otkhodakh proizvodstva i potrebleniya: Federal'nyi zakon № 89-FZ ot 24.06.1998 g. (red. ot 31.12.2017 g.) (s izm. i dop., vstup. v silu s 01.01.2018 g.) [On Production and Consumption Wastes: Federal Law No. 89-FZ of June 24, 1998 (as amended on December 31, 2017) (as amended and supplemented, effective from 01.01.2018]. *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii.* Available at: http://docs.cntd.ru/document/901711591 (11.03.2018) (in Russian).

O vodosnabzhenii i vodootvedenii: Federal'nyi zakon № 416-FZ ot 07.12.2011 g. (red. ot 29.07.2017 g.) [On Water Supply and Sanitation: Federal Law No. 416-FZ of 07.12.2011 (as amended on July 29, 2017)]. *Zakony Rossiiskoi Federatsii*. Available at: https://fzakon.ru/laws/federalnyy-zakon-ot-07.12.2011-n-416-fz/ (11.03.2018) (in Russian).

Ob okhrane atmosfernogo vozdukha: Federal'nyi zakon № 96-FZ ot 04.05.1999 g. (red. ot 13.07.2015 g.) [On Atmospheric Air Protection: Federal Law No. 96-FZ of 04.05.1999 (as amended on July 13, 2015)]. *Konsul'tantPlyus*. Available at: http://www.consultant.ru/document/cons_doc_LAW_22971/ (11.03.2018) (in Russian).

Ob ekologicheskoi ekspertize: Federal'nyi zakon № 174-FZ ot 23.11.1995 g. (red. ot 28.12.2017) (s izm. i dop., vstup. v silu s 01.01.2018 g.) [On Ecological Expertise: Federal Law No. 174-FZ of November 23, 1995 (as amended on December 28, 2017) (as amended and supplemented, effective from 01/01/2018)]. *Konsul'tantPlyus.* Available at: http://www.consultant.ru/document/cons_doc_LAW_8515/655dd7dcb4a739eff184c49e586dc3ac5ad72ee2/ (11.03.2018) (in Russian).

O sanitarno-epidemiologicheskom blagopoluchii naseleniya: Federal'nyi zakon № 52-FZ ot 30.03.1999 g. [On Sanitary and Epidemiological Welfare of the Population: Federal Law of 30.03.1999 No. 52-FZ]. *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii*. Available at: http://docs.cntd.ru/document/901729631 (11.03.2018) (in Russian).

O bezopasnom obrashchenii s pestitsidami i agrokhimikatami: Federal'nyi zakon № 109-FZ ot 19.07.1997 g. (red. ot 17.04.2017 g.) [On Safe Handling of Pesticides and Agrochemicals: Federal Act No. 109-FZ of July 19, 1997 (as amended on April 17, 2017)]. *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii*. Available at: http://docs.cntd.ru/document/9045962 (11.03.2018) (in Russian).

O promyshlennoi bezopasnosti opasnykh proizvodstvennykh ob"ektov: Federal'nyi zakon № 116-FZ ot 21.07.1997 g. (red. ot 07.03.2017 g.) (s izm. i dop., vstup. v silu s 25.03.2017 g.) [On Industrial Safety of Hazardous Production Facilities: Federal Law No. 116-FZ of July 21, 1997 (as amended on March 7, 2017) (as amended and supplemented, effective from March 25, 2017)]. *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii.* Available at: http://docs.cntd.ru/document/9046058 (11.03.2018) (in Russian).

O zashchite naseleniya i territorii ot chrezvychainykh situatsii prirodnogo i tekhnogennogo kharaktera Federal'nyi zakon № 68-FZ ot 21.12.1994 g. [About the protection of the population and the territories against emergency situations of natural and technogenic nature. Federal Law of December 21, 1994 No. 68-FZ]. *Konsul'tantPlyus.* Available at: http://www.consultant.ru/document/cons_doc_LAW_5295/ (11.03.2018) (in Russian).

[2] Ob okhrane okruzhayushchei sredy: Federal'nyi zakon №7-FZ ot 10.01.2002 g. (red. ot 31.12.2017 g.) [On Environmental Protection: Federal Law of 10.01.2002 No. 7-FZ (as amended on December 31, 2017)].]. *Konsul'tantPlyus.* Available at: http://www.consultant.ru/document/cons_doc_LAW_34823/ (11.03.2018) (in Russian).

The "limits", "technical" and "technological" standards are not directly related to the danger of chemicals for human health, so their discussion was not part of the study objects.

In addition, there is the concept of "target" index in global practice, which is interpreted in our country in different ways.

The term of a "target index" for ensuring chemical safety in international law aimed at protecting the environment is borrowed from economy, and characterizes the level of achievement of the goals set by management bodies, and the degree of approximation to their values describes the efficiency level of the measures taken.

For example, one of the important conditions for the implementation of Protocol on Water and Health to the 1992 [1] is the development of national targets in accordance with article 6, paragraph 2 (a). Water management activities should be aimed at preserving, first, the quantity and quality of water resources for future generations; secondly, at implementing measures to prevent water-borne diseases, primarily, infectious ones, which is more effective economically, than eliminating their consequences. The third principle is to ensure access to information and public involvement in the decision-making process aimed at improving the quality of drinking water supply for broad sectors of society.

Thus, targets at the international level are not considered as water quality norms or standards. They are a criterion for assessing achievement of the proper conditions for not only a safe, but also an optimized water supply for the population.

In Russia, the standards for the chemical quality of environment are the maximum permissible concentrations (MPCs) and time limits – SRL (Safety Reference Level of a substance) and SRLI (Safe Reference Level of Impact), justified by accelerated methods.

At present, there are three systems of standards for water bodies: hygienic MPCs for water bodies' chemicals for domestic, drinking and cultural purposes; MPCs for fishery water facilities and the MPCs specified for pesticides which results in disputes and inconsistencies in assessing the risk of water pollution. There is no system of fishery MPCs in place, either in international documents or in any developed country. The "environmental quality standards" mentioned in the Federal Law No. 7-FZ of January 10, 2002 (Ed. December 31, 2017)[2] "On Environmental Protection" do not exist, and there are no methods for their development both in the national and global practice. MPCs for atmospheric air in populated areas are meant to protect public health and improperly applied to nature protection.

At the same time, a number of standards require revision, since they, being old-established, do not take into account the data on new types of specific effects of chemicals toxic actions. So, A.N. Sysin Research Institute of Human Ecology and Environmental Health, now a structural unit of the Federal State Institution "Centre for Strategic Planning and Management of Biomedical Health Risks", Ministry of Health of Russian Federation (hereinafter referred to as the Center) did work to harmonize the MPCs for several dozens of chemicals in water and atmospheric air with the international standards, taking into account their carcinogenic properties [2]. However, this work needs to be continued considering new approaches, including the international ones[3], as well as new data on chemicals toxic properties.

A.N. Sysin Research Institute of Human Ecology and Environmental Health

developed proposals and methodic approaches to create a system of ecological and hygienic standards for chemicals concentrations in water, taking into account their life cycle [3]. Based thereupon, a methodology has been developed to justify regional standards for chemicals with due account for the comprehensive effect on a human body following an allowable daily dose [4]. However, an adoption of legislative and organizational decisions is required to implement such proposals and approaches.

For environmental pollution control, the lists of chemicals are being formed, and in determining them, the hazard characteristics are of great importance. Thus, a stability index as one of the leading criteria for chemicals hazard was established in the 1970s [5]. Then it was acknowledged at the international level that chemical compounds with high stability, property of cross-media transitions and spatial distributions pose a great danger. As a result, a list of 13 persistent organic pollutants (POPs) was approved at the UN level in the Environmental Program, followed by more than 50 persistent bioaccumulative toxins (PBTs) [6].

Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade provides for the prohibition or strict limitation of about 30 chemical compounds [7], and this list is constantly being updated.

The UN recommendations have been considered when approving the "Indicative list of the main pollutants to be taken into account when establishing emission limit values", given in the Directive of the European Parliament and the Council of the European Union 2008/1/EC of January 15, 2008 on the integrated pollution prevention and control[4]. The list contains 13 groups of chemical compounds for atmospheric air, and 12 groups of substances for the aquatic environment without deciphering these groups of substances[4]. It is made taking into account enterprises and technologies specific to EU, but does not fully reflect the diversity of industrial enterprises and technologies located on the territory of Russia, and is not always detailed by chemicals nomenclature.

Each country has its own list of priority hazardous compounds. For example, drinking water in different countries is monitored by 15-30 parameters. In the US, the Scorecard list contains 670 substances (without specifying the safe level), and ATSDR list (Agency for Toxic Substances and Disease Registry) list contains 275 substances [8]. At the same time, these lists serve as the guidelines.

The Directive of the European Parliament and the Council of the European Union of November 3, 1998 "On the quality of water intended for human consumption" (98/83/EC)[5], Article 5 states that "Member States shall set values applicable to water intended for human consumption; The values shall not be less stringent than those set

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[3] R.1.2.3156-13. Otsenka toksichnosti i opasnosti khimicheskikh veshchestv i ikh smesei dlya zdorov'ya cheloveka [Estimation of toxicity and danger of chemicals and their mixtures for human health]. *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii.* Available at: http://docs.cntd.ru/document/1200115595 (20.03.2018) (in Russian).

[4] O kompleksnom predotvrashchenii i kontrole zagryaznenii (kodifitsirovannaya versiya): Direktiva ES № 2008/1/ES ot 15 yanvarya 2008 g. [On the integrated pollution prevention and control (codified version): EU Directive of January 15, 2008 No. 2008/1/EC]. *PRAVO*^{RU}. Available at: http://docs.pravo.ru/document/view/25520201 (20.03.2018) (in Russian).

[5] O kachestve vody, prednaznachennoi dlya upotrebleniya lyud'mi (98/83/ES): Direktiva Evropeiskogo parlamenta i Soveta Evropeiskogo soyuza ot 03.11.1998 g. [On the quality of water intended for human consumption (98/83 / EC): Directive of the European Parliament and the Council of the European Union of 03.11.1998.] *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii.* Available at: http://docs.cntd.ru/document/456029632 (16.03.2018) (in Russian).

out in Annex 1; A Member State shall set values for additional parameters not included in Annex 1, where necessary the protection of human health within its national territory or part of it so requires".

Based on these guidelines, Russia issued a Decree of the Russian Federation Government ddt. 08.07.2015, No.1316-r "On approval of the list of pollutants to which the state regulation measures of environmental protection are applied"[6]. This list contains 160 chemicals and 94 radioactive isotopes for atmospheric air; 163 substances, 5 generalized indices and 81 isotopes for water bodies, and 59 chemicals and 4 isotopes for soil.

This List is of an abstract nature, since it contains neither MPC values, nor methods for determining substances, nor instructions in which cases substances should be determined by certain compounds.

From a comparative analysis of our own studies findings and the List14 it follows that the substances lists do not completely coincide with the recommended EU documents for monitoring. In addition, the list contains a number of errors, both for the substances listed in it, and for their names. For example, it is necessary to control benz(a)pyrene content for air, but for water – no; as for hydrargyrum, it is specified as follows: "Hydrargyrum and its compounds," while for the other heavy metals and inorganic elements only their names are indicated; the list includes dioxins and furans instead of the actually dangerous polychlorinated dioxins and furans, and etc.

In Russia, there have been approved over 1,400 MPCs and about 500 SRLIs for substances concentrations in water[7] about 700 MPCs and about 1,700 SRLs – in atmospheric air of the populated areas[8], about 600 standards for pesticides[9], which is considerably beyond the List presented. It should be emphasized that the standards were usually developed at the request of

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[6] Ob utverzhdenii perechnya zagryaznyayushchikh veshchestv, v otnoshenii kotorykh primenyayutsya mery gosudarstvennogo regulirovaniya v oblasti okhrany okruzhayushchei sredy: Rasporyazhenie Pravitel'stva RF № 1316-r ot 08.07.2015 g. [On approval of the list of pollutants to which the state regulation measures of environmental protection are applied: a Decree of the Russian Federation Government of 08/08/2015 N 1316-r]. *GARANT*. Available at: http://base.garant.ru/71126758/ (21.03.2018) (in Russian).

[7] GN 2.1.5.1315-03. Predel'no dopustimye kontsentratsii (PDK) khimicheskikh veshchestv v vode vodnykh ob"ektov khozyai-stvenno-pit'evogo i kul'turno-bytovogo vodopol'zovaniya (s izmeneniyami i dopolneniyami) [HS 2.1.5.1315-03. Maximum permissible concentration (MPC) of chemicals in water of the water bodies of domestic, drinking, cultural and household water use (with amendments and additions)]. Moscow, Federal Center for Hygiene and Epidemiology of Rospotrebnadzor, Publ. 2003,154 p. (in Russian).

GN 2.1.5.2307-07. Orientirovochnye dopustimye urovni (ODU) khimicheskikh veshchestv v vode vodnykh ob"ektov khozyaistvenno-pit'evogo i kul'turno-bytovogo vodopol'zovaniya [HS 2.1.5.2307-07. SRLI (Safe Reference Level of Impact of chemicals in water in water bodies for domestic, drinking and cultural and household water use]. Moscow, Federal Center for Hygiene and Epidemiology of Rospotrebnadzor, Publ., 2008, p. 48 (in Russian).

[8] GN 2.1.6.2309-07. Orientirovochnye bezopasnye urovni vozdeistviya (OBUV) zagryaznyayushchikh veshchestv v atmosfernom vozdukhe naselennykh mest [HS 2.1.6.2309-07. Safety Reference Level of a substance (SRL) for pollutants in the atmospheric air of the populated areas]. *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii.* Available at: http://docs.cntd.ru/document/902081964 (21.03.2018) (in Russian).

Ob utverzhdenii gigienicheskikh normativov GN 2.1.6.3492-17 «Predel'no dopustimye kontsentratsii (PDK) zagryaznyayushchikh veshchestv v atmosfernom vozdukhe gorodskikh i sel'skikh poselenii»: Postanovlenie glavnogo gosudarstvennogo sanitarnogo vracha RF № 165 ot 22.12.2017 g [On Approval of Hygienic Standards HS 2.1.6.3492-17 "Maximum permissible concentrations (MPC) for pollutants in the atmospheric air of urban and rural settlements": Resolution of the Chief State Sanitary Doctor of the Russian Federation No. 165 of December 22, 2017]. *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii.* Available at: http://docs.cntd.ru/document/556185926 (22.03.2018) (in Russian).

[9] Ob utverzhdenii GN 1.2.3111-13 «Gigienicheskie normativy soderzhaniya pestitsidov v ob"ektakh okruzhayushchei sredy (perechen')» (s izmeneniyami na 13 iyulya 2016 goda): Postanovlenie glavnogo gosudarstvennogo sanitarnogo vracha RF № 55 ot 21.10.2013 g. [On Approval of HS 1.2.3111-13 "Hygienic standards for the content of pesticides in environmental objects (list)" (as amended on July 13, 2016): Decree of the Chief State Sanitary Doctor of the Russian Federation No. 55 of October 21, 2013]. *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii.* Available at: http://docs.cntd.ru/document/499057253 (22.03.2018) (in Russian).

enterprises polluting the environment through emissions and discharges, as well as organizations offering chemical products for use in various fields of activity. This indicates that the substances, for which standards are established, actually pollute the environment, and can pose a danger to human health, so the lack of control over their content is unacceptable.

It is obvious that all substances specified in the RF Government Decree of 08.07.2015 No. 1316-r and in the lists of hygienic standards for substances are inappropriate and impossible to be controlled. Therefore, surveillance authorities often reduce the number of indices. For example, according to the retrospective analysis data submitted by Moscow Government, the water quality control for Moskva River is carried out by at least 3 organizations: Moscow Department for Environmental Management and Protection, "Mosvodokanal" and "Mosvodostok". At the same time, the number of parameters controlled by these organizations ranges from 25 to 42, with the list of indices mainly consisting of inorganic substances, while certain organic substances and composite indexes are undifferentiated, and do not reflect the features of wastewater discharges in Moscow [9].

So, for an adequate control of emissions and discharges, recommendations have been developed for selecting the most dangerous indices[10].

As can be seen from the table, the list of criteria for selection of the priority indices to be monitored is given in the Guidance to UNECE Protocol on Pollutant Release and Transfer Registers to "Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (1998) "[10] in terms of major toxicological criteria corresponds to the one approved in our country, and expanded with respect to some environmental, economic and geographical indicators (Table).

In our institution, studies were carried out [11], which made it possible to identify the priority indices of the pollution with effluents discharged into water bodies by the operating enterprises of eleven industries [12].

In consideration of the foregoing, it becomes evident that the lists of various levels indices under control are subject to significant adjustment with a view to creating a single control document that includes guidelines for selecting the priority indices.

At present, Russia introduces an assessment system for chemicals emissions based on the best available technologies index. This system is in line with international regulatory documents. Thus, according to the Directive of the European Parliament and Council of the European Union 2008/1/EC "Best Available Techniques (BAT) means the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole". Paragraph 20 states: "When an environmental

[10] SanPiN 2.1.5.980-00. Gigienicheskie trebovaniya k okhrane poverkhnostnykh vod [SanPiN 2.1.5.980-00. Hygienic requirements for surface waters protection]. *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii.* Available at: http://docs.cntd.ru/document/1200006938 (20.03.2018) (in Russian).

SanPiN 2.1.6.1032-01. Gigienicheskie trebovaniya k obespecheniyu kachestva atmosfernogo vozdukha naselennykh mest [SanPiN 2.1.6.1032-01. Hygienic requirements for quality assurance of atmospheric air in inhabited areas]. *Kodeks: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii.* Available at: http://docs.cntd.ru/document/901787814 (20.03.2018) (in Russian).

Criteria for selecting priority indices for emissions into environment

Criteria for the selection of priority pollutants (UN UNECE) [10]	Criteria for the selection of priority regional indices for water quality control (RF)[10]
1. Type of pollution source 2. Composition of contamination 3. Amount of pollutant delivered to the environment 4. Polluted objects of the environment 5. Geographical range of pollution 6. Stability 7. Bioaccumulation 8. Acute, subacute and chronic toxicity for humans and animals 9. Ecotoxicity 10. Carcinogenicity 11. Teratogenicity	1. Substance specificity 2. Substance MPC excess level 3. Hazard category and limiting harmful index 4. Carcinogenicity 5. Substance detection rate 6. Upward trend in concentrations of a substance at long-term monitoring 7. Biodegradability 8. Substance level of contact with population 9. Bioaccumulation 10. Stability 11. Transformation to higher toxicity compounds 12. Accumulative potential in benthal deposits 13. Absorption through skin 14. Relative extent of long-term effects 15. Complexity of impact on the population due to cross-media transitions properties of a substance

quality standard requires more stringent conditions than those that can be achieved by using the best available techniques, supplementary conditions should in particular be required by the permit, without prejudice to other measures that may be taken to comply with the environmental quality standards".

At the same time, in the Russian legislation, policies are being persistently introduced to replace the limit values, i.e. MPCs, with the concept of "best available technologies". For example, Article 23 of the Federal Law of 10.01.2002 No. 7-FZ (Ed. of 13.07.2015) "On Environmental Protection"[11] indicates the need to create a step-by-step plan for the introduction of BAT by enterprises. The Article 26, paragraph 4, Federal Law No. 416-FZ of 07.12.2011 "On Water Supply and Sanitation" (as amended on July 29, 2017)[11] states: "The requirements for the content of the plan for reducing discharges, the procedure and timing for its approval, the grounds for refusing to agree on such a plan are established by the Russian Federation Government". However, no criteria are set for determining the level of chemical pollution, which the discharges and emissions rate should be reduced to.

When developing amendments to Federal Law No. 7-FZ of 10.01.2002 "On Environmental Protection"[11] Article 31, the Center made the following proposal: "In cases where environmental quality standards are more stringent than the levels attained using BAT, the application for a comprehensive environmental permit should contain information on additional measures to ensure compliance with regulations". However, this proposal was not taken into account, which resulted in the absence of the corresponding requirements in all regulatory documents related to envi-

[11] O vodosnabzhenii i vodootvedenii: Federal'nyi zakon № 416-FZ ot 07.12.2011 g. [On Water Supply and Sanitation: Federal Law of 07.12.2011 N 416-FZ]. *Konsul'tantPlyus.* Available at: http://www.consultant.ru/document/cons_doc_LAW_122867/ (16.03.2018) (in Russian).

ronmental protection, for example, the Federal Law No. 416-FZ of 07.12.2011 "On Water Supply and Sanitation", the Russian Federation Government Decree of 9.13.2016 No. 913 "On rates of charges for environment pollution and additional coefficients" (as amended on 09.12.2017)[12]. This means that such an important safety criterion, as MPC is replaced by reducing emissions approach, without a legislative requirement to further reduce the pollution level to MPC values.

Thus, it is necessary to develop a single consistent system of laws and by-laws to ensure the protection of human health from chemical pollution of the environment.

Conclusion. Thus, with the optimization of legislation in the field of environmental protection, an adjustment is suggested according to the following proposals:

1. The targets are not only and not so much indicators of environmental quality as the criteria for assessing achievement of its proper conditions. They are not the standards. Therefore, it is necessary to develop a single definition and a methodology for setting targets.

2. Lists of various levels indices under control are subject to significant adjustment with the aim of creating a unified document on control with recommendations on choice of priority pollutants.

3. The RF legislation should contain a requirement on the possibility of harmonization of chemicals emissions on the basis of BAT provided that a plan for further reducing discharges and emissions to MPC levels is provided.

4. To improve the situation in the field of environmental quality management, the following measures should be taken:

1. To harmonize legislative framework in the field of environment and health protection, having eliminated contradictions on indexes and hazard criteria.

2. To improve methodic approaches to determining qualitative and quantitative composition of emissions, discharges, pollution status of various environmental objects, and choice of priority index for monitoring.

3. To improve and objectify control, expand the system of independent laboratories equipped with modern analytical tools, where all industrial enterprises would have to conduct extended studies of their discharges and emissions at certain time intervals.

4. The charges for environment pollution should be replaced by an increase or decrease in taxes with further allocation of funds saved by an enterprise for environment protection measures.

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HYGIENIC ASSESSMENT OF PM_{10} AND $PM_{2.5}$ CONTENTS IN THE ATMOSPHERE AND POPULATION HEALTH RISK IN ZONES INFLEUNCED BY EMISSIONS FROM STATIONARY SOURCES LOCATED AT INDUSTRIAL ENTERPRISES

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Our research focused on air contamination with solid particles which occurred in settlements influenced by stationary sources located at enterprises involved in construction materials production. Our goal was to examine concentrations and fractional structure of solid particles and to assess health risks caused by air contamination with fine-dispersed solid particles for population living on territories adjoining to sanitary-hygienic zones of industrial enterprises. The research was conducted with laboratory control techniques, health risk assessment, sanitary-hygienic and statistic techniques. We measured solid particles concentrations in real-time detecting them incessantly, and it allowed us to obtain data on concentrations of fine-dispersed solid particles (10 and 2.5 microns diameter) averaged over 20-minutes period; we also managed to calculate sums of solid particles (dust/aerosol not differentiated in its compound) in the atmosphere in settlements influenced by stationary sources located at industrial enterprises. We analyzed fractional structure of solid particles, performed a hygienic assessment of atmospheric air contamination, and determined population health risks caused by atmospheric air contamination with fine-dispersed particles. The obtained results gave grounds for working out analytical (laboratory) techniques for control over atmospheric air contamination at a border between a residential area and a sanitary-hygienic zone and for hygienic assessment of solid particles content in the air in settlements, both for overall fraction and for particles with aerodynamic diameter 10 microns and 2.5 microns.

Key words: *atmospheric air, concentration, sanitary-hygienic zone, fine-dispersed solid particles, enterprise, health risk, a residential area.*

In Belarus hygienic standards for fine-dispersed solid particles content in the atmospheric air were fixed in 2004. The maximum permissible concentrations for 3 averaging periods (maximum single, average daily and average annual concentrations) were fixed for PM_{10} solid particles at 150 μg/m^3, 50 μg/m^3, and 40 μg/m^3; and for $PM_{2,5}$ solid particles, at 65 μg/m^3, 25 μg/m^3, and 15 μg/m^3 м[31]. They were also fixed at 300 μg/m^3, 150 μg/m^3, and 100 μg/m^3 for dust/aerosols which were not

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Normativy predel'no dopustimykh kontsentratsii zagryaznyayushchikh veshchestv v atmosfernom vozdukhe: gigienicheskii normativ / utv. postanovleniem Ministerstva zdravookhraneniya Respubliki Belarus' № 113 08.11.2016 g. [Standards for maximum permissible concentrations of contaminants in the atmosphere: hygienic standard / approved by the Order of.Belarus Public Healthcare Ministry on November 08, 2016 No. 113]. *Belarus Public Healthcare Ministry: official web-site*. Available at: http://minzdrav.gov.by/upload/dadvfiles/000352_132617_postan113.doc (23.07.2017).

differentiated in their composure (total suspended particles or TSP).

In Belarus solid particles are one of the most widely spread air contaminants which exert negative influence on population health. Contribution made by solid particles into multi-component air contamination accounts for 7-25%. Dusts are among top five contaminants which form 70% of the total technological emissions [1].

A sum of solid particles is a widely used, controllable, and informative parameter of air contamination. System of monitoring over atmospheric air quality in Belarus involves observations over total concentrations of solid particles at 67 stationary observation points belonging to the National Environmental Monitoring System. Laboratory control over total contents of solid particles in the air is performed via weight method, without any allowance for their component and disperse structure.

Monitoring over PM_{10} in the atmosphere is provided by an automated monitoring system which consists of 19 automatic control stations. PM_{10} concentrations are measured round-the-clock continuously. $PM_{2,5}$ concentrations in the air are controlled only at 2 automatic stations located in Minsk and Zhlobin [2, 3].

Results of analytic laboratory control are another source of information on solid particles contents in the atmosphere. This control is performed by laboratories at industrial enterprises and regional bodies of state sanitary surveillance and is based on data collected at borders of enterprises sanitary-hygienic zones and on housing territories influenced by industrial emissions. However, the existing monitoring system in Belarus doesn't envisage industrial control over technological emissions containing fine-dispersed solid particles. As a result, today we don't have sufficient data on solid particles dispersity and how they spread in the atmosphere. The existing practices for setting up borders of sanitary-hygienic zones don't allow for the disperse structure of solid particles. And when such zones are designed, emissions of various solid particles fractions are not taken into account, and it results in considerable decrease in accuracy of detecting a zone on territories adjacent to an industrial source and influenced by its emissions. But at the same time, a lot of researchers state that fine-dispersed dusts exert negative influence on population health (the cardiovascular system [4], and the respiratory organs [5–7]), including mortality caused by respiratory organs and cardiovascular system diseases [8, 9].

We analyzed results of research on background PM_{10} concentrations and solid particles sum in the atmosphere near 450 regional industrial complexes in Belarus (over 2012-2016). It was detected that a contribution made by solid particles into total atmosphere contamination accounted for more than 30%; it was also true for the hazard index which described possibility of negative responses from the respiratory organs caused by background atmosphere contamination with a set of various contaminants. A share of PM_{10} concentrations in solid particles mixture amounted to 55.00±0.02 % (95 % CI 51.20–58.80 %). These data are in line with the results obtained in other research works, including foreign ones, which show that shares of fine-dispersed solid particles in the air vary from 30 to 60% of total suspended particles [10–14].

In Belarus the highest background concentrations were detected in Mogilev, Minsk, and Gomel regions. In terms of regional industrial complexes, the highest background PM_{10} concentrations and solid particles sums were detected near large industrial enterprises dealing with construc-

tion materials manufacturing. Background concentrations of solid particles made a 62.58% contribution into the overall air contamination on such territories. Hazard index showing possibility of negative responses from the respiratory organs reached 2.23, solid particles contribution into the danger being equal to 47.48% [2].

Fine-dispersed dusts can be found in emissions from various productions such as ferrous and non-ferrous metallurgy, civil engineering, electrical engineering, and construction materials production [15–19].

A lot of technological processes existing at construction materials production result in solid particles formation. In 2014 research on fine-dispersed solid particles was performed on housing territories in three different functional zones: a) a zone influenced by emissions from motor transport; b) a zone influenced by emissions from stationary sources located at industrial enterprises; and c) a "conditionally clean" housing territory. The research results proved a hypothesis that emissions from construction material productions made a considerable contribution into population exposure to air contamination with fine-dispersed solid particles [3].

Grinding, mixing, storage and transportation of dried breakages and fine-dispersed powders result in formation of poly-dispersed solid particles. Industrial emissions contain solid particles sized from 0.5 to 200 microns. However, particles with their aerodynamic size being less than 10 microns are the most interesting research objects due to the fact that they are practically uncatchable for most dust collectors applied at industrial enterprises, as opposed to larger particles, 90-95% of those being easily caught [16, 20].

Our research goal was to examine fraction structure and concentrations of total suspended particles, $PM_{2,5}$ and PM_{10} in the atmosphere in settlements influenced by emissions from stationary sources located at industrial enterprises and to perform consequent health risk assessment for people living on such territories.

Data and methods. We chose our examined territory basing on the spatial territorial analysis, positional relationship between sources of solid particles emissions and housing territories, as well as on preliminary calculations of contamination dispersion and spreading.

We examined a housing territory located in a zone which was under maximum influence exerted by emissions from stationary sources located at large industrial enterprises dealing with construction materials production. Control points for taking air samples and instrumental measuring of solid particles were located in zones where maximum calculated concentrations caused by technological emissions sources were likely to occur. Overall, we selected 6 points on the housing territory located 500-800 meters away from an emission source. Research was performed from March to June, at weekdays, when an enterprise dealing with construction materials production worked in its standard functioning regime. The points were located on dust-free grounds, beyond aerodynamics shadows cast by buildings and trees.

Concentrations of TSP, $PM_{2,5}$ and PM_{10} were measured real-time (with each second detection) via short-range infra-red radiation dispersion technique with a SKCEPAM-5000 appliance. Registered particles sizes ranged from 0.1 to 100 micron. Range of aerosol particles mass concentration measuring was 0.01–200 mg/m^3. Totally, we performed 144 measurements of single (20 minute) concentrations of TSP, $PM_{2,5}$ and PM_{10}.

Results of atmospheric air research were assessed in conformity with the val-

ues of maximum single permissible concentrations of TSP, PM_{10} and $PM_{2,5}$ (300 μg/m^3,150 μg/m^3 and 65 μg/m^3, correspondingly) in the atmosphere [8]. Hygienic assessment of hazard caused by air contamination with fine-dispersed solid particles was performed as per "P" complex parameter value and air quality index on the basis of the upper 95% confidence limits of average single solid particles concentrations obtained during the research. Air quality index was calculated for each fraction and for solid particles sum separately, and the least obtained value was taken as the value of air quality index which characterized complex air contamination with solid particles on the examined territory [9].

When assessing health risks caused by fine-dispersed solid particles concentrations in the air, we calculated risks of an immediate (reflex) impacts and hazard quotients (indexes) under short-term exposure to TSP, PM_{10} and $PM_{2,5}$, taking critical organs (systems) into account [10]. All the obtained data were processed with Microsoft Office Excel 2010 and Statistica 10 software (serial number 1234567890).

Results and discussion. Our research on atmospheric air contamination revealed that single concentrations of both fine-dispersed PM_{10} and $PM_{2,5}$ solid particles and TSP mixture was correspondingly 2.0, 2.7 and 1.7 times higher than the fixed standards on the examined housing territory influenced by emissions from stationary sources located at industrial enterprises. Detected single concentrations of solid particles in the atmosphere are given in Table 1.

Comparative analysis of TSP content and PM_{10} and $PM_{2,5}$ fine-dispersed fractions allowed us to reveal that PM_{10}:$PM_{2,5}$:TSP ratio was 0,58:0,34:1 in zones influenced by emissions from stationary sources located at industrial enterprises. PM_{10} fraction share in TSP mixture was from 56.41 to 60.04%; and $PM_{2,5}$ fraction share, from 21.61 to 46.13%. On average, PM_{10} contribution into TSP concentration amounted to 58.34 ± 0.05 % (95 % CI 58.24–58.44 %); $PM_{2,5}$contribution, 34.38 ± 0.18 % (95 % CI 34.02–34.73 %), Table 2.

Table 1

Atmospheric air contamination with solid particles on the housing territory influenced by emissions from stationary sources located at industrial enterprises

Contaminant	Control point No.	Actual single concentration, μg/m3,M ± m	Minimum - maximum, μg/m3
PM_{10}	1	298,30 ± 0,97	287,00–316,00
	2	299,00 ± 0,88	286,00–308,00
	3	299,35 ± 0,53	291,00–313,00
	4	297,22 ± 0,89	272,00–309,00
	5	298,59 ± 0,89	272,00–309,00
	6	294,46 ± 0,45	274,00–310,00
	On the overall territory	297,94 ± 1,40	272,00–316,00
$PM_{2.5}$	1	167,65 ± 1,72	136,00–213,00
	2	183,63 ± 0,35	113,00–250,00
	3	172,82 ± 0,81	150,00–232,00
	4	170,11 ± 2,70	135,00–206,00
	5	187,25 ± 1,23	174,00–206,00
	6	185,46 ± 0,51	175,00–206,00
	On the overall territory	175,56 ± 3,43	113,00–250,00
TSP	1	515,86 ± 0,81	505,00–536,00
	2	520,25 ± 0,46	507,00–542,00
	3	511,51 ± 1,17	497,00–538,00
	4	502,79 ± 1,66	467,00–525,00
	5	508,70 ± 1,42	467,00–535,00
	6	502,17 ± 0,72	463,00–523,00
	On the overall territory	510,38 ± 2,48	467,00–542,00

Table 2

Fractional structure of solid particles in the atmosphere on housing territories influenced by emissions from stationary sources located at industrial enterprises предприятий

Control point No.	Mass fraction of solid particles, %, M ± m	
	PM_{10}	$PM_{2.5}$
№ 1	57,82 ± 0,13	32,49 ± 0,31
№ 2	57,47 ± 0,12	35,27 ± 0,49
№ 3	58,53 ± 0,07	33,81 ± 0,44
№ 4	59,12 ± 0,08	33,82 ± 0,51
№ 5	58,70 ± 0,01	35,89 ± 0,94
№ 6	58,61 ± 0,01	36,07 ± 0,06

PM_{10} and TSP concentrations were on average correspondingly 4.08 and 4.56 times higher in zones influenced by industrial emissions than the background solid particles concentrations in the atmosphere (background PM_{10} concentration is 73.00 μg/m^3; TSP, 112.00 μg/m^3, and $PM_{2,5}$ background concentration is not fixed [2]), which means that "higher" atmospheric contamination with solid particles is local.

"P" atmospheric air contamination with PM_{10} and $PM_{2,5}$ fractions amounts to 3.35±0.05 (95 % CI 3.26–3,45) and corresponds to "moderate" atmospheric contamination. Air quality index determined by solid particles contents in the atmosphere is equal to 137.33±6.96 (95 % CI 122.49–152.17). "Moderate" atmospheric air contamination causes stress in a body adaptation to impacts exerted by contaminants, considerable health risks, and a growth in background morbidity. Air quality index values obtained on the examined territory prove that background morbidity is likely to grow among the exposed population.

$PM_{2,5}$ and PM_{10} concentrations in the air which are above permitted standards (higher than MPC) are primary factors which cause risk of unfavorable responses from the respiratory organs. And the hazard index for such responses and potential risk of immediate (reflex) impacts exerted by $PM_{2,5}$ is authentically higher than the same parameters related to PM_{10} effects ($t = 13.54$ and $t = 12.66$, at $p < 0.05$).

Thus, potential population health risk caused by the atmospheric air contamination with PM_{10}, amounts to 0.108 ± 0.001 (95 % CI 0.105–0.111) and can be considered satisfactory, the hazard index for unfavorable responses from the respiratory organs is moderate (1.99±0.01, 95 % CI 1.97–2.01). Such risk, as a rule, can result in a growth in background morbidity, and

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population are likely to complain about various discomfort related to impacts exerted by the examined factor [2].

At the same time, potential population health risk caused by effects exerted by $PM_{2,5}$ is unsatisfactory (0.230 ± 0.010, 95 % CI 0.209–0.250), the hazard index for unfavorable responses from the respiratory organs and the cardiovascular system is average (2.70 ± 0.05, 95 % CI 2.59–2.81). Unsatisfactory risk results in constant complaints from the population about various discomfort related to impacts exerted by the examined factor and a trend for a growth in overall morbidity [8].

Hazard index for unfavorable responses from the respiratory organs and potential risk of immediate (reflex) impacts exerted by TSP allowing for solid particles dispersity is equal to 4.81±0.05 (95 % CI 4.71–4.91) and 0.338±0.010 (95 % CI 0.316–0.359) and is correspondingly 2.8 and 5.0 times higher than the same parameters without any allowance for dispersity (1.70±0.01, 95 % CI 1.68–1.72 and 0.068±0.001, 95 % CI 0.066–0.071) (t= 6.39 and 2.62, at $p < 0.05$). Qualitative assessment of risks obtained with allowance for dispersity of solid particles in TSP composition makes population health risks caused by TSP impacts unsatisfactory. $PM_{2,5}$ contribution into the hazard index for unfavorable responses from the respiratory organs caused by TSP impacts amounts to 56.07±0.57% (95 % CI 54.86–57.29 %); PM_{10} contribution, to 41.34±0.34 % (95 % CI 40.61–42.06%).

These data are extremely significant as they can help to develop relevant monitoring programs for atmospheric air quality which will be aimed, first of all, at control over the greatest population health risk factors [21].

Conclusion. So, maximum single PM_{10}, $PM_{2,5}$ and TSP concentrations are correspondingly 2.0, 2.7 and 1.7 higher than the hygienic standard on the examined housing territory influenced by stationary emission sources located at industrial enterprises. Atmospheric air contamination with fine-dispersed solid particles can be considered moderate.

Maximum single PM_{10} and TSP concentrations are on average correspondingly 4.08 and 4.56 times higher than the background solid particles concentrations in the atmosphere and it proves air contamination with solid particles is local, that is, higher air contamination occurs within zones influenced by stationary emission sources located at industrial enterprises.

A share of $PM_{2,5}$ solid particles in overall TSP amounts to 34.38 %; a share of PM_{10}, about 58.34%. Potential population health risks and hazard indexes for unfavorable responses from the respiratory organs allowing for solid particles dispersity in TSP structure are correspondingly 2.5 and 5.0 times higher than the same parameters without any allowance for particles dispersity.

Potential population health risk can be considered satisfactory in case of PM_{10} effects and unsatisfactory in case of $PM_{2,5}$ effects. Hazard index for unfavorable responses from the respiratory organs and risk of immediate (reflex) impacts is authentically higher under exposure to $PM_{2,5}$ than the same risk parameters related to PM_{10} impacts.

Therefore, all the obtained data prove it is vital to determine disperse structure of solid particles both to assess atmospheric air quality and impacts exerted by fine-dispersed solid particles on population health adequately. When solid particles dispersity is taken into account, it allows to reveal actual population health risk, to develop adequate programs for control over contamination, to give grounds for optimal

design decisions related to housing zones placement, and to make other relevant decisions in the sphere of population health risk management.

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IRRATIONAL NUTRITION AS POPULATTION HEALTH RISK FACTOR IN IRKUTSK REGION

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Insufficient and unsafe nutrition causes a lot of diseases. The article contains assessment of long-term (2006–2016) dynamics describing food products consumption by Irkutsk region population, and food substances contents in consumed food products. The author analyzed population morbidity in Irkutsk region in terms of basic alimentary-dependent diseases, groups of diseases, and specific nosologic forms, and compared it with average country and regional morbidity; she also assessed prevalence of "irrational nutrition" factor among adult population.

It was deleted that there was a deficiency in basic food products consumption by Irkutsk region population; basic food products were consumed in smaller quantities than in the country on average. Taken in dynamics over 2006–2012, consumption of proteins, fats, hydrocarbons, as well as caloric value of consumed food tended to grow. But then, taken in dynamics over 2012–2016, all these parameters decreased.

The author analyzed alimentary-dependent population morbidity in Irkutsk region over 2012–2016 and detected more negative trends in it in comparison with the average country levels. Morbidity with most analyzed categories and groups of diseases and specific alimentary-dependent diseases were higher in Irkutsk region than in the country on average. There were negative trends detected in dynamics of morbidity caused by such a risk factor as unhealthy nutrition (blood diseases; endocrine system diseases, including obesity; thyroid gland diseases; thyrotoxicosis; diseases related to increased blood pressure; digestive organs diseases).

Key words: *population nutrition, basic food substances, caloric value, alimentary-dependent morbidity, diseases categories, nosologic forms, irrational nutrition*

Healthy nutrition is one of the state policy priorities in the field of public health. Prevention of diseases caused by inadequate and unbalanced nutrition, preservation and strengthening of public health are the main goals of the state policy in the field of healthy nutrition[1]. It's been established that as a result of a complex of activities in which nutrition plays a leading role, it is realistic and quick enough to improve public health [1, 2].

Disturbances in the structure of nutrition largely determine high morbidity and mortality from cardiovascular and other non-infectious diseases. Therefore, the problem of food safety in the region is viewed both from the standpoint of food consumption adequacy to physiological needs of a human, and from the standpoint of sanitary and epidemiological safety, that

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[1] Ob osnovakh gosudarstvennoi politiki Rossiiskoi Federatsii v oblasti zdorovogo pitaniya naseleniya na period do 2020 goda: Rasporyazhenie Pravitel'stva RF № 1873-r ot 25.10.2010 g. [On the fundamentals of the Russian Federation state policy in the field of healthy nutrition of the population for the period up to 2020: Order of the Russian Federation Government of 25.10.2010 No. 1873-r]. *Kosul'tantPlyus*. Available at: http://www.consultant.ru/document/cons_doc_LAW_106196/ (30.01.2018) (in Russian).

is, protection of an organism internal environment from ingesting various xenobiotics of chemical and biological nature. In view of the above, providing the population of our country with safe agricultural products, fish and other products from aquatic resources and food is a strategic goal of food safety. To assess food safety status, the following indices which includes: food consumption per capita; daily human nutrition caloric intake; amount of proteins, fats, carbohydrates, vitamins, macro- and microelements consumed by a person per day, and others[2] are in use.

Studies of the actual nutrition of the population, carried out in recent years in various regions of the country, showed presence of both general and specific problems that depend on socioeconomic, environmental and production factors, as well as on the traditions of nutrition [3]. In most countries, there is a distinct tendency to increasing prevalence of alimentary-dependent pathology [2, 4, 5]. Unhealthy diet, overweight and obesity contribute to the development of many non-infectious diseases, including cardiovascular diseases, type II diabetes, and certain types of cancer, which together are the main causes of death. In most countries, examinations of population indicate an excessive consumption of calories, saturated fats, transfats, sugar and salt, inadequate consumption of vegetables, fruits and whole grains, and an increase in the number of obese people. It is established that these factors not only reduce the prospective life expectancy, but also worsen the quality of life [4, 6–12].

