

# ASSESSMENT AND RISK MANAGEMENT HEALTH AND SAFETY IN MEDICAL HEALTH ORGANIZATION

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## RISK FACTORS CAUSING EVOLVEMENT OF ALIMENTARY-DEPENDENT DISEASES IN SPECIFIC GROUPS OF WORKERS EMPLOYED AT METALLURGY PRODUCTION AND PREVENTION MEASURES DEVELOPMENT

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*The article gives the results of hygienic and epidemiologic research of morbidity, nutrition structure, food stuffs safety, working conditions, and actual nutrition of workers employed at metallurgy productions. The research was carried out at "Magnitogorskiy metallurgy plant" PLC. 1208 steel workers and founders made up the main group. Average age of research participants amounted to  $40.0 \pm 0.75$ . The sampling was representative. We studied actual nutrition over 2010–2015 via analyzing food consumption frequency and applying extended base of food stuffs chemical structure and analyzing menus with lists of dishes offered for an organized group nutrition. We assessed both qualitative and quantitative parameters, including consumption of basic nutrients, energy, irreplaceable amino acids, lipids, vitamins, dietary fiber, essential and conditionally essential microbiological elements (60 nutrients totally, allowing for losses on a product peeling, edible contents, and other losses occurring at various treatments during cooking). We also assessed nutrition regime and other nutrition features. We detected that ratio between proteins, fats and carbohydrates was the evidence of mostly fat nutrition type. Workers were found to consume insufficient quantity of certain vitamins (A, D, and folic acid) and biological elements (calcium), but they instead consumed excessive quantities of saturated fats and common salt. It is shown that actual nutrition of specific workers' groups at metallurgy production is not rational, imbalanced, and doesn't satisfy body needs causing risks of nutrition state shifts and alimentary-dependent diseases evolvement. Alimentary-dependent diseases on average amounted to 21.6 % in the total morbidity structure in 2010–2015. 10.0 % of all diseases with temporary working disability are diseases determined by mostly nutrition factor. Epidemiologic analysis of morbidity comprising diseases related to non-rational nutrition enabled us to determine priority nosologies, risk groups and risk factors.*

*We have the grounds for hygienic recommendations aimed at correcting nutrition structure depending on detected deviations.*

**Key words:** actual nutrition, working conditions, nutrition state, metallurgy production, risk factors, prevention, nutrition hygiene, alimentary-dependent diseases, preventive nutrition.

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Development of labor potential in our country, professional health preservation and prolonging working period of active population is a significant function of state authority and a base of social policy in the Russian Federation.

Prevention of health losses among working population is a very important task of prevention medicine and it is especially vital nowadays as there are negative forecasts in relation to labor resources dynamics in our country in medium-term period.

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Working population today is to be treated as a risk group as it constantly undergoes exposure to a whole set of production and non-production factors. And primarily life-style factors belong to the latter ones [3].

It is very important not only preserve workers' health in working environment but also to improve it as work at industrial enterprises requires a lot of efforts. Such pathogenic factor as irrational nutrition exerts negative impact on population together with other environment factors (of chemical, physic, biological, and social nature) causing morbidity and mortality [11].

Various scenarios can occur due to this exposure; among other phenomena, potentiation of negative effects on health can underlie them.

Working conditions at a large metallurgic enterprise include physic factors, namely increased air temperature in a working area, increased noise and vibrations, impacts of various radiation, such as heat, ionizing, electromagnetic, and laser one, dustiness and gas pollution, unfavorable illumination environment.

Besides that, plenty of inhalable agents are generated during production processes; among them there are gases, vapor, dust, and aerosols. These agents represent certain toxicological dangers as they exert irritating, fibrogenic, allergenic, carcinogenic, and mutagenic impacts on a human body [1, 3, 10].

Metallurgic production is characterized with a combination of impacts exerted by negative physic and chemical environmental factors and high physical and neuro-psychic overloads. Therefore, complex impacts of these factors are fundamental in risk assessment.

Working process, in its turn, is characterized with high load on musculoskeletal system and functional systems of a body, as well as on central nervous system [13, 14].

Nutrition is an unique environment factor which influences a human body; it is both an internal and an external factor. It's also a social factor if we consider nutrition structure and nutrition habits; it is also a biological fac-

tor as it is related to essential nutrients intake. Finally, this factor can become pathogenic but it can also raise protective functions of body physiological barriers as it lowers risks of exotoxins penetration and facilitates processes of binding poisons and products of their metabolism. It is these nutrition effects which a concept of medical-preventive nutrition is based on [1, 3, 10, 16]. A number of works, both by Russian and foreign researchers, is dedicated to scientific grounds and practical implementation of such approaches [2, 3, 4, 6, 8, 9, 15].

Functional deviations and chronic pathologies growth is one of the factors among certain occupational groups of workers employed at industrial enterprises; such pathology can be alimentary-dependent and it makes it necessary to find ways of improving prevention activities on the basis of up-to-date labor medicine data [5, 12, 17].

First of all, we think it is advisable to perform a complex assessment of influence which occupational risk factor and lifestyle factors have on workers' health. In some authors' opinion, occupational risk concept which has been developing quite intensely over the recent years is a truly innovative and up-to-date approach used to define prevention priorities [7, 11].