Nutrition of the Irkutsk region population is characterized by a sharp imbalance in its structure, a lack of micro and macronutrients, eating disorders, which can lead to the development of diseases associated with the influence of alimentary factor [13].

The purpose of this study is to analyze the dynamics and levels of food products consumption and the main nutritional diseases in the Irkutsk region population, to give a comparative description in relation to the average Russian and regional indices.

Materials and methods. To study the population nutritional status we used Rosstat data over the period 2005–2016 [14, 15]. The norms of food consumption are given in accordance with the Order of the Ministry of Health of Russia, ddt. 19.08.2016, No. 614 "On approval of recommendations on rational norms for consumption of food that meet modern requirements for healthy eating"[3]. Prevalence of "improper nutrition" factor was estimated according to the statistical report form No. 131 «"Information on clinical examination of certain adult population groups"[4] for 2014–2016. Analysis of the alimentary-dependent incidence in the population was

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carried out for the period 2012–2016, according to the Ministry of Health of Russia [16–18]. Data were statistically processed using classical methods.

Results and discussion. It was established that in Irkutsk region there is a deficit (comparing to the recommended consumption norms) in a number of important groups of food products (Table 1). It should also be noted that Irkutsk region belongs to the Russian Federation group of subjects with a lower level of consumption of staple foods comparing to the average Russian indices, except for vegetable oil and potatoes (32nd and 28th, respectively), and ranks 51st–73rd among 85 subjects of the Russian Federation.

Following the data in Table 1, the consumption of meat and meat products in 2016 was 68 kg per capita, per year in Irkutsk region (at a standard value of 73 kg/year) and was below the recommended norm of 5 kg (by 6.8 %). In the dynamics for the period 2005–2016, there is a significant increase in meat consumption (+28.3 %). At the same time, in the recent 3 years there has been a decrease in consumption of meat products by 3 %.

Table 1

Consumption of basic food products by the population of Irkutsk region (per capita, per year, kg)

Product groups (rating for 2016)*	2005	2010	2011	2012	2013	2014	2015	2016	Recommended consumption, kg/ person/year
Meat and meat products (51)	53	62	66	69	70	70	68	68	73
Milk and dairy products (64)	184	190	198	202	199	200	197	193	325
Eggs, pcs. (58)	174	203	208	213	219	224	230	232	260
Vegetables and cucurbits crops (73)	63	77	82	84	83	84	85	86	140
Sugar (67)	29	32	34	34	33	32	31	32	24
Vegetable oil (32)	11,8	11,7	12,7	13,4	13,0	13,0	12,7	12,9	12
Potatoes (28)	130	123	127	125	125	127	126	126	90
Bread products (64)	120	109	113	113	108	105	106	106	96

Note: * – Rating among 85 subjects of Russian Federation (in descending order)

Consumption of milk and dairy products in Irkutsk region in 2016 was 193 kg per capita, per year, which is lower than the recommended norm by 132 kg (1.7 times). According to the consumption of milk and dairy products among 85 subjects of Russian Federation, Irkutsk region held 64th rating position. Evaluation of the dynamics in this index for the period 2005–2016 shows presence of multidirectional trends, including growth of dairy products consumption in the period 2005–2012 (growth rate + 9.8 %), and decline trends for this index in the following period 2012–2016 (decline rate is 4.5 %). In 3 years dynamics, there is a decrease in consumption of dairy products by 3.5 %.

Consumption of eggs in Irkutsk region in 2016 was 232 pcs. per capita, per year, which is below the recommended value by 28 pcs. (by 10.8 %). By the consumption of eggs among 85 subjects of Russian Federation, Irkutsk region ranked 58th. In the dynamics for 2005-2016, there is a significant increase in consumption of this type of products (+ 33.3 %).

Consumption of vegetables and cucurbits crops in Irkutsk region was 86 kg per capita, per year, which is below the recommended norm by 54 kg (1.6 times).

In 2016, Irkutsk region held 73rd rating in the consumption of this product per capita. In the dynamics for 2005-2016, there is a significant increase in consumption of vegetables and cucurbits crops (+ 36.5%).

Consumption of potatoes, sugar, bread products and vegetable oil in Irkutsk region exceeded the recommended standards.

The consumption of potato was 126 kg, which is 36 kg higher than the recommended value (1.4 times). Among 85 subjects of Russian Federation, Irkutsk region ranked 28th. In the dynamics for 2005–2016, potato consumption significantly decreased (-3.1 %), over the recent 3 years, the consumption level is characterized by a tendency to stabilization of this index (126–127 kg/year).

Consumption of sugar was 32 kg, which is higher than the recommended norm by 8 kg (by 33 %). Evaluation of this indicator in dynamics for the period 2005-2016 shows presence of multidirectional trends, including a growth trend in sugar consumption for 2005–2011 (+ 17.2 %), stabilization of consumption in 2011-2012, and the decline trend in this index in the following period: the decline for the period 2012–2016 made 5.9 %.

Consumption of bread products made 106 kg/person per year, which is higher than the recommended norm by 10 kg (by 10.4 %). In dynamics, for the period 2005–2016, there is a significant decrease in bread products consumption (-11.7 %).

Consumption of vegetable oil in 2016 was 12.9 kg, which is 7.5% higher than the recommended norm (0.9 kg). Evaluation of this index in dynamics for the period 2005–2016 speaks for multidirectional trends. Thus, in the period 2005-2012, there was an increase in vegetable oil consumption (+ 13.6 %), and the trend of decline in this index in the following period (the decline for the period 2012–2016 made 3.7 %).

Caloric intake of food products by the population in Irkutsk region in 2000 was 2,757.8 calories per consumer, per day, which is 3.1 % higher than the Russian average (2674.8 kcal) (Figure).

Excess in food ration caloric content in Irkutsk region relative to the Russia's average level is due to a higher carbohydrate intake (in 2016: by 6.3 %), fat (by 0.6 %). Consumption of protein in Irkutsk region population diet for 2016 was lower than the average Russian index by 2.3 %. The dynamics for the period 2006-2016 in Irkutsk region observes two different trends: in the period of 2006–2012, the growth tendency in consumption of proteins, fats, carbohydrates and calories content of the diet was 19.1 %, 29 %, 8.1 %, 15.9 %, respectively. In the period 2012-2016, the decrease tendency in the dietary intake of protein, fat, carbohydrate and caloric intake itself – by 5.6 %, 5.9 %, 9.9 % and 8 % respectively (Table 2).

Thus, nutrition of the population in Irkutsk region is unbalanced; there is a significant gap between the recommended norms for the consumption of vegetables and fruits, milk and dairy products (more than 1.5 times), eggs, meat products, which causes deficit in protein and fiber in a diet. At the same time, an excessive consumption of carbohydrates is noted, among other things, due to potatoes, sugar, grain products.

The high prevalence of "improper nutrition" factor in the adult population is confirmed by the medical examination data. According to the data for 2016, this risk factor was registered in 30.1% of persons who passed medical examination (2013: 22.7 %, 2014: 30.1 %, 2015: 29.4 %).

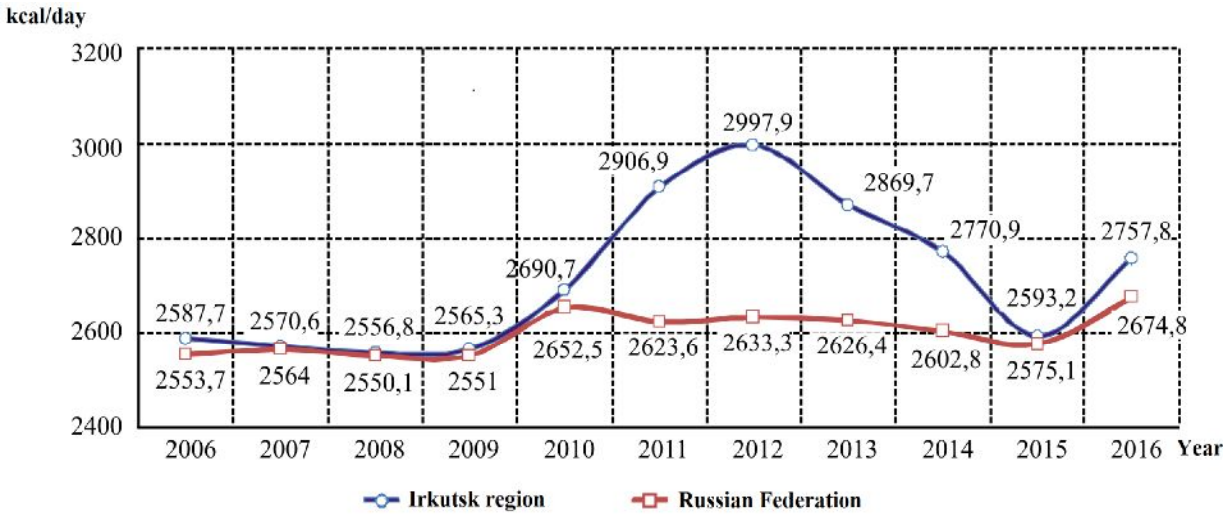

Figure. Caloric intake of food products by the population of Irkutsk region (on average, per household member, per day)

Table 2

Composition of nutrients in the consumed food products in Irkutsk region and Russian Federation for 2006–2016

Year	Quantity of nutrients (per consumer, per day)							
	Proteins, g.		Fats, g		Carbohydrates, g		kcal	
	Irkutsk region	RF	Irkutsk region	RF	Irkutsk region	RF	Irkutsk region	RF
2006	69,5	70,7	90,1	95,2	372,2	350,8	2587,7	2553,7
2007	69,1	71,7	90,4	97,4	367,5	347,4	2570,6	2564,0
2008	70,7	72,8	92,3	98,5	358	340,4	2556,8	2550,1
2009	71,5	73,3	95,2	99,3	352,9	338,2	2565,3	2551,0
2010	75,3	76,6	101,5	104,5	366,4	348,4	2690,7	2652,5
2011	81,0	76,7	109,3	104,7	396,8	340,6	2906,9	2623,6
2012	82,8	77,5	116,2	105,3	402,3	341	2997,9	2633,3
2013	80,1	78,1	114,2	106,2	377,6	336,5	2869,7	2626,4
2014	78,4	77,7	110,7	105,3	362,3	333	2770,9	2602,8
2015	73,5	77,1	103,2	104,6	339,9	328,4	2593,2	2575,1
2016	78,2	80,0	109,3	108,7	362,6	341,1	2757,8	2674,8

The diet imbalance leads to an increased level and growth in the incidence rates of endocrine system diseases (thyroid diseases, thyrotoxicosis, type 2 diabetes, obesity, blood diseases, including anemia, cardiovascular system) and other alimentary-dependent diseases.

Analysis of the alimentary-dependent morbidity of the entire population in Irkutsk region, for the period 2012-2016, testifies that the average long-term levels of this pathology in Irkutsk region for most of the analyzed classes, groups of diseases, and certain diseases were higher than the average Russia's values (Table 3).

Table 3

Morbidity in the whole population, per classes, groups of diseases, and certain diseases diagnosed first time in life for the period 2014–2016 (per 100 th. people of the population)

Region	2012	2013	2014	2015	2016	**Long-term annual average for 2012–2016**
In total						
Irkutsk region	92057,1	94560,2	95607,4	95218,9	99980,3	**95484,8**
Siberian Federal District	84611,4	86943,7	86041,9	84796,6	85056,4	**85490,0**
Russian Federation	79390,4	80030,3	78615,7	77815,7	78602,1	**78890,8**
Blood diseases						
Irkutsk region	529,3	558,4	588	602,6	607,4	**577,1**
Siberian Federal District	520,5	525,8	521,8	510,4	515,5	**518,8**
Russian Federation	471,2	466,1	470,5	472,4	469,5	**469,9**
incl. anemia						
Irkutsk region	481,9	511,8	544,5	547,8	548,5	**526,9**
Siberian Federal District	483,8	491	481,1	463,3	476,5	**479,1**
Russian Federation	429,2	424,8	427,2	433,9	433,1	**429,6**
Diseases of endocrine system						
Irkutsk region	1784,7	1760,6	1882,9	1841,7	2017	**1857,4**
Siberian Federal District	1382,8	1405,9	1479,6	1700,9	1910,5	**1575,9**
Russian Federation	1061	1065	1118,4	1333,8	1390,4	**1193,7**
incl. thyroid gland diseases						
Irkutsk region	664,1	607,9	690	671,2	730,1	**672,7**
Siberian Federal District	463,4	465,4	466,4	486,1	501,2	**476,5**
Russian Federation	354,3	339,5	346,9	357,7	355,1	**350,7**
incl. thyrotoxicosis						
Irkutsk region	23,4	20	19,4	24,1	25,8	**22,5**
Siberian Federal District	19,7	17,6	18,2	20,9	21,6	**19,6**
Russian Federation	15,2	14,5	15	16,6	17,2	**15,7**
incl. obesity						
Irkutsk region	250,4	312,3	336,1	344,9	367,7	**322,3**
Siberian Federal District	301,4	353,2	368	458,3	483,5	**392,9**
Russian Federation	172,9	206,4	228,3	314,8	317,3	**247,9**
incl. type 2 diabetes mellitus						
Irkutsk region	224,5	224,7	212,1	202,2	205,7	**213,8**
Siberian Federal District	219,5	211,3	214,9	217,7	204,4	**213,6**
Russian Federation	220,2	218,4	216,9	221,8	212,8	**218,0**
Irkutsk region	3223,2	3407,1	3445,6	3257,9	3376,1	**3342,0**
Siberian Federal District	3373,7	3676,5	3536,1	3537,7	3641,3	**3553,1**
Russian Federation	2663,1	2989,1	2874,9	3116,7	3172,1	**2963,2**
Diseases characterized by high blood pressure						
Irkutsk region	735,4	942,8	1047,7	915,2	1027,7	**933,8**
Siberian Federal District	900,9	999,5	1074	1155,1	1209,1	**1067,7**
Russian Federation	587,5	617,4	690,7	898,3	954,9	**749,8**
Diseases of digestive system						
Irkutsk region	4153,7	4315,2	5466,7	5497,7	5859,5	**5058,6**
Siberian Federal District	5613,2	5722,8	5801,6	5664,4	5420,6	**5644,5**
Russian Federation	3478,9	3526,6	3652,4	3526,6	3568	**3550,5**
incl. gastric ulcer and duodenal ulcer						
Irkutsk region	129,0	140,8	127,2	105,8	112,5	**123,1**
Siberian Federal District	131,2	127	122,6	119,4	120,2	**124,1**
Russian Federation	86,9	83	79,3	85,6	83,5	**83,7**

As it follows from the data in Table 3, the incidence of blood diseases, for the period 2012–2016, made 577.1, which is 22.8 % higher than the Russia's average index, and 11.2 % higher than the regional index for Siberian Federal District (SFO). The blood diseases incidence dynamics of the Irkutsk region population is characterized by a pronounced growth trend. The growth rate for 5 years made 14.8 %. The index increased from 529.3 in 2012 to 607.4 in 2016.

91.3 % in the structure of blood diseases morbidity belong to anemia. The incidence of anemia in Irkutsk region in the average for the period 2012–2016 was 526.9, which is 22.6 % higher than Russia's average and 10.0 % higher than the regional index for Siberian Federal District. The anemia incidence dynamics of the population in Irkutsk region is also characterized by a pronounced growth trend. The growth rate for 5 years made 13.8 %. This index increased from 481.9 in 2012 to 548.5 in 2016.

The long-term annual average level of endocrine system primary incidence in Irkutsk region for the period 2012–2016 was 1857.4, which is 55.6 % higher than Russia's average, and 17.9% higher than the regional index. The incidence dynamics of the Irkutsk region population with endocrine system diseases is characterized by a growth trend. The growth rate for 5 years was 13.0 %. The incidence rate increased from 1784.7 in 2012 to 2017.0 in 2016.

In the structure of "endocrine system" class, a significant proportion (36.2 %) belongs to thyroid disease. The incidence rate of the Irkutsk region population with the given pathology over the period 2012–2016 averaged to 672.7, which is 91.8 % higher than the national average, and 41.2 % higher than the regional index. The incidence dynamics of Irkutsk region's population with thyroid gland diseases is characterized by the emerging tendency of growth. The growth rate for 5 years made 9.9 %. This index increased from 664.1 in 2012 to 730.1 in 2016.

Thyrotoxicosis makes 1.2 % in the endocrine system diseases incidence. The long-term annual average level of thyrotoxicosis primary incidence in Irkutsk region for the period 2012–2016 was 22.5, which is 43.6 % higher than Russia's average, and 15 % higher than the regional index. Thyrotoxicosis incidence dynamics of the Irkutsk region population in 2012–2014 was characterized by a downward trend; in 2014–2016 the growth in this index was registered from 19.4 to 25.8. The growth rate for 3 years was 13.0 %.

In the structure of endocrine system diseases incidence, 17.4 % is obesity. The incidence rate of the Irkutsk region population with this pathology averaged 322.3 over the period 2012–2016, which is 30 % higher than the Russia's average, and 18 % lower than the regional index. It should be noted that the morbidity dynamics in the Irkutsk region population is characterized by a pronounced growth trend. The growth rate for the analyzed period was 46.8 %. This index increased from 250.4 in 2012 to 367.7 in 2016.

The incidence of type 2 diabetes mellitus is 11.5 % in the endocrine system diseases morbidity structure. The long-term annual average level of type 2 diabetes mellitus primary incidence in the Irkutsk region population for the period 2012–2016 was 213.8, which is 1.9 % lower than the Russia's average. The dynamics of type 2 diabetes mellitus morbidity in Irkutsk Region was characterized by a downward trend. The decrease rate for the period under study was -8.4 %.

The long-term annual average level of circulatory system diseases primary inci-

dence in the population of Irkutsk region, for the period 2012–2016, was 3342.0, which is 12.8 % higher than the Russia's average, and 5.9 % lower than the regional index. The incidence dynamics of circulatory system diseases in the Irkutsk region is characterized by an emerging tendency of growth. The growth rate for the analyzed period was 4.7 %. This index increased from 3223.2 in 2012 to 3376.1 in 2016.

In the incidence structure of circulatory system diseases, 27.9 % are the diseases characterized by high blood pressure. The incidence rate of the Irkutsk region population with this pathology averaged 933.8 over the period 2012–2016, which is 24.5 % higher, than the Russia's average and 12.5 % lower than the regional index. The incidence dynamics of the Irkutsk region population with the diseases characterized by high blood pressure featured a pronounced growth trend. The growth rate for the analyzed period was 39.7 %. This index increased from 735.4 in 2012 to 1027.7 in 2016.

The long-term annual average level of primary incidence of digestive organs diseases in the Irkutsk region population for the period 2012–2016 was 5058.6, which is 42.5 % higher than the Russia's average, and 10.4 % lower than the regional index. The incidence dynamics of the Irkutsk region's population with digestive organs diseases was characterized by a pronounced growth trend. The growth rate for the analyzed period was 41.1 %. The index increased from 4153.7 in 2012 to 5859.5 in 2016.

In the incidence structure of the digestive system diseases, 18.3 % is gastritis and duodenitis, 2.4 % belong to gastric ulcer and duodenal ulcer. The morbidity rate among the Irkutsk region's population with gastritis and duodenitis over the period 2012–2016 averaged 927.3, which is 88.3 % higher than the Russia's average index and 30.4 % than the regional index. The incidence dynamics of the Irkutsk region population with gastritis and duodenitis was characterized by a pronounced growth trend. The growth rate for the analyzed period was 31.9 %. The index increased from 794.4 in 2012 to 1047.7 in 2016.

The incidence rate of the Irkutsk region's population regarding to stomach ulcer and duodenal ulcer over the period 2012–2016 averaged 123.1, which is 47.1 % higher than the national average. The morbidity dynamics of this pathology in the Irkutsk region's population was characterized by a downward trend. The decrease rate in this index for the analyzed period made -12.8 %. The incidence rate declined from 129.0 in 2012 to 112.5 in 2016.

Thus, our findings testify the deficit in consumption of the main groups of food products formed in the residents of Irkutsk region due to unbalanced nutrition. In the region, health disorders manifested in the development of alimentary-dependent types of pathology are registered. The indices of such incidence, comparing to the Russia's average, are higher. Unhealthy diet is a risk factor for a number of diseases. In particular, the blood diseases, endocrine system diseases (obesity, thyroid disease, thyrotoxicosis) can be noted, as well as the diseases characterized by high blood pressure, digestive system disorders.

All of the above indicates the need for taking measures to improve the nutrition quality of the population. One of the important components is the implementation of measures aimed at improving the food products mix in retail, catering enterprises, as well as increasing the economic accessibility and attraction of healthy foods [4, 5].

The study findings were used to conduct a comprehensive assessment of the risk factors effect on public health. Information and proposals on the problem of improper diet in Irkutsk region, and the need to adopt prevention programs for alimentary-dependent diseases were submitted to the Governor of Irkutsk region, local authorities, other interested bodies and organizations with a view to make relevant management decisions.

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RISK FACTORS CAUSING PERSISTENT DELAY IN NEURO-PSYCHIC DEVELOPMENT IN INFANT CHILDREN DURING THEIR FIRST YEAR IN A FOSTER FAMILY

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Our research goal was to detect risk factors which cause delay in neuro-psychic development in infant children a year after they were adopted by a foster family. We examined health of 100 infant children at the moment they were adopted and after their first year spent in a foster family; we also examined health of their 100 hundred parents. Our research was focused on social and biological case histories, clinical examinations performed on children, and assessment of their mental development ("Chart for Infants' Neuro-Psychic Exam" technique), as well as psychological examination of foster parents: MINI-SPET (standardized personality examination technique) test, techniques developed by Yu.A. Alyoshina, L.Ya, Gozman, E.M. Dubovskaya and A.Ya. Varga, and V.V. Stolin. All the results were statistically processed with MA Excel XP and Statistica 6.0 software. Relative risks caused by various factors were calculated with Open Epi program; we applied Wald's sequential analysis to draw up an expectancy table. We revealed the following factors which could cause persistent delay in a child's mental development after a year spent in a foster family: a child already suffered from retarded mental development prior to being adopted; a child was adopted when he or she was older than 7 months; a child had had a psychological traumatic experience; a foster mother's attitude towards an infant also mattered a lot. Younger age of a child at the moment of adoption, psychological traumas minimization, and adequate educating techniques in a foster family make for better prevention of any delays in mental development. The obtained data prove it is necessary to provide long-term complex medical, psychological, and pedagogical support for an infant in a foster family under a psychiatrist's supervision.

Key words: *risk factors, prediction, delay in neuro-psychic development, infants, younger age, foster families, foster parents.*

It is well known that if children are deprived of mother's care during first years of their life it exerts negative effects on their further development [1–3]. Delay in neuro-psychic development (DNPD) is detected in most children from orphanages and it is determined by combined impacts exerted on their health by biological and psychosocial factors. A lot of authors note in their works that practically all orphans and children who are deprived of their parents' care, including those who are adopted by foster families (FF), have burdened obstetrician-gynecological case history, intra-

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uterine development disorders, and diseases during their neonatal period[1]. Researchers also mention that biological mothers of such children smoke, drink alcohol or take drugs during a pregnancy, their lifestyle is asocial, and they often suffer from psychoneurological diseases [4–6].

Psychic deprivation is another factor which can cause a delay in emotional and intellectual development of children kept in orphanages. Any period of time spent in an orphanage leads to a decrease in a child's overall and verbal intellect [4]. A lot of researchers give strong evidence that the earlier this deprivation factor[2], occurs, the more pathogenic and significant it is for a child's further development [7–9].

According to data given in multiple works [2, 3, 10, 11], 80–98% of children from orphanages have delays in their neuro-psychological development at least as per one parameter. Active speech, sensory development, actions with objects, drawing activities, thinking, attention, and memory are damaged most frequently. Mental development disorders rank first in mental deviations structure; 30.0% of orphans suffer from emotional disorders and behavioral disorders, as well as imbalance between parasympathetic and sympathetic sections in the vegetative nervous system with the latter being insufficient[3] [7, 9, 10].

Therefore, nowadays adoption of children from orphanages and disadvantaged families by foster families is one of a key social and demographic tasks in the RF [11]. Foster parents are most eager to adopt infants. Infants are most vulnerable to pathogenic factors but this age is the most favorable for correction[4]. The brain grows and develops intensively at this age, and its maximum flexibility determines high efficiency of educational conditions improvement. This improvement can not only stimulate functional responses in the mental sphere, but also lead to structural changes in actively forming cerebral systems [11–13]. Clinical picture at this age is mosaic and mental disorders here are tightly connected with neurological ones thus creating a unified psychoneurological complex of various symptoms [11, 14].

When a child is placed in favorable conditions ("family therapy"), when he or she receives adequate nutrition, is taken care of properly, and there are no disorders in his or her sleep and wake regime, normal growth rate and neuro-psychic development is recovered (development canalization law) [13, 15, 16]. M.J. Hayes et al. came to a conclusion that a family was a factor which could improve psychoemotional state and cognitive abilities of orphans and children deprived of their parents' care [8]. A foster family is able to compensate deprivation symptoms in orphans; qualitative changes occur in children's intellectual development when they are adopted, and their social adaptation grows, they master moral values and standards, and their emotional sphere also improves [16]. The earlier a child is adopted by a foster family, the less damaged his or her neuro-psychic and emotional development is.

Many authors have proved that children adopted by foster families have better health than those who remain under state custody in orphanages [1, 2, 17, 18], but still, as per many parameters, such children lag behind those who have been growing in their kin families since the very birth [2, 6]. According to foreign researchers, prevalence of mental disorders among children adopted by foster families is within 29-96% range and is higher than the average population level of mental deviations [19, 20].

When a child is adopted by a foster family, it usually has a positive effect on

his or her development; but still, some children suffer from DNPD [1, 7, 10, 13]. They usually have low initial potential of somatic and mental health caused by negative influence exerted by biological and social-psychological factors and it can result in poorer adaptation to a new family [9]. Adaptation to a new family is a most essential criterion for creating normal life conditions for orphans; it to a great extent depends on foster parents' motivation related to adopting a child, their psychological peculiarities, somatic and mental health they and their adopted child have, and gradually developing psychological relationships between a child and his or her new parents [21–25].

All the above mentioned calls for necessity to find new markers which can be applied as additional predictive criteria for delay in neuro-psychic development in children during a period of their adaptation to a foster family (the first year after adoption). These markers will help to work out scientifically grounded recommendations on how to optimize it.

Our research goal was to analyze a set of social, psychological and biological parameters and to reveal risk factors which could cause delays in neuro-psychic development of infants after they have spent a year in a foster family.

Data and methods. We examined health state of 100 children aged 1–3 at the moment they were adopted (average age being 18±7 months) and after a year spent in a foster family (FF) (average age being 33±9 months); we also examined health state of 100 foster parents. We studied their social and biological case history (taking data from medical documents and performing parents' questioning). We accomplished clinical examination of children, observed their behavior, analyzed their medical case histories, assessed their mental development quotients (applying "Chart for Infants' Neuro-Psychic Exam" technique developed by G.V. Kozlovskaya et al., 2007), and performed their foster parents' questioning with a structured clinical-statistical chart which we developed. The chart included features of psychopathologic symptom complexes which were described in the V(F) section of ICD-10.

All the examinations on children were performed in full conformity with the ethical principles stated in WMA Declaration of Helsinki (Ethical principles for medical research involving human subjects, 1975, with 1983 and 1989 additions). Parents (legal representatives) of all the examined patients gave their voluntary informative consent to medical interference and personal data processing.

We performed psychological examination of foster parents; MINI-SPET test was applied to reveal their personal traits; a technique developed by Yu.A. Alyoshina, L.Ya. Gozman, and E.M. Dubovskaya, to determine attitudes in a family; a technique developed by A.Ya. Varg and V.V. Stolin, to get an insight into relationships between parents and children. All the obtained data were statistically processed with MS Excel XP and Statistica 6.0 programs. Relative risk (RR) of various factors was calculated with OpenEpi program, with 95% confidence interval (CI) detection.

We applied Wald's sequential analysis to draw up an expectancy table. After verifying validity of discrepancy related to frequency of an examined factor occurrence among children with delays in neuro-psychic development and without them, we calculated predictive quotients (PQ) for each gradation of a factor. A predictive quotient was calculated as per the following formula: $PQ=10 \lg (P_1/P_2)$ if a factor occurred, $PQ=10 \lg (1-P_1/1-P_2)$ when a factor was absent, where P_1 and P_2 were frequen-

cies of a factor occurrence in compared groups. If an obtained value was positive, it meant the prediction was unfavorable.

Results. Mental and behavioral disorders were diagnosed in 72.31% of examined infants at the moment they were adopted by foster families. Mental deviations in children from the examined group were mostly delays in mental development (Disorders of psychological development, F80-89, 69.24% cases). As for specific nosologies, mixed specific developmental disorders (F83) accounted for 56.93%; expressive language disorders (F80.1), 9.23%; specific developmental disorders of motor function (F82), 3.08%.

We studied mental and behavioral disorders prevalence in adopted children after they had spent a year in a foster family and revealed that a number of children with mental (psychological) developmental disorders (F80–89) decreased considerably from 69.24% to 44.62 ($p<0.01$). Prevalence of mixed specific developmental disorders (F83) fell down from 56.93% to 33.85% ($p<0.01$), but that of specific language articulation disorders (F80.0) increased from 0% to 10.77%, $p<0.01$).

We detected the following significant biological factors which caused risks of delays in psychic development of children after a year spent in a foster family: already existing delay in mental development (RR 4.10; 95% CI 1.56-10.80); children belonging to IV-V group of neuro-psychic development (NPD) (RR 3.86; 95% CI 1.47–10.15); planovalgus deformity (M21.0) (RR 2.51; 95% CI 1.3–4.84); and small body length of a child when he or she was adopted by a foster family (RR 2.43; 95% CI 1.09-5.42). We detected a correlation between a lag in children's neuro-psychic development at the moment of adoption and after a year spent in a foster family ($R=0.624$, $p=0.000$) and children's body length and a lag in neuro-psychic development at the moment of adoption ($R=0.281$, $p=0.036$,) and after a year spent in a foster family ($R=0.272$, $p=0.031$). These data prove there is a strong correlation between infants' physical and mental development and that perinatal damages to the central nervous system are the basic reason for later lags in it.

We also detected the following social and psychological risk factors: a child was adopted by a foster family at an age older than 7 months (RR 6.86; 95% CI 1.01–47.01); a biological family lived in a room in a shared apartment (RR 3.73; 95% CI 1.62–8.59); a child was kept in an orphanage before being adopted (RR 3.02; 95% CI 1.01–9.09); a foster mother preferred her family to be a patriarchic one (RR 2.76; 95% CI 1.53–4.95); foster parents' attitude towards an adopted child was symbiotic (RR 2.52; 95% CI 1.38–4.61); an education style in a foster family was authoritarian (RR 2.52; 95% CI 1.38–4.61); a foster mother having an original personality (RR 2.33; 95% CI 1.26–4.34).

So, there are several risk factors which make the most significant contribution into possible persistence of an infant's delay in mental development after a year spent in a foster family. They are psychic disorders and small body length; biological family living in a shared apartment; a child being kept in an orphanage before adoption; a foster mother preferring her family to be a patriarchic one; symbiotic attitude towards a child or authoritarian education style; a foster mother's originality.

To predict whether a delay in mental development would persist in an infant after a year spent in a foster family, we created the following expectancy table.

To predict whether a delay in mental development will persist in a child, a psychologist at a support center for foster

The expectancy table for predicting wheter a delay in mental development would persist in an infant after a year spent in a foster family

Risk factors	PQ	IC
Children's health and age at the moment of adoption by a foster family		
III-V health groups		8,43
Yes	1,66	
No	–25,01	
Mixed specific developmental disorders (F83)		3,63
Yes	3,22	
No	–5,26	
IV-V groups of neuro-psychic development		3,24
Yes	2,95	
No	–5,08	
A child was under state custody		2,10
Yes	1,87	
No	–5,08	
A child was left without parents' care at an age younger than 1 year		2,09
Yes	1,56	
No	–6,05	
Small body length		1,80
Yes	2,44	
No	–3,32	
A child was adopted by a foster family at an age older than 7 months		1,79
Yes	1,40	
No	–5,75	
Disorders of psychological development (F80-89)		1,66
Yes	1,83	
No	–4,06	
Symptoms of para-autism		1,17
Yes	2,70	
No	–1,92	
Foster mother's personal traits and her attitude towards a child:		
Authoritarian education style (Varg test)		2,11
Yes	5,96	
No	–1,52	
Originality (MINI-SPET test)		1,46
Yes	6,87	
No	–0,90	
Symbiotic attitude towards a child (Varg test)		1,40
Yes	5,13	
No	–1,22	

Note: PQ is a predictive quotient, IC is a informativeness coefficient

families performs a psychological examination of a foster mother before a child is adopted; this examination is performed with MINI-SPET tests, and A.Ya. Varg and V.V. Stolin technique, and it helps to reveal psychological risk factors. A pediatrician at an orphanage takes data from a child's development history and uses the expectancy table to detect occurrence or absence of risk factors which can cause unreliable affection formation.

If the PQ sum is equal to +13 score or higher, experts predict unreliable affection formation. But if the PQ sum is equal to or lower than -13 scores, than reliable affection is expected. If the PQ sum is higher than -13 but lower than +13, than in this case we don't have sufficient information to make a judgment.

If a prediction is unfavorable, then a pediatrician prescribes differentiated prophylaxis measures for children from risk groups and in case of necessity recommends to visit a psychologist or a psychiatrist. He or she also works out and implements an individual support program for a foster family which is aimed at risk minimization.

Conclusions. When infant children were adopted by foster families, delays in mental development prevailed in them. When favorable micro-social conditions are created in a foster family, it can lead to elimination of such disorders or their significant decrease in most cases due to good compensatory capabilities of infants. However, we don't observe complete mental well-being in infant children who spent a year in a foster family due to persistent delays in mental development caused by a complex interaction between biological (residual organic cerebral insufficiency) and social factors.

A lag in mental development prior to adoption, a child being older than 7 months

at the moment of adoption, psychological traumas, and inadequate attitude of a foster mother to a child are basic risk factors which can cause persistent delays in a child's mental development after a year spent in a foster family. Earlier age at the moment of adoption, psychological traumas minimization, and adequate education styles in a foster family help to prevent further delays in mental development.

The obtained data call for a long-term complex medical, psychological, and educational support for an infant in a foster family under a psychiatrist's supervision.

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BEHAVIORAL FACTORS WHICH CAN INFLUENCE PRESERVATION OF YOUNG PEOPLE'S HEALTH

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Young people play a most important role in society's life as they possess significant intellectual, creative, labor and reproductive potential. However, this potential might not find its implementation in reality due to both inevitable reduction in number of people belonging to this population category and deteriorating quality of it. And a key issue here is preservation of young people's health. Contemporary young people have poorer health than the previous generations and we can observe a so called "social ill health funnel". There is another acute issue related to demographic losses caused by mortality among young people; they die due to outer causes, circulatory system diseases, malignant neoplasms, and digestive organs diseases, and this mortality is to a great extent determined by behavioral factors. The paper dwells on the analysis of basic self-preservation behavioral parameters determined via a sociological questioning performed among people living in Vologda region. We revealed that those respondents who were younger than 30 tended to evaluate their health as being "good" and "very good" more frequently than older ones; chronic diseases were significantly less frequent among people from younger age groups. We detected that 74 % young people pursued certain health-preservation practices while the remaining 26 % did nothing to preserve their health. Young people explain their striving for health

preservation mostly by a desire to have healthy children, to look well, and to achieve their life goals. They don't often visit a doctor with prophylaxis in mind; they tend to do sports. But still, there are young people who indulge in self-destructing behavior. Young people drink low alcohol beverages more often than people from older age groups. 36 % of them smoke but 51 % of smokers wish to give this bad habit up. Fast food is also more popular with young people: 39 % eat it several times a week. And sometimes it is a desire to overcome a stress that makes young people smoke, drink alcohol or eat unhealthy food.

***Key words**: young people, health, behavioral factors, self-preserving behavior, healthy lifestyle, Vologda region.*

Young people as a peculiar social-demographic group possess great intellectual and creative potential; they are generally in good shape and play a key role in reproduction thus being a great reserve for labor resources replenishment.

Over 2000-2016 a number of young people aged 15–29 decreased both in Russia as a whole and in Vologda region. The number of people in this population category went down by 17% in the country in general (to 27,588 thousand people), and its share in the overall population structure fell by 4% (to 19%). The decrease in young people's number and specific weight was even greater in the region and reached 27% (to 206 thousand people) and 4% (to 17%) correspondingly [1]. So, a quantita-

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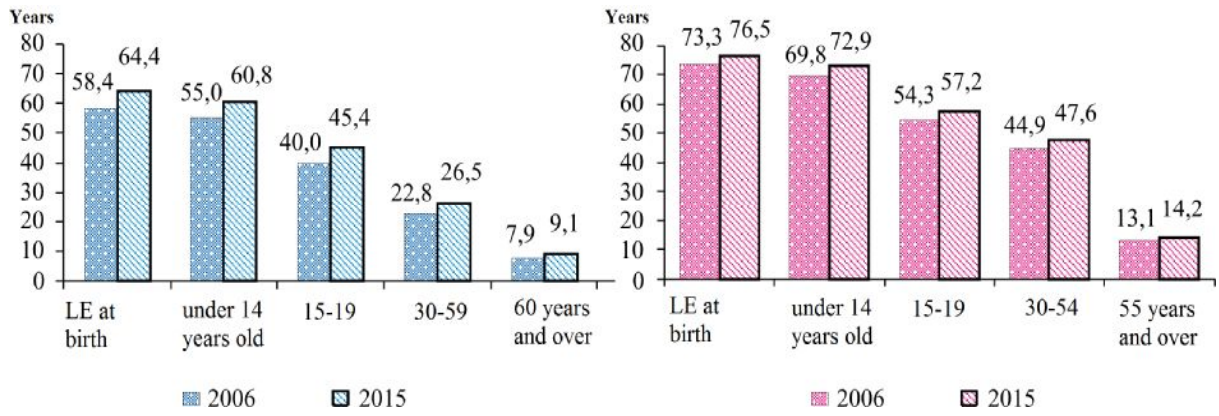
tive potential of young generations is gradually running out. According to the Rosstat mean predictive variant, this trend is likely to continue in the next two decades. As a results, a number of people aged 15-29 in Russia will decrease by 379.6 thousand by 2035 in comparison with 2016 and will amount to 27,208.4 thousand people [2].

Better quality of this population category is a condition for overcoming negative trends in dynamics of young generations number. Young people's health is the most important qualitative characteristic of young people due to its being a vital indicator of the future labor, economic, and reproductive potential of any society [3]. Health is a kind of a "superstructure" for formation and development of other components in human potential. However, loss of youth's health potential is a serious problem which our society faces in the 21st century. As N.M. Rimashevskaya states, in Russia we can observe a so called "social ill health funnel" when each subsequent generation has weaker health than the previous one [4, 5], that is, contemporary young people have less health resources than their parents.

But still, there are mostly positive trends in statistical health indicators. Since 2006, when active social and demographic policy was first implemented in Russia, and up to 2015 life expectancy (LE) in Vologda region grew significantly, including young people aged 15–29 (by 5 years for males, and by 3 years, for females; Figure 1)[1]. However, a significant discrepancy in it between males and females still exists. Thus, LE for young males aged 15–29 is 12 years shorter than for females from the same age category.

A parameter showing "lost years of potential life" (LYPL) is a leading population health indicator; it shows a number of years which population failed to live to reach a certain standard level [8, 9].



a *b*

Figure 1. LE for male (a) and female (b) populations in Vologda region for various age groups in 2006 and 2015 (years). Sources: calculated by the authors as per: [6, 7].

The choice of the category of 15-29 years in the analysis of statistical indicators of health is due to the peculiarities of calculating the LE tables for 5-year age groups.

Table 1

LYPL due to population mortality in Vologda region as per age and sex groups and death causes, 2015. (person-years per 100,000 people according to age and sex)

Death causes	Age, years							
	Males				Females			
	Under 14	15–29	30–59	60–64	до 14	15–29	30–54	55–74
All the causes	***7244,1***	***8669,4***	***20289,6***	***11395,9***	***4376,8***	***3316,4***	***9209,6***	***13646,8***
Circulatory system diseases	472,4	737,5	6213,8	5812,4	354,0	308,3	3605,0	2337,9
Neoplasms	321,5	606,6	1970,5	2553,9	128,8	592,3	3091,1	1202,1
Outer causes	2981,8	**5679,8**	5981,6	1012,8	**683,4**	**1497,8**	2212,4	273,6
Digestive organs diseases	399,3	578,9	3259,6	933,5	215,3	186,1	2259,5	456,0
Respiratory organs diseases	222,2	385,3	891,2	475,6	71,8	0,0	456,8	107,8
All the causes	177,2	114,3	494,8	88,1	143,6	340,3	266,6	24,9

Note: *as a discrepancy in life expectancy for males and females is significant both in the country as a whole and in the region (more than 10 years), we applied a different age standard a person should live to for men and women, 65 and 75 years correspondingly. Source: calculated by the authors as per: [6, 7]

We analyzed demographic losses via calculating LYPL and revealed that outer causes made the greatest contribution into losses due to untimely death among population aged 15–29. They accounted for 5,679.8 person-years per 100,000 people or 66% for males; and for 1,497.8 person-years per 100,000 people or 45% for females (table 1). But at the same time we should note that there are high LYPL losses due to circulatory system diseases (9% for males and females); malignant neoplasms (7% for males, 18% for females); digestive organs diseases (7% for males, and 6% for females).

In this respect, research on specific health determinates becomes truly vital as it helps to reveal possibilities how to manage them, to eliminate influences exerted by adverse factors, and to enhance positive effects.

Yu.P. Lisitsyin, a Russian expert in social hygiene, spotted out such key health factors as a life style and social-economic conditions, quality of the environment, genetic and biological factors, and an existing public health care system, basing on a model created by the World Health Organization (WHO) experts [10]. And the first factor here makes the greatest contribution into one's health (50–55%). Other experts also confirm this conclusion. Thus, foreign experts in the sphere of public health and health care note that such preventable behavioral factors as tobacco smoking, lack of physical activity, irrational nutrition, and alcohol abuse, are now basic reasons causing most widely spread non-infectious diseases (cardiovascular diseases, cancer, chronic respiratory diseases, and pancreatic diabetes) [11–13]. It is these factors that determine four basic physiological changes: high blood pressure, excessive body weight (obesity), hyperglycemia, and hyperlipidemia [14].

So, factors related to a life style play the leading role in formation of one's health, and this fact calls for more profound research on population behavior which helps to preserve it and there are such concepts here as "self-preserving behavior" and "healthy life style". Self-preserving behavior is a system of needs, attitudes, motives, and actions which an individual pursues in striving for his or her health preservation and improvement. Self-

preserving behavior can be both negatively and positively oriented; in the first case in is called "self-destructing behavior" [15]. Healthy life-style is closely connected with the positive side of self-preservation. Primarily it means giving bad habits up, rational and balanced nutrition, physical and medical activity, reasonable work and rest regime, and mental well-being [16]. Our research goal was to examine youth's self-preserving behavior and reveal its peculiarities in comparison with other age groups.

Our research goal – study of self-preserving behavior of young people and the identification of its specific characteristics in comparison with other age groups.

Data and methods. Sociologic research results allow to analyze peculiarities of self-preserving behavior at an individual level. Sociological data collected at a certain stage of sociological monitoring over physical health of population in Vologda region were used as an information ground in this work. This monitoring stage was performed in 2016 by Vologda Scientific Center of the Russian Academy of Science via questioning. The first questioning took place in 2002 and has been performed each two years since then in Vologda, Cherepovets, and in eight municipal districts in Vologda region. Sampling volume is 1,500 respondents aged 18 and older[2]; each sampling is multi-stage and quota. Sampling error doesn't exceed 3%. Empirical data are usually collected via questioning; social workers visit people in their apartments, hand questionnaires out and then collect them. All the collected information is then technically processed with SPSS and Excel software.

Results and discussion. Health occupies the leading place in key values of the region population. Young people gave such answers a bit less frequently than people from other age groups: 70% against 75% among respondents aged 30–55 (60)[3] and 89% among retired people (criterion $\chi^2 = 46.343$ with $p < 0.001$).

A desire to live a long life is vital for self-preserving practices implementation. People younger than 30 have the greatest desire to live longer than 90 years; that is, they have a motivation to take care of their health. It fits well with the fact that 90% young people state they bear their own personal responsibility for their health, and only 29% believe that medical staff are responsible for it. People from older age groups give quite different answers and they more frequently think that medical workers are responsible for their health: 33% of people aged 30–55 (60) and 45% of retired people adhere to such an opinion (criterion $\chi^2 = 24.350$ at $p < 0.001$).

In spite of the overall deterioration of

[2] Representativeness of received sociological information about methods of multistage regionalized sample with quota selection of units of observation. At the first stage, in order to ensure homogeneity of the sample population, the allocation of typical economic regions within the Vologda region was carried out. Two cities (Vologda and Cherepovets) and eight municipal districts with different levels of social and economic development have entered the zoning structure: three districts with high and medium development level (Sheksninsky, Gryazovetsky, Veliky Ustyug municipal districts), three districts with medium (Tarnogsky , Kiril-Lovsky, Babaevsky) and two with a low level of development (Nikolsky, Vozhegodsky). (Except for Tarnogsky, since the administrative center of the district is Tarnogsky Gorodok - is a village). For the cities of Vologda and Cherepovets, zoning on city (electoral) districts was additionally carried out. Further, the sample set is broken up in accordance with the quotas for the sex and age composition of the population. At the last stage to participate in the voice process - the selection of respondents was conducted by random route method.

[3] Age groups: from 18 to 30 years - young people, from 30 to 55 (60) - adult population, 55 years and older (60) - pensioners, where 55 years old - retirement age of women, 60 years old - retirement age for men.

contemporary youth's health against previous generations, young people, as a rule, tend to be healthier than people from older age groups and retired people as they haven't yet accumulated "health problems" including those caused by their own behavior. Therefore, there is a regularity traced in all the responses collected during questionings: young people more frequently assess their health as good and very good (about 70%) while people aged 30– 55 (60) give such answers only in 40% cases, and retired people, in 12% cases only (χ^2= 279.915 at $p < 0.001$). 13% of young people stated they had various chronic diseases while this parameter was substantially higher among people from other age categories (18% of respondents aged 30-55(60), and 39% of retired people; χ^2 = 86.473 at $p < 0.001$).

There are several motives that make population in the region to preserve and improve their health; they are a desire to feel oneself well (46% responses), a desire to look well (32%), and a wish to avoid causing any inconvenience for one's family (32%) (Table 2). Young people also stress their desire to look well and to be liked by others (42%; χ^2 = 15.669 at $p < 0.001$). Young years are a great time for active studies and building one's career, and it is confirmed by motives that make young people care about their health. Young people state that they need good health to achieve their goals in life, work, and studies, more frequently than people from other age groups (15%; χ^2 = 30.524 at $p < 0.001$). A desire to have healthy children is the most popular answer to a question about reasons for taking care of one's health among young people (47%; χ^2 = 241.719 at $p < 0.001$).

A more profound analysis of Vologda population lifestyle revealed that only 5% of people living in the region didn't have any destructive habits in their everyday life or self-preserving behavior, and their lifestyle could be considered truly healthy. Accordingly, 95% people had at least one destructive component in their behavior [17, 18]. The questioning revealed that 26% young people didn't take any measures to preserve and

Table 2

Distribution of answers to the question "What makes you take care of your health?" (in %; ranked as per answers given by young people)

Motives	Age groups			criterion χ^2	*p*-level
	Under 30	From 30 to 55 (60)	55 (60) and older		
A desire to have healthy children	**47,3**	17,3	2,2	**241,719**	**< 0,001**
A need to feel oneself well	46,3	43,0	51,4	8,062	= 0,018
A need to look well, to be liked	**41,6**	30,9	28,4	**15,669**	**< 0,001**
A wish to increase (preserve) working capacities	30,2	30,0	22,6	8,639	= 0,013
A wish to avoid visiting doctors	25,8	27,6	28,4	0,589	= 0,745
A wish to avoid causing any inconvenience for a family	21,5	26,9	47,9	76,327	< 0,001
A wish to have a long life	19,1	17,8	23,7	6,252	= 0,044
A desire to be a good example for one's children and family	16,1	18,4	20,8	2,734	= 0,255
A wish to achieve goals in life, work, or studies	**15,4**	9,5	3,8	**30,524**	**< 0,001**
A fear to get ill	14,8	18,2	24,8	13,168	= 0,001
Health deterioration or a disease	6,7	13,7	26,4	57,834	< 0,001

Note: * – data taken from "Physical health" sociological questioning performed by Vologda Scientific Center of the Russian Academy of Science, 2016.

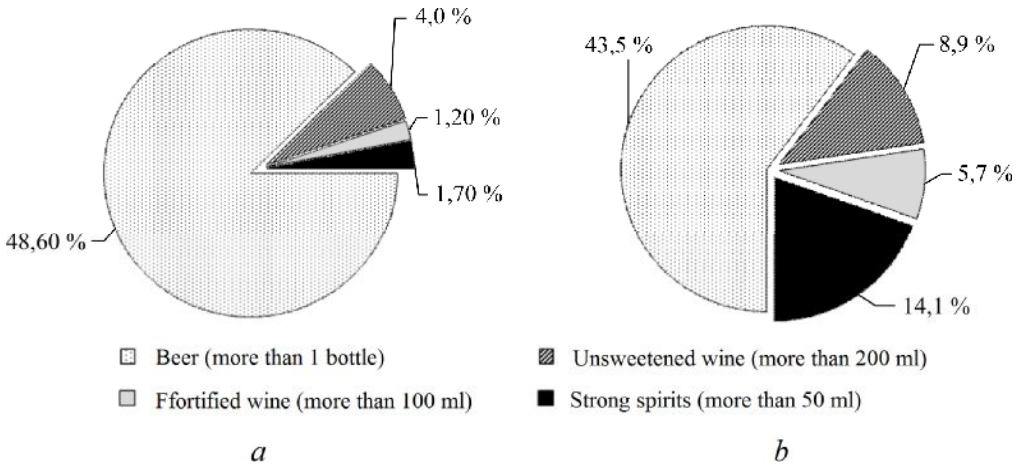


Figure 2. A structure of frequent alcohol consumption: *a* – by young people (answers chosen are every day and every week end) (% of all the respondents); *b* – by people aged 30–55(60), answers chosen are every day and every week end (% of all the respondents)
(data taken from "Physical health" sociological questioning performed by Vologda Scientific Center of the Russian Academy of Science, 2016)

improve their health, but this parameter was significantly higher among working population (aged 30–55(60)) (36%; χ^2 = 36.322 at $p < 0.001$). Therefore, 74% young people take these or those self-preserving actions. However, a question arises immediately: how can these actions go together with self-destructing practices?

Bad habits. Approximately 65% young people in Vologda region drink various alcohol in certain volumes. Beer is the most popular alcohol beverage among young people as 47% admit taking it every weekend against 43% among people aged 30–55(60) and 20% among retired people. Strong spirits are usually taken during holidays: 46% adults and 38% young people drink more than 50 ml of a strong spirit on holidays (Figure 2).

As per data obtained during the questioning in 2016, 36% of young people smoked; smokers accounted for 40% among middle-aged people, and for 15% among retired people (χ^2 = 84.590 at $p < 0.001$). Half of young smokers (51%) would like to give this bad habit up.

Drug taking is rather rare in the region as a share of people who do it or have at least once tried drugs remains stably low (4% in 2016). However, a specific weight of those young people who has at least once tried taking drugs is higher than the average level among population in the region (6%; $\chi^2 = 21.526$ at $p < 0.001$).

Physical activity. Young people in the region definitely go in for it. This population category do sports regularly on average two times more frequently than people from other age groups (χ^2 = 39.515 at $p < 0.001$): 13% do it every day; 20%, at least 2–3 times a week. Such sports as jogging (almost 17% do it regularly) and cycling (27%) are the most popular among young people. However, morning exercises are not so popular among young people aged under 30 as only 10% of them do them. Young people frequently mention the following reasons for their low physical activity: lack of free time and poor self-organization (being lazy), 40% answers for both reasons. But young people also state that higher incomes (47% answers) and lower prices on sport inventory and season

tickets to sport clubs (37%) would help them to increase their physical activity.

Medical activity. Medical activity involves a person attending medical organizations and using resources provided by the public healthcare system. It is related to a frequency of applying for a medical health, regular use of medical services, and following medical recommendations [19]. Young people a bit less frequently attend a doctor bearing prevention in their minds (12% against 16% among people older than 30). But as for the rest, their activity is similar to that of population from other age groups: 27% apply to a doctor in case of a disease or feeling bad, 22% had to have a medical examination before starting work, and 12% preferred self-treatment. 18% of young people have regular medical examinations.

Nutrition. Overall, most young people in Vologda believe their nutrition is adequate and rational (more than 80% answers). However, their nutrition includes carbohydrates in excessive quantities (bakery, cereals, and sweets). Frequent consumption of bakery and sweets is a threat to one's health as such food products contain free sugars in high quantities. Experts on nutrition and WHO nutritionists recommend to minimize free sugars consumption and make it not more than 10% of the overall consumed energy; to get additional healthy effect, they recommend to keep this parameter even lower than 5% of the overall consumed energy [20]. Young people, in terms of medical standards[4], consume very few vegetables, and correspondingly, very little dietary fiber and vitamins. Meat, milk, eggs and fish are consumed in quantities which in general correspond to standards. Fast food is a bit more popular among young people than among other age groups as 39% consume it several times a week (Table 3) while only 28% of people

Table 3

Distribution of answers to the question: "How often do you consume the following products?: (in % of all respondents)

Age	Frequency of consumption	Meat	Fish	Bakery	Eggs	Dairy products	Fresh vegetables	Fruit	Sweets	Fast food
Under 30	***Daily***	***28,5***	***3,4***	***72,1***	***21,5***	***63,4***	***58,1***	***45,3***	***41,9***	***3,7***
	Several times a week	68,4	85,7	25,2	74,4	34,9	42,0	52,0	49,3	38,9
	Rarely, never	3,0	10,8	2,7	4,0	1,7	0,0	2,7	8,7	57,3
30–55 (60)	***Daily***	***33,2***	***4,8***	***81,3***	***21,6***	***61,8***	***58,0***	***37,8***	***36,4***	***1,8***
	Several times a week	63,7	87,5	16,0	75,0	36,5	40,7	58,6	53,2	28,4
	Rarely, never	3,1	7,6	2,7	3,4	1,7	1,3	3,6	10,5	69,8
55 (60) and older	***Daily***	***23,3***	***4,9***	***83,7***	***25,9***	***67,2***	***61,9***	***36,6***	***35,1***	***0,7***
	Several times a week	73,3	86,8	15,1	71,4	30,6	38,0	58,2	54,1	9,4
	Rarely, never	3,3	8,3	1,1	2,7	2,2	0,2	5,1	10,7	89,9
criterion χ^2		**13,252**	3,827	**19,116**	4,150	4,594	9,174	8,747	4,125	**106,397**
p- level		**0,010**	0,430	**0,001**	0,386	0,332	0,057	0,068	0,389	**< 0,001**

Note: * – data taken from "Physical health" sociological questioning performed by Vologda Scientific Center of the Russian Academy of Science, 2016.

[4] According to WHO recommendations, fruits and vegetables should be eaten daily, while their daily intake should be at least 400 g (5 servings). Potatoes, sweet potatoes, tapeworms and other starchy roots are not counted [21].

aged 30–55(60) and 9% of retired people do it with the same frequency.

To keep their nutrition rational, young people most frequently try not to overeat and to consume qualitative food products (40% answers in both cases), and it is quite the same for people from other age groups. 19% of young respondents were on a diet because they wanted to control their body weight and not because their doctors told them so; it confirms that a desire to look well prevails among other motives for self-preserving behavior in this age group.

Proneness to stress and ways to overcome it. Mental health is an integral and most significant component of the overall human health. A lot of experts believe that people nowadays face stresses more and more frequently and it has adverse effects on their health [22]. As per data obtained by Vologda Scientific Center of the Russian Academy of Sciences, 82% of people in Vologda mention being in a stressful situation; 16% are under stress regularly (every day or twice a week). 78% of young people have experienced it at least once, 17% are under regular stress. Physical exercises, rest, hobby, or an expert's help are considered to be the most correct and harmless ways to overcome and prevent stresses. Our monitoring data prove there are both "healthy" (^{2} = 15.596 at $p < 0.001$) and destructive ways to overcome stress among young people (^{2} = 32.715 at $p < 0.001$). The former include walking (37%), doing a hobby (23%), or physical exercises (15%). But being under a stress, young people often resort to the quickest, most available and not always useful means. Thus, for example, when they want to "calm down and come to their senses" they use such destructive measures as "eating a stress away" (28%), smoking (20%), and alcohol intake (6%). And stress becomes one of key reasons for abuse. Besides, 27% of young people do nothing to overcome stresses due to various reasons, including their own unwillingness to do something (13%) and lack of knowledge how to fight stresses (14%).

Health-preserving practices. Giving up smoking is the most widely spread health-preserving practice both among young people (46% respondents) and population in general. It can be to a great extent explained by a large-scale anti-tobacco program now being implemented in the RF, including stricter anti-tobacco legislation. Thus, the RF Federal Law No. 15-FL "On protecting citizens' health from impacts exerted by tobacco smoke and consequences of tobacco consumption"[5] came into force on June 01, 2013; this law bans smoking completely in all closed public places, and it also prohibits tobacco advertising, sales promotions for cigarettes, smoking by under-age citizens, and it imposes certain limits on explicit smoking in TV programs and movies as well as selling cigarettes and tobacco-containing goods.

Besides there are other popular actions such as visiting saunas, moderate alcohol intake, and use of water-purifying appliances. Young people do active sports and tempering more often than people from other age groups (21%; ^{2} = 10.183 at $p = 0.006$).

[5] Ob okhrane zdorov'ya grazhdan ot vozdeistviya okruzhayushchego tabachnogo dyma i posledstvii potrebleniya tabaka: Federal'nyi zakon № 15-FZ ot 23 fevralya 2013 g. [On protecting citizens' health from impacts exerted by tobacco smoke and consequences of tobacco consumption: RF Federal Law No. 15-FL]. Garant: informatsionno-pravovoi portal. Available at: http://base.garant.ru/70321478/#text (27.03.2018).

Conclusion. To sum up, we should note that young people's behavior in respect of their health has certain peculiarities in comparison with people from other age groups. Traditionally young people who haven't yet accumulated "health problems" assess their health as being quite good and feel themselves responsible for it. Their values as regards their health preservation fit their age: they wish to have healthy children, they want to feel themselves well to pursue active social and working life; they also have aesthetic motives (a desire to look good and to be fit via keeping a diet). Young people visit a doctor less frequently, but they do sports more often than people from other age groups. But still there are certain self-destructive practices in their lives: they consume low alcohol drinks (beer) more frequently than people from other age groups, they also eat fast food and smoke more often, and they are not strong-willed enough to give this bad habit up even when they want to. And it is their desire to overcome stresses that makes young people smoke, drink alcohol, or eat unhealthy food.

A positive experience of self-preserving practices among people from this population group should be applied in motivating them to pursue a healthy lifestyle; such practices should become a part of their life and remain in it at older ages, and this successful experience should be transferred to the following generations. There are several tools to achieve it; we can mention such relevant and up-to-date ones as creation of a socially approved and "fashionable" image of a healthy person in mass media, the Internet [23] and art works; working out health improvement programs at educational establishments and at workplaces; making medical services aimed at prevention more available as it makes for early detection of diseases.

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THYROID PATHOLOGY AS LATE RADIATION EFFECT CAUSED BY EXPOSURE TO RADIATION DURING EMERGENCIES

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Several emergencies at "Mayak" Production Association (PA Mayak) led to radioactive contamination of some territories in the Urals; the territories were contaminated with radionuclides mixture and it caused consequent external and internal irradiation of population living there. Our research goal was to examine thyroid state 50–60 years after exposure to radiation in childhood. Our research objects to study thyroid gland structure and functioning were people who lived on territories contaminated with radionuclides in their childhood (The Techa river banks and the Eastern Urals radioactive track territory) and who then moved to Ozersk. The group was made of 256 people who accounted for 70 % of all such migrants who were available to us. Thyroid gland diseases were examined allowing for all the available data of subjective and objective clinical and laboratory screening examination, namely complaints, thyroid gland and neck area examination, ultrasound examination of thyroid gland structure, laboratory tests of thyroid gland functions.

Our research results revealed that all thyroid gland diseases prevailed in people who lived on radioactively contaminated territories in their early childhood 50–60 years after they moved to other places. Thus, such morbidity amounted to 64 % among women and to 32 % among men which was 1.6 times higher against people who were not exposed to any technogenic radiation during their lives. We detected statistically significant 2–2.6 times higher risks of thyroid pathology in migrants at P-value 0.012 and <0.001 for men and women correspondingly. Besides, migrants ran higher thyroid pathology risks than people irradiated in their childhood due to exposure to ^{131}I, which accumulated in the thyroid gland: odds relation amounted to 2.8 and 2.4 (90 % confidence interval being 2.08–3.83 and 1.45–4.06 for women and men correspondingly).

Key words*: thyroid gland, nodular goiter, radioactive contamination, the Techa river, the Eastern Urals radioactive track (EURT), irradiation in childhood, long-lived radionuclides, ^{131}I*

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In the middle of the 20th century atomic industry was just emerging and there wasn't enough technical experience in dealing with sources of ionizing radiation. It caused a number of radiation accidents all over the world and resulted in environmental contamination with radiation and population exposure to it. Large-scale contamination of vast territories in the Urals was related to activities by "Mayak" Production Association. Due to several accidents which happened there territories in Chelyabinsk, Sverdlovsk, Tyumen, and Kurgan regions were contaminated with radionuclides haing different half-decay; consequently, a large population group were irradiated externally and internally [1, 2]. Thus, people who lived in settlements located on the banks of the Techa river were exposed to radiation due to regulated and emergency discharges of liquid radioactive wastes from "Mayak" PA into the river in 1949-1956. Another population cohort was exposed to radiation due to their living on the territory of the so called Eastern Urals Radiation Track (the EURT) which occurred in 1957 after an emergency at "Mayak" PA when a tank with highly radioactive solid wastes exploded. Radiation doses in people living on contaminated territories occurred due to combined effects exerted by external and internal irradiation, mostly because of ^{90}Sr and ^{137}Cs long-lived isotopes incorporation [1, 2]. A major part of such doses emerged in most people in their childhood, in other words, at an age when the thyroid gland (TG) was the most radio-sensitive [3, 4].

A lot of data have been accumulated by now on TG non-carcinogenic diseases emergence long after the atomic bombings in Japan [5, 6], as well as after exposure to ^{131}I-containing regulated gas-aerosol emissions from "Mayak" PA [7, 8]. However, we couldn't find any data on remote thyroid effects caused by exposure to combined external and internal irradiation with radionuclides which didn't deposit in the thyroid gland.

Our research goal was to perform screening examination of thyroid state and to diagnose thyroid gland diseases in people who lived on territories contaminated with radionuclides as a results of emergencies at "Mayak" PA in their childhood.

Data and methods. Our basic group for TG state screening was made up of people living in Ozersk, Chelyabinsk region, who migrated there themselves or were made to do so (hereinafter called "migrants") in 50-60ties last century from territories contaminated with radionuclides (The Techa river banks and the EURT territories). They moved to Ozersk mostly at an age younger than 15. We didn't contemplate any limitations as per sex, nationality, or socio-economic peculiarities. Simultaneously we created a reference group with the following criteria of inclusion into it: a person moved to Ozersk at an age older than 15 from territories without any contamination with radionuclides and similar in terms of provision with iodine; he or she lived in social and communal conditions which were similar to those of migrants for not less than 20 years; he or she was at an age comparable to that of migrants at the moment of examination. The examination was voluntary; patients' rights were observed as they all gave their informative written consent to participation in our project. Physical examination included neck area checking and the thyroid gland palpation. Ultra-sound examination was performed with "SonoScape SSI-600" (China) with a linear sensor at a working frequency being 7.5 MHz. We detected thyroid stimulating hormone (TSH), free thyroxin (thyroid gland hormone, CT4), and concentration of anti-bodies to thyroid peroxidase

(TP), in blood serum with test sets manufactured by "Chema" company (Russia). Thyroid gland diseases were diagnosed on the basis of medical records given by endocrinologists and specialists on the thyroid gland allowing for all the available data obtained via subjective and objective examinations.

Significance of discrepancies in distribution of an effect among examined people was statistically assessed with "case-base" technique which is the most simple two-sample variant of cohort epidemiologic research. We assessed odds relations (OR) in samples which were different from each other because they had/lacked this or that factor which could supposedly influence observed morbidity levels. We applied two techniques to statistically assess significance of discrepancies; they were so called "1-tail exact Fisher test" [9] and "1-tail exact Altham test" [10]. The first one is based on a conventional frequency approach and allows to assess odds relation together with confidence interval (CI) and probability of an observed distribution occurrence and its more remote variants (P-value). The second one is based on strictly probabilistic Bayesian approach without any reliance on a zero hypothesis. As opposed to any classic statistic significance test, Altham test allows to establish a correlation between a marker of an effect ($OR < 1$ or $OR > 1$) and estimated probability of its occurrence. It is also important to note that odds relation value during Altham test application is an adequate measure of relative risk (RR) when we compare two groups with rare specific events due to the following: $R\{OR < 1\} = R\{RR < 1\}$, where RR is a relative risk in cohort examination. We applied a typical decision making level $\alpha = 0.05$ for both statistic tests as a one-side significance level; 90% CI matches it; CI was numerically assessed as per a technique [11], which is the most similar analogue to Altham test.

Results and discussion. 265 people took part in our examination and it accounts for approximately 70% of all the migrants who were irradiated in their childhood and who now live in Ozersk. As we can see from the Table 1, women prevailed among them (75%), most were Slavs (67%), 93% participants were irradiated in their childhood, and more than a half migrants (62%) were older than 60 at the moment they were examined by us. Our research results revealed thyroid gland pathology in 149 migrants from territories contaminated with radionuclides; 54% cases were diseases diagnosed for the first time.

Table 1

Migrants group: characteristic

Parameters	*n*	% from *n*
OVERALL	265	100
Sex		
Men	65	24,5
Women	200	75,5
Nationality		
Slavs (Russians, Ukrainians)	177	67,0
Tatars and Bashkir	88	33,0
Living on contaminated territories		
The Techa river banks	121	45,7
EURT	144	54,3
Age at which exposure to radiation occurred for the first time		
≤ 15	246	93,0
> 15	19	7,0
Age at the moment of examination		
50–59	100	38,0
60 years and older	165	62,0
Hereditary predisposition		
Yes	65	24,5
No	198	74,7
Not known	2	0,8

Thyroid pathology structure mostly included nodular goiter (Table 2). As per data taken from medical documentation, all the three cases of thyroid gland cancer were diagnosed long before our screening examination started.

Table 2

Thyroid gland diseases in the examined group

Diagnoses	Women		Men	
	n	%	n	%
Overall	136	100	23	100
Non-nodal forms, including:	50	36,8	6	26,1
diffuse goiter	7	5,2	4	17,4
Autoimmune thyroiditis (AIT)	43	31,6	2	8,7
Nodal forms, including:	86	63,2	17	73,9
one-nodular goiter	46	33,8	15	65,2
multi-nodular goiter	37	27,2	2	8,7
thyroid gland cancer	3	2,2	–	–

Overall, 149 people had 159 cases of thyroid gland diseases due to 10 of them having two diseases each; these diseases were, as a rule, nodular goiter combined with AIT. Prevalence of thyroid gland diseases as per most specific nosologic forms was statistically significantly higher among women than among men (Table 3), and it is well in line with data obtained in other research [6, 12].

Age is one of the most important non-radiation factors which cause thyroid pathology emergence. Our previous screening research performed on Chernobyl disaster liquidators revealed that nodular goiter was detected more frequently in people older than 60 than in people who were younger: OR amounted to 1.7 and 1.9 (at 95% CI 1.0–3.0 and 1.1–3.2) for women and men correspondingly [13]. Data on one-nodular goiter prevalence among men older than 60 in comparison with younger people can also be found in the work [14]. More than a half migrants examined by us were older than 60 (Table 1). And yet, we didn't detect any statistically significant discrepancies between different age groups (<60 years and ≥ 60 years) as per any nosologic form. Thus, OR as per all the nosologies amounted to 0.85 and 0.83 (90% CI 0.52–1.4 and 0.34–1.96) for women and men correspondingly; P-value was 0.35 and 0.45 (as per Fischer's test), and 0.70 and 0.64 (as per Altham test) correspondingly.

Table 3

Prevalence of thyroid gland diseases among migrants depending on their sex

Nosologic forms of thyroid pathology	Groups				OR median value (90% CI)	*P-value* (Fischer's test)	*P* { OR < 1} (Altham test)
	Women *n*=200		Men *n* = 65				
	n	%	n	%			
All patients	128	64,0	21	32,3	3,66 (2,25–6,05)	< 0,001*	< 0,001*
Non-nodal forms	42	21,0	4	6,1	3,55 (1,65–8,95)	0,003*	0,002*
Nodal forms:	86	43,0	17	26,1	2,08 (1,26–3,53)	0,011*	0,008*
Nodular goiter	83	41,5	17	26,1	1,96 (1,19–3,32)	0,018*	0,013*
One-nodular goiter	46	23,0	15	23,1	0,98 (0,57–1,71)	0,556	0,529
Multi-nodular goiter	37	18,5	2	3,1	5,48 (2,14–18,7)	0,001*	< 0,001*
Thyroid gland cancer	3	1,5	–	–	1,76 (0,29–25,9)	0,428	0,319

Note: * – means discrepancies are statistically significant at $p < 0,05$.

Our own data as well as those taken from literature prove that people who have thyroid pathology in their family case histories tend to suffer from various thyroid pathologies more frequently [8,12,15]. 25% migrants stated their closest blood

relatives had thyroid gland diseases. And indeed, people from a subgroup with hereditary predisposition tended to have thyroid pathology diseases more frequently, both overall and as per specific nosologic forms. The only one statistically significant parameter was an increase in multi-nodular pathology prevalence among women with hereditary predisposition: OR amounted to 2.30 (90% CI 1.24 – 4.26); P-value as per Fischer's test was 0.023; as per Altham test, 0.014.

Medical-biological research revealed that people who lived on territories contaminated with radionuclides accumulated significant radiation doses in their bodies, including up to 1 Gy on soft tissues [1, 16]. And here irradiation scenarios were different for people who lived on the Techa river banks and on the EURT territories in terms of such parameters as types of radionuclides, exposure power, and ways of radiation exposure; these differences led to intensity of post-irradiation consequences. However, as our examined group was not big, we don't think it possible to assess remote thyroid effects depending on different irradiation scenarios.

Table 4 contains the results of thyroid pathology prevalence among people from our focus group and risk assessment in comparison with the reference group. We reveled 2-2.6 times higher risks of thyroid gland pathologies in migrant men and women correspondingly; this increase was statistically significant. The only exclusion were non-nodal thyroid gland pathologies, such as AIT and diffuse goiter. Despite these pathologies having the lesser share in thyroid pathologies structure, they are more serious in terms of their clinical course and quality of patients' life.

Table 4

Prevalence of thyroid gland pathology depending on irradiation status

Nosologic forms of thyroid pathology	Migrants		Reference group		OR median value (90% CI)	*P-value* (Fischer's test)	*P* { OR < 1} (Altham test)
	n	%	n	%			
Women							
Overall	200		248				
All patients	128	64	101	40,7	2,57 (1,87–3,56)	< 0,001*	< 0,001*
Non-nodal forms	42	21	42	16,9	1,30 (0,88–1,94)	0,165	0,136
Nodal forms:	86	43	59	23,8	2,40 (1,72–3,38)	< 0,001*	< 0,001*
Nodular goiter	83	41,5	57	23,0	2,36 (1,68–3,33)	< 0,001*	< 0,001*
One-nodular goiter	46	23	35	14,1	1,81 (1,21–2,72)	0,011*	0,008*
Multi-nodular goiter	37	18,5	22	8,9	2,30 (1,45–3,71)	0,002*	0,001*
Thyroid gland pathology	3	1,5	1	0,4	2,74 (0,65–15,2)	0,236	0,127
Benign tumors	–	–	1	0,4	0,51 (0,03–4,31)	0,554	0,694
Men							
Overall	65		304				
All patients	21	32,3	59	19,4	2,00 (1,21–3,25)	0,019*	0,012*
Non-nodal forms	4	6,1	13	4,3	1,62 (0,61–3,83)	0,350	0,200
Nodal forms:	17	26,1	46	15,1	2,01 (1,18–3,38)	0,028*	0,017*
Nodular goiter	17	26,1	43	14,1	2,18 (1,27–3,67)	0,017*	0,010*
One-nodular goiter	15	23,1	28	9,2	2,99 (1,66–5,27)	0,003*	0,001*
Multi-nodular goiter	2	3,1	15	4,9	0,78 (0,22–2,11)	0,398	0,651
Thyroid gland pathology	–	–	3	1,0	0,87 (0,06–5,21)	0,558	0,545

Note: * – means discrepancies are statistically significant at $p < 0,05$.

It is proved by the fact that 58% patients suffering from AIT have thyroid dysfunction, but as for those who have nodal forms it is detected only in 2.2% of them.

We should note that statistical estimates obtained as per all the applied criteria (OR, Fischer's test, and Altham test) are well in line with each other.

By now a lot of data have been accumulated on non-carcinogenic effects in the thyroid gland under various radiation exposure scenarios. Research performed on a Japanese cohort of people 60 years after they had suffered the atomic bombing in Hiroshima and Nagasaki revealed a statistically significant positive correlation between an irradiation dose in childhood (doses range was 0.0–4.0 Gy) and prevalence of one-nodular goiter ($p<0.001$) [5, 6]. Earlier we came to a conclusion that a relative risk of benign nodal diseases in the thyroid gland for people living in Ozersk increased 40–50 years after they were exposed to technogenic irradiation caused by ^{131}I-containing gas-aerosol emissions from "Mayak" PA: OR against a reference group amounted to 1.56 (95% CI 1.1–2.2) and 1.52 (95% CI 0.92–2.5) for women and men correspondingly [12]. As per various estimates, reconstructed doses of ^{131}I which the city population got on their thyroid gland varied from 2.3 to 4 Gy [1, 17]. It is interesting to compare thyroid pathology prevalence among people who moved to Ozersk and who were exposed to a set of radionuclides from "Mayak" PA emergency emissions in their childhood with all the earlier obtained data on prevalence of thyroid gland diseases among the city population irradiated as a result of exposure to ^{131}I-containing regulated emissions from this enterprise [8]. It is well known that the skeleton and soft tissues are the organs where long-lived radionuclides (^{90}Sr,^{137}Cs) are deposited, and it is these nuclides that basically determine radiation exposure on contaminated territories; the thyroid gland is known to accumulate radioactive iodine.

Data given in Table 5 prove that migrants run statistically significantly higher relative risks of various thyroid gland pathologies (women, 1.9-4 times higher; men, 2.4-2.7 times higher) than Ozersk population who were irradiated with radioactive iodine contained in gas-aerosol emissions in their childhood. And a question naturally arises: what are the reasons for greater thyroid pathology prevalence among people who were exposed to irradiation by long-lived radionuclides? An answer to it is likely to be obtained via comparison of radiation doses, doses rates, exposure duration, combination of radiation and non-radiation factors; such comparison is an issue for further research.

Apart from increased risks of thyroid gland pathologies, we noted some peculiarities in thyroid pathology structure in the migrants group. A very interesting fact is that one-nodular goiter prevalence among men grew to the same extent as among women (Table 4), and it contradicts another commonly known fact that there are hormones-based and genetically-based sex differences in thyroid pathology emergence [6, 8, 18]. A phenomenon of these sex difference being "wiped off" became even more apparent when we applied an index which we tentatively called "inter-gender". This index is a ratio of this or that thyroid gland disease prevalence among men to that among women. As we can see in the Figure, one-nodular goiter prevalence among men from the reference group and men from the group of people irradiated with ^{131}I was 2 times lower than among women. And on the contrary, as this pathology prevalence was the same among male and female migrants, "inter-gender" index becomes equal to 1 as per "one-

Table 5

Prevalence of thyroid gland pathology (%) depending on an irradiation scenario

Nosologic form of thyroid pathology	Ionizing radiation sources		OR median value (90% CI)	*P-value* (Fischer's test)	*P* { OR < 1} (Altham test)
	Radionuclides from emergency emissions	^{131}I from gas-aerosol emissions [cited as per 8]			
Women					
Overall	*n* = 200	*n* = 332			
All patients	64,0	38,5	2,82 (2,08–3,83)	< 0,001*	< 0,001*
Non-nodal forms	21,0	12,0	1,94 (1,30–2,88)	0,004*	0,003*
Nodular goiter	41,5	25,6	2,06 (1,50–2,81)	< 0,001*	< 0,001*
One-nodular goiter	23,0	20,5	1,16 (0,82–1,66)	0,281	0,242
Multi-nodular goiter	18,5	5,1	4,12 (2,52–6,88)	< 0,001*	<0,001*
Thyroid gland cancer + benign tumors	1,5	0,9	1,67 (0,48–5,79)	0,406	0,244
Men					
Overall	*n* = 65	*n* = 249			
All patients	32,3	16,4	2,43 (1,45–4,05)	0,005*	0,003*
Non-nodal forms	6,1	3,6	1,89 (0,69–4,74)	0,272	0,145
Nodular goiter	26,1	12,0	2,60 (1,48–4,52)	0,006*	0,003*
One-nodular goiter	23,1	10,0	2,71 (1,49–4,84)	0,007*	0,003*
Multi-nodular goiter	3,1	2,0	1,81 (0,47–5,91)	0,444	0,221
Thyroid gland cancer	–	0,8	0,98 (0,06–6,57)	0,628	0,506

Note: * – means discrepancies are statistically significant at $p < 0,05$.

nodular goiter" criterion. Besides, multi-nodular goiter prevalence increased substantially among female migrants while this parameter remained at the same level among men as in the reference group (Table 4); as a result, the index decreased to 0.2 (Figure).

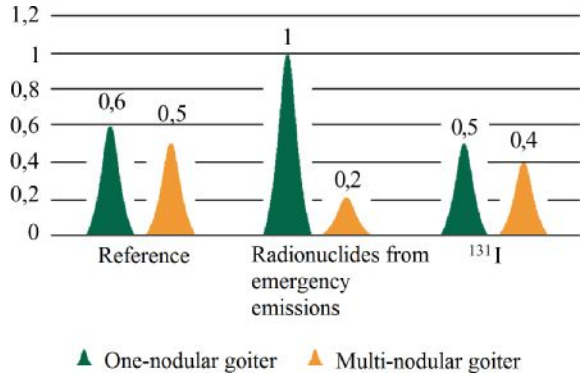

Figure. "Inter-gender" index depending on an irradiation scenario. Y-axis shows P_m: P_f (arbitrary units), where P_m is a disease prevalence among men (%); P_f is a disease prevalence among women (%). X axis shows the reference group and groups irradiated by various ionizing radiation sources

Pathological value of various nodular goiter types is being discussed now. Solitary nodes, especially those with big diameter, are thought to be highly risky in terms of malignant transformation [19]. There are data that multi-nodular goiter is combined with functional disorders and emergence of functional autonomy in the thyroid gland more frequently than one-nodular goiter [20, 21]. Combined irradiation with a set of radionuclides which formed due to emergencies can possibly change hypothalamo-pituitary-thyroid system regulation; it, in its turn, combined with non-radiation factors (hormonal or genetic ones), can lead to activation of various nodular goiter pathomorphism both in men and women.

Conclusion. Our research revealed that people who lived on territories contaminated with radiation (such areas in the

Urals as the Techa river bank and EURT) in their childhood suffered from thyroid gland diseases 50-60 years later; prevalence of such diseases amounted to 64% among women and 32% among men which was 1.6 times higher than among people who weren't exposed to radiation. These deviations are determined by statistically significant increase in risks of nodular goiter emergence; OR amounted to 2.2 for men (90% CI 1.27-3.67), P-value 0.01; 2.4, for women (90% CI 1.68-3.33), P-value <0.001. Post-radiation responses from the thyroid system in migrants irradiated by a set of radionuclides turned out to be even more apparent than in people who were exposed to ^{131}I in their early childhood, despite of the fact that only iodine out of all the existing radionuclides tends to concentrate in the thyroid gland. OR for nodular goiter amounted to 2.06 and 2.6 (90% CI 1.50–2.81 and 1.48–4.52) for women and men correspondingly. One-nodular goiter prevalence increased statistically significantly in male migrants as opposed to men exposed to ^{131}I.

We can't clearly define the reasons for these shifts in thyroid pathologies prevalence in migrants after exposure to combined irradiation in their childhood, caused mostly by long-lived radionuclides which are basically deposited in the skeleton and soft tissues. Obviously, it is necessary to perform further examination of remote effects occurring in the thyroid gland in order to assess risks of pathology under various scenarios of radiation exposure for population who lived on the Teach river bank and the EUTR territory in their childhood. It is also vital to examine and compare radiation doses, doses rates, and duration of exposure, as well as to make allowance for contribution made by external irradiation, radionuclide distribution, and non-radiation factors occurrence.

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PECULIARITIES OF NEURO-PSYCHIC STATE AND LIFE QUALITY OF CHILDREN AND TEENAGERS FORMED UNDER INFLUENCE EXERTED BY RISK FACTORS EXISTING IN EDUCATIONAL ENVIRONMENT

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Today education is being modernized in the RF and it involves active development of innovative educational establishments, particularly, those where students stay round-the-clock. Intra-school environment in such establishments has its peculiarities and there are several factors in the educational process there which influence a child's body thus deteriorating his or her physical and mental health. To make educational processes efficient in such establishments, it is necessary to pay close attention to children's neuro-psychic state and quality of their life. Our research goal was to assess students' neuro-psychic state and quality of their life in an educational establishment where they stayed round-the-clock. We performed this assessment via questioning with standard questionnaires. As a result, we revealed that such adverse factors in the intra-school environment as non-rational organization of the educational process and daily regimen led to poorer neuro-psychic state and lower quality of children's life. It became obvious through an increase in number of students with higher anxiety level, from 16 % in the fifth grade to 19 % in the tenth grade. Both physical and mental components of life quality also deteriorated. We revealed that anxiety level and life quality parameters depended on non-rational organization of the educational process and daily regimen.

The existing situation calls for working out and implementation of modern preventive health-preserving activities and active medical support provided for the educational process; these activities should be aimed at lowering risks caused by negative influence exerted by intra-school environment factors on students' neuro-psychic state and quality of their life.

Key words: *neuro-psychic state, life quality, educational process, children, teenagers, risk factor, educational environment.*

The system of school education in the RF has been undergoing substantial reforms over the recent years. These reforms, in particular, involve creation of occupational training for senior school students, and it results in greater education loads. So, it is necessary to explore issues related to health preservation in case of children and teenagers who attend new innovative educational establishments where intensive training technologies are implemented, including those schools where students stay round-the-clock [1, 2]. Educational processes in such establishments have their peculiarities which are determined by round-the-clock influence exerted on a child's body by a set of intra-school factors and intense educational loads; this influ-

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ence leads to disorders both in physical and mental health of a student [3–5].

Successful adaptation of children and teenagers during their studies in modern educational establishments depends on a great number of life activity factors which form students' biological and psycho-social state [1, 4–11]. Round-the-clock complex exposure of students' bodies to intra-school factors involves greater educational loads and greater volumes of information which students have to obtain and process. At the same time, students permanently stay in a closed establishment; they are educated under a strict daily regimen and are constantly under their tutors' control; an amount of time they can spend in privacy is minimal, and they socialize only with their classmates [4]. All this makes them fundamentally different from other children and teenagers of the same age who attend other educational establishments with a different structure of social and mental adaptation. Some data reveal that this structure is characterized with significant level of deadaptation in educational and behavioral spheres and emotional ill-being [12, 13].

Given all the above-mentioned, it is necessary to explore neuro-psychic state and life quality of students as well as to detect factors which deteriorate them.

Our research goal was to assess neuro-psychic state and life quality of students who attended an educational establishment with round-the clock staying.

Data and methods. We performed our research on 536 students who attended an innovative comprehensive educational establishment with round-the-clock staying in Orenburg; students were examined in dynamics from the 5th to the 10th grade and their age was from 12 to 17.

We explored how educational processes were organized in the establishment; our research included determining daily and weekly educational loads, how these loads were distributed over a day and a week, and how school subjects were assigned depending on their complexity over a day and a week taking into account dynamics of students' physiological working capacity. Cadets' daily regimen was assessed on the basis of the daily routine fixed in the establishment; we paid attention to six basic components of any daily regimen, their presence and duration, and their conformity to the existing hygienic requirements. The obtained data were then compared with the Hygienic Requirements 2.4.2.2821–10 "Sanitary-epidemiologic requirements to conditions and organization of an educational process in comprehensive secondary schools"[1].

Children's neuro-psychic state was assessed via questioning. Personal traits were examined by determining an anxiety level and negative emotional experience both in everyday life and during classes. We applied Ch.D. Spielberger's questionnaire, modified by Andreeva (1988). Level of aggression was determined as per Buss-Durkey Inventory (20002), and character traits, as per A.E. Lichko's questionnaire

[1] SanPiN 2.4.2.2821-10. Sanitarno-epidemiologicheskie trebovaniya k usloviyam i organizatsii obucheniya v obshcheobrazovatel'nykh uchrezhdeniyakh (s izmeneniyami na 24 noyabrya 2015 goda): Postanovlenie glavnogo gosudarstvennogo sanitarnogo vracha RF № 189 ot 29.12.2010 g. [HR 2.4.2.2821-10. Sanitary-epidemiologic requirements to conditions and organization of an educational process in comprehensive secondary schools (with the latest alterations adopted on November 24, 2015): The Order by the RF Chief Sanitary Inspector dated December 29, 2010 N 189].Available at: http://docs.cntd.ru/document/902256369 (18.02.2018) (in Russian).

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(1995) with character accentuation types being determined as well[2].

Life quality was assessed via questioning with MOS-SF-36 questionnaire (J.E. Ware, 1992) modified by the International Center for Life Quality Exploration (Saint Petersburg, 1998). The assessment was performed as per 8 scales, 4 of them characterizing a physical component, and other 4, a mental one [14].

We applied Person's technique (B.A. Rosner, 1982) to reveal cause-and-effect relationships between risk factors existing in the educational environment in a military school, parameters of neuropsychic state, and students' life quality. All the obtained data were statistically processed with the following software: "Microsoft Office Excel" 2007 and "Statistica" universal statistic package, version 10.0 for Windows.

Results and discussion. Our assessment of the educational process revealed that it was organized in a non-rational way. There were apparent irregularities in classes scheduling for a day and for a week as difficulty of various subjects and physiological dynamics of students' working capacity were not taken into account. We detected that students attending the 5th, 6th, and the 8th grade had to bear high educational loads at the beginning of the week (50-59 scores); students attending the 9th and the 10th grade, at the end of it (46-49 scores); it didn't correspond to periods when students just started to adjust to work, and when their working capacity decreased. Educational loads in the middle of the week were low (26-36 scores) in the 5th, 7th, 8th, and 9th grades, and it didn't correspond to a period of high and stable working capacity either. We detected dual classes in the same subject, absence of rotation between humanitarian classes and classes in mathematics and natural sciences, as well as rotation between "dynamic" classes (sports, technology, music, and art) and "static" ones (basic subjects).

Students' daily regimen also deviated from the fixed standards. Thus, a period of time assigned for doing homework was shorter than the standard by 24.0% for the 5th grade students; by 36.7%, for the 6-7th grade students; by 10.0%, for the 8-9th grade students; by 32.5%, for the 10th grade students. Duration of time spent walking outdoors was shorter than the standard by 73.6% for the 5th grade students; by 58.3%, for the 6-9th grade students; by 50.0%, for the 10th grade students. Night sleep was 10.0% shorted than the standard for the 5th grade students. A period of time assigned for personal hygiene, morning exercises, and breakfast, was 35.0% longer than the standard for the 6-9th grade students; 68.7% longer, for the 10th grade students.

Our assessment of anxiety levels revealed that high anxiety levels during classes were detected in 1.0% of the 9th grade students, but in 23.0% of the 8th grade students; high anxiety levels in everyday life were detected in 7.0% of the 9th grade students, and in 23.0% of the 5th grade students (Table 1).

We assessed a number of students with high anxiety levels in dynamics and detected that there was an increase in number of students who had high anxiety levels during classes, from 16.0% in the 5th grade to 19.0% in the 10th grade. But as for anxiety in everyday life, a number of students with it fell from 23.0% in the 5th grade to 9.0% in the 10th grade. These data prove there are changes in students' emotional state which are probably related to an inadequate reaction of a body to educational loads.

Table 1

Distribution of students depending on anxiety levels in everyday life and during classes (%)

Anxiety levels	Classes											
	5		6		7		8		9		10	
	1	2	1	2	1	2	1	2	1	2	1	2
Low	11,5	17,3	50,5	35,5	54,8	47,3	27,1	33,3	47,4	42,1	4,2	4,2
Average	65,4	66,3	36,6	51,6	33,3	43,0	50,0	43,8	46,1	56,6	86,5	77,1
High	23,1	16,4	12,9	12,9	11,9	8,6	21,9	22,9	6,5	1,3	9,3	18,7

Note: 1is in everyday life; 2 is during classes

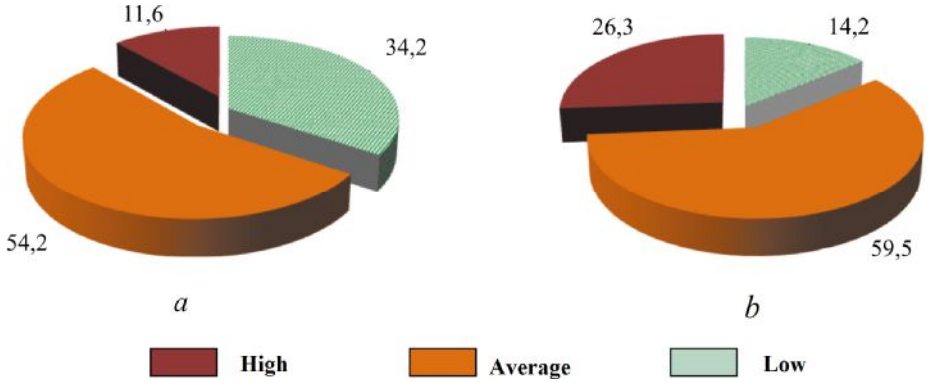

Figure 1. Evidence of negative emotional strain (stress):
a – in everyday life; *b* – during classes

High anxiety levels lead to stress occurrence; therefore, 12.0% and 26.0% students were under high stress in everyday life and during classes accordingly (Figure 1).

We examined learning in dynamics and revealed the greatest number of students under high stress level in everyday life in the 8th grade (43 %); under high stress level during classes, in the 6th grade (18.0%) (Table 2).

Stress occurrence, in its turn, led to emergence of aggression in students. We revealed that aggression signs were quite adequate in 50.0% students; 40.0% had them but tried to suppress their aggression; and only 2.0% behaved truly aggressively (Figure 2).

Depending on time spent in the educational establishment, a number of students with adequate signs of aggression went up to 58.8%; levels of aggression remained approximately the same (Table 3).

Table 2

Distribution of students depending on the level of negative psychoemotional strain (stress), %

Level of negative psychoemotional strain (stress)	Classes							
	6		7		8		9	
	1	2	1	2	1	2	1	2
Low	11,8	19,3	12,5	22,4	12,8	49,5	28,9	39,5
Average	46,2	62,4	31,2	63,2	20,0	30,9	36,8	46,1
High	17,3	18,3	15,0	13,2	42,5	15,5	7,9	7,9

Note: 1 is in everyday life, 2 is during classes

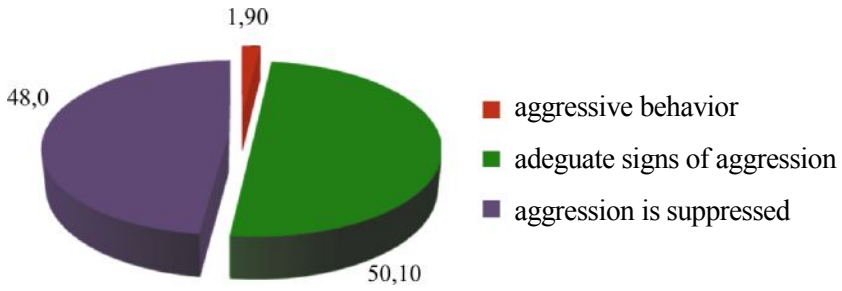

Figure 2. Signs of negative emotional strain (aggression).

As we assessed character accentuation types in students from the 6th - 9th grades, we detected that most of them had a mixed type of character accentuation (from 27.2% in the 8th grade to 38.7% in the 9th grade) (Table 4).

A character accentuation type which could not be diagnosed accounted for a rather high share, 10.7% in the 9th grade, and up to 25.0% in the 7th grade. About 2.0% students in the 7th grade and up to 12.0% students in the 9th grade had hyperthymic character accentuation which is characterized with great willingness to act but also with a tendency to do too much at once and to abandon tasks without completing them. It is important to note that about 6.4% students in the 6th grade and up to 25.0% students in the 7th grade had demonstrative character accentuation; a person with such accentuation type behaves demonstratively, is emotional and vivid, makes contacts easily, strives for leadership, is eager to be recognized and to constantly attract everybody's attention. And here we should also note that 1.9% students in the 8th grade and up to 12.0% in the 7th grade had anxious-pedantic accentuation type, or, in other words, were indecisive, prone to thinking and self-analysis, and susceptible to obsessive fears and thoughts. Other types of character accentuation were rather rare.

Table 3

Distribution of students depending on levels of aggression (%)

Level of aggression	Classes			
	6	7	8	9
Aggressive behavior is natural	1,8	2,6	1,0	2,4
An examined person tends to demonstrate adequate signs of aggression in certain situations	49,1	44,2	48,5	58,3
Aggression is suppressed	49,1	53,2	50,5	39,3

Table 4

Distribution of students depending on a type of their character accentuation (%)

Accentuation type	Classes			
	6	7	8	9
Not diagnosed	15,5	25,0	15,5	10,7
Instable	2,7	–	1,9	5,3
Asthenoneurotic	1,8	–	1,0	1,3
Excitable	7,3	2,0	4,9	1,3
Hyperthymic	10,9	2,0	2,9	12,0
Demonstrative	6,4	25,0	19,4	18,7
Introvert	3,6	–	5,8	6,7
Unsteady	1,8	–	7,8	–
Sensitive	2,7	2,0	4,9	–
Anxious-pedantic	9,1	12,0	1,9	4,0
Cycloid	1,8	3,0	6,8	1,3
Mixed	36,4	30,0	27,2	38,7

Our next examination stage included assessment of life quality and we performed it in order to obtain students' subjective estimations of their health.

We detected the highest score (66 scores) for a physical component of health in the 6th grade where students gave a lot of scores to such parameters as "physical

functioning" and "role physical functioning"; the lowest score was detected in the 7th grade, where very few scores were given by students to "physical functioning" and "overall health".

The highest scores for a mental component of health (76 scores) were detected in the 6th grade due to "role emotional functioning" and "social functioning"; the lowest scores were detected in the 8th and 9th grade (45 scores) due to "role emotional functioning" and "life activity" in the 8th grade, and "life activity" and "mental health" in the 9th grade.

We performed a correlation analysis and detected that a number of students from various age groups who had high anxiety level grew depending on their overall educational loads (r = 0.82), a period of time they spent doing their homework (r = 0.92), and a period of time they spent outdoors (r = - 0.83). Basic life quality parameters changed depending on educational loads during a working day and a week, and it was proved by a detected direct correlation between educational loads and role physical functioning (r = 0.91), overall health (r = 0.91), social functioning (r = 0.98), and role emotional functioning (r = 0.91).

So, to sum up, we can conclude, that intra-school environment and organization of educational processes in establishments with round-the-clock staying for students cause risks of negative effects on their neuro-psychic state and overall life quality. Therefore, it is necessary to develop and implement up-to-date preventive and health-preserving activities and practicable programs of medical support for children attending such establishments.

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HEALTH RISKS FOR WORKERS CAUSED BY WEATHER AND CLIMATIC CONDITIONS DURING A COLD SEASON

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The authors assessed influences exerted on a body by physical environmental factors in autumn, winter, and spring in Dagestan and Kaliningrad region (the 4th climatic region where such assessments are not regulated) as per risks of exposure to cold; our assessments focused on Wind Chill Index (WCI), and frostbites of open body parts as per chilling conditions (CC) parameter under average temperature, average and maximum winds.

In Dagestan heat losses in winter under average winds were higher than optimal in the highest alpine region; but when winds reached their maximum power, such losses increased 1.35–1.48 times and overcooling was very much possible in alpine regions (WCI was higher than 1,190.0 kcal/m^2 · h). In spring heat loss was higher than its optimal level in highlands under wind gusts. One could feel real discomfort in autumn at 1,661 meters high.

Body chilling was quite possible in winter in Kaliningrad region when winds blew at their maximum; and discomfort could occur under wind gusts in spring and autumn.

As per CC parameter, frostbites risk was moderate in Dagestan in winter under average winds; and there was no such risk in autumn and spring. However, if winds were at maximum, the most critical risks occurred in Makhachkala district and in Khunsakhskiy district, and in Kaliningrad region as well. Risk was moderate in Kaspiyskiy district and Akhtyinskiy district. In spring and autumn risk was moderate under maximum winds in all Dagestan districts, but it was close to being critical in Kaliningrad region.

Nowadays, influences exerted by physical factors are determined as per temperature and wind speed. We detected that these influences could be adverse under different winds and could even become critical. Chilling and frostbite can occur even if a person is in winter clothing. However, influence exerted by air humidity is not taken into account. We can assume that this factor will potentiate influences exerted by temperature and wind, and it calls for working out a complex assessment of environmental factors in different seasons.

Key words: *chill, health risk, Chill Wind Index, integral parameter, body chilling conditions, the fourth climatic region.*

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Cold, or chilling environment, is a combination of physical factors (air temperature, air humidity, radiation temperature, and wind speed). This combination causes chilling of a human body and requires relevant measures to be taken to prevent heat losses[1]. Exposure to cold influences temperature homeostasis and it leads to emergence of cold-induced immune deficiency and activation of lipid peroxidation and metabolic processes. Shifts in protein, fat and hydrocarbon metabolism cause compensatory increase in heat production [1–5]; compensatory "cold vasodilatation" develops [6]. Cold wind is also harmful for human thermal physiological reactions. It results in higher blood pressure and heart rate which act as cardiovascular triggers [7]. When daily temperature changes occur during a cold season, it leads to elevated relative risks of non-accidental death due to respiratory diseases [8–9]. Nowadays a lot of researchers try to get better insights into how to predict hazards related to thermal health [10].

According to the RF Federal Law passed on December 28, 2013 г. No. 426-FL[2] microclimate parameters (air temperature, relative air humidity and air speed) are to be explored (tested) and measured when a specific assessment of working conditions is performed. However, according to the Order issued by the Ministry for Labor and Social Protection on January 24, 2014, No. 33[3], experts apply only a procedure for assigning working conditions to a working conditions category (subcategory) under influences exerted by heating or chilling microclimate in workrooms.

Hygienic requirements to a working regime during a cold season necessarily regulate an uninterrupted staying of workers outdoors when they are exposed to cold and a period of time which they can spend in a heated room in order to normalize their thermal state. These requirements are based on criteria which determine a permissible degree to which a human body protected from cold with specific clothing can be chilled, as well as how fast human thermal state gets back to normal in a heated room. And here standards for influences exerted by exposure to cold are fixed only for climatic regions which are specific in terms of temperature parameters and air speed[1].

But still, exposure to cold is well-known to cause health risks under high humidity [11, 12]. Military personnel run especially high risks under such conditions. Thus, when soldiers take part in military operations, and unfavorable weather conditions prevent them from proper tending to their boots, they have to stay in wet footwear, and it causes emergence of cold-induced damages without frostbites

[1] MR 2.2.7.2129-06. Rezhimy truda i otdykha rabotayushchikh v kholodnoe vremya na otkrytoi territorii ili v neotaplivaemykh pomeshcheniyakh [MG 2.2.7.2129-06. Work and leisure regimes for personnel during cold seasons on open air or in rooms without any heating]. *Federal'naya sluzhba po nadzoru v sfere zashchity prav potrebitelei i blagopoluchiya cheloveka: ofitsial'nyi sait*. Available at: http://rospotrebnadzor.ru/documents/details.php?ELEMENT_ID=4570 (03.03.2018) (in Russian).

[2] O spetsial'noi otsenke uslovii truda: Federal'nyi zakon RF № 426-FZ ot 28.12.2013 g. [On specific assessment of working conditions: The RF Federal Law passed on December 28, 2013 г. No. 426-FL]. *Konsul'tantPlyus*. Available at: http://www.consultant.ru/document/cons_doc_LAW_156555/ (03.03.2018) (in Russian).

[3] Ob utverzhdenii Metodiki provedeniya spetsial'noi otsenki uslovii truda, Klassifikatora vrednykh i (ili) opasnykh proizvodstvennykh faktorov, formy otcheta o provedenii spetsial'noi otsenki uslovii truda i instruktsii po ee zapolneniyu: Prikaz Ministerstva truda i sotsial'noi zashchity RF № 33n ot 24.01.2014 g. [On Approval of Procedure for conducting a specific assessment of working conditions, Classifier of adverse and (or) hazardous production factors, reporting form on a specific assessment of working conditions and instructions how to fill it in: The Order issued by the RF Ministry for labor and Social Protection on January 24, 2014 No. 33n]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii*. Available at: http://docs.cntd.ru/document/499072756 (03.03.2018) (in Russian).

(CIDWF). For example, when military operations on the Falkland Islands (the Malvinas) took place, average day temperature was 10^0 C, and night one dropped up to -4^0 C; military personnel had to stay in wet trenches for a long time, and later 20 % of hospital patients suffered from CIDWF. A lot of soldiers who happily avoided hospitalization also suffered from symptoms which were similar to those of the initial CIDWF stages. When occurring, CIDWF can put military personnel out of action and cause a substantial decrease in their military efficiency [13].

There are some factors which are considered to cause CIDWF; they are long-term exposure to cold and (or) wet environment, and congestive effects in veins caused by a long-term staying in the same posture or by wearing tight boots. CIDWF emergence can also be stimulated by dehydration, insufficient nutrition, mental stress during military operations, fatigue, body weakening due to a concomitant diseases or a wound. There are several CIDWF types, namely "trench foot", "immersion foot", "tropical immersion foot", and "Irish foot", and it highlights their difference from frostbites.

"Trench foot" is a syndrome which results from damages to tissues when they are long-term exposed to cold under temperature from 15^0C to 1^0C.

At the initial CIDWF stages, feet get back to their normal state on the 8–9 the day after exposure to cold stops, and here intense paresthesia occurs. Patients suffer from piercing and shooting pains and almost continuous tingling for 3–4 weeks.

Cold traumas, frostbites in particular, which occurred in the North Caucasus, were apparently seasonable (autumn, winter, and spring). Military personnel most frequently suffered from such traumas when they were in an ambush or on a patrol (55.4 %); when scouting, 28.6 %; at blocks, 7.6 %; on armored troop carriers, 7.1 %; and on guard, 1.3 %. Damages to lower extremities prevailed (74.0 %). Damages to elbow joints (2.4 %), knee joints (2.4 %), and buttocks (1.3 %) most frequently occurred in case of snipers who had to lie on snow for a long time. 50.8 % patients had frostbites of I-II degree; 26.4 %, II-III degree; 21.7 %, III-IV degree. Overall chilling was detected in 1.1 % patients [14].

All the above-mentioned motivated us to choose our **research goal** which was to assess influence exerted on workers' health by physical factors of the environment in the Republic of Dagestan and Kaliningrad region.

To achieve this, we set **the following tasks:**

- to assess weather and climatic conditions in autumn, winter, and spring;
- to assess influences exerted by a chilling environment on a human body when workers had to perform their work tasks at various heights;
- to assess risks of frostbites of open body parts when working outdoors.

Data and methods. Parameters of microclimate underlie preservation of heat balance between a human body and the environment thus keeping body optimal or permissible heat status. Due to that, we applied methodical procedures and criteria fixed in the Rospotrebnadzor's methodical guidelines MG 2.2.7.2129-06 " Work and leisure regimes for personnel during cold seasons on open air or in rooms without any heating". Safety criteria for work which is performed in a chilling environment allowing for a duration of exposure to cold take into account combinations of different negative temperatures and energy losses borne by workers in the 1st climatic region (the 4th climatic zone) with the

most probable wind speed being 1.3 m/sec; in the 2nd climatic region (the 3rd climatic zone) with the most probable wind speed being 3.6 m/sec; and in the 3rd climatic region (the 1st and the 2nd climatic zones) with the most probable wind speed being 5.6 m/sec.

We used meteorological data collected over 2012-2016 and obtained from the Dagestan regional and Kaliningrad regional centers for hydrometeorology and environmental monitoring. We estimated average air temperatures, air humidity, and air speed (average and maximum) during three seasons: autumn, wind, and spring. Environmental conditions in Dagestan varied depending on a height above the sea level; therefore, we performed our assessments at 4 meters height (near Makhachkala), at 16 meters height (near Kaspiysk), at 1,040 meters height (Akhtyinskiy district), and at 1,661 meters height (Khunzakhskiy district).

We followed recommendations on hygienic requirements to a working regime during a cold season on open air[1] and determined an integral parameter of conditions for body chilling (IPCBC) in scores as per the formula: $34.654-0.4664\times at+0.6337\times v$ (where *at* is air temperature, ^{0}C; v is wind speed, m/sec). This parameter allows to assess risks of frostbites of open body parts. Thus, IPCBC $\leq$34 scores meant there were no such risks; 34 < IPCBC $\leq$ 47 meant the risk was moderate; 47< IPCBC $\leq$ 57, critical; and IPCBC > 57 meant there was a disastrous risk of frostbites of open body parts. When the risk was moderate, the document fixed safe staying out in the chill to be not longer than 60 minutes; when the risk was critical, it was safe to say out for 1 minute only; and went the risk was disastrous, staying outdoors shouldn't exceed half a minute.

Besides, we assessed chilling environmental effects as per the Wind Chill Index (WCI) which was equal to $(10\sqrt{v}+10.45-v)\times(33- t^0)$, where v was air speed, m/sec; t^0 was air temperature ^{0}C [15]. WCI value equal to 761.6 kcal/($m^2\times$h) corresponded to comfortable weather conditions. A person in proper winter clothing gets chilled when WCI values are equal to 1193.34–1551.3 kcal/($m^2\times$h).

Results and discussion. Dagestan Republic and Kaliningrad enclave are located in the 4th climatic region in which working regimes on open air during a cold season have not been standardized yet.

In Dagestan, air temperature on open air varied from +1.0 to -3.2^{0}C in winter (Table 1). However, negative temperatures could drop to –14.0±0.7 – –15.7 ±0.9^{0}C in December-February, with their minimum values being detected at 1,040 and 1,661 meters heights above the sea level.

In Kaliningrad region, minimal temperatures also reached -12.5±1.5^{0}C (the lowest temperature was -24.3^{0}C). It made body chilling and frostbites of open body parts quite possible if workers had to work outdoors during this season.

Heat losses borne by a body which resulted from influences exerted by environmental conditions in Dagestan were higher than the optimal level only in the highest mountain region, only in winter, and when the wind speed was average. However, when the wind speed was maximum, heat losses due to convection increased substantially and exceeded their optimal level 1.35-1.48 times on lowlands, and as for highlands, body over-chilling could occur there, even if a person was in winter clothing (the Wind Chill Index was equal to or even higher than 1,190.0 kcal/$m^2\times$h) (Table 2).

Table 1

Parameters of physical environmental factors in 2012–2016 during different seasons and under different conditions of occupational activities, absolute values

Parameters	Districts where observations took place in Dagestan, Height above the sea level, m				Kaliningrad region
	16	4	1040	1661	
Winter					
Average air temperature, 0 C	3,53 ± 0,46	1,0 ± 2,3	–0,5 ± 1,7	–3,2 ± 2,8	–0,3 ± 0,8
Relative humidi-ty, %	87,3 ± 0,51	85,5 ± 3,5	68,3 ± 3,3	59,8 ± 3,3	84,5 ± 0,7
Air speed, m/sec (av./ max.)	3,1 ± 0,72 19,3 ± 2,2	1,7 ± 0,3 20,7 ± 2,7	1,6 ± 0,3 14,8 ± 2,5	1,9 ± 0,4 20,7 ± 3,4	2,0 ± 0,05 17,3 ± 0,8
Spring					
Average air temperature, 0 C	10,6 ± 1,15	11,0 ± 3,2	9,7 ± 2,8	5,4 ± 1,7	8,2 ± 1,2
Relative humidi-ty, %	80,3 ± 0,62	76,3 ± 2,5	66,0 ± 3,6	66,0 ± 3,5	72,5 ± 0,9
Air speed, m/sec (av./ max.)	2,8 ± 0,51 20,4 ± 1,9	3,3 ± 0,3 22,8 ± 1,1	1,8 ± 0,3 16,5 ± 2,3	2,7 ± 1,1 23,0 ± 3,2	1,9 ± 0,07 14,3 ± 0,5
Autumn					
Average air temperature, 0 C	14,5 ± 1,13	14,8 ± 3,5	10,6 ± 3,0	7,8 ± 2,8	9,0 ± 1,0
Relative humidi-ty, %	80,3 ± 0,81	79,3 ± 1,7	68,2 ± 3,3	65,5 ± 3,9	84,0 ± 1,0
Air speed, m/sec (av./ max.)	3,3 ± 0,68 21,2 ± 2,5	3,6 ± 0,3 24,2 ± 3,0	1,4 ± 0,3 13,3 ± 2,1	1,7 ± 0,2 18,8 ± 3,4	1,5 ± 0,1 14,7 ± 1,0

Table 2

The WCI parameters in various districts of Dagestan and Kaliningrad region during various seasons at average and maximum wind speed, kcal/m^2 ×h

Season	Districts where observations took place in Dagestan, Height above the sea level, m				Kaliningrad region
	4	27	1040	1661	
Winter	773,8 ± 13,8 1127,9 ± 21,8	735,3 ± 2,0 1033,8 ± 11,5	720,2 ± 14,8 1143,0 ± 16,5	808,3 ± 15,5 1938,5 ± 23,6	752,3 ± 13,5 1611,5 ± 17,1
Spring	557,0 ± 12,4 778,8 ± 11,1	544,3 ± 1,6 772,1 ± 1,9	467,5 ± 13,9 805,5 ± 15,2	667,4 ± 16,0 977,3 ± 14,9	553,9 ± 13,2 937,8 ± 13,4
Autumn	469,9 ± 14,1 645,8 ± 16,9	468,2 ± 7,3 652,8 ± 9,3	467,7 ± 12,8 753,1 ± 15,5	549,1 ± 14,6 882,2 ± 17,0	234,0 ± 9,2 920,2 ± 8,9

Table 3

IPCBC calculations as per seasons in districts where observations took place, scores

Season	Districts where observations took place in Dagestan, Height above the sea level, m				Kaliningrad region
	4	16	1040	1661	
Winter	34,2 ± 0,7 47,29 ± 1,5	34,97 ± 0,5 45,23 ± 1,8	35,9 ± 1,0 44,26 ± 1,5	37,35 ± 0,9 49,25 ± 1,6	37,1 ± 1,0 48,05 ± 1,7
Spring	31,61 ± 0,4 43,96 ± 1,1	31,48 ± 0,6 42,62 ± 1,3	30,32 ± 0,7 39,19 ± ± 1,1	31,26 ± 0,9 40,57 ± 1,2	33,84 ± 0,9 46,69 ± 1,4
Autumn	30,03 ± 0,4 43,07 ± 1,6	29,98 ± 0,3 41,31 ± 1,3	28,24 ± 0,4 39,13 ± 1,5	30,6 ± 0,6 38,13 ± 1,4	32,09 ± 0,6 42,91 ± 1,7

Body heat exchange went down in spring. However, when wind speed was maximum, and air humidity was high, physical environmental factors exerted rather adverse influence even on lowlands. Heat losses in highlands exceeded optimal level under harsh wind gusts.

In autumn, when air humidity was high, and wind speed was average, weather conditions could cause overheating in lowland Dagestan; but when wind gusts occurred, weather conditions probably got close to being comfortable. In highlands, when wind speed was average, conditions for body overheating could also occur; a person probably felt comfortable under wind gusts at 1,040 meters height; but a feeling of discomfort could occur under the same conditions at 1,661 meters height.

In Kaliningrad region, maximum winds in winter created adverse conditions which could cause body chilling. Uncomfortable conditions could also occur in autumn and spring under wind gusts.

IPCBC calculations showed that average winds in winter resulted in moderate risks of frostbites of open body parts at all places of observations; in spring and autumn there were no risks under the same weather conditions. However, when winds were maximum, it caused critical risks in Dagestan (near Makhachkala and in Khunsakhskiy district), as well as in Kaliningrad region. Risks of frostbites near Kaspiysk and in Akhtyinskiy district were moderate under the same weather conditions. In autumn and spring, risks of frostbites were moderate under maximum winds in all the districts where observations took place. In Kaliningrad region, risks were close to the upper boundary of being moderate and were nearly critical; they were more apparent near Makhachkala in spring and autumn (Table 3).

Our research revealed that climatic conditions in Dagestan and Kaliningrad region were rather similar in terms of air temperature, air speed, and relative air humidity. In Russia, existing conventional procedures for determining influences exerted on a body by physical environmental factors in cold seasons take into account only two basic parameters: air temperature and wind speed. Our data prove that effects on a body can be adverse under various wind speeds, and they can become even critical. Body chilling and frostbites of open body parts can occur even if a person is in winter clothing.

We can assume that elevated humidity can make adverse influences on workers' bodies even worse. Besides, to assess biological climatic conditions and their influences on people, we should implement up-to-date assessment procedures and technologies which is also proved by results of foreign research [16, 17].

Conclusions:

1. We should develop scientific justification for the assessment of working conditions as per degree of their hazard and danger which result from outdoor microclimate parameters in all seasons of the year, and especially under extreme climatic conditions in summer and winter time.

2. Regulation of a single time period which can be spent outdoors during a work shift in a cold season in various climatic zones which is accepted in our country is based on assessments depending on air temperature and energy losses. It doesn't take into account influences exerted on a body by air humidity. It calls for the development of new approaches to assessing complex effects which environmental factors have on a body.

3. The data obtained in the course of our research prove it is necessary to assess

working conditions on open air in all the climatic zones in the country.

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HOW TO REDUCE RISKS RELATED TO BIOLOGICAL FACTOR IMPACTS ON RAILWAY TRANSPORT WORKERS

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The paper focuses on impacts exerted by occupational biological factors on railway transport workers. The authors showed that these impacts resulted in significant social and economic losses and caused about 40 % of overall morbidity with temporary disability. It was also proved that a basic parameter of biological safety in a working zone was full conformity of air in it to requirements set forth by the existing standards. The authors justify the necessity to improve working conditions for railway transport workers allowing for adverse biological impacts. The following devices were created and patented: 1) a device to disinfect air indoors, with its basic working principle being combined influences exerted on air being disinfected, namely ionization and high frequency ultrasound exposure with frequency being within 1 to 3 MHz range; 2) a shock absorber for an elevator shaft made up of materials unsusceptible to pathogenic microorganisms. The paper contains two variants of designed specifications for an air-disinfecting device: for small volume rooms (up to 300 m^3) and for greater ones, their volume being up to 5.000 m^3. If shock absorbers which we suggest are applied instead of bio-destructive ones, it will allow to eliminate a major source of pathogenic microorganisms and mold fungi in administrative, communal, and passenger premises. Besides, the authors showed that the developed shock absorber was more efficient in emergency cases due to being made of materials with different density, two-layer structure, and vertical layout of its elements. A predicted social and economic effect which we can expect due to implementation of the proposed working conditions improvements was assessed in conformity with the guidelines approved by the Federal Law No. 255-FL issued on December 29, 2006.

Key words: *working conditions, biological factor, working conditions assessment, labor protection, risk, occupational hygiene, railway transport, morbidity.*

Social and economic development in Russia is linked directly to the demographic situation in the country and, above all, to the quality of the state's labor resources, determined by the number, health status and social well-being of the employable population. Taking into account special working factors of the railway industry staff, one can say that a significant part of them are in the risk zone of exposure to pathogenic microorganisms (working environment biological factor). Representatives

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of railway workers' professions are in contact with media that do not meet standards not only in terms of microbiological parameters, but also of parasitic indicators [1, 2]. The exposure to biological factor in the railway sector, by more than 40%, determines negative dynamics of morbidity with temporal disability (MTD).

The formal professional approach adopted for special assessment of working conditions (SAWC) does not allow identify the biological factor in most of the workplaces at railway transport enterprises, since it is not included in the Federal Law "On Special Assessment of Working Conditions"[1] and the Procedure for SAWC [3–6]. All of the above has a negative impact on employees' safety, and reduces functional intensity of the industry's labor protection services for ensuring personnel biological safety. So, for example, the facts of workers diseases and deaths due to infections carriers and products of their vital activity are completely excluded from the legal framework. For a number of jobs, the effect of pathogenic microorganisms [7–9] has not been taken into account.

One of the most informative criteria in assessing the cause-effect relationships of workers' health loss and working conditions is the incidence of temporal disability (MTD). Based on Russian Federal State Statistics Service (Rosstat) data, it's been proved that the cause of MTD cases among the Russian Federation working population, in the period between 1990 and 2016, in 38 to 41% were the consequences of exposure to pathogenic microorganisms by airborne transmission [10, 11]. At the railway industry enterprises, according to the Central Directorate of Healthcare, a branch of OJSC «Russian Railways», this percentage is even higher, which is due to the industry features of working conditions.

Table 1 shows MTD analysis figures for West Siberian Railway.

Table 1

Share of the diseases per categories and ICDs, and their rank in the structure of temporal disability among the West Siberian Railway employees

No	Disease category and individual nosological forms	1995		2005		2010		2017	
		%	Rank	%	Rank	%	Rank	%	Rank
1	**A.R.V.I** (airborne droplet transmission of infection)	43,71	**I**	43,34	**I**	42,71	**I**	40,62	**I**
2	Diseases of musculoskeletal system and connective tissue	14,79	II	18,02	II	17,28	II	17,12	II
3	Diseases of respiratory system	9,60	III	8,62	III	8,77	III	8,69	III
4	Injuries and poisoning in everyday life	5,71	IV	7,57	IV	8,64	IV	8,74	IV
5	Cardiovascular diseases including:	5,71	IV	5,09	VI	3,40	VI	3,45	VI
6	Diseases of digestive system	5,32	V	5,74	V	6,15	V	6,11	V
7	Infections of skin and subcutaneous tissue	3,11	VI	2,87	VII	2,75	VII	2,65	VII
8	Other	12,05	–	8,75	–	10,3	–	12,62	–
9	Total for all diseases (in percent)	100,0	–	100,0	–	100,0	–	100,0	–

[1] O spetsial'noi otsenke uslovii truda: Federal'nyi zakon № 426-FZ ot 28.12.2013 g. [On a special assessment of working conditions: Federal Law No. 426-FZ of December 28, 2013]. *GARANT*. Available at: http://base.garant.ru/70552676/#friends (18.02.2018) (in Russian).

Currently, using materials that are resistant to biodegradation, especially the ones used for passenger cars finishing, is topical. Materials exposed to microorganisms are the medium for their growth, which in turn leads to an increase in the level of air bacterial contamination [12, 13].

It turned out that microorganisms destroy a shock absorber made of foam rubber, used as a backup protection system. Such shock absorber is located in the bottom of an elevator shaft and is necessary to mitigate the fall of an elevator car in case of emergency. Biodegradation of foam rubber is accompanied by an increased concentration of pathogenic microorganisms in the air due to regular movements of an elevator car in a shaft. The intensity of biodegradation increases with dampness, insufficient ventilation in an elevator shaft.

JSCo «Russian Railways» uses passenger and freight-passenger elevators in administrative and passenger buildings. «Russian Railways» is actively involved in equipping the passenger infrastructure facilities with elevators and lifts for low-mobility population groups, which is dictated by the state program "Accessibility" for 2011–2020.

The purpose of this paper is to develop ways to reduce risk and exposure level to the negative biological factor in production environment on the railway industry employees with the estimation of predicted benefits from the proposed methods to be introduced.

Material and methods. Viral diseases of respiratory organs form a consistently high level of MTD at the enterprises of JSCo «Russian Railways». Viral diseases are frequently observed among the roadlines service workers, in particular. In order to ensure safe working conditions, special attention should be paid to microbial indices of the air in the working zones, rest areas and common areas on site. It is necessary to introduce modern decontamination and operational air quality control systems, which are permitted for use at railway transport facilities. At present, there are devices introduced that implement ultraviolet air disinfection technology. For some working zones, one can use equipment that functions with the combined effect of ionization and high-frequency ultrasound in the frequency range from 1–3 MHz[2] [14]. Ultrasonic effect makes it possible to obtain an excessively fine dispersed aerosol in a liquid-gas system, and also to enhance disinfection capacity of the device [15, 16]. Within the specified frequency range, airborne ultrasound does not have negative effect on humans [17]. The patented device provides: high efficiency of air disinfection for individual working areas; absence of negative impact on the worker's organism when used; low power consumption, versatility from the point of installation and connection to mains.

Table 2 presents the designed technical specifications of the developed device for working areas disinfection.

Results and discussion. A two-layer shock absorber[3], made of flexible elastomeric foam and neoprene has been

[2] Shchetinin A.N., Khamanov I.G., Latyshov D.A., Evstegneeva A.A. Ustroistvo dlya obezzarazhivaniya atmosfernogo vozdukha v pomeshchenii: patent 150551, Rossiiskaya Federatsiya, MPK A61L 9/16 (2006.01) [Device for disinfection of atmospheric air in the room: patent 150551, Russian Federation MPK A61L 9/16 (2006.01)]. No. 2014115041/15; zayavl. 15.04.2014; opubl. 20.02.2015. Byul. № 5. Novosibirsk, SGUPS.(RU) (in Russian).

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Table 2

Specifications of the device for working areas disinfection

No	Specifications	Device developed	
		For working zones	For supply (supply and exhaust) ventilation systems of working
1	Capacity, m^3/hour	310	5106
2	Power consumption, Wt	45	250
3	Frequency range of the emitted ultrasound, MHz	1–3	1–3
4	Room volume, m^3	Below 300	below 5000
5	Feeding electrical power, V/Hz	220 / 50	220 / 50
6	Working cycle duration (work/technical break), h	6 / 0,5	6 / 0,5
7	Volume of water to be poured, l	10	До 100
8	Dimensions, mm	360 × 295 × 290	ionizer 711 × 660 × 457, emitter 390 × 353 ×353, capacity 500 × 505 × 505
9	Weight, including water to be filled in, kg	15	below 137
10	Noise level, dBA	41 max	50 max

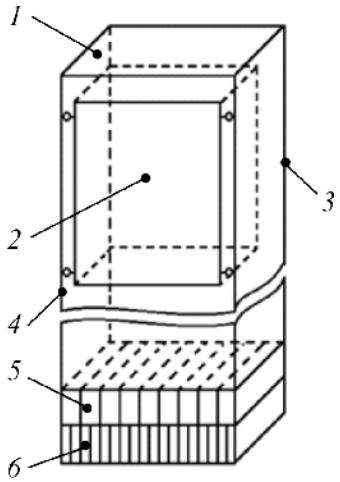

Figure. 1. An elevator shaft with a proposed two-layer shock absorber: *1* – elevator shaft; *2* – elevator car; *3, 4* – sliding guide-ways; *5, 6* – double-layer absorber

developed. These materials, unlike the ones used, are immune to the effects of microorganisms, hence if applied it will reduce concentration of pathogenic microorganisms and mold fungi in the air in public places of administrative, communal, and passenger premises.

The utility model sketch is shown in Figure 1. Characteristics of the proposed and applied materials for shock absorber are given in Table 3.

Such absorber is made as a three-dimensional body consisting of different density layers. Layers are being placed with the possibility to be shifted relative to each other; each layer of volumetric body is made in the form of prismatic elements, installed vertically. Such arrangement of elements enables more efficient shocks absorption and bounce minimization. The proposed absorption layers are placed in the pit of an elevator shaft. The obtained values of thickness and cushioning layers area for the proposed materials do not exceed pits sizes for typical elevators shafts, so no technical modifications will be required at installation.

The proposed shock absorber in use for the elevator contributes to solving two problems:

Table 3

Specifications for materials used and proposed

No	Specification	Materials		
		Polyurethane foam	Flexible elastomeric foam	Neoprene
1	Apparent density, kg/m^3	25–30	40–65	66–200
2	Modulator of direct elasticity, kPa	3,5–4,5	8	10–15,5
3	Elasticity	high	high	high
4	Operating temperature range	От –15 до 100 °С	От –50 до 105 °С	От –55 до 90 °С
5	Moisture resistance	destroyed in a humid environment	waterproof	waterproof
6	Combustibility	combustible	low-combustible	low-combustible
7	Wear resistance	nondurable	durable	durable
8	Susceptibility to microorganisms	destroyed when exposed to microorganisms	***resistant***	***resistant***

Table 4

Initial data for calculating economic effect of the proposed ways to improve working conditions

Index	Number of employees	Normative period for calculating average earnings	Average monthly salary of an employee at JSCo «Russian Railways» and its branches	Number of temporal disability cases at JSCo «Russian Railways» due to biological factor, for a calendar year
Value	756 000 people [1]	730 calendar days [2]	25 th. Rub.	178 315 cases [3]

Notes:

[1] As of 01.01.2017, based on analysis data of labor protection status and conditions at JSCo «Russian Railways» for 2016. (Ref.-5305 dated March 24, 2017).

[2] According to Part 1, Article 14, No. 255-FZ of 29.12.2006 "On Compulsory Social Insurance for Tempory Disability and Cases related to Maternity"[4].

[3] According to the Central Directorate of Healthcare, a branch of JSCo «Russian Railways».

- reducing the risk of biological factor' negative impact on workers in administrative and passenger buildings by eliminating one of the sources;

- increasing the effectiveness of backup protection system of lifting and transport mechanism to save people's lives in case of elevator car falling into a shaft.

The forecasted economic component is estimated according to the procedure approved by the Federal Law "On Compulsory Social Insurance for Tempory Disability and Cases related to Maternity" dated 29.12.2006 No. 255-F[4]. Economic efficiency is achieved by reducing payments for tempory disability due to illness with acute respiratory viral infections (A.R.V.I). The initial data for

[4] Ob obyazatel'nom sotsial'nom strakhovanii na sluchai vremennoi netrudosposobnosti i v svyazi s materinstvom: Federal'nyi zakon № 255-FZ ot 29.12.2006 g. [On Compulsory Social Insurance for Tempory Disability and Cases related to Maternity: Federal Law ddt. 29.12.2006, No. 255-FZ]. *Konsul'tantPlyus*. Available at: http://www.consultant.ru/document/cons_doc_LAW_64871/ (18.02.2018) (in Russian).

calculations are given in Table 4.

The daily average earnings $E_{d.a.}$ is determined according to Part 3, Article 14, No. 255-FZ of 29.12.2006 [4]:

$$S_{d.a.} = \frac{S\ earnings}{730}.$$

where *S_earnings* is the sum of a worker's earnings for a settlement period (during recent 730 calendar days).

The daily allowance for temporal disability $A_{t.d.}$ is determined according to Part 4, Article 14, No. 255-FZ of 29.12.2006[4]:

$$DA_{t.d.}=S_{earnings}\,P_{a.e.} \quad (2)$$

where $P_{a.e.}$ is the percentage of average earnings, depending on a worker's employment period.

The percentage of average earnings is calculated depending on a worker's employment period and makes, in accordance with Part 1, Article 7 No. 255-FZ of December 29, 2006 [4]:

– 100 % of the average earnings with an insurance period of 8 years or more;

– 80 % of the average earnings with an insurance period from 5 to 8 years;

– 60 % of the average earnings with an insurance period of up to 5 years.

To calculate the daily allowance, the value of 80% of the average earnings is taken.

The amount for temporal disability allowance $A_{t.d.}$ is determined in accordance with the Part 5, Article 14 No. 255-FZ of 29.12.2006[4]:

$$A_{t.d.}= DA_{t.d.}\,D_{t.d.}, \quad (3)$$

where $D_{t.d.}$ – the days of temporal disability according to a sick leave. For calculations, 7 days are taken as temporal disability period due to biological factor.

The calculation results are given in Table 5.

In accordance with the current legislation, payment of temporal disability allowances is made from the funds of the Russian Federation Social Insurance Fund (SIF) and at the expense of an employer. The first three days of a sick leave, in case of correct filling and registration, are paid by an employer, the rest days – from SIF. Taking into account the accepted condition (7 days are taken as temporal disability period due to biological factor), we will describe the distribution of a financial burden of paying allowances due to temporal disability between SIF and JSCo «Russian Railways» in Figure 2.

As a result of a set of activities to reduce exposure to biological factor on the railway industry workers, MTD level due to biological factor will decrease by 15–35%.

Table 5

The results of calculating the average amount for temporal disability allowance due to biological factor, at JSCo «Russian Railways»

Index	Average daily earnings	Amount of daily allowance	The amount of temporal disability allowance for a single case	Total amount of temporal disability allowance due to biological factor, at JSCo «Russian Railways»
Value	0,82192 kRub.	0,65754 kRub.	4,60278 kRub.	820 744,7157 kRub.

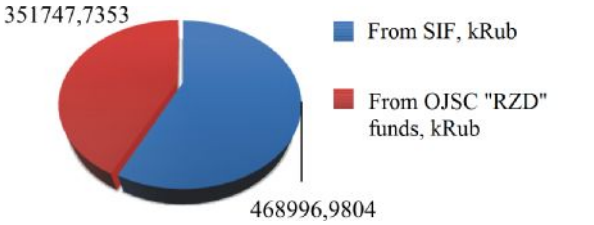

Fig. 2. Distribution of temporal disability allowances' payments to JSCo «Russian Railways» employees due to biological factor

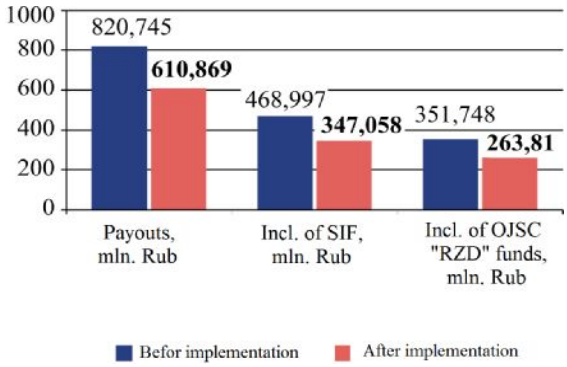

Fig.3. Forecasted economic effect of a set of activities to improve working conditions of JSCo «Russian Railways» employees

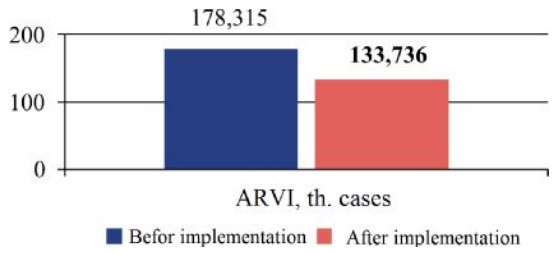

Fig. 4. Forecasted social effect of a set of activities to reduce impact of biological factor for JSCo «Russian Railways»

Figures 3 and 4 show the results of assessing social and economic efficiency of activities to reduce exposure to biological factors of «Russian Railways» employees.

Social performance of the introduced set of measures to reduce impact of biological factor for employees of JSCo «Russian Railways»:

- in reducing MTD level among workers in the railway industry;
- in improving working conditions (bringing the working zone air in compliance with the requirements set out with the Order No. 33n of the Ministry of Labor ddt. 24.01.2014 and SP 2.5.1198-03[5]) and, as a consequence, in reducing the level of occupational risk;
- in increasing labor performance.

It's been proved that exposure to biological factor of the railway industry workers leads to significant social and economic losses. We confirmed that the main indicator of biological safety is the compliance of air environment with the requirements of effective standards. We justified the necessity and development of new ways to improve working conditions, taking into account negative biological effects. We did the prognostic assessment of the socio-economic effect from the proposed methods for improving working conditions.

Conclusions. An integrated application of the proposed methods to improve working conditions at the railway industry enterprises will significantly reduce risk of the biological factor negative effect on workers. Implementation thereof will allow for:

- reducing MTD level;
- reducing payments for temporal disability;
- improvements in the working conditions (bringing the working zone air into compliance with the requirements set out in the Order No. 33n of the Ministry of La-

[5] Ob utverzhdenii Metodiki provedeniya spetsial'noi otsenki uslovii truda, Klassifikatora vrednykh i (ili) opasnykh proizvodstvennykh faktorov, formy otcheta o provedenii spetsial'noi otsenki uslovii truda i instruktsii po ee zapolneniyu (s izmeneniyami na 14 noyabrya 2016 goda): Prikaz Ministerstva truda i sotsial'noi zashchity Rossiiskoi Federatsii [On approval of the Methodology for conducting special assessment of working conditions, the Classifier of harmful and (or) hazardous production factors, report forms on a special assessment of working conditions and instructions for filling it (as amended on November 14, 2016): Order of Ministry of Labor and Social Protection of Russian Federation]. *KODEKS: Elektronnyi fond pravovoi i normativno-tekhnicheskoi dokumentatsii*. Available at: http://docs.cntd.ru/document/499072756 (18.02.2018) (in Russian).

bor ddt. 24.01.2014 and SP 2.5.1198-03) and, as a consequence, reducing the level of occupational risk;

- increase in labor performance by reducing MTD level and improving working conditions.

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ASSESSMENT OF RISK FACTORS WHICH CAUSE EMOTIONAL BURN-OUT IN TEACHERS FROM VARIOUS EDUCATIONAL ESTABLISHMENTS IN MAGADAN REGION

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The authors examined 32 teachers from a natural sciences lyceum, 26 teachers from Magadan vocational schools, and 32 teachers from a boarding school located in Evensk, a remote settlement in Magadan region. The research goal was to assess risk factors which could lead to occupational emotional burn-out syndrome in teachers working in secondary and vocational schools in Magadan region. Emotional burn-out parameters were determined as per V.V. Boiko's "Diagnostics of emotional burn-out" questionnaire; neuro-psychic adaptation was measured as per a scale developed by I.N. Gurvich; social frustration was determined as per L.I. Wasserman's technique. The research revealed that "Strain" syndrome phase didn't occur in any group of the examined teachers. "Resistance" phase was the most apparent one as it was just starting to appear. "Depletion" phase was detected only in teachers from a lyceum in Magadan, and it was at the stage of just being formed. This teachers' group also had more apparent specific symptoms as per various burn-out phases against two other examined groups, and this discrepancy was statistically significant. We showed that schoolteachers from Magadan and Evensk were significantly more frustrated with various social functioning spheres and had more apparent problems in their neuro-psychic sphere than teachers from vocational schools ($p<0.05$). Social frustration and occupational activities make their contribution into disorders in teachers' psychic adaptation. High occupational loads borne by schoolteachers, especially in a lyceum where requirements and educational loads are more serious, make adverse impacts exerted by frustrating factors even worse, and result in disorders occurring in neuro-psychic sphere. Occupational deformation of schoolteachers' personalities deteriorates due to long-term exposure to extreme climatic conditions existing in the North-Eastern regions. Teachers from vocational schools don't run similar risks of occupational burn-out syndrome which can be explained by less strict requirements to educational process in such establishments.

Key words: *teachers, risk factor, emotional burn-out syndrome, frustration, neuro-psychic adaptation, the North.*

Occupational activities of a teacher involve frequent micro-stresses and neuro-emotional strain [1]. Teaching is a peculiar social micro-environment and it is associated with continuous impacts exerted on the nervous system by emotional stressful factors. Teachers often have adverse psychic state and it results in their lower working capabilities and poorer health. Issues related to teachers' occupational risks are becoming truly vital at present when the contemporary education system is undergoing major restructuring [2, 3]. When body strain reaches a certain level, multiple

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symptoms of occupational burn-out syndrome occur.

In order to save their energy resources, a lot of teachers resort to various psychological protection mechanisms, and they are doomed to emotional burn-out. According to V.V. Boyko [4], "emotional burn-out is a psychological protection mechanism which a personality creates and which means complete or partial removal of emotions (lowering their energy) as a response to selective psychological traumas". Emotional burn-out makes for deterioration of physical and mental health and causes higher risks of various psychogenic disorders and deadaptation [3, 5, 6]. Burn-out was shown to be related to higher risks of cardiovascular diseases including metabolic syndrome, hypothalamo-pituitary-adrenals axis deregulation together with activation of the sympathetic nervous system and sleep disorders [7–10].

Life under severe natural-climatic conditions existing in the North-Eastern Russian regions requires great psycho-physiological reserves of a body, causes significant stress in the functional systems, and is an additional factor causing occupational stress emergence in teachers [11]. We proved that teachers in Magadan region tended to suffer from rather high psycho-emotional stress, increased fatigue, weakness, inertia, and nervous processes imbalance [11]. The situation can become even worse due to long-term exposure to social frustrating factors which cause adaptation mechanisms strain and lead to disorders in mental adaptation and lower life quality [12]. Therefore, it is vital to assess social frustration (a person's inability to satisfy his or her social needs) and disorders in social adaptation of people living under severe conditions in the North-Eastern regions as a factor which causes health deterioration. Examination of risk factors which cause teachers' occupational burn-out can help to prevent diseases caused by nervous system overstrain and to provide successful implementation of timely prevention activities [13].

Given all the above mentioned, we thought it interesting to examine risk factors causing health disorders in teachers which were related to their occupational activities; our research objects were teachers living in urban and rural environment in the North-Eastern Russian regions.

Our research goal was to assess risk factors causing occupational emotional burn-out in teachers from secondary and vocational educational establishments in Magadan region.

We set the following tasks:

1. To perform comparative examination of symptoms phases and how apparent they were in teachers from various educational establishment in Magadan region.

2. To assess neuro-psychic adaptation and social frustration in teachers from various educational establishments in Magadan region.

3. To examine correlations between neuro-psychic adaptation, social frustration, and emotional burn-out symptoms in teachers from various educational establishments in Magadan region.

Data and methods. We included 3 groups into our examination. The first group comprised 32 teachers from Magadan N.K. Krupskaya's natural sciences lyceum No. 1 (average age was 41±2.2, teaching experience was 18±2.1). The second group was made up of 26 teachers employed at vocational schools No. 3 and No. 7 (accordingly, 44±2.3 and 17±3.3). The third group were 32 teachers from a boarding school located in Evensk (accordingly, 40±2.1 and 17±2.3). Evensk is a settlement in Magadan region located 535

kilometers to the north of Magadan. It is the most uncomfortable place in terms of natural-climatic and social-economic conditions. The only way to get to the regional center from there is to take a flight on a small plane.

All teachers participated in our research voluntarily; the research was conducted in full conformity with the requirements set forth by biomedical ethics; all the participants gave their informative written consent to it in accordance with established procedures.

To assess risks of occupational emotional burn-out, we applied V.V. Boiko's "Emotional burn-out diagnostics" questionnaire [4, 14] based on G. Selye's theory which describes how a stress emerges and develops. Emotional burn-out syndrome (EBS) has three phases in its development; each phase consists of four symptoms. Intensity of each symptom varies from 0 to 30 scores: 9 scores or less mean symptom hasn't formed yet; 10-15 scores mean it is being formed; 16 scores and more mean a symptom has formed. Symptoms with 20 scores and more are predominating for this phase or for the whole syndrome. Each phase can score from 0 to 120: 36 and less scores mean a phase hasn't formed yet; 37-60 scores mean a phase is being formed; 61 and more scores mean a phase has formed. The overall scores equal to 108 and less are considered to be low; 109-180, average; 181 and more, high [4, 14]. We determined neuro-psychic adaptation (NPA) with a scale which included 26 questions and helped to diagnose pre-nosologic subclinical states similar to a neurosis [15]. People who score more than 20 according to this scale suffer from neuro-psychic instability and emerging stress. A technique for determining social frustration (SF) is aimed at detecting zones where the greatest social frustration appears. The higher scores are, the more dissatisfied a person is [12, 14].

All the obtained data were processed as per conventional techniques with "Statistica-6.0" software. Sampling distribution which corresponded to a standard one was determined for all the examined parameters; simple mean (M) and error of mean (±m) were calculated. We applied Student's t-criterion to test significance of discrepancy between groups. Parameters relationships were detected with Spearmen's rank correlation coefficient.

Results and discussion. Our research results are given in Figures 1-4; they focus on comparison between teachers working in secondary schools and vocational schools in Magadan, and their colleagues from Evensk (a remote settlement in Magadan region) in terms of phases formation and burn-out symptoms intensity.

As we can see from Figure 1, "Strain" phase of the syndrome hasn't formed in all three teachers' groups. "Resistance" phase is the most apparent and it is being formed; it shows that mechanisms of protection against significant expenditure of emotional resources are already functioning.

"Depletion" phase hasn't formed either, excluding teachers from the lyceum (group 1). It is interesting to note, that average values of "Resistance" phase and "Depletion" phase are significantly higher in this group ($p<0.05$), than in two others.

If we consider burn-out symptoms intensity in greater details, we can see (Figure 2) that teachers from the lyceum in Magadan suffer from "psychological traumatic experience" in "Strain" phase and this symptom is much more apparent in them against two other groups ($p<0.05$). These people also have "anxiety and depression" symptom more frequently. In

other words, they are more aware of occupational factors which cause psychological traumatic experience, such as despair, personal anxiety, disappointment in themselves and their occupation. Teachers from vocational schools are dissatisfied with themselves and an occupation they chose. This parameters is the highest among them ($p<0.05$) in comparison with two other examined groups (Figure 2). All the other symptoms are, on average, not so apparent. And as for teachers from Evensk, they don't have any formed symptoms in this burn-out phase.

"Inadequate selective emotional response" is a formed symptom detected in teachers from the lyceum in "Resistance" phase. It means they suffer from high emotional instability which is characteristics for teachers' personal profile (Figure 3). "Occupational duties reduction" symptom is also practically formed, and these symptoms are statistically significantly ($p<0.05$) more apparent among them than in two other groups. "Expansion of emotions saving sphere" is being formed among teachers from groups 1 and 3. "Emotional-moral disorientation" and "occupational duties reduction" symptoms are being formed in teachers from all three examined groups (Figure 3). "Resistance" phases symptoms are being formed in teachers from vocational schools in Magadan and teachers from the boarding school in Evensk except "Expansion of emotions saving sphere" in the former group, and "Inadequate selective emotional response" in the latter one.

We didn't detect any "Depletion" phase signs in teachers (Figure 4). However, teachers from the lyceum stated that "emotional deficiency" symptom was already forming in them. And as we can see, average scores of such symptoms as "emotional deficiency" and "personal detachment or depersonalization" were significantly more apparent in them ($p<0.05$) in comparison with two other groups. Teachers from vocational schools mentioned having "psychosomatic and psycho-vegetative disorders" significantly less frequently ($p<0.05$) than their colleagues from Evensk and the lyceum in Magadan.

As a result, we didn't detect any signs of "Strain" or "Depletion" phase in teachers from Evensk and burn-out symptoms in general. However, as regards "Depletion" phase symptoms, "psychosomatic and psycho-vegetative" disorders prevail in them. Average scores for "Resistance" and "Depletion" phases are significantly higher in teachers from the lyceum in Magadan ($p<0.05$), than in their colleagues from two other groups. Also, specific symptoms of the syndrome are more apparent in them than in teachers from two other examined groups. "Psychological traumatic experience" which is being formed is the most apparent in "Strain" phase ($p<0.05$). Such symptoms as "inadequate selective emotional response" and "occupational duties reduction" are significantly more apparent and formed in "Resistance" phase ($p<0.05$); "emotional deficiency" and "personal detachment or depersonalization", in "Depletion" phase ($p<0.05$).

Such "Resistance" phase symptoms as "emotional-moral disorientation", "expansion of emotions saving sphere", and "occupational duties reduction" are mainly forming in teachers from Evensk. We also detected "Strain" phase symptom, "psychosomatic and psycho-vegetative disorders", in them. "Dissatisfaction with oneself" symptom of "Strain" phase which was being formed was the most apparent in teachers from vocational schools against their counterparts ($p<0.05$). "Resistance" phase symptoms, excluding "expansion of emotions saving sphere", were also being formed in them.

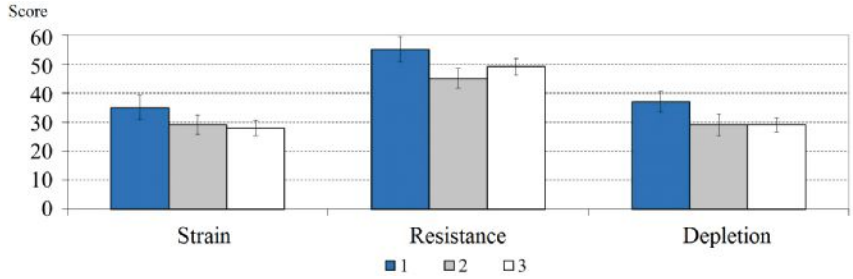

Figure 1. Intensity of emotional burn-out syndrome phases in teachers from 3 different groups:
1 is a group of teachers from a lyceum in Magadan; 2 is a group of teachers from vocational schools in Magadan; 3 is a group of teachers from a boarding school in Evensk

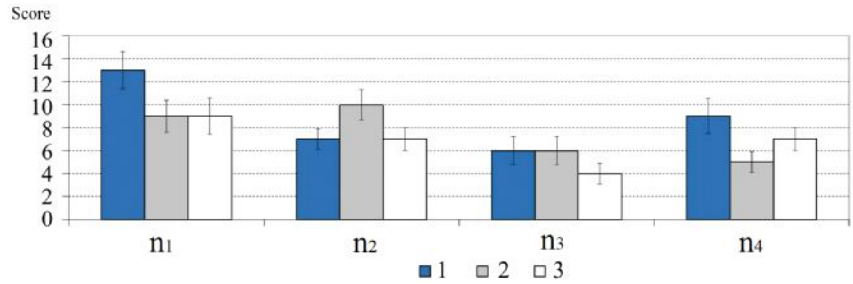

Figure 2. Burn-out symptoms in "Strain" phase in teachers from various groups:
1 is a group of teachers from a lyceum in Magadan; 2 is a group of teachers from vocational schools in Magadan; 3 is a group of teachers from a boarding school in Evensk; n1 is "psychological traumatic experience"; n 2is "dissatisfaction with oneself"; n 3 is "a feeling of being caged"; n 4 is "anxiety and depression"

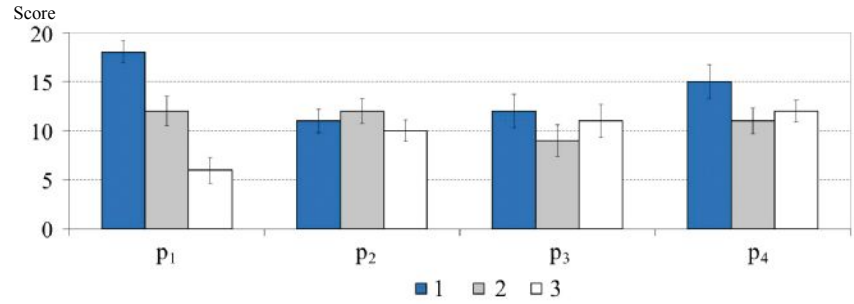

Figure 3. Burn-out symptoms in "Resistance" phase in teachers from various groups:
1 is a group of teachers from a lyceum in Magadan; 2 is a group of teachers from vocational schools in Magadan; 3 is a group of teachers from a boarding school in Evensk; p1 is "inadequate selective emotional response"; p2 is 'emotional-moral disorientation"; p3 is "expansion of emotions saving sphere"; p4 is "occupational duties reduction".

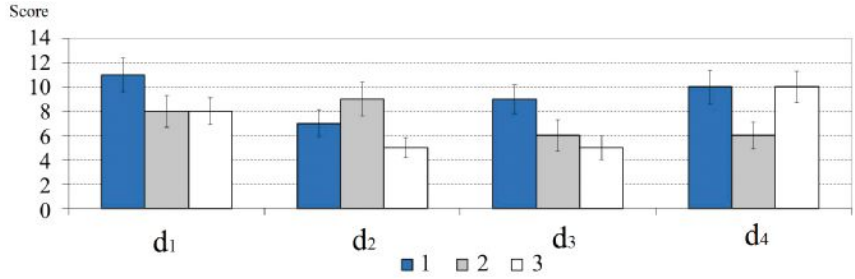

Figure 4. Burn-out symptoms In "Depletion" phase in teachers from various groups:
1 is a group of teachers from a lyceum in Magadan; 2 is a group of teachers from vocational schools in Magadan; 3 is a group of teachers from a boarding school in Evensk; d1 is "emotional deficiency"; d2 is "emotional detachment"; d3 is "personal detachment or depersonalization"; d4 are "psychosomatic and psycho-vegetative disorders".

We should draw your attention to the fact that teachers from the boarding school located in a remote settlement were to a greater extent exposed to adverse social-economic and natural-climatic conditions of the North-Eastern zone than their colleagues who lived and worked in Magadan. However, teachers working in the lyceum No. 1 in Magadan ran the highest risks of occupational burn-out. In can possibly be due to higher requirements and educational loads in this establishment, that is, due to their direct occupational activities.

When we assessed neuro-psychic adaptation and social frustration of teachers from different educational establishments in Magadan region, we obtained similar results from teachers working in a lyceum in Magadan and a boarding school in Evensk. And their parameters were statistically significantly higher ($p<0.05$), than in teachers from vocational schools (Figure 5). Individual distribution as per the scale which determines neuro-psychic adaptation (NPA) was within 8-76 scores for teachers from group 1; within 7-36, for teachers from group 2; and 9-39, for teachers from group 3. NPA parameter is a significant criterion which shows social-psychological adaptation; according to the methodology [15], it corresponded to neuro-psychic instability and limited mental health with apparent signs of stress in teachers from group 1 and 3. Teachers from vocational schools were, on average, neuro-mentally stable (Figure 5).

Social frustration in teachers from groups 1 and 3 was, on the whole, not apparent, but was statistically significantly higher ($p<0.05$), than in their colleagues from vocational schools (Figure 5). As a result, teachers from vocational schools seem to be in better conditions as regards neuro-psychic adaptation and social frustration than their colleagues from two other groups.

Analysis of correlations between these NPA parameters and social frustration revealed there was a positive relationship between them in teachers from the lyceum in Magadan ($r=0.63$; $p<0.001$) and the boarding school in Evensk ($r=0.47$; $p<0.01$). We didn't detect any correlations between the above-mentioned parameters in teachers from vocational schools. When frustration occurs, a lot of subcortical masses become active, and significant emotional discomfort appears [12]. Frustrating factors stimulate such responses as aggression and depression which, in their turn, can transfer into self-aggression and fixation of rigid behavioral practices [12]. Therefore increased social frustration in teachers can be a risk factor which causes mental health disorders.

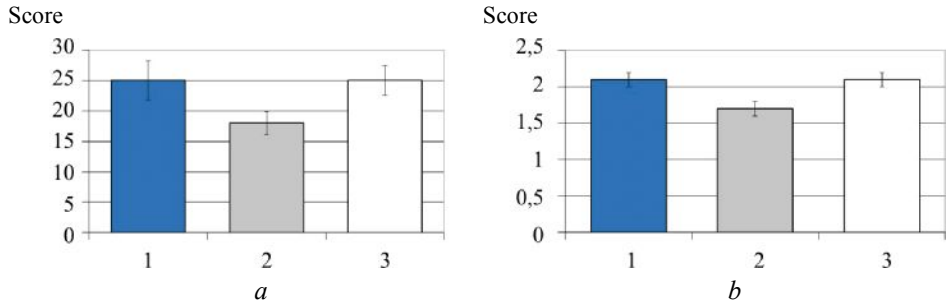

Figure 5. Neuro-psychic adaptation (a) and social frustration (b) in teachers from Magadan region:
1 is a group of teachers from a lyceum in Magadan; 2 is a group of teachers from vocational schools in Magadan; 3 is a group of teachers from a boarding school in Evensk

We detected positive correlations between parameters of neuro-psychic adaptation, social frustration, and emotional burn-out syndrome. The greatest number of correlations between these parameters was detected in group 1; group 3 followed; the least correlations were detected in group 2.

Neuro-psychic adaptation parameters in teachers from the lyceum in Magadan didn't have any correlation only with "emotional-moral disorientation" and "emotional detachment" out of 15 emotional burn-out syndrome symptoms (correlations within other syndrome parameters were within r=0.44-0.69, p<0.05-0.01). 9 positive correlations between neuro-psychic adaptation parameters and emotional burn-out syndrome were detected in teachers from Evensk; namely, correlations within r=0.36-0.74 range (p<0.05-0.01) were detected with "Strain" and "Depletion" phases parameters, and such symptoms as "psychological traumatic experience", "a feeling of being caged", "anxiety and depression", "expansion of emotions saving sphere", "personal detachment", and "psychosomatic and psycho-vegetative disorders". The examined parameters had 3 correlations in teachers from vocational schools: neuro-psychic adaptation correlated with "Resistance" phase and such symptoms as "inadequate selective emotional responses" and "psychosomatic and psycho-vegetative disorders" (r=0.46-0.62, p<0.05-0.01).

Our analysis of correlations between social frustration parameters and emotional burn-out syndrome revealed the following: just as it was with neuro-psychic adaptation, there were no correlations detected in Magadan teachers only with "emotional-moral disorientation" and 'emotional detachment", while correlations with all the other symptoms were within r=0.39-0.66, p<0.05. As for teachers from Evensk, we revealed 5 statistically significant positive correlations between social frustration parameters and "Strain" phase parameters, "psychological traumatic experience", "a feeling of being caged", "anxiety and depression", and "personal detachment" symptoms (r=0.39-0.66, p<0.05). We detected 3 correlations between social frustration and emotional burn-out symptoms in teachers from vocational schools; these symptoms were "dissatisfaction with oneself", "personal detachment", and "psychosomatic and psycho-vegetative disorders" (r=0.57-0.68, p<0.01).

At the same time, we detected positive correlation between overall emotional burn-out syndrome scoring and neuro-psychic adaptation and social frustration parameters in all the examined groups. We obtained the following values, correspondingly: group 1, r=0.63 and r=0.58; group 2, r=0.45 and r=0.44; group 3, r= 0.57 and r=0.47 (at p<0.05-0.01).

Conclusion. The research revealed that "Strain" phase of the syndrome wasn't formed in all three examined teachers' groups. "Resistance" phase was the most apparent and it was being formed. "Depletion" phase was being formed only in teachers from the lyceum in Magadan. Their average "Resistance" and "Depletion" phases parameters were also significantly higher (p<0.05) than in teachers from two other groups, and specific symptoms as per burn-out phases were also more apparent in them. As a result, teachers from the lyceum in Magadan ran the highest risks of occupational emotional burn-out; teachers from vocational schools were the least susceptible to it. Our research also revealed that teachers from secondary schools in Magadan and Evensk were significantly more frustrated with various spheres of their social functioning and had more apparent problems in their

neuro-psychic sphere than teachers from vocational schools.

Correlation analysis of all the obtained data revealed that the most strained mechanisms were formed in teachers from school, especially the lyceum in Magadan. It is obvious that social frustration and teachers' occupational activities are basic components in psychic adaptation disorders. Serious occupational loads teachers have to bear, especially in a lyceum where requirements and educational loads are higher make adverse effects exerted by frustrating factors even worse, and make for disorders in neuro-mental sphere, neurotization, and mental deadaptation occurrence. Personal occupational deformation becomes deeper under long-term exposure to extreme conditions existing in the North-Eastern regions. Teachers from vocational schools run lower risks of occupational burn-out syndrome. It is quite possible that requirements to educational process in vocational schools are not so strict as in a natural sciences lyceum.

All the above stated proves it is necessary to perform timely prevention activities in educational establishments as it will help to prevent occupational burn-out syndrome, pathological mental deadaptation, and psychosomatic diseases.

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TOXICOLOGICAL AND HYGIENIC ASSESSMENT OF ALLERGENIC ACTIVITY AND HAZARDS CAUSED BY DRY YEAST FUNGI

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This research significance was determined by the fact that health disorders, mostly allergenic ones and immune pathologies, prevailed among workers exposed to native yeast fungi of Saccharomyces cerevisiae L153 strain and dry bakery yeast. We observed apparent shifts and imbalance between humoral and cellular immune system parameters and detected allergenic responses in a body which had occupational etiology. Our research goal was to experimentally determine sensitizing power and allergenic hazards of dry bakery, wine, and spirit yeast fungi. We developed an original technique based on oxidizing hydrolysis which we performed with an organic acid on surface β-glucoside bonds between elementary units of nitrogen-containing polysaccharide (chitin); the next stage was extraction in alkaline medium, and it allowed us to obtain extracts-allergens out of dry bakery, wine, and spirit yeast fungi with high contents of soluble protein-containing substances. It was quite sufficient for experimental modeling of their impacts on a body and detecting peculiarities of their biological effects.

We validated an alternative short-term procedure which includes unified technology aimed at reproducing and objective detection of delayed hypersensitivity during an experiment performed on white mice. This procedure allows to detect allergenic power and allergenic hazard of a biological substance using its soluble proteins-antigens.

Our experiments allowed to reveal that protein-antigen complexes contained in dry bakery, wine, and spirit yeast fungi had high sensitizing powers (allergenic powers) and belonged to the 1st allergenic hazard category (extremely dangerous occupational allergen).

We showed that bakery, wine, and spirit yeast fungi had common antigen immune determinants. It makes body poly-sensitization quite possible under inhalation exposure to them in working conditions and causes high risks of cross allergenic responses in people who contact them.

***Key words**: health disorders, inhalation exposure, yeast fungi, extracts, oxidizing hydrolysis, sensitizing power, allergenic hazard.*

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Determination of maximum allowable concentrations and control over hazardous substances contents in working area air are the most efficient measures which can prevent occupational and production-related pathologies in workers. And unfortunately, there are no existing hygienic standards for permissible contents of various microorganisms-producers and biological preparations in working area air despite their wide application in production.

First of all, we can mention such widely-spread industrial microorganisms strains as bakery, wine, and spirit yeast fungi *Saccharomyces cerevisiae*. They are applied in their natural or dry state in production of food stuffs, spirits, and wine raw materials, and a lot of workers contact them during production processes. Workers who are exposed to aerosols of native yeast fungi belonging to *Saccharomyces cerevisiae L153* and dry bakery yeast suffer from health disorders, mostly allergies and immune pathologies. Apparent shifts and imbalance between humoral and cellular parameters of the immune system occur in a body, and occupational allergic responses can also be observed [1, 2].

By now, maximum allowable concentration of yeast cells belonging to *Saccharomyces cerevisiae L153* strain in working area air has been experimentally grounded and fixed in Belarus. This maximum allowable concentration in working area air is equal to 1,000 m.cells/m^3; the strain is assigned into the 3rd hazard category and considered to be an allergen. There is also a certified procedure for measuring concentrations of such cells in working area air [3].

Another vital task here is to give grounds for maximum allowable concentration of dry bakery, wine, and spirit fungi in working area air. Dry yeast fungi which contaminate working area air belong to organic protein-containing aerosols, and methodical approaches to their hygienic standardization differ from those which are applied in standardizing viable industrial microorganisms strains. When giving experimental justification for maximum allowable concentrations of dry bakery, wine, and spirit fungi, it is necessary to determine their sensitizing power and allergenic hazard.

Our research goal was to experimentally determine sensitizing power and allergenic hazards of dry bakery, wine, and spirit yeast fungi.

Data and methods. We chose dry bakery, wine, and spirit yeast fungi as our experimental objects; these fungi were produced from a biomass of industrial yeast fungi belonging to *Saccharomyces cerevisiae* strains. Research samples were obtained from "Yeast works" LLC, located in Minsk.

We applied some techniques and methodical approaches to examining biological effects and fixing standards for organic aerosols contents in working area air; when fixing such standards, experts paid their greatest attention to proteins. Some of these approaches were developed and tested to set standards for certain organic dusts of animal, vegetative, and mixed origin [4].

To achieve our goals, first of all, we had to solve two tasks. First, to perform experimental modeling of influences exerted on a body by dry yeast cells which were practically water-insoluble, and to reveal their biological effects, mainly allergic and immune toxic ones, we should obtain soluble protein-antigen substances out of them. The task was hard to solve due to high resistance and strength of yeast fungi cell walls as they had chitin in their structure.

We tested different ways of hydrolysis of chitin and other yeast cell structures and detected optimal conditions

for the process; we also developed an original procedure for obtaining extracts-allergens with maximum possible contents of soluble protein-containing substances out of dry yeast fungi.

Techniques for experimental modeling and determining sensitization are comprehensively developed and widely used to explore industrial organic aerosols as obligate allergens and to fix hygienic standards for their contents in working area air; however, such experiments have been performed only on albino guinea pigs as these animals are the most sensitive in terms of immunologic reactivity [4]. Nowadays, it is too expensive to use these laboratory animals during experiments as they cost too much; it is even next to impossible as there isn't any facility for breeding them in Belarus. Therefore, to determine sensitizing power of dry yeast using their extracted soluble protein-antigen substances, we should solve two tasks. First, it was necessary to select and test available and objective experimental techniques for sensitization modeling and detection of delayed specific hyperimmune response to an obligate allergen; second, we had to determine criteria for assessing allergenic activity and for ranking allergenic hazards which antigen substances of dry yeast cells had.

We modified an alternative procedure (which is described below) and applied it in short-term experiments on white mice to determine sensitizing power and allergenic hazard of soluble polysaccharide-protein substances extracted from dry yeast cells. We performed our experiments on 5 groups of white mice, 12 animals in each; animals were distributed into the groups randomly in terms of their body mass (all were males, weighing 24–27 grams).

To sensitize animals and test the results, we applied obtained extracts from samples of dry bakery, wine, and spirits yeast. Sensitizing mixtures were as follows: 1:1 Freund's complete adjuvant ("Sigma") and a corresponding extract, on the basis of a standard dose per 1 animal being 0.03 cm^3 of Freund's complete adjuvant and 0.03 cm^3 of an extract, protein content being equal to 300 μg.

Laboratory animals were kept and attended to during experiments as well as taken out of them in full conformity with the requirements set forth by technical regulatory and legislative acts; all our experiments were based on international principles of biological ethics.

Research results were statistically processed with conventional techniques in STATISTICA 10 software package.

Results and discussion. To experimentally model influence exerted on a body by practically water-insoluble dry yeast cells and to reveal their biological effects, mainly allergic and immune toxic ones, it was necessary to obtain an extract out of them with maximum possible content of soluble protein-containing substances.

Literature sources have data on more than 16 different ways of how to extract antigens out of yeast and yeast-like fungi [5]. Previously, as various extraction techniques were tested, the following procedure was applied: yeast cells membranes were inactivated and partially destroyed via 4 times freezing (at –22 °C) and fast thawing; via exposure to ultrasound; via 4-day extracting out of a biomass in alkaline water-salt Coca solution under low temperature thus obtaining soluble polysaccharide-protein antigen complexes. An extract obtained out of dry bakery yeast was reaginic and antigen-isolated but it contained only 3 mg/cm^3 of protein (50000 units PNU), which was quite enough for efficient use of it as a test-allergen in laborato-

ry procedures aimed at allergy diagnostics [6], but the concentration was extremely low for any experimental modeling.

We tested another well-known technique for obtaining allergens out of coccal bacterial cells developed by V.F. Runova [6, 7]. This technique is based on extraction of protein-containing substances out of dry bacterial cells mass with 1% solution of potassium hydroxide during 1 day under room temperature with their sedimentation with 50% acetic acid solution and consequent dilution of a protein precipitate in weakly alkaline medium. This technique turned out to be efficient for obtaining diagnostic extracts-allergens out of industrial strains of Bacillus subtilis and Pseudomonas fluorescens bacteria; such extracts-allergens were proved to be highly specific, antigen-isolated, and antigen-pure. But none the less, the technique was hardly efficient for obtaining an extract out of yeast fungi.

Yeast fungi cell walls are highly resistant and rigid due to chitin which is present in their structure. Chitin is a natural polymer which comes from N-acetyl-D-glucosamine remnants bound to each other with β-(1–40)-glucoside bonds which are associated with proteins. Therefore, to obtain an extract out of dry yeast cells, we relied on a principle which underlay acid hydrolysis of glucoside bonds found in natural polymers. This principle was applied, for example, by V.V. Sokolovskiy et al. [8] to determine protein-vitamin concentrate in the environment; determination focused exactly on proteins. To perform hydrolysis of surface β-glucoside bonds between elementary units of nitrogen-containing polysaccharide of fungi cell walls, we took prepared dry yeast samples and exposed them for 5 minutes to 0.5 M water solution of trichloracetic acid under heating. Then, after fast cooling, we extracted cell suspension for 2 hours in alkaline medium (pH 8–8.4) by introducing 2H water solution of sodium hydroxide; the precipitate was then separated from the mass via centrifuging. To achieve sedimentation of protein-containing substances in the obtained supernatant, we applied cooled hydrochloric acid and centrifuging, and the precipitate was diluted in saline with 1H water solution of sodium hydroxide and pH was gradually reaching 7.2–7.4. We determined concentrations of protein-contained substances in the extracts with Lowry procedure.

The developed procedure allowed us to obtain extracts out of dry bakery, wine, and spirit yeast with high contents of soluble polysaccharide-protein substances (with protein concentrations being higher than 30.0 mg/cm^3), which was quite sufficient for experimental modeling of influences on a body and determining their biological effects. The obtained extracts were kept under –18 ^{o}C with no preservatives being added to them.

There are well-developed principles for experimental assessment of sensitizing power and allergenic hazards related to industrial chemicals and industrial biological substances [9]. These principles are based on objective quantitative criteria for taking into account a number of experimental animals with delayed hypersensitivity which was determined as per results of positive skin or intra-dermal challenge. It is important to determine significance of discrepancies between average scores of integral parameters which describe skin reactions to a challenge in a focus and a reference group of animals; this significance of discrepancies is to be determined as per Students' t criterion, or Mann-Whitney *"U"* criterion, as well as per Van der Warden *"X"* criterion. But unified techniques for sensitization and detection

of delayed hypersensitivity which are applied mostly in experiments on albino guinea pigs are costly and sometimes not available.

It makes an alternative procedure for exploring and assessing sensitizing power of chemicals which involves experiments on white mice even more attractive. According to this procedure, a mixture of a tested substance with Freund's complete adjuvant in a strictly fixed dose is applied to sensitize white mice; delayed hypersensitivity is detected on the 6th day with a skin (on an ear) or intra-dermal (in an ear or in a hind leg) challenge [10, 11]. Sensitization reproduction technique which involves Freund's complete adjuvant application on mice is based on the fact that delayed hypersensitivity is easily reproduced in them, and Freund's complete adjuvant introduction together with a tested substance enhances delayed hypersensitivity induction due to inhibition of regulatory T-lymphocytes (suppressors) subpopulations. The process is accompanied with stronger allergic reactions which allow to reveal allergenic properties of even weak chemical allergens [11].

A body reacts to a protein-containing substances (complete antigens) with a hyper-immune processes occurring in it together with mixed allergic reactions, but an immediate anaphylactic mechanism prevails here. This mechanism is promoted by antigens, namely specific immunoglobulin IgE, due to prevailing activation of helper regulation belonging to the second type of immune response. At the same time, when experts apply a mixture of an explored heteroantigen and Freund's complete adjuvant and this mixture contains tubercle bacillus antigens and is introduced intracutaneously (a "depot" is created), it stimulates a helper regulation to switch from the 2nd type immune response (Th2) to the 1st one together with development of predominantly cells-mediated mechanisms of delayed hypersensitivity [11, 12].

Given all the above-stated, we justified development of an adapted procedure for determining allergenic activity and allergenic hazard of biological substances as per their soluble protein-antigen substances during experiments performed on white mice. The procedure applied in yeast fungi examination was as follows: a mixture containing a specific extract was introduced into animals from each experimental group only subcutaneously, at the bases of their tales, in a dose equal to 0.06 cm^3; a mixture of Freund's complete adjuvant and saline was introduced in the same way and dose into animals from reference groups. On the 6th day of the experiment, we measured initial thickness of a hind leg of each animal, both in experimental and reference groups, with an electronic micrometer. After it, we introduced direct or cross provocation doses of corresponding extracts (400 μg of protein) in a volume being equal to 0.04 cm^3 into a pad (under the aponeurosis) of each measured hind leg. On the next day (24 hours after the introduction) we performed a repeat measuring of the same hind legs, calculated an absolute value of edemas in them in mm basing on a difference between thickness of white mice's legs before and after intra-dermal testing. We then transformed obtained absolute values of intra-dermal leg swelling detected in each animal into relative values of an integral parameter in scores as per a conventional scale [4]. A unified technology for conducting experiments as per this procedure allows to apply existing quantitative criteria [9] for assessing allergenic activity and detecting allergenic hazard category of protein-containing yeast fungi substances.

Application of this alternative procedure allowed us to obtain the results which are shown in the Table.

Absolute value of intra-dermal challenge was 2.4 times higher in animals from the experimental group 1 than in the reference group; a relative parameter of intra-dermal leg swelling was 8.8 times higher than in the reference group A ($t = 4.71$, $p < 0.001$). And here positive skin reactions to a challenge with an extract of dry bakery yeast with their intensity being 1–3 scores were registered in 10 out of 12 white mice from the focus group (83 % animals). So, a calculated statistical "X" criterion of a discrepancy between groups was equal to 6.77 ($p<0.01$).

Similar results were obtained during sensitization of white mice with an extract of dry spirit yeast: skin reactions to a challenge with a test dose of dry spirit fungi extract which scored 1–4 were detected in 83% animals from the experimental group 2; average group values of both absolute and relative intra-dermal leg swelling were 2.5 and 17.8 times higher correspondingly than in the reference group B ($t = 3.98$ and 4.12, $p < 0.001$). Statistical discrepancies in intra-dermal legs swelling between the focus and the reference group were authentic at $p < 0.01$ as per "X" criterion (6.93).

Frequency and intensity of intra-dermal leg swelling resulting from direct and cross challenges in white mice which were sensitized with extracts of dry bakery, wine, and spirit yeast fungi

Groups being compared	Delayed hypersensitivity as per intra-dermal leg swelling	Extracts of dry yeast fungi		
		bakery	wine	spirit
Reference group A	10^{-2} mm	7,88 ± 1,30	7,78 ± 1,10	–
	N	2/12	2/12	–
	Score	0,17 ± 0,10	0,17±0,10	–
Reference group B	10^{-2} mm	–	–	7,76±1,16
	N	–	–	1/12
	Score	–	–	0,08 ± 0,08
1 experimental group, bakery	10^{-2} mm	19,0 ± 2,30**	–	15,5 ± 2,24*
	N	10/12	–	9/12
	Score	1,50 ± 0,30**[1)]	–	1,08 ± 0,22**[1)]
22 experimental group, spirit	10^{-2} mm	–	13,7 ± 1,70*	19,6 ± 2,74**
	N	–	9/12	10/12
	Score	–	1,00 ± 0,20*[1)]	1,42±0,31**[1)]
33 experimental group, wine	10^{-2} mm	18,2 ± 2,60*	23,6 ± 3,40**	–
	N	9/11	9/11	–
	Score	1,18 ± 0,30*[1)]	1,64 ± 0,30**[1)]	–

Note: * – authentic discrepancies from the reference group at $p<0.01$ as per t criterion,
** – authentic discrepancies from the reference group at $p<0,001$ as per t criterion
1) – authentic discrepancies from the reference group at $p<0.01$ as per "X" criterion,
N: numerator is a number of animals with positive intra-dermal leg swelling parameters, denominator is a total number of animals in a group.

A bit elevated absolute and relative intra-dermal leg swelling was detected in white mice sensitized with dry wine yeast extract; average groups parameters in the 3rd experimental group were 3 and 9.6 times higher correspondingly than in the reference group A (t=3.82 and 4.30, p<0.001). Frequency of apparent skin reactions (1-3 scores) in the experimental white mice from the 3rd group amounted to 81.8%, and the discrepancy between relative intra-dermal leg swelling in the experimental and reference group (7.05) was authentic at p<0.01.

So, extracts-allergens obtained from dry bakery, wine, and spirit fungi sensitized more than 75% animals from the experimental groups under standard experimental conditions; average mean values of integral intra-dermal leg swelling parameter were authentically different in animals from the experimental and reference groups as per "X" criterion at p<0.01. As per classification criteria [9], these data allow us to rank dry bakery, wine, and spirit yeast fungi as having great sensitizing power (allergenic activity) and to assign them into the 1st allergenic hazard category (extremely dangerous industrial allergen).

We should also note that that there was high frequency and intensity of skin reactions in sensitized animals from the experimental groups which occurred as a response to a cross testing with test-allergens of various yeast fungi strains; these reactions were authentically significantly stronger than in white mice from the corresponding reference groups (p < 0.01 as per t and "X" criteria). Although both absolute and relative intra-dermal leg swelling which occurred in animals from the experimental groups as a response to cross test-doses of dry bakery, wine, and spirit yeast was lower than that occurring as a response to specific extracts-allergens, but still it didn't differ statistically significantly in terms of its intensity and frequency. Thus, for example, positive skin reactions to a test allergen of dry spirit fungi extract were detected in 9 out of 12 white mice from the 1st experimental group which were sensitized with dry bakery yeast extract and their relative intra-dermal leg swelling was equal to 1.08±0.22 scores; and in case of a response to a specific test-allergen of dry bakery yeast extract it was equal to 1.50±0.30 scores (t=1.19, p>0.05). Cross reactions occurring due to application of various fungi allergens, even to a fungi belonging to different strains, have been known for some time already, and antigen similarity between fungi belonging to the same species is even more substantial [5, pages 76–79]. Thus, when guinea pigs were sensitized with Candida albicans cells, experts detected high frequency and intensity of cross allergic reactions in them to mold fungi antigens and even to penicillin which was their producer [13, pages 87–89].

So, occurrence of common antigen immune determinants in dry bakery, wine, and spirit yeast fungi makes poly-sensitization quite possible under inhalation exposure to them and causes high risks of cross allergenic reactions in people who contact them.

This fact is important as it helps to justify the same maximum allowable concentration in working area air for all these fungi and to apply a standardized strain of dry yeast cells as a reference allergen.

Conclusion. The results of the performed experimental research allow us to make the following conclusions:

1. We developed an original procedure based on oxidizing hydrolysis performed with organic acid on surface β-glucoside bonds between elementary units of nitro-

gen-containing polysaccharide (chitin) of fungi cell walls with consequent extracting in alkaline medium. It allowed us to obtain extract-allergens out of dry bakery, wine, and spirit yeast fungi with high contents of soluble protein-containing substances which was sufficient for experimental modeling of their influences on a body and determining their biological effects.

2. We validated a short-term alternative procedure which includes a unified technology for reproducing and objective detection of delayed hypersensitivity during an experiment performed on white mice. This procedure allows to determine allergenic activity and allergenic hazard category of biological substances focusing on their soluble protein-antigen components.

3. We experimentally revealed that protein-antigen complexes contained in dry bakery, wine, and spirit fungi have substantial sensitizing power (allergenic activity) and are assigned into the 1st allergenic hazard category (extremely dangerous industrial allergen).

4. Bakery, wine, and spirit yeast fungi have common antigen immune determinants and it makes body polysensitization highly possible under inhalation exposure to them at a work place and causes high risks of cross allergenic reactions in people who contact them.

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PECULIARITIES OF LABORATORY SUPPORT FOR MASS INTERNATIONAL EVENTS

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Any mass political, cultural, or sport event causes risks of complicated medical and sanitary situations and health disorders. It makes it necessary to perform profound preparations, both at all objects where such events take place and on overall territories of settlements where these objects are located. Orientation at risk minimization requires changes in existing schemes of state sanitary-epidemiologic surveillance and, accordingly, in providing efficient laboratory support. The article dwells on peculiarities of laboratory examinations during preparations to mass international events and events themselves. It also justifies the necessity to work out hygienic model of laboratory support for the said events.

The authors suggest to create laboratory support programs for sanitary-epidemiologic surveillance allowing for specific features of various stages in preparation to an event: 1) a stage when objects and infrastructure necessary for an event are planned and constructed; 2) a stage when an actual event takes place; 3) a stage after an event is over. The first stage involves concentration on control over materials and constructions applied when objects are erected. At the second stage it is necessary to provide strict control over environmental objects with wider application of express tests and mobile laboratory equipment. The third stage should involve systemic monitoring over loads on a territory caused by growth in number of tourists and the necessity to provide proper functioning of hygienically significant infrastructural systems.

The suggested approaches were tested during preparations to 2018 FIFA World Cup In Rostov-on-Don. A test laboratory center, supervised by Rospotrebnadzor regional office, used the latest laboratory equipment which allowed to perform a wide range of research on construction and finishing materials, as well as environmental objects. The equipment operated practically round-the-clock, and it is advisable to apply the accumulated potential in future.

The authors stress that it is vital to develop a hygienic model of laboratory control over mass international events.

Key words: *a mass international event, risks minimization, laboratory research, stages of an event, hygienic model, laboratory support, systemic monitoring.*

The growing credibility of Russian Federation predetermines further increase in the number of mass international events held on our territory. The World Health Organization stresses that "... in the course of a mass event, urgent, complex medical and sanitary situations may arise ... risks to human health may increase ..." [1]. This fact causes the need for a huge preparatory work, both on the sites themselves and in the territories of municipalities hosting the events. The above requires modification of the existing schemes of state sanitary and epidemiological surveillance and, accordingly, its effective laboratory support. This applies to events of very different levels and content - from political and cultural

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ones to sports, including sports of higher achievements [2].

Participants in sport events are most demanding for factors of the external environment. This is due to the intensification of physiological processes of athletes in the process of training and competitions [3, 4]. A number of sport events are held in natural conditions, but most large-scale sport events take place in cities, often large and densely populated, where the natural environment is aggravated by exposure to high levels of air, water and noise. At the same time, pollution of an external and indoors environment often affects negatively the health of competitors and sports results [5–8]. As a consequence, the task of quality control over the habitat of mass sports events participants and guests is becoming urgent, with its highest credibility achieved by laboratory research [9].

The peculiarities of laboratory studies aimed at determining epidemiological risks, as well as the radiation situation, have been widely and thoroughly studied in scientific works devoted to the mass international events in Russian Federation[1] [10, 11]. The research was carried out to support the organization of events such as World Universiade in Kazan, Winter Olympic Games in Sochi, and others.

Changes in the levels of exposure to hygienically significant factors affects all the stages of preparing and hosting mass international event and, the organization of laboratory support at different stages has certain features. Therefore, it is advisable to analyze such changes in the context of various stages of an international event, and namely: the preparatory, including facilities reconstruction and construction; holding itself of a large-scale international event; post-event period.

On the example of Rostov region, the features of laboratory control at various stages of preparation and holding of FIFA World Cup 2018 games are considered.

The provision of laboratory research during the preparation and holding of the World Cup games in Rostov Region is carried out in accordance with the "Procedure for laboratory support of environmental research during the preparation and holding of FIFA World Cup 2018 games in Rostov-on-Don" approved by Rospotrebnadzor

This procedure considers research in two areas:

– monitoring of environmental factors (water, air, soil, etc.) in a hosting territory, the relevance of which has been confirmed many times [12, 13];

– laboratory research on the involved facilities for living, catering, sports and training bases, life support facilities (studies of the construction materials, water from centralized systems, administrative premises, food, etc.) [14].

The approved procedure does not regulate clearly the conduct of laboratory research, depending on the stage of preparation and holding a massive international

[1] O sostoyanii sanitarno-epidemiologicheskogo blagopoluchiya naseleniya Krasnodarskogo kraya v 2014 godu: Gosudarstvennyi doklad [On the state of sanitary and epidemiological welfare of the population of the Krasnodar Territory in 2014: State report]. Krasnodar, Upravlenie Rospotrebnadzora po Krasnodarskomu krayu, Publ., 2015, 212 p. (in Russian).

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event, although each stage is characterized by the specific features.

I. Stage of preparation and construction of the facilities and infrastructure required for an event.

By virtue of the provisions of Part 2, Article 44 of the Federal Law of 30.03.1999 No. 52-FZ "On Sanitary and Epidemiological Welfare of the Population"[2] in 2007, during the construction, reconstruction, overhaul of capital construction facilities, state sanitary and epidemiological surveillance is in place within the framework of state construction supervision, and also by the bodies authorized to carry out state construction supervision – the federal executive authority, executive authorities of the subjects of Russian Federation in accordance with the Russian Federation legislation on urban development. So, the need for laboratory provision of state sanitary and epidemiological surveillance at capital construction sites was practically absent.

The relevance of this problem increased in the preparation for mass international events and a vivid example of this: the preparations for 2014 Winter Olympic Games in Sochi.

Restoration and updating of unused techniques and laboratory equipment required additional financial costs from Rospotrebnadzor institutions, which were almost completely compensated by the Federal Service for Surveillance over Consumer Rights Protection and Human Well-being.

Test laboratory centers under jurisdiction of Rospotrebnadzor institutions in the territories of mass international events received the latest laboratory equipment that allows for a wide range of studies of construction and finishing materials. At the stage of preparation for an international event, this equipment was used almost in a round-the-clock mode, and the accumulated potential is advisable to be further used [15].

In Rostov region, in the specified period of time the objects of laboratory control were:

– "Rostov-Arena" stadium under construction;

– training grounds under reconstruction (5 stadiums);

– hotel complexes under construction;

– "Platov" airport complex under construction.

The main objects of research at this stage are the construction, paints and varnishes, both of domestic and foreign manufacturers.

For the expired period of 2017, 356 samples of construction materials were selected by the testing laboratory center of the Federal Budgetary Institution "Center for Hygiene and Epidemiology in Rostov region", and 3445 studies were carried out. Among the determinable indexes: formaldehyde, methanol, toluene, xylene, methyl methacrylate, dibutyl phthalate, dioctyl phthalate, phenol, styrene, ammonia, etc.

A special feature of these studies is the need for consistency in the use of laboratory equipment (climatic chambers, gas chromatographs, etc.). At the same time, the volume of the studied samples of construction materials at the stage of preparation for a mass international event is determined namely by the number of climatic chambers.

Despite the use of the modern high-precision gas chromatographs with a two-stage thermal desorber, no samples incompliant with regulatory requirements have been revealed.

In this regard, the issue of laboratory control optimization and determining the scientifically-based indicative parame-

ters for an integrated safety assessment of construction products becomes topical [3].

In general, the preparatory stage of almost any mass international event is characterized by the benefits of sanitary-chemical, sanitary-hygienic and toxicological laboratory studies carried out in stationary conditions in particular, and the absence of certain laboratory equipment used in the intermediate stages of research, significantly reduces the efficiency of using the expensive equipment intended for quantitative evaluation of limiting indices.

II. Stage of a mass international event itself:

The most important requirement for laboratory research during an international event is the promptness of the results, which predetermines the use of express methods and direct measurements instruments, i.e. obtaining the result directly at the object of control. In addition, the characteristic feature is the requirements of international organizations to comply with global standards, which are not always harmonized with the national regulations.

For example: for our region, dust is the most common unfavorable factor of atmospheric air pollution. The geographic features of a region play a leading role in this process.

Upon request of international organizations, the assessment of dust level should be carried out taking into account the dispersion of dust, and gas contamination – taking into account the organoleptic properties of certain pollutants.

In order to achieve the set goals, during FIFA World Cup 2018 in Rostov region, the direct-measurement aerosol analyzers with applicators change-over functions for dust differentiation by fractions, and portable chromatographs for identification and qualitative assessment of air pollutants were purchased.

The efficiency of laboratory support at the stage of holding mass international event depends to a large extent on the structured analysis of the available information, incl. the results of sanitary and epidemiological expertise of maximum permissible emissions (MPE), locations of radio-transmitting facilities, maximum permissible discharges, etc. Systematization of expertise sanitary and epidemiological assessments of MPEs allows you to determine the list of emitted substances, taking into account the priority ones in terms of emissions share, and organize a focused laboratory control over the concentration of these pollutants. The use of modern software systems for calculation and evaluation of electromagnetic radiation can define the indicative points for instrumental monitoring of electromagnetic radiation intensity. It should be noted the positive experience with the use of photometers for drinking water express-analysis. Time spent on research, in comparison with the classical photometric and atomic absorption, decreased 2 times, and it became possible to conduct research directly on site.

Among the peculiarities of laboratory control during mass international event, the global organizations requirements for sampling are also worth to pay attention to. For example: the requirement of contact-free temperature determination, the ban on using glass containers in stadiums, etc. In view of this, sterile polymer containers and bags must be used for food products sampling, which does not affect the quality of laboratory tests, but significantly increases their cost.

In general, the mass international event holding stage itself is characterized by an advantage of laboratory research conducted directly on sites, which necessitates the use of express techniques and mobile laboratory equipment.

III. The post- event stage of laboratory monitoring.

The influence of the already held international event on hygienic factors of habitat requires special attention and is studied incompletely by now. The infrastructure, newly created for a mass international event, has a significant influence on economic situation in the territory of a municipality, and is a catalyst for the processes of changing the structure of the entire region economy.

In the territories hosted mass international events, in the future, there is a tendency to increase tourist flow, which increases the anthropogenic load on a habitat, incl. hotel room stock occupancy, loading on public catering facilities, life support systems, etc. At the same time, calculations of the population consumption needs in the municipalities' territories are primarily focused on the number of inhabitants.

The consequences of the given situation is an increase in the volume of drinking water consumption, an increase in the load on sewage treatment plants, and an increase in the volume of wastewater discharges, a significant increase in the amount of wastes transported to landfill, an increase in traffic, and an increase in fugitive source of emissions, accordingly, etc.

A considerable portion of costs for preparing and operating an infrastructure that affects hygienic factors of the environment during international events is financed from the federal budget, and allows for the planned project operation of all life support systems. At the same time, the operational costs of ensuring proper functioning hygienically critical infrastructure systems of territorial entities after an event are becoming a financial commitment of local budgets, and the occurrence risks of emergency situations are increasing [2].

The peculiarities mentioned should be taken into account at implementing a risk-based model of state sanitary and epidemiological surveillance in the territories that hosted mass international events, so there is a need to revise approaches to laboratory control in these territories.

Conclusions: The laboratory support of state sanitary and epidemiological surveillance in preparing for and hosting mass international events should be arranged taking into account the peculiarities typical for each stage of an event that defines the urgency of developing a hygienic model for laboratory control at mass international events.

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SEPARATE QUONTITATIVE DETERMINATION OF ORGANIC AND NON-ORGANIC ARSENIC IN SEA PRODUCTS

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The performed research is truly vital, as As (arsenic) concentration in food products is now of great interest. The US ATSDR and EPA enlist As among the most toxic substances which are dangerous for human health.

We suggest a procedure for separate quantitative mass fraction determination for organic (oAs) and non-organic (iAs) arsenic compounds in sea products with solid phase extraction (SPE) application combined with atomic adsorption spectrometry. Samples were prepared according to the following procedure: liquid extraction phase with simultaneous As (III) oxidation into As (IV) with hydrogen peroxide and As (V) extraction into a 0.055 M liquid phase with hydrochloric acid. Arsenic organic and non-organic compounds were separated via solid phase extraction with Strata SAX cartridges (Sorbent Lot Number: S208-0058). To quantitatively assess the obtained samples, we applied atomic-adsorption techniques for As determination with "KVANT-2A-GRG" spectrometer according to the State Standard 51766-2001. We revealed that common As concentration didn't conform to fixed standards in 8 out of 17 analyzed samples (2 shrimps, 1 crab, 1 fish, and 4 seaweeds). However, iAs concentration was significantly lower than oAs concentration in all the samples. 6 out of 17 analyzed samples didn't contain any iAs within detection limits (0.1 mg/kg), and apparently all the As concentration occurred due to its organic compounds. The suggested procedure for separate oAs and iAs detection is relatively simple in terms of devices applied in it, and quite cheap, as SPE cartridges needed to perform it can be re-used after re-conditioning. This procedure, after a proper metrological validation, can be implemented in most laboratories which are certified to examine chemical safety of food products.

Key words: *arsenic, non-organic form, solid phase extraction, atomic-adsorption spectrometry, risk assessment.*

Arsenic (As) is a chemical element of the fourth period 15th group in the periodic system. The electron shell structure: $Ar3d^{10}4s^{2}4p^{3}$. According to the materials presented by A. Gomez-Caminero et al. [1], As is a metalloid found in the structure of rocks, soil and groundwater in an average concentration of 2 mg/kg in inorganic and organic forms. The major sources of environment anthropogenic pollution with

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As are the extraction and burning of fossil fuels, using arsenic pesticides in agriculture, disposal of chemical weapons stockpiles, and using wood preservatives containing As. In most cases, human exposure to inorganic As (iAs) occurs through contaminated groundwater (drinking water, water used for cooking, and for irrigation of agricultural land). Along with this, people are regularly exposed to As through the consumption of products from aquatic organisms (fish, and shellfish and algae of sea fishery: mollusks, crabs, squid, seaweed, etc.), capable of As bioaccumulation in significant amounts from sea water.

The processes of metabolism and As bioaccumulation in a human body cause active interest in the scientific society [2]. The European Food Safety Agency (EFSA) data show a serious problem caused by As content in food products for public health in the world. The US Agency for Toxic Substances and Disease Registration (ATSDR) and the US Environmental Protection Agency (EPA) enlisted As among the most toxic substances to human health [3].

In toxicological terms, As compounds refer to "thiol poisons" that block sulfhydride groups of functionally significant proteins, including enzymes. A critical contribution to As toxicity is apparently made by its ability to stimulate reactive oxygen species formation, induce an excessive expression of growth factors, influence the transcription of genes indirectly, induce immunosuppresion and apoptosis [4]. iAs compounds are considered as the most dangerous. And trivalent As, as a rule, is more toxic. According to the International Agency for Research on Cancer (IARC), iAs refers to carcinogens of Group 1 (substances with proven carcinogenic activity for humans) [5]. Unlike inorganic forms, the organic derivatives of As (oAs), the most common in seafood and seaweed, are considered low-toxic, according to the world literature, and in the IARC documents referred to as the "non-classified, in terms of human carcinogenicity" (Group 3). In this regard, their toxicological assessment in food products is not carried out [6–10].

In Russian Federation and EAEC countries, the method of atomic absorption spectrometry is currently adopted to assess As content in food products, which makes it possible to quantify the total As content only without fractionation into iAs and oAs. (TR CU 021/2011[1]). The permissible levels of total As in food products, according to Technical Regulations "On Food Safety" (TR CU 021/20111) vary from 0.1 mg/kg in raw milk to 5.0 mg/kg in shellfish and algae, and seaweed (in terms of product wet weight). It is these parameters that are used in hygienic assessments, studies, inspections [11–15]

Our research goal of the given study was to develop a procedure for separate determination of iAs and oAs content in seafood (fish, shrimp, squid, mussels, seaweed).

Materials and methods. Fish and non-fish objects of sea fishery (mollusks, crabs, squid, seaweed) purchased in Moscow consumer market were chosen as objects of study.

Reagents used: a standard As sample (a solution with As (III)mass concentration of 0.1 mg/cm^3) produced by EcoAnalytical Association "Ecoanalytika", 33% special

[1] TR TS 021/2011. O bezopasnosti pishchevoi produktsii: tekhnicheskii reglament Tamozhennogo soyuza [On Food Safety: Technical Regulations of the Customs Union]. *Evraziiskaya ekonomicheskaya komissiya*. Available at: http://www.eurasiancommission.org/ru/act/texnreg/dep-texreg/tr/Pages/PischevayaProd.aspx (15.03.2018)

purity hydrogen peroxide, according to CU 6-02-570-75[2], methanol h.p., according to the State Standard GOST 6995-77[3], hydrochloric acid (HCl), part by weight, mass fraction ≥ 37%, ρ≥1.15 g/cm^3, according to GOST 3118-77[4], ammonium carbonate, mass fraction ≥ 99.999% according to the State Standard GOST 3770-75[5], acetic acid, h.h. according to the State Standard GOST 61-75[6], deionized water obtained in "Milli-Q Advantage A10" system, solid-phase extraction cartridges with a strong anion-exchange fixed phase 'Strata SAX' by Phenomenex (sorbent mass 500 mg, volume 6 cm^3); special purity acid nitric oxide, concentrated in accordance with the State Standard GOST 11125-84[7]; acid citric monohydrate or anhydrous by the State Standard GOST 3652-69[8] h.h., carbamide according to the State Standard GOST 6691-77[9], sodium boron hydride h.ch .; sodium hydroxide according to the State Standard GOST 4328-77[10]. h.p.; propane-butane, a mixture in cylinders according to the State Standard GOST 20448-90[11].

Product samples were scissor-cut into pieces of 1-3 mm in size, weighed to within ± 0.01 g, placed in a Petri dish, frozen and vacuum-dried in LS-500 device (made in Russia). The dried samples were reweighed to determine the moisture content, and then grounded into a powder in a

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[2] TU 6-02-570-75. Vodoroda perekis' osoboi chistoty: tekhnicheskie ukazaniya [Hydrogen peroxide of special purity: Technical guidelines]. *Rossiiskii nauchno-tekhnicheskii tsentr informatsii po standartizatsii, metrologii i otsenke sootvetstviya*. Available at: http://www.vniiki.ru/document/3404123.aspx (15.03.2018) (in Russian).

[3] GOST 6995-77. Reaktivy. Metanol-yad. Tekhnicheskie usloviya (s izmeneniyami № 1, 2): gosudarstvennyi standart Soyuza SSR [Reagents. Methanol- poison. Specifications (with Amendments 1, 2): State Standard of the USSR]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at: http://docs.cntd.ru/document/1200017517 (15.03.2018) (in Russian).

[4] GOST 3118-77 (ST SEV 4276-83). Reaktivy. Kislota solyanaya. Tekhnicheskie usloviya (s izmeneniem № 1): gosudarstvennyi standart Soyuza SSR [Reagents. Hydrochloric acid. Specifications (with Amendment No. 1): State Standard of the USSR]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at: http://docs.cntd.ru/document/1200017281 (15.03.2018) (in Russian).

[5] GOST 3770-75. Reaktivy. Ammonii uglekislyi. Tekhnicheskie usloviya (s izmeneniem № 1): gosudarstvennyi standart Soyuza SSR [Reagents. Ammonium carbonate. Specifications (with Amendment No. 1): State Standard of the USSR]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at: http://docs.cntd.ru/document/1200017294 (15.03.2018) (in Russian).

[6] GOST 61-75 (ST SEV 5375-85). Reaktivy. Kislota uksusnaya. Tekhnicheskie usloviya (s izmeneniyami № 1, 2, 3): mezhgosudarstvennyi standart [Reagents. Acetic acid. Specifications (with Amendments N 1, 2, 3): Inter-State Standard]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at: http://docs.cntd.ru/document/1200017471 (15.03.2018) (in Russian).

[7] GOST 11125-84. Kislota azotnaya osoboi chistoty. Tekhnicheskie usloviya (s izmeneniem № 1): mezhgosudarstvennyi standart [Nitric acid of special purity. Specifications (with Amendment No. 1): Interstate Standard]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at: http://docs.cntd.ru/document/1200017537 (15.03.2018) (in Russian).

[8] GOST 3652-69 (ST SEV 394-88). Reaktivy. Kislota limonnaya monogidrat i bezvodnaya. Tekhnicheskie usloviya (s izmeneniyami № 1, 2): gosudarstvennyi standart Soyuza SSR [Reagents. Citric acid monohydrate, anhydrous. Specifications (with Amendments N 1, 2): State Standard of the USSR]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at: http://docs.cntd.ru/document/1200017479 (15.03.2018) (in Russian).

[9] GOST 6691-77 Karbamid. Tekhnicheskie usloviya (s izmeneniyami № 1, 2): mezhgosudarstvennyi standart [Carbamide. Specifications (with Amendments N 1, 2): Interstate Standard]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at:http://docs.cntd.ru/document/1200017516 (15.03.2018) (in Russian).

[10] GOST 4328-77 Reaktivy. Natriya gidrookis'. Tekhnicheskie usloviya (s izmeneniyami № 1, 2): mezhgosudarstvennyi standart [Reagents. Sodium hydroxide. Specifications (with Amendments N 1, 2): Interstate Standard]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at:http://docs.cntd.ru/document/1200017363 (15.03.2018) (in Russian).

[11] GOST 20448-90 Gazy uglevodorodnye szhizhennye toplivnye dlya kommunal'no-bytovogo potrebleniya. Tekhnicheskie usloviya (s izmeneniyami № 1, 2, s popravkoi): mezhgosudarstvennyi standart [Hydrocarbon liquid petroleum gases for municipal consumption. Specifications (with Amendments N 1, 2, as amended): Interstate Standard]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at: http://docs.cntd.ru/document/1200004726 (15.03.2018) (in Russian).

mortar. A homogenized and shredded dry sample of 0.1-0.2 g (taken with an accuracy of ±0.001 g) was introduced into a sectional-view glass tube No.14, of 20 cm^3, added with 10 cm^3 of extraction solution (3% by mass of hydrogen peroxide in 0.055 M hydrochloric acid on deionized water) and placed in a water bath with a shaker at a temperature of 95°C for 45 minutes. The samples were then cooled to a room temperature, placed in centrifuge tubes, and centrifuged during 10 minutes in an angular rotor centrifuge at 2100 g. The supernatants were transferred to polypropylene tubes and added with deionized water to a volume of 10 cm^3; 5 cm^3 of each supernatant was selected to determine the total As content using atomic absorption spectrometry; 3 cm^3 was taken from the residues for further solid-phase extraction. To test the completeness of the extraction, simultaneously we took 0.1-1.0 g (± 0.001 g) weighted portion of the analyzed dry sample to determine the total As content.

iAs was separated from oAs using solid phase extraction on SPE cartridges placed in a vacuum chamber. For completeness of samples solid-phase extraction we adhered to the recommended elution rate: 2 cm^3 of liquid/5 min. The cartridges were pre-conditioned by 2 cm^3 methanol. The sorbent balancing of cartridges was accomplished with a 2 cm^3 solution consisting of equal volumes of 40 mM ammonium carbonate and an extraction solution. Prior to being applied onto a cartridge, supernatant of 3 cm^3 was mixed with 3 cm^3 40 mM ammonium carbonate. Using a multi-purpose indicator-paper, we determined the mixture pH, which was to correspond to 6.5 ± 1.0. The buffered solution of the sample was centrifuged for 10 minutes at 4000 rpm, thereupon an aliquot

Determinations of total arsenic, organic and inorganic arsenic form, in seafood samples

No	Sample	Moisture %	Extraction %	As content, mg/kg M±□		
				Total As	oAs	iAs
1	Shrimp, cooked-frozen, with head, sample No. 1	72,2	83	3,27±1,14	1,97±0,70	1,30±0,45
2	Shrimp, cooked-frozen, with head, sample No. 2	75,3	≥100**	**10,6±3,7**	7,49±2,62	3,07±1,07
3	Whole shrimp, cooked-frozen, sample No. 3	87,5	≥100	**6,88±2,41**	5,27±1,84	1,60±0,56
4	Pacific mussels, peeled	73,5	≥100	0,70±0,24	0,88±0,31	н/о*****
5	Mussels, cooked-frozen	74,8	≥100	0,81±0,28	0,86±0,30	н/о
6	Squid trunk, sample No. 1	84,5	≥100	0,30±0,10	0,34±0,12	н/о
7	Squid trunk, sample No. 2	82,9	≥100	0,25±0,09	0,24±0,08	н/о
8	Squid No. 3	83,0	≥100	0,04±0,01	0,04±0,01	н/о
9	Squid No. 4	83,0	66	0,05±0,02	0,03±0,01	0,02±0,01
10	Crab, cooked-frozen	83,2	91	**9,90±3,45**	6,67±2,33	3,23±1,13
11	Halibut	76,6	≥100	2,84±0,99	2,15±0,75	0,69±0,24
12	Sea bass	81,4	≥100	0,49±0,17	0,41±0,14	0,08±0,03
13	Navaga	81,2	100	**28,8±10,1**	18,9±6,6	**9,86±3,45**
14	Laminaria, dried	***	≥100	**20,3±7,1**	20,4±7,1	н/о
15	Laminaria, dry, chopped	***	≥100	**25,2±8,8**	24,5±8,6	0,66±0,23
16	Laminaria, frozen, unwashed	***	≥100	**17,5±6,1**	16,0±5,6	1,54±0,54
17	White Sea fucus, chopped	***	≥100	**12,3±4,3**	10,2±3,6	2,11±0,74

Note : * – Confidence interval at a significance level of p=0,95; ** – Completeness of extraction made 100% within determination error limits.

of 4 cm^3 was applied to the pre-sorbent equilibrated SPE cartridges installed in a vacuum chamber. After the solution passed through cartridge (for 10 minutes), it was washed with 6 cm^3 of 0.5 M acetic acid, and then dried under vacuum until complete drying. The combined solutions treated in the cartridge at this stage were an oAs fraction. The cartridge-adsorbed fraction was further eluted with 2.5 cm^3 of 0.4 M hydrochloric acid. During an elution, iAs (V) fraction retained on SPE cartridges was collected in polypropylene tubes with further vacuum dehydration for at least 5 minutes. The initial dry product sample, an extract aliquot, oAs and iAs fractions obtained were mineralized, according to the State Standard GOST 26929-94[12]. After that, the total As content was determined using an atomic-absorption spectrometer "KVANT-2A-GRG" (Russia) with a hydride accessory GGR-107. According to the State Standard GOST P 51766-2001[13] for this method of analysis, its relative error limit at 2 repetitions and a significance level in confidence interval of 95% is ± 35%, the detection threshold is 3×10^{-4} μg/cm^3.

Results and discussion. The findings upon iAs and oAs separate determination in 17 seafood samples (shrimps, mussels, squid, sea fish and seaweed) are shown in Table.

As follows from the table, in 8 out of 17 samples analyzed (2 samples of shrimp, 1 crab, 1 fish, 4 (all analyzed) samples of algae), total As content does not correspond to the norm. However, in all these cases, iAs content in the samples was significantly lower, comparing to that of oAs. In 6 out of 17 analyzed products, within the range of detection sensitivity (0.1 mg/kg), iAs was not detected, and, apparently, As totally was represented by its organic form. The obtained data confirm the previous assumption that food products risk assessment, in terms of total As content, gives an overestimated result due to the prevalence of a relatively low-toxicity oAs in the whole As pool. As known, products of sea hydrobionts have high nutritional value, being the sources of essential minerals: iodine, selenium, etc., of dietary fiber (algae) and high-grade protein (fish and invertebrates). In view of this, the issue of obtaining scientific data on iAs content in these types of food products is topical. The procedure proposed for separate determination of oAs and iAs has good prospects, since it is relatively simple in hardware, of low cost (SPE cartridges can be reused after reconditioning many times) and, after an appropriate metrological validation, can be implemented in most laboratories certified to examine chemical safety of food products.

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A conflict of interests. The authors state there is no conflict of interests.

[12] GOST 26929-94. Syr'e i produkty pishchevye. Podgotovka prob. Mineralizatsiya dlya opredeleniya soderzhaniya toksichnykh elementov: mezhgosudarstvennyi standart [Raw materials and food products. Preparation of samples. Mineralization to determine the content of toxic elements: Interstate Standard]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at: http://docs.cntd.ru/document/1200021120 (15.03.2018).

[13] GOST R 51766-2001. Syr'e i produkty pishchevye. Atomno-absorbtsionnyi metod opredeleniya mysh'yaka: gosudarstvennyi standart RF [Raw materials and food products. Atomic Absorption Method for Determination of Arsenic: State Standard of the Russian Federation]. *KODEKS: elektronnyi fond pravovoi i normativno-tekhnicheskii dokumentatsii*. Available at: http://docs.cntd.ru/document/1200025461 (15.03.2018).

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METHODICAL AND PRACTICAL ASPECTS RELATED TO TOTAL MERCURY DETERMINATION IN WHOLE BLOOD, URINE AND HAIR WITH MASS-SPECTROMETRY WITH INDUCTIVELY COUPLED PLASMA

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A precise, selective, and sufficiently sensitive quantitative procedure for determining chemicals contents in environmental objects and a human body is often a key to correct health risk assessment.

The authors describe optimized conditions for analyzing whole blood, urine, and hair samples used for determining total mercury contents with mass-spectrometry with inductively coupled plasma (sampling, samples storage, preparations to analysis, instrumental settings of a device, analysis conditions).

We quantitatively determined mercury in blood, urine, and hair samples with Agilent 7500cx mass spectrometer with octopole reaction/collision cell (Agilent Technologies, USA). To prepare for whole blood samples analysis, we applied acid dilution in concentrated nitric acid with consequent centrifuging. Urine samples were directly analyzed after 1/10 (V/V) dilution with 1 % nitric acid solution. The suggested conditions of conventional biological media analysis applied in total mercury determining with mass spectrometry with inductively coupled plasma allow to determine the element in blood within 0.5–100 μg/l with measurement error being equal to 29.4 %; in urine, within 0.4–100 μg/l with measurement error being equal to 24.2 %; in hair, within 0.001–100 μg/l with measurement error being equal to 22.4 %. When validating the procedure, we found the following limits of detection (LOD): 0.0015 μg/l for blood; 0.012 μg/l, for urine; and 0.003 μg/l, for hair.

Correctness of the results was confirmed by examination of standards blood samples SERONORM (Sero AS, Norway) blood L1 (LOT 1103128), L2 (LOT 1103129), L3 (LOT 1112691), urine samples Seronorm™ (Sero AS, Norway) urine (LOT 0511545), and hair samples Reference Material in Human Hair (IAEA-086, Vienna, Austria).

Total mercury contents in children's blood was determine within 0.02–1.2 μg/l; within 0.45–0.8 μg/l in urine. Contents in urine taken from exposed adults amounted to 0.65–8.2 μg/l, and to 0.29–0.49 μg/l in hair.

***Key words**: mercury, quantitative determination, mass spectrometry, inductively coupled plasma, whole blood, urine, hair, acid dilution.*

Research based on human biomonitoring (HBM) is attracting considerable attention these days. By measuring concentrations of chemicals or their metabolites in biological materials researchers can perform a complex assessment of exposure

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under different introduction; they can also determine speed of absorption, metabolism, and excretion. The WHO recommends various procedures and techniques aimed at determining concentrations of persistent and bioaccumulating contaminants, and requirements to such procedures and techniques are becoming stricter in order to achieve better comparability and validity of HBM results [1].

Mercury is now not so widely applied as it used to be; none the less, it is still a global contaminant. Mercury is a heavy metal, a cumulative poison, and it belongs to chemicals with the 1st hazard degree (CAS 7439-97-6). Toxicity of mercury for people is related to erythrocytes agglutination, inhibition of enzymes, and disorders in protein metabolism. Mercury enters a body via various ways as it can be inhaled, introduced orally or transdermally; it is then detected in all organs and tissues of a human body [2–4]. Mercury concentrations in blood allow to estimate recent or current contamination with all the types of this metal; mercury concentrations in urine help to estimate current or recent contamination with elemental and inorganic mercury; an analysis performed on hair allows to determine contamination with organic mercury which occurred during various periods of time [1, 5].

Table 1 below contains reference mercury concentrations in various biological media as per data obtained from scientific literature 1.

L.M. Karimova, T.K. Larionova, and G.R. Basharova think that maximum mercury concentration which doesn't lead to shifts in hematologic, biochemical, and immunologic parameters amounts to 1 μg/l [9]. Methodical guidelines for early diagnostics of toxic mercury effects in low intensity doses in children (MG 2000/140) approved by the RF Public Healthcare Ministry set forth background mercury concentration in children's morning urine which is equal to 0.56±0.07 μg/l (the range is 0.3–0.9 μg/l)[1]. The Commission on HBM of the German Federal Environmental Agency offers reference values of HBM-1 and HBM-2 which amount to 5 and 15 μg/l for mercury in blood, and to 7 and 25 μg/l in urine correspondingly [1]. HBM-1 is such a concentration in a biological material below which there isn't any health risk. When BHM-2 concentration is reached, it causes an elevated risk of adverse influence, and toxic effects should be eliminated immediately. Obviously, considerable differences in the given values and the data which can be found in Table 1 are related not only to peculiarities of examined populations, but also to application of different analysis techniques.

To detect mercury in biological media, we need highly sensitive and highly

Table 1

Reference mercury concentrations in blood, urine (μg/l) and hair (μg /g)

Author / analysis technique	Blood, μg/l	Urine, μg/l	Hair, μg /g
WHO, 2010 [5]	5–10	5,6 (<10)	<10
Tits N.U.,(AAC) [3]	0,6–59	<20	<15
Kaletina N.I. [4]	3–11	2	0,5–1,5
Skal'niy A.V. [2]	–	0,1–2,0	0,05–2,0
Schulz C. (ICP-MS) [6]	0,8–1,0	0,4–0,7	–
ALS Scandinavia (ICP-MS) [7]	0,46–7,5	0,14–4,2	0,05–0,93
Goulle J.P. (ICP-MS) [8]	0,94–8,13	0,14–2,22	0,31–1,66

[1] MG 2000/140. Metodika rannei diagnostiki i prognozirovaniya techeniya toksicheskogo deistviya rtuti v dozakh maloi intensivnosti u detei: metodicheskie rekomendatsii № 2000/140 ot 28.05.2001 g. [A procedure for early diagnostics and prediction of toxic effects exerted on children by mercury in low intensity doses: Methodical guidelines approved on May 05, 2001 N 2000/140]. *Hippocratic.ru: Medical information source*. Available at: http://www.hippocratic.ru/medtext1/medtext_8833.htm (23.01.2018).

efficient analysis techniques. They are primarily mass-spectrometry with inductively coupled plasma (ICP-MS) and electrothermal atomic-absorption spectrometry (ET-AAS)[2] [10]. Atomic-absorption spectrometry as a technique for mercury determination is usually applied via absorption of cold mercury vapor with specific mercury-hydride detachable devices (MHDD) for atomic-absorption spectrometers or with mercury analyzers [11]. Atomic absorption of cold vapor is highly sensitive (detection limits are similar to those of ICP-MS) and selective due to distillation of elemental mercury vapor from a sample matrix. At the same time, N.B. Ivannko et al. state [12] that such techniques are still inferior to ICP-MS due to their much lower productivity. In 2003 Methodical Guidelines No. 4.1.1483-03 were approved and became valid in the RF; these guidelines fix procedures for determining concentrations of chemical elements, including mercury, in biological substrates via ICP-MS technique[3]. Ranges within which mercury is detected in various biological media and biologically active additives amount to 0.1–10 μg/l, determination inaccuracy is 40%, 10–100 μg/l, determination inaccuracy is 20%, detection limit is equal to 0.01 μg/l.

But still, when we perform quantitative determination of mercury via ICP-MS, we often face certain difficulties which are related to physical and chemical properties of the element. Mercury is a liquid metal of silver color, volatile, and resistant to water and air. High volatility of mercury calls for a sample preservation at a stage when it is being taken. Mercury has a very high ionizing potential which is equal to 10.44 eV, and it imposes substantial limits on efficiency of its ionization in plasma during a mass-spectrometry analysis and results in low sensitivity of the technique. Besides, another serious problem is related to a so called "memory effect". This disturbing action is caused by a great difficulty which we face when we try to wash residual quantities of mercury off feeding equipment, a spray chamber, burner, and interface parts of a mass spectrometer [12, 13].

It turned out to be rather difficult to apply MG 4.1.1483-03[3] in clinical and laboratory practices to determine mercury contents as this procedure didn't fix precise parameters for samples preparation and analysis conditions.

Therefore, all the above mentioned made us choose our **research goal** which was to optimize conditions for a routine biological media analysis aimed at determining overall mercury contents via mass-spectrometry with inductively coupled plasma.

Data and methods. We performed quantitative determination of mercury in blood, urine, and hair samples with Agilent 7500cx mass spectrometer with an octopole reaction/collision cell (Agilent Technologies, the USA) with 27.12 millihertz transistor oscillator. To introduce samples, we applied a two-channel Scott spray chamber which was cooled down to 2 ºC

[2] MG 4.1.1470-03. Atomno-absorbtsionnoe opredelenie massovoi kontsentratsii rtuti v biomaterialakh (moche, volosakh, kondensate al'veolyarnoi vlagi) pri gigienicheskikh issledovaniyakh [Atomic-adsorption determination of mercury mass concentrations in biological materials (urine, hair, and alveolar liquid condensate) in hygienic research]. *CODEX: Electronic data fund for legal and technical regulatory documentation*. Available at: http://docs.cntd.ru/document/1200034849 (23.01.2018).

[3] MG 4.1.1483-03. Opredelenie soderzhaniya khimicheskikh elementov v diagnostiruemykh biosubstratakh, preparatakh i biologicheski aktivnykh dobavkakh metodom mass-spektrometrii s induktivno svyazannoi argonovoi plazmoi issledovaniyakh [Determination of chemical elements in diagnosed substrates, preparations, and biologically active additives via mass-spectrometry with inductively coupled argon plasma]. *CODEX: Electronic data fund for legal and technical regulatory documentation*. Available at: http://docs.cntd.ru/document/1200032531(23.01.2018).

with a Peltier device (thermoelectric cooler). A sample was fed into the spray chamber at a speed equal to 0.4 ml/min. The mass-spectrometer was equipped with Fassel plasma torch, its injector tube diameter being 2.5 mm. We used liquid argon with high purity equal to 99.998% (TC-2114-005-00204760-99). Maximum speed of argon flow amounted to 20 l/min, pressure in the gas-feeding channel was equal to 700±20 kPa, plasma temperature was 8000–10000 K. The process of the analysis was automated with G3160B autosampler (Germany).

To adjust the device receptiveness, we applied ^{7}Li, ^{59}Co, ^{89}Y, and ^{205}Tl solution in 2% nitric acid with each element concentration being equal to 1 μg/l (Tuning Solution, the USA). We chose gaseous helium with high purity (99.995%) as a gas-reagent. To make Internal Standards (IS) solutions, we used a complex standard solution of ^{209}Bi, ^{73}Ge, ^{115}In, ^{6}Li, ^{45}Sc, ^{159}Tb, ^{89}Y with their concentration being equal to 10 μg/l in a water solution of nitric acid (Internal Standard Mix, the USA), as well as a standard ^{103}Rh solution with its concentration being 10 μg/l in 2% water solution of hydrochloric acid (Rhodium Internal Standard, the USA). We applied highly pure nitric acid with As, Cd, Cu, Mn, Pb, Sr, and V contents ≤ 0.01 mg/kg; Cr and Ni contents ≤0.02 mg/kg; Tl and Zn contents ≤0.05 mg/kg (Nitric acid 69%, Sigma-Aldrich, the USA).

To dilute, we applied deionized water with its specific resistance being equal to 18.22 Mom·cm which was purified with Milli-Q Integral system (Millipore SAS, France). All the laboratory dishes made of glass, teflon, and polypropylene, were washed in Elmasonic S 100H ultrasound cleaner (Germany) at 45^{o} C–50^{o} C as per the following procedure: 3–4 times washing in distilled water, each lasting 10 minutes after which water was changed; then 30 minutes washing in nitric acid diluted with distilled water in a ratio 1:5; after that the dishes were washed with 2-3% hydrochloric acid solution or with 1% nitric acid solution containing 5 μg/l of auric chloride.

A substantial stage in chemical-analytical research is a sample taking and storage, especially when we examine volatile elements. Thus, to prevent losses of mercury during its transportation and storage, it is necessary to freeze samples or to add auric chloride (III) solution into them. To add $AuCl_3$ to samples, we should apply reaction/collision cells, because chlorine ions cause interferences during determination of vanadium, arsenic, and selenium. To achieve efficient ionization of mercury in plasma and to increase receptiveness of a mass spectrometer, it is important to preset power of a frequency generator at 1500–1600 Wt, and a distance between a burner and a selective cone should be about 7-7.5 mm. Prior to an analysis, the device was adjusted in No Gas mode (without a gas-reagent); its receptiveness was checked, as well as background levels, and levels of secondary oxide and doubly charged ions; then the device was switched into Reaction mode.

Before starting an analysis, we made sure that helium had filled all the feeding channels and the reaction cell at a speed equal to 10 ml/min; after that, the device remained untouched for 30 minutes for stabilization.

To prepare calibration solutions, we applied a standard solution of mercury ions with their concentration being 10 mg/l in 5% solution of nitric acid (Calibration Standard 2A – HG, the USA).

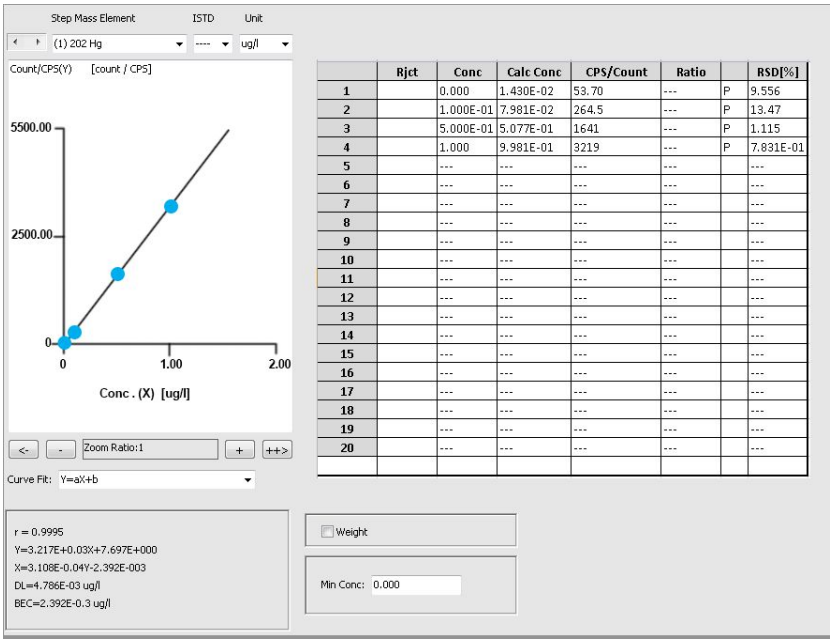
A specific order in which calibration solutions and the samples themselves are measured is a way to minimize "memory

effect": first, actual samples with low contents of mercury are fed into plasma, and then calibration solutions follow, starting from one with the lowest concentration and then proceeding with ones with higher concentrations. At present, the highest peak of a calibration graph which we achieved during our research on mercury contents in samples doesn't exceed 1.0 µg/l; it minimizes the device contamination and, consequently, "memory effects". Our calibration graph was designed as per the following points: 0.0; 0.1;0.5;1.0 µg/l (Figure 1).

To obtain precise and authentic results, it is necessary to achieve the lowest device background level possible. As we can see from the calibration graph on Figure 1, a concentration which is equivalent to the background (BEC) doesn't make any contribution into analysis results. Correlation coefficient *r* is equal to 0.9995, and the detection limit of the device amounts to 0.00478 µg/l.

Determination of an optimal element of Internal Standard (IS) is a technique which allows to level off matrix influences exerted by a saturated structure of blood matrix, shifts in a device receptiveness during an analysis, differences in densities of calibration solutions and examined ones, and low ionization degree of ions which are being determined. To do that, we took blood samples with certified mercury contents and prepared them via adding a solution of complex internal standard. Minimal inaccuracies in determining mercury in blood within various concentration ranges were detected when ^{159}Tb and ^{103}Rh were used as internal standards. A blank experiment also matters a lot, especially when an element is detected in quantities equal to ng/l. Thus, when ^{159}Tb and ^{103}Rh were applied, a blank sample was equal to approximately 8 µg/l, and in case of ^{115}In and ^{209}Bi, it was about 18–19 µg/l.

Blood. Blood samples were taken from the ulnar vein into vacuum vials made of polypropylene with lithium heparin sputtering (PUTH, China). Samples could be stored in a fridge (from 0ºC to 4ºC) in a hermetically closed vial for 3 days; long-term storage was possible only if they were frozen.



	Rjct	Conc	Calc Conc	CPS/Count	Ratio		RSD[%]
1		0.000	1.430E-02	53.70	---	P	9.556
2		1.000E-01	7.981E-02	264.5	---	P	13.47
3		5.000E-01	5.077E-01	1641	---	P	1.115
4		1.000	9.981E-01	3219	---	P	7.831E-01
5		---	---	---	---		---
6		---	---	---	---		---
7		---	---	---	---		---
8		---	---	---	---		---
9		---	---	---	---		---
10		---	---	---	---		---
11		---	---	---	---		---
12		---	---	---	---		---
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15		---	---	---	---		---
16		---	---	---	---		---
17		---	---	---	---		---
18		---	---	---	---		---
19		---	---	---	---		---
20		---	---	---	---		---

Figure. Calibration graph for mercury ions

Table 2

Analysis of spiked samples for blood, urine, and hair samples

Sample	LOD in solution	Unspiked sample	Spiked sample	Analysis	Δ, %
blood (No. 1), μg/l	0,0015	0,012	0,03	0,02/0,018	10
blood (No. 2), μg/l	0,0015	0,042	0,065	0,02/0,023	15
urine (№ 1), μg/l	0,012	0,080	0,19	0,1/0,11	10
urine (№ 2), μg/l	0,012	0,045	1,18	1,0/1,14	14
hair (№ 1), μg/g	0,003	0,087	0,19	0,1/0,103	3
hair (№ 2, μg/g	0,003	0,147	0,253	0,1/0,105	5

To decompose blood samples, an examined sample with its volume being 0.1-0.2 ml was introduced into cone centrifuge plastic screw-top vials; than 0.2-0.4 ml of nitric acid (68%) and 0.1 ml of a complex internal standard were added; then the mixture was thoroughly stirred. The vials were kept untouched for 2-3 hours; then the volume of the mixture was increased up to 10 ml and the mixture was centrifuged for 10 minutes at a speed equal to 2700-3000 turns per minute with CLMN-R10-01-"Elekon" centrifuge (Russia). The prepared mixture was then put into vials for the consequent mass-spectrometric analysis. At the same time we prepared a blank experiment for each set of samples; blank samples underwent the same preparation and the process included all the reagents which were applied to prepare analyzed samples.

Urine. Samples of morning urine were taken into sterile screw-top polypropylene containers, their volume being 125 ml (F.L.Medical S.r.l., Torreglia, Italy). Urine samples were analyzed after being diluted in a ratio 1/10 with 1% nitric acid solution: 0.5 ml of urine were added with 4.45 ml of 1% water solution of HNO_3 and 0.05 ml of internal standard solution.

Hair. Hair in its full length was cut off the occipital region in a quantity which allowed to obtain an analytical sample equal to 0.1-0.2 grams. Hair samples were kept in paper packs; they were decomposed in open vials as per the following procedure: hair samples weighing 0.1-0.2 grams were put into cone vials made of polypropylene, their capacity being 15 ml; 0.1 ml of IS solution was then added with a doser; then we added 1-2 ml of concentrated nitric acid, its density being 1.415 g/cm^3; the mixture was kept untouched 3-6 hours until all the hair in it was dissolved; then 1-2 ml of concentrated hydrogen peroxide were added. The vial with the mixture was stirred, kept untouched for 3-4 hours, and then the volume of the mixture was increased to 10 ml with deionized water being added into it and centrifuged for 10 minutes at a speed equal to 2700-3000 turns per minute with CLMN-R10-01-"Elekon" centrifuge (Russia).

We checked validity of the results which we obtained during blood, urine, and hair samples analysis with spiked samples analysis (Table 2). A certain amount was added into an analyzed sample before it was prepared. Table 2 contains data on detection limits (LOD) calculated as per 3σ criterion. Determination inaccuracy didn't exceed 15%.

We analyzed standard blood samples SERONORM (Sero AS, Norway) blood L1 (LOT 1103128), L2 (LOT 1103129), L3 (LOT 1112691), urine samples Seronorm^{TM} (Sero AS, Norway) (LOT 0511545) and hair samples Reference Material in Human Hair (IAEA-086,Vienna,Austria). Prior to the analysis, certified reference materials underwent the same preparation procedure as our experimental samples. Reference samples were

analyzed after each 5th actual sample. Data from the Table 3 prove there is an authentic similarity between detected and certified values.

Table 3

Certified and detected average mercury concentrations in standard blood, urine, and hair samples

Level	Certified value	Detected average value	Δ, %
Seronorm™ urine (*n*=5), µg/l	39,8	39,3	1,2
Seronorm blood L1 (*n*=5), µg/l	1,5	1,71	14,0
Seronorm blood L2 (*n*=5), µg/l	16,0	17,3	8,1
Seronorm blood L3 (*n*=4), µg/l	37,1	39,6	6,7
Reference Material in Human Hair (*n*=10), µg/l	0,573	0,635	10,8

The suggested procedure was tested within LAMP international test program which was organized by the US Environmental Protection Agency, Centers for Diseases Control and Prevention (Atlanta, the USA), Results of blood samples examination in terms of mercury contents are given in Table 4.

The results of external quality control prove that the experiment results are quite satisfactory, as Z-index with its value as per modulus being $|Z| \leq 2$ is acceptable.

Table 4

Mercury contents in blood samples from LAMP (CDC, Atlanta, the USA)

Round/ code of a sample	Certified value, µg/l	Detected value, µg/l	*Z*- index
31/1402	3,13	3,43	0,6
31/1403	8,00	8,6	0,7
32/1404	4,13	4,6	0,2
32/1406	2,57	3,7	–0,4
33/1407	1,68	1,38	–0,6
33/1408	6,24	5,58	–0,3
33/1409	10,52	9,58	–0,2

We performed a metrological certification of the suggested procedure for determining mercury in blood, urine, and hair; this certification was accomplished in full conformity with the following regulatory documents: RMG 61-2010 State Standard R ISO 5725-1-2002, State Standard R ISO 5725-2-2002, State Standard R ISO 5725-3-2002, State Standard R ISO 5725-4-2002, State Standard R ISO 5725-5-2002 and State Standard R ISO 5725-6-2002[4].

This procedure for measuring mercury concentrations in blood, urine, and hair allows to obtain results with inaccuracies not higher than values given in Table 5.

The developed ICP-MS-based procedure for determining mercury in biological media allows to determine the element in blood within 0.5 - 100 µg/l range of con

Table 5

Metrological characteristics of the procedure for mercury determination in a solution, µg/l

A component being determined and a range of measurements in a solution	Repeatability (relative standard deviation in repeatability), σ r, %	Reproducibility (relative standard deviation in reproducibility) σ_R, %	Precision (relative inaccuracy limits at probability P=0.95), ±δ, %
Blood, µg/l from 0.005 to 1.0 inclusive	9,19	13,23	29,42
Urine, µg/l from 0.04 to 1.0 inclusive	10,36	10,42	24,25
Hair, µg/g from 0.1 to 1.0 inclusive	9,52	9,74	22,43

Table 6

Mercury contents in examined biological media

Medium	Group	Perm region	Canada [16]	Russia [14]	Germany [6, 17]	HBM-1 [1, 6]
Blood, μg/l	adults	–	0,12–4,7	0,89–2,39	0,02–16	5
	children	0,02–1,2	0,27–6,39	0,2–0,43	0,8–1,0	
Urine, μg/l	adults	0,65–8,2	0,2–3,5	0,27–0,94	–	7
	children	0,45–0,8	0,2–2,82	–	0,4–0,8	
Hair, μg/g	adults	0,29–0,49	–	0,21–0,54	–	1

centrations with inaccuracy being equal to 29.4%; in urine, within 0.4 - 100 μg/l with inaccuracy being 24.2%; in hair, within 0.001 - 100 μg/g with inaccuracy being 22.4%.

We detected the following limits of detection (LOD): 0.0015 μg/l for blood; 0.012 μg/l for urine; and 0.003 μg/g, for hair.

Results and discussion. We tested the developed procedure as we examined patients from the in-patient department and the polyclinic of the Federal Scientific Center for Medical and Preventive Health Risk Management Technologies (Table 6). This Table contains data on mercury concentrations in biological media taken from people living in Canada, Russia, and Germany. We examined a group of children and detected that mercury contents in their blood and urine were lower than HBM-1. Mercury concentration in urine taken from exposed adults was higher than HBM-1. Mercury contents in urine taken from Rus-

[4] Gosudarstvennaya sistema obespecheniya edinstva izmerenii. Pokazateli tochnosti, pravil'nosti, pretsizionnosti metodik kolichestvennogo khimicheskogo analiza. Metody otsenki: rekomendatsii po mezhgosudarstvennoi standartizatsii [State system for ensuring the uniformity of measurements. Accuracy, trueness and precision measures of the procedures for quantitative chemical analysis. Methods of evaluation: Recommendations on interstate standardization]. *CODEX: Electronic data fund for legal and technical regulatory documentation*. Available at: http://docs.cntd.ru/document/1200094703 (23.01.2018).

State Standard R ISO 5725-1-2002. Tochnost' (pravil'nost' i pretsizionnost') metodov i rezul'tatov izmerenii. Ch. 1. Osnovnye polozheniya i opredeleniya [Accuracy (trueness and precision) of measurement methods and results. Part 1. General principles and definitions]. *CODEX: Electronic data fund for legal and technical regulatory documentation*. Available at: http://docs.cntd.ru/document/1200029975 (23.01.2018).

State Standard R ISO 5725-2-2002. Tochnost' (pravil'nost' i pretsizionnost') metodov i rezul'tatov izmerenii. Ch. 2. Osnovnoi metod opredeleniya povtoryaemosti i vosproizvodimosti standartnogo metoda izmerenii [Accuracy (trueness and precision) of measurement methods and results. Part 2. Basic method for the determination of repeatability and reproducibility of a standard measurement method]. *CODEX: Electronic data fund for legal and technical regulatory documentation*. Available at: http://docs.cntd.ru/
document/1200029976 (23.01.2018).

State Standard R ISO 5725-3-2002. Tochnost' (pravil'nost' i pretsizionnost') metodov i rezul'tatov izmerenii. Ch. 3. Promezhutochnye pokazateli pretsizionnosti standartnogo metoda izmerenii [Accuracy (trueness and precision) of measurement methods and results. Part 3. Intermediate measures of the precision of a standard measurement method]. *Internet and law: Juridical company*. Available at: http://www.internet-law.ru/gosts/gost/6182/ (23.01.2018).

State Standard R ISO 5725-4-2002. Tochnost' (pravil'nost' i pretsizionnost') metodov i rezul'tatov izmerenii. Ch. 4. Osnovnye metody opredeleniya pravil'nosti standartnogo metoda izmerenii [Accuracy (trueness and precision) of measurement methods and results. Part 4. Basic methods for the determination of the trueness of a standard measurement method]. *CODEX: Electronic data fund for legal and technical regulatory documentation*. Available at: http://docs.cntd.ru/document/1200029978 (23.01.2018).

State Standard R ISO 5725-5-2002 Tochnost' (pravil'nost' i pretsizionnost') metodov i rezul'tatov izmerenii. Ch. 5. Al'ternativnye metody opredeleniya pretsizionnosti standartnogo metoda izmerenii [Accuracy (trueness and precision) of measurement methods and results. Part 5. Alternative methods for the determination of the precision of a standard measurement method]. *CODEX: Electronic data fund for legal and technical regulatory documentation*. Available at: http://docs.cntd.ru/document/1200029979 (23.01.2018).

State Standard R ISO 5725-6-2002 Tochnost' (pravil'nost' i pretsizionnost') metodov i rezul'tatov izmerenii. Ch. 6. Al'ternativnye metody opredeleniya pretsizionnosti standartnogo metoda izmerenii [Accuracy (trueness and precision) of measurement methods and results. Part 6. Alternative methods for the determination of the precision of a standard measurement method]. *CODEX: Electronic data fund for legal and technical regulatory documentation*. Available at: http://docs.cntd.ru/document/1200029980 (23.01.2018).

sian population who were not exposed to this metal amounted to 0.27 - 0.94 μg/l [14]; mercury concentrations in urine taken from workers employed at an industrial enterprise amounted to 0.2-25.3 μg/l [15].

Mercury contents in urine taken from children whom we examined was at the same level as in children from Germany [6] .

Mercury contents in hair which we detected corresponded to all the literature data we managed to find [1,6].

Conclusions:

1. The performed research gave us grounds to offer optimal conditions for a routine analysis of biological media aimed at determining overall mercury concentrations with ICP-MS. These conditions allow to determine the element in blood within 0.5 - 100 μg/l range of concentrations with inaccuracy being equal to 29.4%; in urine, within 0.4 - 100 μg/l with inaccuracy being 24.2%; in hair, within 0.001 - 100 μg/g with inaccuracy being 22.4%.

2. We achieved high repeatability of measurements in determining mercury contents in blood when we participated in LAMP international test program ($|Z|\leq 2$).

3. The developed ICP-MS based procedure for determining mercury in blood, urine, and hair was tested during examination of children and exposed adults. The obtained results are well in line with literature data.

4. Mercury contents in biological media taken from Perm region population who are not exposed to the metal do not exceed HBM-1 levels recommended by the WHO.

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STANDARD OPERATING PROCEDURES AS A TREND IN ENSURING HEALTHCARE SAFETY

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An analysis of healthcare safety indicators has shown that risks associated with providing healthcare which occur in medical organizations lead to additional economic and material losses, lower efficiency of government measures aimed at developing healthcare, and poorer public trust in a healthcare system. One of the basic reasons for this situation is the lack of proper regulation of the activities performed by medical organization personnel whose work is related to healthcare provision.

At present there is no scientific justification and procedures required to ensure the needed safety of patients and healthcare professionals are not established. Also, the functions of healthcare personnel related to ensuring healthcare safety have not been formalized and standardized, and also certain methodical ways of ensuring healthcare safety have not been established.

The regulation of certain recurring procedures, important for healthcare safety, is most efficiently provided through SOPs. The risk assessment methodology allows to identify the most important elements of the activities performed by the medical organization personnel, to develop and implement standard operating procedures the use of which increases healthcare safety.

The authors worked out basic principles (an algorithm) of standard operation procedures (SOP) development used to ensure safety in the field of healthcare which can be considered universal and can be applied at any healthcare organization. According to the mentioned principles and taking the relevance into account, the authors have described certain types of activities performed by healthcare personnel and developed standard operation procedures in the field of healthcare safety.

The research of SOP's implementation efficiency at core medical organizations is being performed at the moment.

Key words: *healthcare safety, health risks assessment, standard operating procedures (SOP), healthcare system, regulation of the activities performed by medical organization personnel, risk assessment methodology, healthcare quality, prevention of adverse outcomes.*

When we assess healthcare quality, we should pay attention not only to how efficient a certain medical intervention has turned out to be, but also to how safe it has been for a patient. Safety related to medical aid provision means that safe medical technologies and treatment procedures are applied; that patients' staying in a medical organization is safe; and that they enjoy full mental and social comfort there.

Healthcare-related risks for patients, as well as for medical personnel in some cases, are risks of additional substantial economic expenses, material losses, lower efficiency of governmental activities aimed at healthcare development, and lack of

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trust which population have in a public healthcare system. Thus, as per our calculations, additional healthcare expenses related to patients being infected during their staying at in-patient departments amount to about 15% of the overall budget allocation on public healthcare in the RF; these data are quite similar to those obtained in other countries [1]. These are expenses which occur when a clinical course of a primary disease gets worse due to a secondary disease emergence during a patient's staying in a hospital and a consequent longer time which is needed for his or her recovery.

So, healthcare safety is prevention of unfavorable outcomes or harms during treatment or reduction of damage done in case of their occurrence. In order to avoid adverse consequences, we should determine risk factors, perform prevention activities, and assess their results.

It goes well in line with Donabedian's basic elements of healthcare quality provision (a so called Donabedian Model), namely development of structure, process (technology), and result [2]. And here all these elements are interrelated and interdependent.

Of course, we should take into account the fact that there are systematic reasons for insufficient healthcare safety. They are out-of-date regulatory and legal grounds which fix old-fashioned practices of medical activities and education of medical personnel; it is also scientific research which doesn't conform to international standards and is not based on clear and valid evidence; it is narrow specialization, and so on, and so forth [3,4].

A whole set of activities comprising organizational, technical, technological, and preventive ones is aimed at providing safety in medical organizations. And each administrative level in any medical organization has its own competences and responsibilities.

An up-to-date concept of a risk-oriented approach to analysis of risks which can occur in a medical organization, just as at any object in general, involves detecting threats to people's lives and health as well as those objects which generate risks of damages to life and health [5].

In case of a medical organization threats to life and health can be caused by its personnel as their occupational activities can exert direct, and sometimes even indirect, negative impacts on patients. Most frequently such actions are unintentional as they are caused by lack of knowledge and skills, or by absence of proper conditions for performing job tasks.

One of basic reasons for that is absence of proper regulations on functions which personnel of a medical organization have to perform when they deal with routine medical activities.

This reason has been mentioned by the WHO when its experts stated that inefficiency of medical activity was mostly determined by poor knowledge or improper application of clinical standards and protocols; by absence of guidelines and recommendations; by inadequate surveillance [6].

Nowadays, a great deal of work in healthcare is dedicated to development and implementation of standards on medical aid which are to be applied in case of certain diseases. More than 680 standards are in force now; they contain standard requirements to lists of diagnostic and treatment services, medications and medical appliances, blood preparations, and other components which are necessary for providing qualitative medical aid [7].

However, these documents don't include any requirements to activities aimed

at providing safety for patients who have to stay in a medical organization. In general, these documents, just as many other regulatory and legal acts which are related to medical organizations functioning, contain requirements to a way in which work of a medical institution is organized and medical activities are performed; these requirements can't be directly applied to a specific medical worker. Regulation of activities performed by personnel which is aimed at providing greater safety for patients calls for development of a specific document.

A discussion on this necessity to work out regulations (standardization) for certain routine procedures which are important for achieving a target result started some decades ago; it resulted in creation of a specific document, or Standard Operating Procedure (SOP). The term was first introduced in the middle of the 20th century [8].

A Standard Operating Procedure is a document which regulates activities performed by a specific worker and contains specific consequence of actions which are necessary to complete a specific task. A SOP is usually created in such cases when a routine (repeating) procedure should lead to a certain (known) result which is important for overall functioning of an organization.

SOPs became widely spread in various spheres such as industry, business, public administration, education, healthcare, etc. Of course, there are differences caused by a specific sphere where they are applied, but still, all the SOPs have a common structure, common chain of actions which is necessary for completing a routine (repeating) procedure; this procedure, in its turn, is a component of the overall quality system [8].

SOPs fix a goal, outline a task, and determine who should do what, when and how. They contain the clearest possible description of action chains which should be completed. In order to achieve greater visualization and better understanding of actions described by a SOP it can contain figures, diagrams, tables, or photos.

SOPs are usually developed taking into account standard regulations which exist in a specific sphere and envisage procedures of objective control, both intermediate and final.

SOPs have the following advantages: they minimize probability of personnel not fully understanding their responsibilities, provide comparability and conformity with standard requirements.

SOPs were first developed and applied in healthcare less than 10 years ago. First of all, they were applied in pharmacy, where they became an integral part of quality management system as well as activities performed at laboratories and clinical departments [9–13].

In particular, the Order issued by the RF Public Healthcare Ministry on April 01, 2016 No. 199н "On Approval of Rules for Good Laboratory Practice[1] states that proper quality of work is provided due to fixing standard operating procedures which contain detailed, profound, and consistent regulations on how to perform a preclinical examination or how to implement proce-

[1] Ob utverzhdenii Pravil nadlezhashchei laboratornoi praktiki: Prikaz Minzdrava Rossii №199n ot 01.04.2016 g. [On Approval of Rules for Good Laboratory Practice: The Order by the RF Public Healthcare Ministry issued on April 01, 2016. No. 199н]. Available at: https://minjust.consultant.ru/documents/20332 (20.03.2018).

[2] MG 64-04-003-2002. Proizvodstvo lekarstvennykh sredstv. Dokumentatsiya. Obshchie trebovaniya. Primernye formy i rekomendatsii po ikh zapolneniyu: Rasporyazhenie Minpromnauki Rossii № R-16 ot 15.04.2003 g. [Manufacture of medications. Documents. Basic requirements. Model forms and recommendations on filling them in: the Order issued by the RF Ministry for Industry and Science on April 15, 2003 No. P-16]. Available at: http://base.garant.ru/6147324/ (20.03.2018).

dures which are not described in detail in an examination report. Standard operating procedures regulate a) samples arrival, identification, marking, processing, and taking, application, storage, destruction, and utilization of examined substances, medications, and reference samples; b) maintenance and calibration of measurement instruments and equipment; c) preparation of reagents, nutrient media, and feedstuffs; d) maintenance of rooms where research is performed; e) receipt, transportation, storage, description, and identification of examined substances and test-systems; f) filling in a research report [14].

Methodical guidelines MG 64-04-003-2002 "Manufacture of medications. Documents. Basic requirements. Model forms and recommendations on filling them in"[2], approved by the Order issued by the RF Ministry for Industry and Science on April 15, 2003 No. P-16 enlist SOPs among basic documents necessary for enterprises which manufacture medications.

All medical organizations, regardless of their departmental subordination and legal form, are to implement SOPs in their activities. These SOPs should describe quality management systems, production processes, packing and receipt of primary raw materials, auxiliary, packaging and printing materials, sampling procedures, and quality control performance. And here a SOP is a unified detailed printed instruction related to standard actions or operations performed at an enterprise [15].

Importance of SOPs development is also highlighted in documents which set forth requirements to GCP or Good Clinical Practice. It is determined by a desire to achieve greatest possible validity of obtained information via its unification and formalization.

Thus, in December 2004 experts from the RF Ministry for Public Healthcare and Social Development introduced a program for additional pharmaceutical provision for specific population categories (so called cash-for-benefits welfare reform) and stated that SOPs would be applied together with orders and methodical guidelines to fix procedures for distribution of medications, responses to conflict situations, and other rules of additional pharmaceutical provision. Unfortunately, it was absence of clear and precise mechanisms of implementation, SOPs included, which caused a lot of problems when the program was implemented in Russia [16].

SOPs are not so widely spread either in domestic or foreign clinical practices as they really should be.

Foreign literature contains data on certain examples of SOPs implementation and application in clinical practices. It is shown that when they are applied, it allows to decrease a number of medical errors in diagnostics, to reveal risk factors for patients, to detect patients who are prone to suicide etc. However, these examples are only isolated cases, and there is no systemic work in the sphere [9,11,13,17–19].

"Practical recommendations on how to organize internal quality control and safety of medical activities in a medical organization" developed by Rospotrebnadzor's Center for Monitoring and Clinical-Economic Examinations is a good step towards determining methodical approaches to creation and assessment of parameters within a system of internal control over healthcare safety. This document spots out basic tasks which are to be solved if we want to provide quality and safety of medical activities; it also determined what parameters should be assessed (for example, if there are algorithms which describe how to take sample materials for microbiological examination), how they should be assessed (whether there are algorithms in all

divisions, personnel are aware of them and follow them properly etc.). However, the document doesn't determine a methodological procedure for creation of such algorithms and it makes development of regulations (SOPs) more difficult. The only hint is that they are assumed to be created by personnel employed at medical organizations in full conformity with peculiarities of this or that institution [20].

So, up to now, procedures which can provide proper safety of patients and personnel at medical organizations haven't been scientifically grounded and developed; functions performed by personnel at medical organizations and aimed at providing healthcare safety haven't been formalized and standardized; specific methodical techniques for providing healthcare safety haven't been determined.

We developed basic principles (algorithms) for creating standard operating procedures (SOPs) which regulate provision of healthcare safety; these SOPs are basic and universal and can be applied in any medical organization. Thus, any SOP should contain the following:

♦ purpose: what specific activities (procedures, manipulations) are regulated by this SOP;

♦ application sphere: what enterprises (organizations) or structural departments this SOP should be applied at;

♦ regulatory references: a list of documents which regulate activities in the sphere this SOP is related to;

♦ terms and symbols: a conceptual apparatus and expansion of abbreviations which are used in this SOP;

♦ responsibilities assignment: a list of workers who are responsible for control over conforming to SOP requirements and for medical personnel training aimed at creating awareness about rules fixed in this SOP;

♦ logistics and technical support: a list of equipment and materials which are necessary to conform to SOP requirements;

♦ procedure: a SOP should explain what purposes regulated procedures have and what conditions are necessary to provide their successful implementation and achievement of target results;

♦ training for personnel: a SOP should regulate staff training and practical skills development in relevant spheres and determine a person who is responsible for this training and certification of personnel (assessment of their knowledge and skills);

♦ assessment of efficiency: parameters which characterize aspects a SOP is concentrated on should be monitored;

♦ visual information: relevant instructions, posters, and methodical materials are to be created;

♦ statistical forms and supplements: there should be a list of obligatory relevant statistical forms which are included into a SOP and applied when monitoring is performed, records on personnel certification, ands supplements which explain how to conform to proper consequence of relevant manipulations.

So, this developed algorithm for SOP creation includes all the necessary aspects which can give answers to the most important questions related to providing qualitative healthcare: How to do it right? When? Where? and Who should do it? If a SOP is implemented, what will be the results?

With all the above-mentioned principles taken into account and bearing healthcare safety in mind, we selected certain activities performed by medical personnel and developed standard operating procedures for them [21–30].

A SOP named "Receipt and distribution of disinfectants to departments at a medical organization in order to support

their activities" was created in the sphere of providing overall structural safety.

A SOP named "Disinfection-related activities. Training for medical personnel" was created in the sphere of providing healthcare technological safety.

A SOP named "A procedure regulating hygienic treatment of hands and application of medical gloves to prevent infections related to medical aid provision" was created to ensure safety of treatment results.

All the above-mentioned SOPs are now being implemented in several clinical centers in Moscow.

To assess whether the SOP "A procedure regulating hygienic treatment of hands and application of medical gloves to prevent infections related to medical aid provision" was implemented efficiently, we performed a comparative analysis with its purpose being to reveal how requirements to hygienic treatment of hands and application of medical gloves were met in our core medical organizations before the SOP was implemented and after its implementation.

Knowledge and skills which medical personnel had were evaluated by experts in real time mode; we then performed a comparative analysis of the evaluation results.

We processed 875 questionnaires for personnel which were specially designed for this research; 492 questionnaires for patients; we also conducted 104 interviews with medical organizations supervisors and heads of various departments and then processed the results.

Efficiency of SOP implementation was assessed by experts, senior nurses at various departments; they assessed efficiency of their activities before it was implemented and after it. Overall, we had 600 inspections, 300 in 2016 before the SOP was implemented, and 300 in 2017 after its implementation in the core medical organizations.

Results of the comparative analysis revealed that after the SOP was implemented there was a substantial increase in an integral parameter which characterized average level of medical personnel conforming to the rules for hygienic treatment of hands and application of medical gloves in all the structural departments at the core medical organizations. Overall average level also grew from 42.0% before SOP implementation to 57.3% after it.

We intend to continue our research on how efficiently SOPs are being implemented in the core medical organizations.

But at the same time our experience proves that successful implementation of SOPs and, consequently, expected positive results to a great extent depend on how well supervisors and personnel at medical organizations realize the necessity to apply SOPs. Preliminary work is required here, both workshops for personnel and individual conversations with supervisors.

Therefore, the results of the performed comparative analysis allow us to state that SOP implementation undoubtedly had a positive effect on medical personnel compliance with requirements for hygienic treatment of hands and application of medical gloves. Consequently, SOP is an efficient tool for improving quality and providing greater healthcare safety and its implementation into routine practices at other medical organizations is appropriate and meets up-to-date requirements.

Standard operating procedures should be revised taking into account the latest requirements, technical possibilities, and technological and scientific achievements.

We think that SOPs creation and implementation aimed at providing

healthcare safety should be systematic as only systematic work can ensure achievement of target results at all management levels.

SOPs should be created for all the organizations in the healthcare system: starting from federal and regional management authorities and up to a specific medical organization and its personnel. If standards operating procedures are clear, unambiguous, and meet all the requirements of up-to-date medical theory and practices, then their creation and all-round application can truly become an effective instrument in the system of healthcare quality management.

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HEALTH COMMUNICATION: THEORETICAL AND PRACTICAL ASPECTS

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Nowadays chronic non-infectious diseases are spreading rapidly and health risk factors related to people's behavior are becoming more and more significant. Efficient communication between medical personnel and their patients is one of the basic ways to stimulate self-preserving behavior. The paper dwells on health communication phenomenon and basic theoretical approaches which allow to get an insight into the essence of the process. Communication is studied at interpersonal, group, organization, and mass levels.

As information technologies now play a significant role in the life of any society, the author considers certain possibilities of their application in public health care, for example, in such spheres as electronic and mobile health care, or telemedicine, and also analyzes experience accumulated in application of communication programs both in the RF and abroad. Special attention is paid to analyzing how efficient communication programs are, and how they can possibly influence population knowledge, attitudes, and behavior as regards their health. Behavior changing models give theoretical grounds for changes in people's behavior; such models are "a model of belief in health" (I. Rosenstock, D. Becker), "theory of planned behavior" (I. Ajzen), theory of stage changes on behavior (G. Prochask). The paper also contains analysis of possibilities to conduct sociological research when working out, implementing, and assessing communication programs aimed at formation of health-preserving behavior. To efficiently implement communication programs, it is necessary to combine efforts by medical experts and experts in social and humanitarian sciences.

The paper can be of interest to a wide range of readers, especially to those who specialize in prevention medicine and sociology of health.

Key words: *communication, communication programs, electronic health care, mobile health care, health, sanitary education, chronic diseases, health-preserving behavior, changes in behavior.*

Population health is a complicated phenomenon which is determined by a set of biological, social, political, economic, and other factors. In the middle of the 20th century, morbidity structure changed drastically both in developed and developing countries. Non-infectious chronic diseases, such as cardiovascular and oncologic ones, mental disorders etc., started to prevail. According to the data provided by Rosstat [1] the most widely spread death causes in the RF in 2016 were the following: cardiovascular system diseases (57.4%, including primary hypertension and increased blood pressure, which accounted for 21.9%) and malignant neoplasms (19%). Therefore, it is vital to examine risk factors which cause occurrence of such pathologies.

Prevalence of chronic non-infectious diseases results from ecology, political and economic situation in the country, public healthcare functioning as a social institution, as well as behavioral patterns which people have in relation to their health.

The World Health Organization

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spots out three basic criteria which allow to attribute this or that factor to a group of factors which stimulates occurrence or makes for spreading of priority non-infectious chronic diseases. These criteria are: considerable prevalence of a factor in most countries; a scientifically proved correlation between a factor and a disease occurrence; lower risk of such diseases when risk factors are under control. According to the WHO data, risk factors are: increased blood pressure, excessive body weight, increased cholesterol and dextrose contents in blood, alcohol intake, smoking, unhealthy nutrition, and insufficient physical activity [2].

Control over chronic non-infectious diseases is one of priority tasks set in most countries in the world, including the Russian Federation. The state program for public healthcare development adopted for the period up to 2025 includes the following: "giving up smoking, drugs, and alcohol abuse, provision of conditions for healthy lifestyle, correction, and regular control over behavioral and biological risk factors of non-infectious diseases at population, group, and individual levels should become the most important component in the health preservation policy"[1] .

There are some goevrnmental measures which help to gain control over chronic diseases prevalence:

- legislative ones which are aimed at adopting laws protecting public health, for example, a law which forbids smoking in public places;

- economic ones which are related to public healthcare funding and provision of qualitative medical and sanitary aid;

- control over production and distribution of consumer goods, first of all, food products, which include limitation imposed on production and distribution of unsafe products, for example, food stuffs which contain trans fats, synthetic preservatives and dyes etc.;

- information and communicative ones which are aimed at creating greater population awareness about possible health risk factors and changes in behavioral patterns.

There is a term "health communication" which is now established in scientific literature written in English. This term can either mean "communication about health" or "communication in the sphere related to health". Communication about health can be defined as a "scientific sphere and practices how to apply communicative strategies in order to provide information and influence decision-making which can improve health both at individual level and in the whole society" [3]. There are two basic trends within this sphere of knowledge. The first one involves theoretical insights into communication about health, analyzes communication process peculiarities, and is based on theoretical developments in communication science. The second trend is primarily oriented at considering communication as a practical activity aimed at promoting healthy lifestyle to population. Thus, to define this trend, we can apply such terms as "health promotion", or medical (sanitary) education which can include all the activities "related to informing, educating, or consulting aimed at creating such a lifestyle which promotes health preservation" [4].

[1] Razvitie zdravookhraneniya: Gosudarstvennaya programma Rossiiskoi Federatsii / utv. Postanovleniem Pravitel'stva Rossiiskoi Federatsii № 1640 ot 26 dekabrya 2017 g. [Public healthcare development: The RF State program / approved by the RF Governmental Order on December 26, 2017 No. 1640]. *Ministerstvo zdravookhraneniya Rossiiskoi Federatsii: ofitsial'nyi sait*. Available at: https://www.rosminzdrav.ru/ministry/programms/health/info (06.06.2018) (in Russian).

Communication in the sphere related to health started to institutionalize as a scientific branch in 80-90ties last century in the USA, when such American experts as B. Korsch, D.Cassata, T. Costello, T. Thompson and others published their first works on the subject. "Health Communication" journal has been regularly published since 1989; and "Journal of Health Communication: International Perspectives", another periodical edition, was first issued in 1996. The Department for Communication in the sphere related to health became an essential part of the International Association for Media and Communication Research in 1985; this Association unites experts in the field. Nowadays, a number of the US higher educational establishments in such states as California, Massachusetts, North Carolina, Oregon, and others, train experts in communication in the sphere related to health [5]. This scientific branch was recognized as such in Europe a bit later, in early 2000ties. The European Association for Communication in Public Healthcare was established in 2001, and some specialized structures were created to train experts in European universities in the Netherlands, Great Britain, Switzerland, and Denmark. "Communication & Medicine", periodical scientific edition, was first published in Great Britain in 2011.

Unfortunately, we can't speak about this scientific branch being institutionalized in Russia as a specific knowledge sphere. But still, there are a lot of scientific works in the field; here we can mention papers published by E.V. Dmitrieva, I.V. Yakovleva, K.V. Kuz'mina, E.V Semyonova. Theoretical and practical research on "risk communications in the sphere related to health" is described in works by N.A. Lebedeva-Nesevrya and A.O.Barg who consider "risk communications in the sphere related to health as a specific type of risk communications due to essential peculiarities of health risk itself" [6]. The authors draw attention to health risks being perceived in the society as the most significant ones as they are related to basic human needs and affect interests of most people.

When we consider communication as a scientific branch we should rely on theoretical developments in the sphere of communication. Thus, A.S. Babrow and M. Mattson suggest to apply a classification developed by R. Craig to get an insight into a phenomenon of communication in public healthcare sphere. R. Craig outlines seven paradigms: rhetorical, semiotic, phenomenological, cybernetic, psychosocial, socio-cultural, and critical one [7]. Within the rhetorical paradigm, communication is considered as a practical activity which has to persuade. This paradigm can be applied to examine persuasive influence exerted by social communication in public healthcare sphere.

Semiotic paradigm analyzes communication as interaction mediated with various symbols and signs; this interaction is aimed at creating mutual understanding between those who participate in communication. This approach can be applied in communication about health: it is meanings that determine people's attitudes, values and actions concerning their health. T. Caughlin examined possibilities to apply semiotic approaches to construct an ideal identity, a human body.

Within phenomenological paradigm, communication is viewed mostly as a dialogue, as one person surviving experiences of another. This approach can be applied to explain health as a specific being of a person in the world. In real life it means that there should be trust between a doctor and a patient, and communication skills are to be developed.

Cybernetic paradigm for communication was created by Norbert Wiener; in his opinion, " the whole sphere of management and communicative theory, concerning both mechanisms or animals, can be called cybernetics" [8]. It means that information is transferred from one subject to other, and this process underlies communication; this information transferring is based on coding/decoding. As regards communication about health, such subjects are medical experts and patients.

Psychosocial paradigm considers communication as a process involving people's interaction and their mutual influence on each other; this process is determined by psychological factors. This approach is widely used to analyze communication about health. Barbrew and Mattson think that when a patient interprets information given to him by a doctor, he or she "not only obtains and carefully processes this information but also tries to develop understanding of health within the context of related convictions and values which underlie his or her personality; his or her social role; relationships with medical experts, family, and other people" [7].

Socio-cultural paradigm explains how social order is reproduced via communication, and what peculiarities occur in communication due to influences exerted by a society. Thus, communication about health is determined by a set of social, cultural, religious, and other factors.

Critical paradigm is closely related to Frankfurt school. If we take public healthcare, this approach can be applied to analyze how policies can set and even impose certain behavioral standards, notably, in public healthcare sphere.

Therefore, all the above-mentioned paradigms can serve as theoretical grounds for communication about health.

Communication in the sphere related to health can be considered at different levels. K.V, Kuz'min and E.V. Semyonova [9] describe four basic communication types: interpersonal, group, organizational, and social (mass) one. Interpersonal communication is a basic level; for example, interaction between a doctor and a patient. Such communication can be both one-sided and two-sided. For example, within T. Parsons' structural functionalism, such communication can be viewed as a one-side process when a doctor gives orders, and a patient has to obey them. Two-sided communication means there is information exchange between a doctor and a patient, as well as a possibility to refuse following doctor's prescriptions (an informative consent model). According to I.B. Nazarova, "relationships between a doctor and a patient in Russia are definitely paternalistic based on two sides being unequal in treatment and diagnostics" [10]. Then, the next level is group communication which means interaction with this or that social group, for example, a group of drug addicts. Organizational communication means interaction between various components in public healthcare structure. Mass communication is one of the most widely spread types of communication about health and is mostly realized via mass media, such as TV, radio, the Internet, etc.

Nowadays, as information technologies are playing more and more significant role is our life, such a phenomenon as "electronic public healthcare" occurs. It involves application of electronic case histories, mobile public healthcare, social networks, telemedicine, etc. The report titled "From innovations to implementation: Electronic healthcare in Europe" issued by the WHO states that such programs "make for wider range of services provided for population and involvement of population

groups who were hard to reach earlier, help to overcome geographical barriers and reach new levels of economic efficiency in provision of medical services" [11]. The WHO research which was performed in 2015 revealed that 84% of the WHO member states had their national policy related to providing healthcare services to population, and 74% of them applied electronic healthcare and information technologies when implementing this policy [11]. Application of IT in medicine is becoming more and more popular among experts in Russia [12]. "A physician and Information Technologies" periodical edition has been published in our country since 2004. Such specialized societies as Association for Medical Information Technologies Development and the Russian Association for Telemedicine operate in Russia.

American and Western European experts in sociology of health have developed a lot of various communication models. Some of them were thoroughly analyzed by E.V. Dmitrieva, a Russian sociologist [13]. There is a therapeutic model which focuses on relationships between a doctor and a patient. According to T. Brewin [14], basic tasks a doctor has to perform in this approach is informing a patient and readiness to provide psychological support to him or her. "A concept of health" model developed by I.Rosentock includes "such components as individual concepts about susceptibility to a disease, on how grave a diseases is, what are the advantages of preventive behavior, and what prevents a patient from pursuing such behavior" [13]. These concepts are determined by social, psychological, demographic, and other factors which can be analyzed; this analysis will help to assess influence exerted by communication programs in the sphere of public health on a person's behavior. Interaction model developed by I. King also focuses on interaction between a doctor and a patient, however, greater attention is paid to interpersonal relations.

A model of communication about health developed by L. Northoust and P. Northoust describes interactions between medical staff (doctors, nurses, social workers, and pharmacists), patients, and "significant others" (family members, colleagues, and friends). This model also considers context, that is, an environment which communication process takes place in. "In the narrow sense, we speak here about hospitals, polyclinics, and other medical organizations; about conditions in which doctors meet their patients (a size of a room, foreign objects being found in it, privacy, etc.). In the wider sense, we speak about attitudes of individuals or groups of people to their health, medical organizations, etc." [13].

Communication context can be considered most profoundly and include various aspects. I.V. Yakovleva [15] highlights several contexts of communication. First, intrapersonal context, which includes a person's knowledge, values, and attitudes. This context enters communication and obtains information about health. Secondly, there is interpersonal communication which implies mutual relationships between all the subjects in communication. Third, there is an organizational aspect related to medical organizations functioning, possibilities and ways to organize communication processes. Fourth, there is cross-cultural aspect of communication which allows to analyze how significant culture is in development of people's ideas on health and diseases as well as to explain cross-cultural differences which occur in interactions between doctors and patients in a particular country. The fifth communication context is a social one, and mass media, the

sixth. We should examine their technological capabilities as well as their ability to influence a person's behavior related to his or her health.

A Kleynmann's explanation model is the next to discuss. This model includes five components: "etiology, a set of symptoms, pathophysiology, clinical course, and treatment" [12]. Interactions between a doctor and a patient, or between a patient and his or her family are examined in this model as communication between different explanation schemes and cognitive systems. These systems can either interact in harmony, or enter a conflict. Thus, for example, the same physiological state can be seen by a doctor and a patient in a different way: patients wait not only treatment from their doctors, but also relevant explanation, or interpretation of various actions and manipulations. To sum up, there are a lot of communication models which can give grounds for analyzing communicative process in healthcare.

N.A. Lebedeva-Nesevrya [16, 17] thoroughly analyzes subjects who participate in communication process about health risks in her works; she spots out 5 basic subjects [16]. The most significant subjects are experts in health risk assessment representing such expert societies as Rospotrabnadzor, medical experts, and scientists. Their basic task is to detect occurring risks and to analyze how to minimize them. Another significant subject in risk communication is population represented by various social groups susceptible to various risks. The third subject in risk communication is represented by mass media which can play either a positive role making for health risk reduction or, on the contrary, provide certain information which only causes new risks to arise. The fourth subject is authorities who are responsible for decision-making in the sphere of risk communication implementation. The fifth subject can be various non-commercial public organizations, their basic task being implementation of programs aimed at stimulating changes in people's behavior. Interaction between all the above mentioned subjects creates a complicated system of health risk communication which can either help to detect and reduce health risks or, on the contrary, be rather dysfunctional.

Communication as a practical activity is realized via specific communication programs. The latter can focus on population as a whole or on specific social groups. let us consider some examples showing how communication in the sphere of public health is realized in Russia and abroad. There is a complex program, called "Healthy people" which has been existing in the US since 2010; this program was created to provide efficient communication in public health sphere. In order to analyze communication practices in the sphere, a whole set of parameters was created; they were people's access to the Internet; websites related to health issues; health literacy of population; communications between a doctor and a patient; communication campaigns; etc.

According to research results [18], medical literacy depends on a race and ethnic group as well as education. Thus, only 9% Whites had little medical knowledge while this figure amounted to 24% among Blacks; it was 23% among American Indians and Alaska population; and it was 41% among Spanish and Latin American population. poor awareness about healthy lifestyle prevailed among people with education lower than secondary (54%). This parameter amounted to 15% among secondary school graduates, and only 5%, among those who graduated from a higher educational establishment.

The research also contains some data on peculiarities which occur in communication between a doctor and a patient. Thus, 65% respondents stated doctors listened to them attentively during their visit and showed respect; 66% told doctors managed to provide them with information which was easily understood; 53% claimed doctors spared them enough time.

The Internet became accessible to significantly greater number of people in the US from 2000 to 2010: a share of people older than 18 who had access to it and actively used it grew by 165.4%. A quantity of web-sites which provided information about health also increased greatly. Thus, for example, a number of sites with a possibility to get a feedback grew from 59% to 88% over 2006-2009.

The research also revealed that 80% campaigns performed formative research; 68% had a monitoring system which they applied in their programs; and 645 analyzed the results [18].

So, communication about health is an essential part of the US public healthcare system and is supported by the state itself. This system is implemented via multiple communication campaigns which are aimed at maintaining population health. Thus, the Centers for Diseases Control and Prevention in the US held the following campaigns [19]: 1) HIV/AIDS prevention, "HIV Treatment Works", "Act Against AIDS"; 2) against tobacco smoking, "Tips From Former Smokers"; 3) a campaign with its goal being an increase in population's physical activity; 4) osteoporosis prevention, "Nutrition for Everyone: Calcium and Bone Health"; 5) oncologic diseases prevention, "Inside Knowledge: Get the Facts About Gynecologic Cancer Campaign", and some others.

Some programs and projects aimed at creating healthy lifestyle of the population are planned to be implemented in the RF by state authorities. Thus, "Healthy lifestyle creation passport"[2], was approved on July 26, 2017; the basic idea here is to increase a share of people who pursue healthy lifestyle from 50% by 2020 and to 60% by 2025; this share is assumed to grow due to more people taking on responsibility for their own health. This project goals are to reduce tobacco smoking and alcohol intake, and to stimulate people do more exercises and sports. It includes an information campaign aimed at creating self-preserving behavior towards one's health, especially, when it comes to reproductive health. The campaign is to be held in the media and social networks via micro-targeting.

The RF Public Healthcare Ministry stimulated creation of "Healthy Russia" portal in the Internet dedicated to healthy lifestyle; there is a hot line functioning on it, and it contains reference information on healthy nutrition, and on ways how to give up tobacco smoking and drugs taking.

Various prevention programs are also implemented by medical and educational establishments in the RF regions; they are, for example, "Healthy generation", "It's cool to be healthy", "My choice", "All colors except black", and a lot of others.

Domestic experts perform research aimed at detecting and assessing population health risks. Thus, in 2013-2014 in Perm region Rospotrebnadzor's Federal

[2] Pasport prioritetnogo proekta «Formirovanie zdorovogo obraza zhizni» / utv. Prezidiumom Soveta pri Prezidente RF po strategicheskomu razvitiyu i prioritetnym proektam, protokol № 8 ot 26.07.2017 g. [Priority project passport "Healthy lifestyle creation" / approved by the Presidium of the RF President Council on Strategic Development and Priority projects, minutes dated July 26, 2017 N 8] // *Konsul'tantPlyus*. Available at: http://www.consultant.ru/document/cons_doc_LAW_222210/ (07.06.2018).

Scientific Center for Medical and Preventive Health Risk Management Technologies questioned people employed at industrial enterprises as well as people who were employed in spheres not related to any industry. It helped to reveal basic population risks factors which existed in Perm region from the respondents' point of view [20]. The results revealed that both groups considered adverse ecological situation at a place where they lived to be one of the most significant risk factors (68.8%); hazardous working conditions followed (54.9%); smoking and alcohol abuse were mentioned by 48.5%; and low quality food products, by 40.2%. Therefore, awareness about risk factors can be considered quite high, but at the same time there is not enough information on how these factors influence people's health. We should also note that this information is not fully accepted and it becomes apparent when people continue to pursue behavior which is risky for their health.

Results of national monitoring over population health in Russia performed by the Russian Public Opinion Research Center in 2009–2017 [21] revealed that people considered stress and excessive work to be the most significant factor which cause diseases (35%), as well as not having enough money to spend on diseases treatment and prevention (35%). And here we can also state that the contribution made by the second factor has increased over the last 5 years, from 19% to 35%. Such morbidity causing factors as adverse environment (32%) and age (32%) follow. So, people see a lot of outer causes, while at the same time they are not fully aware of risks related to nutrition, physical activity or bad habits.

There are public organizations which develop and implement communication programs among population. "Health and Development" Fund for Supporting National Projects in the sphere of public healthcare is one of them [22]. Its activities are aimed at implementation of free-of-charge communication programs on the RF territory; for example, a program called "an SMS to a mom". Its goal is to provide pregnant women and women with infant children (under 1 year of age) with useful knowledge, to create correct attitudes in them, and to make them change their behavior. The program is supported by the RF Public Healthcare Ministry. There are other programs such as "We Are Giving Up Smoking": to promote abandoning this bad habit; "IVF School" which deals with issues arising when reproductive technologies are applied; "Everything That Concerns You" program motivates teenagers to pursue healthy lifestyle. Most of these programs are mobile and they allow to get information from SMS, messengers, mobile applications, social networks, etc.

Let us consider some data obtained during sociological research which was conducted within "An SMS to a mom" mobile communication program by E.V. Dmitrieva, S.A. Phrolov, and M.A. Grishina in 2013–2014. The research was performed as a questioning at V.I. Kulakov's Scientific Center for Obstetrics, Gynecology, and Perinatology, as well as a questioning in the Internet. 751 pregnant women and women with infant children (under 1 year of age) from 64 RF regions took part in the program and received qualitative medical information on pregnancy and a child's development during its first year of life. The information was provided with SMS, at webinars, on a specialized website, and in social networks. Most of the women participating in the programs became mothers for the first time in their lives (70 %).

Participants got the information about the program form the following sources: posters and leaflets in antenatal clinics (37.8%), their doctors' recommendations (23.5%), the Internet (18.5%). The fact that almost one fourth of the questioned women obtained useful information from their doctors, that is, the program was recommended by medical staff (gynecologists), proves that communication process is a complex one.

Women's motivation to receive information from reliable sources, first of all, their appeal for a piece of advice to medical staff, is one of the basic indicators o the program. One fourth of respondents (24.9 %) in 2013 and one third (35.8%) in 2014 stated that they asked their doctors to consult them on issues which were discussed in SMS. When asked if an SMS was a motive to search for additional information on a certain subject, most participants (77 %) gave positive answers. 9 out of 10 participants claim their follow recommendations received via SMS in their everyday life. When we examine actual behavior of subscribers we can see that pregnant women took vitamins regularly (76.8 %); in 2013 each third woman was physically active (30.4 %), but in 2014 each second (48.5 %). A bit more than a half women practiced breastfeeding. Most women (84.2 %) vaccinated their children in full conformity with the vaccination schedule approved in the country. Pregnant participants noted they obtained a lot of vital and useful information on the following: 1) healthy nutrition (77.5 %); 2) data on welfare and benefits (69.3 %); 3) emotional state during pregnancy (67.3 %). Mothers with infant children (under 1 year of age) stated the most useful information included the following 1) information about a newborn health (91.4 %); 2) key stages in a child's development during its first year of life; 3) information about a mother's health after childbirth (80.4 %); 4) vaccination (79.3 %). Most participants gave positive feedback about the program (85.9 %); 77.9% recommended it to their friends and acquaintances. About 82% subscribers kept SMS with useful information in their phones so that they would be available in case of necessity. Given all the abovementioned, we can state that any communication programs when it is implemented should be followed with estimations and analysis of influence it had on a target audience. It corresponds to basic principles of the World Health Organization (WHO).

From the WHO point of view [23], there are several significant aspects which should be taken into account when such programs and communicative influences are implemented among population. First of all, it is very important to remember that a program should be implemented within a specific context which, on an individual level, is determined by accumulated experience, knowledge and beliefs of a person, and at a society level, by existing social standards, cultural and religious traditions. Secondly, one should always bear in mind that there can be a discrepancy between planned and actual effects which occur due to a program. It can be caused by possible differences in information perception by those who receive and decode it, as well as by absence of preliminary testing and examining how information provided by a program is perceived by a target audience. The third significant aspect here is understanding that communication is a two-side process, and a key task of such programs is to perform assessment research, that is, to assess audience needs, to perform formative assessment, monitoring, and to assess influence exerted by a program with help of sociologists and experts in the sphere of healthcare. Communication in the sphere

related to health requires a lot of sociological research, as it is various qualitative and quantitative sociological techniques that can help us to develop communication programs and to assess their effects correctly. Quantitative sociological techniques (questioning, content-analysis, etc.) allow to estimate prevalence of diseases, bad habits, and how committed people are to various self-preserving behavioral attitudes. Qualitative sociological techniques (depth interviews, focus groups, etc.) help to reveal peculiarities related to interpretation of obtained information, cultural aspects, and other specific features of various target groups.

D.V. Vizgalov thinks that a key peculiarity of qualitative techniques applied in programs assessment is a task "to understand how examined people or groups perceive existing processes, their behavior, and conditions" [24]. Sociological research can enlighten on target audience needs; existing gaps in people's knowledge and problems related to their behavior; how information provided by a program is perceived; whether a language applied is easy to understand; whether an information channel is a convenient one; on planned results of a program effects on people's knowledge, attitudes, and behavior. As a rule, such research is based on theories which describe changes in behavior.

The theory of planned behavior developed by I.Ajzen [25] is one of the most well-known theories which describe changes in behavior. This theory explains changes in behavior making it more favorable by a person's intention. However, this intention, in its turn, depends on three factors: "attitudes towards a new behavioral model (a person is sure a result will be positive); subjective standards (including social ones, for example, negative attitudes towards smoking); inner or outer control over behavior" [8]. This model often serves as theoretical grounds for implementation of communication programs aimed at changes in behavior.

Another theory is a cognitive one which represents "a model of belief in health" developed by I. Rosenstock and D. Becker. According to this theory a person's behavior is determined by his or her beliefs as regards existing health risks. As R. Nisbeth states, "in order to change their behavior, people should feel there is a personal threat to their health; they should consider possible consequences to be serious; and they should see that certain actions which they take can possibly reduce or even eliminate risks completely" [26]. The theory of stage changes in behavior developed by J. Prochaska and K. DiClemente states that changes in behavior occur in certain stages. The researchers spot out 5 following stages of changes in behavior: 1) unawareness when a person doesn't intend to change his or her behavior in the nearest future; 2) awareness when a person gets to know a certain problem exists; 3) intention, a person is ready to take an action; 4) an action itself when behavior changes; and 5) commitment, keeping one's behavior within these new frameworks [26]. Such domestic researchers as Yu.P. Averina and E.V. Dmitrieva adapted this theory and now use it in their work. In their opinion, efficiency of a communication program can be analyzed with 3 basic components: "awareness, people knowing about problems related to health, health risks, and ways to solve this problem; formation of personal attitude towards a certain problem; changes in behavior" [27]. So, there are several basic theories which can be applied when we analyze influence exerted by communication programs and projects. Communication programs efficiency is often analyzed only within medical statistics

frameworks. And here we should note that sociological research plays a significant role in analyzing communication about health because it helps to examine changes in people's knowledge and motivation, their satisfaction with information they get, as well as to be more precise in determining essence of changes in behavioral strategies, and how committed people are to health preserving behavior.

So, we can state that communication about health is a scientific branch which is being institutionalized at the moment. Its theoretical aspects are built on scientific postulates developed in communication sociology, health sociology, and medical sciences. There are several basic theoretical models which consider functioning of communication about health. They focus on analysis of communication participants, such as medical experts, specialists in healthcare, authorities, mass media, public organizations, and population, who receive information which should help them reduce their risky behavior as regards their own health. Communication about health can be considered at several levels: interpersonal (a doctor and a patient), group, organizational, and mass one. Occurring interactions are examined by scientists within a wide social context (political and economic situation, public healthcare functioning) and are seen as a social institute, as people's behavioral practices that exist in this particular society. Special attention during communication analysis is paid to theoretical understanding how communication influences people's awareness, attitudes, and behavior; it allows to apply such classic theories of changes as the theory of planned behavior, the theory of "belief in health", and theory of stage changes in behavior when we analyze communication about health.

Communication about health in its practical aspect is realized via communication programs which are aimed at raising population awareness and reducing health risks. Such communication programs are widely spread in the USA and Western Europe and are most frequently implemented within electronic healthcare, mobile healthcare, or telemedicine. There are a lot of prevention programs existing in the RF at the moment; their main task is to reduce risky behavior as regards people's health. Experts perform various research aimed at assessing and analyzing existing health risks. However, we can state that mass communication media have a significant potential which is not fully realized in terms of its possible application in order to exert complex influence on population. There are some unsystematic initiatives to implement mobile and electronic healthcare programs. Efficiency of such programs should be assessed not only within medical statistics frameworks, but also with sociological techniques application which will help to reveal what influence was exerted by this or that program on health and social relationships as a whole.

To conclude, we can state that it is quite promising both to get better theoretical insight into communication about health and to implement information and communication programs. When such a complicated phenomenon as communication in the sphere related to health is examined, both medical experts and specialists in social and humanitarian sciences should combine their efforts.

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NEW LEGAL, REGULATORY AND METHODOLOGICAL DOCUMENTS ISSUED IN THE RF IN THE SPHERE OF HEALTH RISK ANALYSIS

April – June 2018

The Decision by The Board of the Eurasian Economic Commission No. 40 dated March 20, 2018 «On making alterations into the Customs Union Technical Regulations "On safety of milk and milk products" (TR CU 033/2013)»

The Decision fixes validity for documents on conformity assessment of milk products. Documents which concern products enlisted in the Decision by the EAC Council No. 102 dated November 10, 2017 and contain data on assessment of their conformity with the obligatory requirements set forth by the TR CU 033/2013 "On safety of milk and milk products" and which were issued or approved before the Decision by the EAC Council No. 102 dated November 10, 2017 came into force are considered to be in force until their validity expires but not longer than 180 days since the Decision by the EAC Council No. 102 came into force. Products can be manufactured and distributed on the EEU customs territory within 180 days since the Decision by the EAC Council No. 102 came into force provided that there are the above mentioned documents issued for them on assessment of their conformity. Products can be distributed until validity of documents on their conformity assessment expires but only up to expiration of their shelf life.

The Decision by The Board of the Eurasian Economic Commission No.41 dated March 20, 2018 «On registration, suspension, renewal, and cancellation of declarations on conformity of products to the requirements fixed in the Technical Regulations issued in the Eurasian Economic Union»

The Decision fixes July 1, 2018 as a date since which a new procedure for registration, suspension, renewal, and cancellation of declarations on conformity of products to the requirements fixed in the EEU Technical Regulations becomes valid. A declaration on conformity is registered by authorized bodies (organizations) in the EEU member states, including accredited certification authorities, which are enlisted in the unified register with their accreditation covering products which are to be declared. The Decision also fixes a list of documents which should be submitted by an applicant to an authorized certification body.

The Decision by The Board of the Eurasian Economic Commission No.72 dated May 10, 2018 «On validation procedure for alterations into the Customs Union Technical Regulations "Food products as regards their marking" (TR CU 022/2011)»

The Decision specifies the term during which food products which were manufactured with GMO and which were marked before can be distributed. It is stated that food products which are manufactured with GMO can be manufactured and distributed on the EEU Customs Territory during 18 months since the alterations made into the TR CU 022/2011 "Food products as regards their marking" and fixed in the Decision by the EEC Board No. 90 dated December 20, 2017 came into force; nonetheless, requirements to marking of such products are to be taken into account. Such products can be distributed only up to a date of their shelf life expiration which is fixed by their manufacturers.

The Decision by The Board of the Eurasian Economic Commission No. 75 dated May 10, 2018 «On Approval of list of products a distributor or manufacturer of which should submit a customs declaration and a document on assessment of conform-

ity with the requirements set forth by the Customs Union Technical Regulations "On safety of packed drinking water including natural mineral water" (TR EEU 044/2017) or references on existence of such documents»

The Decision fixes a list of products distributor or manufacturer of which should submit not only a customs declaration but also a document on their conformity with the requirements fixed in the TR EEU 044/2017. The list includes table waters, curative-medical waters, and table-curative mineral waters, natural, processed, and blended drinking waters, drinking waters for children nutrition, artificially mineralized drinking waters.

The Decision by The Board of the Eurasian Economic Commission No. 75 dated May 10, 2018 «On making alterations into the Decision by the Customs Union Commission No. 299 dated May 28, 2010»

The Decision fixes that the Unified sanitary-epidemiologic and hygienic requirements to products (goods) which are subject to sanitary-epidemiologic surveillance (control) are to be applied to products (goods) manufacture and/or distribution of which is regulated by the Customs Union Technical Regulations and which are manufactured and distributed on the basis of documents on their conformity with the above-mentioned requirements issued or approved prior to July 1, 2020 (inclusive): in section 1 "Requirements to safety and nutritional value of food products" concerning requirements to products regulated by the EEU TR 044/2017 "On safety of packed drinking water including natural mineral water"; in section 9 "Requirements to drinking water packed in bottles"; and in section 21 "Requirements to mineral waters". The Decision has been issued due to the above-mentioned technical regulations coming into force.

The Decision by The Board of the Eurasian Economic Commission No. 53 dated April 10, 2018 «On a list of standards application of which should provide voluntary conformity with the requirements fixed in the EEU TR "On safety of attractions" (EEU TR 038/2016) and a list of standards which contain rules and techniques for examinations (tests) and measurements including sampling procedures necessary for providing conformity with the requirements fixed in the EEU TR "On safety of attractions" (EEU TR 038/2016) and conformity assessment for objects which are subject to technical regulations»

The Decision fixes lists of standards which are necessary for providing conformity with the requirements set forth by the EEU TR 038/2016, as well as lists of standards which contain rules and techniques for examinations (tests) and measurements necessary for providing conformity with the requirements set forth by the EEU TR 038/2016 and conformity assessment for objects which are subject to technical regulation.

The Decision by The Board of the Eurasian Economic Commission No. 53 dated April 10, 2018 «On making alterations into the Decision by the Customs Union Commission No. 799 dated September 23, 2011»

The Decision fixes alterations which were made into lists of standards applied to provide conformity with the requirements set forth by the CU TR 009/2011 "On safety of perfumes and cosmetics". These alterations specify a list of standards application of which provides voluntary conformity with the requirements set forth by the above mentioned technical regulations and a list of standards which contain rules and techniques for examinations (tests) and measurements necessary for providing conformity with the requirements set forth by the CU TR 009/2011.

The Decision by The Board of the Eurasian Economic Commission No. 91 dated May 29, 2018 «On approval of list of products which are to be declared and provided with a documents on assessment of conformity with the requirements set forth by the Eur-

asian Economic Union Technical Regulations "On safety of equipment installed on children playgrounds" (TR EEU 042/2017)»

The Decision fixes a list of products which cannot be imported without a document which confirms their compliance with the requirements set forth by the EEU TR 042/2017 "On safety of equipment installed on children playgrounds". The list includes equipment for children playgrounds (sliding boards, swings, merry-go-rounds, toy houses etc.), rubber and synthetic surfaces.

The Federal Law No. 81-FL dated April 18, 2018 «On making alterations into some enactments approved in the Russian Federation»

The Law grants the permission to make test purchases in the process of surveillance over consumer rights protection and in the process of providing sanitary-epidemiologic welfare of the population. It is fixed that test purchases can be performed by control (surveillance) authorities without any preliminary notification given by the Procuracy to a tested person or a legal entity. In case no violations of the obligatory requirements have been detected as per the results of performed test purchases, any other unscheduled inspections on the same grounds are not allowed. Data on each test purchase and its results are to be fixed in the unified inspections register.

The Federal Law No. 94-FL dated April 23, 2018 «On making alterations into the Federal law "On protecting rights of juridical persons and private entrepreneurs when state control (surveillance) and municipal control is performed»

This Federal Law introduces a new informative procedure for performing activities related to erection, demounting, and operation of lifting platforms for people with limited abilities, passengers conveyors, and escalators.

The RF President Decree No. 198 signed on May 06, 2018 «On the RF State Policy in the sphere of industrial safety for the period up to 2025 and subsequent years»

The Decree outlines targets, principles and priority trends of the state policy in the sphere of industrial safety for the period up to 2025 and subsequent years. The targets of this state policy are prevention of incidents and emergencies at industrial objects; finding solutions to legal, economic, and social tasks aimed at providing industrial production growth, fulfillment of citizens' constitutional rights for labor under working conditions which are compliant with the safety requirements and for favorable environment; stronger law and order in the sphere of industrial safety.

The RF President Decree No. 204 signed on May 07, 2018 «On national targets and strategic tasks of the Russian Federation development for the period up to 2024»

The RF President set a number of national targets of the country development; some of them are: to provide sustained natural population growth; to increase life expectancy to 78 years (to 80 years by 2030); to provide better living conditions for 5 million families annually; to provide faster implementation of digital technologies; to make the country economy enter the top five world economies etc.

Prior to 2024, The RF Government, among other things, should solve the following tasks: to create favorable conditions for working mothers; to create motivation in the country population to pursue healthy lifestyle including healthy nutrition and giving up bad habits; to build a network of national medical research centers; to develop mechanisms for interaction between medical institutions based on a unified state information system in the public healthcare sphere; to implement innovative medical technologies including early diagnostics and remote monitoring of patients' health state; to provide high-volume housing construction together with nature preservation and preservation of territories which are valuable as recreational or health-improving; to build up a complex system for solid communal wastes processing including elimination of dumps and most hazardous objects; to increase

drinking water quality; to reduce a number of regulatory and administrative barriers which prevent labor productivity growth; to develop a digital economy etc.

The RF Governmental Regulation No. 421 dated April 07, 2018 «On Approval of Rules for developing and adjusting The Strategy for the RF scientific and technological development and The Rules for monitoring how The Strategy for the RF scientific and technological development is being implemented»

The RF Government determined the rules for development of The Strategy for the RF scientific and technological development and for monitoring of its implementation; this is a strategic document which outlines targets, basic tasks, trends and priorities of the state policy which are aimed at long-term stable, dynamic, and balanced scientific and technological development of the Russian Federation

The RF Governmental Regulation No. 542 dated May 04, 2018 «On Rules for organization of activities aimed at elimination of accumulated environmental hazards»

The document fixes the requirements to a procedure of activities aimed at elimination of accumulated environmental hazards. The rules set forth the requirements to a plan of activities aimed at eliminating accumulated environmental hazards; a procedure for a plan development and coordination; an overall term during which elimination of accumulated environmental hazards should be accomplished; a mechanism of control over activities aimed at elimination of accumulated environmental hazards; a procedure for acceptance of accomplished work.

The RF Governmental Regulation No. 482 dated April 21, 2018 «On State Information System called "A standard cloud solution for automation of control (surveillance) activities»

The document envisages development of a state information system called "A standard cloud solution for automation of control (surveillance) activities". The system should have the following functions: keeping data on juridical persons and private entrepreneurs with their activities or production objects being subject to control and making entries on risk categories and hazard categories which were assigned to surveillance objects; planning control activities taking into account assigned risk and hazard categories, drawing out annual inspections schedules, and transfer of these plans to the unified inspection register; keeping up checklists; making enquiries and collecting data within interdepartmental information interaction; keeping up a register of authorized officials from surveillance (control) bodies; keeping up data on productivity and efficiency; providing access to lists of regulatory acts or their parts which contain obligatory requirements etc.

The RF Ministry for Communications is the operator of the system. The system users are authorized officials in the state control sphere. The information system is to be put into operation by October 1, 2018.

The RF Governmental Regulation No. 498 dated April 24, 2018 «On making alteration into the RF Governmental Regulation No. 9 dated January 14, 2017»

Starting from June 1, 2018, the RF Ministry for Industry and Trade is an authorized body to issue certificates which confirm that products are manufactured on the RF territory.

The RF Governmental Regulation No. 501 dated April 24, 2018 «On making alterations into the Regulations on the Federal Service for Surveillance over Consumer Rights protection and Human Well-being»

Rospotrebnadzor is now authorized to fix a list of tonics which cannot be contained in alcohol drinks with ethanol contents in them being less than 15% when such drinks are produced and distributed (excluding exports).

The RF Governmental Regulation No. 414 dated April 06, 2018 «On making alterations into some RF Governmental Acts on issues related to state control (surveillance) and municipal control as well as on licensing issues»

Rules for issuing reports on performance of state (municipal) control (surveillance) and its efficiency have been adjusted. Terms and procedures for issuing reports including consolidated ones have been adjusted; a list of data and documents which are to be collected, processed and analyzed in order to monitor efficiency of state and municipal control (surveillance) has been updated. The document also introduces a new requirement set forth for federal executive bodies responsible for granting licenses to two or more various activities. Such authorities are now to submit data on each sphere of licensing separately to the RF Ministry for Industry and Trade.

The RF Governmental Regulation No. 635 dated May 31, 2018 On making alterations into the Rules for sanitary hygienic zones establishment and use of ground areas located within the boundaries of sanitary hygienic zones»

The document adjusts the Rules for sanitary-hygienic zones establishment concerning airfields. It is stated that if there is a decision to establish a near-field area with the seventh subzone isolated in it, then it is not necessary to establish a sanitary-hygienic zone concerning this airport or airfield. The above-mentioned decision on a near-field area gives grounds for elimination of a sanitary-hygienic zone near this airport or airfield. An owner of this object is to apply to an authorized body within a month stating that there is no sanitary-hygienic zone near this airport or airfield.

The RF Governmental Regulation No. 788-p dated April 27, 2018 «On Approval of Key Performance Indicators of control and surveillance activities performed by federal executive bodies»

The document fixed basic key performance indicators of control and surveillance activities performed by the EMERCOM of Russia, the RF Federal Environmental, Industrial and Nuclear Supervision Service, the RF Federal Service for Veterinary and Phytosanitary Surveillance, The Federal Service for Supervision of Transport, the RF Federal Service for Surveillance in Healthcare, the RF Federal Service for Surveillance over Use of Natural Resources, the Federal Service for Surveillance over Consumer Rights protection and Human Well-being, The Federal Service for Labor and Employment, the RF Federal Antimonopoly Service; these key performance indicators concern their surveillance activities, in particular:

Federal State Surveillance over consumer rights protection:

– material damage caused by violation of the obligatory requirements in the sphere of consumer rights protection (concerning gross domestic product).

Federal State Sanitary-Epidemiologic Surveillance:

– a number of people who caught infectious diseases (excluding chronic hepatitis, bites, tuberculosis, syphilis, gonococcal infections, HIV-infections, ARVI, influenza, and pneumonia), per 100,000 people;

– a number of people who caught parasitic diseases per 100,000 thousand people;

– a number of people who suffered from food poisonings, excluding household ones, per 100,000 people;

– a number of people who died from food poisonings, excluding household ones, per 100,000 people.

The RF Governmental Regulation No. 791-p dated April 28, 2018 «On Approval of a model describing how a system of goods marking with identification codes should function in the RF»

The document states that the system of goods marking with identification codes in the RF should function according to the following principles: costs on introduction of goods marking with identification codes should be minimized; each unit of goods should be identified due to an unique code being assigned to it; all the stages in goods distribution should be registered in an information system; all the participants in goods distribution bear full responsibility for validity of information and its timely submission to an information system, as well as transparency and availability of information;

each code for goods marking should be paid for only once, at the moment when it is generated; a unified catalogue of all the goods distributed in the RF and marked with identification codes should be created and all the participants should have unlimited access to a unified information system.

The RF Ministry for Industry and Trade is a system coordinator; the RF Ministry for Finance provides legal regulation of its functioning; the RF Ministry of Digital Development, Communications and Mass Media supervises overall functioning of the system.

The RF Governmental Regulation No. 792-p dated April 28, 2018 «On approval of a list of specific goods which are subject to obligatory marking with identification codes»

The document fixes a list of goods which are subject to obligatory marking with identification codes. The list contains the following information: denomination of a group of goods, ARPC (All-Russian Products Classifier) 2 code, CU CNFEA code, as well as a term within which obligatory marking should be done. The list, in particular, includes tobacco products, perfumes and toilet water, various pieces of clothing, foot wear, tyres, tyre casing, bed linen, cameras, and others.

The RF Governmental Regulation No. 500-p dated March 24, 2018 «On making alterations into the RF Governmental Regulation No. 1187-p dated July 10, 2013»

The document specifies what environmental data provided by the RF Federal Service for Surveillance over Use of Natural Resources and the RF Federal Service in Hydrometeorology and Environmental Monitoring should be in open access on the Internet:

The RF Federal Service for Surveillance over Use of Natural Resources provides state registers of objects where wastes are stored and objects which exert negative influence on the environment; databases on wastes and ways of their utilization and neutralization; reports on wastes generated by industrial enterprises; lists of permissions on discharges of hazardous substances into the atmosphere; registers of licenses which grant permission to deal with wastes;

The Federal Service in Hydrometeorology and Environmental Monitoring provides forecasts for the next 1-3 days predicting spontaneous hydrometeorological events; temperature forecasts for the next 5-10 days in the Northern hemisphere; basic meteorological parameters; data of hydrometeorological cosmic monitoring; data on the ozone layer state over the RF regions; data on acidity and chemical composure of atmospheric precipitations; data on contamination of atmospheric air and surface waters; data on extremely high and high contamination of atmospheric air, water objects, and soils on the RF territory, as well as on radioactive contamination.

The Order by the RF Chief Sanitary Inspector No. 12 dated February 05, 2018 «On approval of sanitary-epidemiologic rules SR 3.1.3525-18 "Prevention of chicken pox and shingles»

The document outlines briefly what are symptoms of these diseases and their clinical course; prevalence of the diseases; a procedure for detecting, registering, and statistical observation over people suffering from chicken pox or those who are thought to have the disease; a description of laboratory diagnostics aimed at the disease detection; a set of measures related to elimination of a the virus niduses; rules for organizing sanitary-epidemiologic activities in the infection niduses; a procedure for scheduled vaccination of the population against chicken pox; a procedure for epidemiological surveillance over the diseases and activities aimed at hygienic education of people in the sphere of chicken pox and shingles prevention.

The Order by the RF Chief Sanitary Inspector No. 28 dated April 05, 2018 «On suspension of retail trade in alcohol-containing non-eatable goods, alcohol-containing food additives, and flavoring agents»

The Order fixes a temporary ban on retail trade in specific alcohol-containing non-eatable goods. This 180-day ban is on retail trade in alcohol-containing non-eatable goods, alcohol-containing food additives and flavoring agents (excluding glass-washing liquids, non-liquid alcohol-containing products, alcohol-containing goods which are packed in such a way which makes their oral consumption impossible), with ethanol contents in them being higher than 28% of their overall volume. This concerns only trade in goods with prices lower than retail prices on 0.5 liter of vodka, strong spirits, and other alcohol goods with ethanol content in them being higher than 28% (see The Order by the RF Ministry of Finance No. 58n dated may 11, 2016). Heads of Rospotrabnadzor's regional offices are given the instructions to enhance control over trade in glass-washing liquids, alcohol-containing food additives, and flavoring agents.

The Order by the RF Chief Sanitary Inspector No. 32 dated May 10, 2018 «On Approval of Hygienic Standards HG 2.1.6.3537-18 "Maximum permissible concentrations (MPC) of microorganisms-producers, bacterial agents, and their components in the atmospheric air in urban and rural settlements" and Hygienic Standards HG 2.2.6.3538-18 "Maximum permissible concentrations (MPC) of microorganisms-producers, bacterial agents, and their components in working area air"»

The Order approves two new hygienic standards: maximum permissible concentrations of microorganisms-producers, bacterial agents, and their components in the atmospheric air in urban and rural settlements and maximum permissible concentrations of microorganisms-producers, bacterial agents, and their components in working area air. The approved hygienic standards are valid till May 10, 2028.

The Order by the RF Chief Sanitary Inspector dated February 28, 2018 on Approval of Methodical Guidelines MG 2.3.0122-18. 2.3. «Nutritional hygiene. Color indication on food products marking aimed at providing information for consumers»

Color indication is to be put on food products depending on contents of the following components in them: sugar, salt, saturated fat acids and trans fats taking into account the analysis of average food products consumption in the RF and average volumes in which the above-mentioned products are consumed. Color indication is to be put voluntarily; it is not considered to be indicating hazardous food products; this indication should provide more detailed visual information for consumers so that they are able to make their conscious and right choice on healthy food products.

The Order fixes basic principles of such color indication.

The Order by Rospotrebnadzor No. 66 dated February 27, 2018 «On enlisting objects where wastes are stored in the unified state register of objects for wastes storage»

To secure fulfillment of Clause 12 of the Federal Law No. 89-FL dated June 24, 1998 "On industrial and consumption wastes", the lists of objects included into the unified state register of objects for wastes storage have been updated. Wastes storage objects are shown in a table which contains the following information: denomination of an object; purpose of its creation, types of wastes which are permitted to be stored there and their code as per the Federal Wastes Classifier; data on negative influence which can be exerted by an object on the environment; an object code as per the Russian Classification on Objects of Administrative Division; a settlement which is the closest to an object; a name of an organization which operates an object. All the newly included objects where wastes are stored are given for each RF region separately.

The Order by The Ministry of Natural Resources and the Environment of the Russian Federation No. 74 dated February 28, 2018 «On Approval of requirements to industrial environmental control program, procedure and terms of delivering reports on its implementation and results»

The Order fixes that an industrial environmental control program should be developed and approved by juridical persons and private

entrepreneurs who perform their activities at objects with the I, II or III hazard category; it should be developed for each such object taking into account its hazard category, technologies which are applied there, and production process peculiarities, as well as negative impacts on the environment. The Order also fixes requirements to sections of a program and data which each section of a program should contain.

«The list of legal acts and regulations or their parts which contain obligatory requirements which should be met and the compliance with which is subject to federal state surveillance in the sphere of consumer rights protection; the list is drawn up taking into account specific types of entrepreneurial activities and works and services related to their accomplishment fixed in the RF Governmental Regulation No. 584 dated July 16, 2009» (approved by Rospotrebnadzor on March 26, 2018)

Rospotrebnadzor approved the list of legal acts and regulations compliance with which is subject to stated surveillance over consumer rights protection. The list includes acts issued by the EEU authorities and other international agreements signed by the RF; Federal Laws and laws issued in the RF; Orders by the RF President and Government which contain obligatory requirements compliance with which is subject to federal state surveillance over consumer rights protection. The list is systematized as per 40 types of entrepreneurial activity.

«The list of legal acts and regulations or their parts which contain obligatory requirements which should be met and the compliance with which is subject to federal state sanitary-epidemiologic surveillance; the list is drawn up taking into account specific types of entrepreneurial activities and works and services related to their accomplishment fixed in the RF Governmental Regulation No. 584 dated July 16, 2009» (approved by Rospotrebnadzor on March 27, 2018)

Rospotrebnadzor approved the list of legal acts and regulations compliance with which is subject to stated sanitary-epidemiologic surveillance. The list is given in a table which contains data on types of activities and works and services related to them; an activity code as per All-Russian classifier; lists of documents which contain obligatory requirements. These lists contain data on documents related to 40 types of entrepreneurial activity.

The Letter by Rospotrebnadzor «On a possibility to provide electronic sanitary-epidemiologic reports»

Rospotrebnadzor informs that now it is possible to receive an electronic sanitary-epidemiologic report. Such electronic reports will be provided for applications which have been submitted starting from May 21, 2018 by filling in an electronic enquiry form on the Unified Portal for State and Municipal Services (https: //www.gosuslugi.ru/). Electronic sanitary-epidemiologic reports can be obtained at Rospotrebnadzor' unified web-source located at http: //epgu.edoc.rospotrebnadzor.ru/; to do it, an applicant should give attributes of an application and an issued electronic sanitary-epidemiologic report which are automatically given to an applicant when an application is processed on the Unified Portal for State and Municipal Services.