We constantly face resources deficiency, so scientific grounds of prevention work priorities are very important for leading risk factors elimination. In relation to that, implementation of activities aimed at nutrition system reorganization is a vital task for the state as nutrition is a vital factor determining workers' health.

All contemporary activities aimed at workers' health protection don't allow for a possibility of production-induced diseases formation, especially under joint impacts exerted by working conditions and lifestyle factors. Here health preservation depends not only on working conditions improvement but also on a set of social, hygienic, medical, and educational activities. At the same time, such important prevention activities as production

control and periodical medical examinations are accomplished without taking production-induced morbidity into account and it has negative influence on their efficiency.

An attempt to estimate actual nutrition as a risk factor which can cause chronic pathology evolvement together with unfavorable working conditions and working process factors determined the importance of the chosen research issue for creating efficient preventive activities.

**Our research goal** was to accomplish hygienic assessment of actual nutrition of workers with several occupations employed at metallurgic production in terms of its contribution into production-induced morbidity.

**Data and methods.** Our research was performed at "Magnitogorskiy metallurgic plant" PLC (MMP). 1,208 steel workers and founders were our basic group. Average age of research participants was equal to  $40.0 \pm 0.75$ . Our sampling was representative.

We studied actual nutrition of certain workers' groups employed at the enterprise over 2010-2015; when doing it, we analyzed food consumption frequency using extended database on foodstuffs chemical structure and analysis of menus with lists of dishes offered for organized groups nutrition.

When analyzing whether ration was balanced, we assessed qualitative and quantitative indices. Then we compared the obtained consumption values for basic nutrients, energy, essential amino acids, lipids, vitamins, dietary fiber, essential and conditionally essential macro- and microbiological elements (60 nutrients totally, allowing for losses on a product peeling, eatable content, and other losses occurring at various treatments during cooking) with "Standards of physiological needs in nutrients and energy for various population groups in the RF".

We assessed nutrition regime as well as its other features. We calculated consumption values and provision with nutrients with the help of an original computer program based on Visual Basic module to Excel-2000. This program included database on chemical structure of foodstuffs and

dishes based on "Foodstuffs chemical structure" tables (2012) and data obtained via laboratory research of foodstuffs.

Analysis was performed with the use of Statistica 6.0 software and MS Excel-2003. We checked normalcy of signs distribution with the use of Shapiro-Wilk criterion. We took  $p$  equal to 0.05 as a critical significance in all statistic analysis procedures. To check statistic hypotheses, we applied distribution-free techniques. To compare quantitative data from two independent groups, we used Mann-Whitney U-criterion.

**Results and discussion.** As we assessed whether ration was balanced, we detected that proteins, lipids and hydrocarbons ration amounted to 1:1.6:5.1 with recommended level being 1:1.1:4.8, and it proves that nutrition type was mainly a fat one.

Daily average values for separate foodstuffs which were consumed by workers employed at metallurgic production are given in table 1.

Table 1

Average daily consumption of various food stuffs by workers employed at metallurgic production (allowing for losses caused by peeling a product and other losses occurring due to treatment when cooking; 2010–2015)

Food stuffs category	P16*	P50	P84	<i>M</i>	<i>SE</i>
Chicken eggs	6,1	16,8	36,4	27,6	4,59
Bakery	86,1	213,7	298,7	233,6	20,02
Cereals, macaroni	61,1	136,4	332,0	220,0	38,08
Vegetables	261,4	497,4	911,6	590,2	46,56
Fruit	76,1	243,8	443,5	322,4	40,39
Confectionary	7,8	22,0	67,8	36,4	4,16
Butter, fat	10,5	24,7	49,8	30,6	2,75
Meat and meat products	129,4	222,5	362,0	247,3	15,85
Fish and seafood	7,6	20,2	60,6	30,7	3,37
Milk and dairy products	107,7	253,9	644,6	392,8	46,06
Beverages	453,0	777,9	1373,6	907,9	57,07

**Note:** P16, P50, P84 are the 16th, 50th (median) and 84th percentile of variational series correspondingly, *M* is a simple average, *SE* (or *m*) is a standard error of the mean.

Qualitative assessment revealed that specific weight of individuals with excessive energy consumption amounted to 41.6% (excess being equal to 43.7%) whereas only 7.8% respondents had ration with lowered energy value. Also, 26.0% workers didn't consume enough carbohydrates, while 19.5% consumed them in excessive quantity. Protein consumption was average, quite sufficient, and corresponded to physiological standards (109.2 %).

We should note that specific weight of people who consumed food cholesterol in

excessive quantity amounted to 75.3% (excess value being 139.5%); the same figure for triglycerides was 98.3% (excess value being 200.4%)/ When we analyzed omega-6-fatty acids contents we found out that specific weight of people who consumed them in excessive quantity was equal to 61.0% with excess value being 190.9%, and omega-6/omega-3-fatty acids (FA) content deviated from the recommended level rather substantially (table 2).

Table 2

Qualitative assessment of average daily lipids consumption by workers employed at metallurgic production (2010–2015)

Index	Specific weight of individuals with insufficient consumption, %	Specific weight of individuals with excessive consumption, %	Excess value, %
Fats	6,5 ± 0,7	74,0 ± 1,3	60,9
Cholesterol	5,2 ± 0,6	75,3 ± 1,2	139,5
Saturated fatty acids	10,4 ± 0,9	44,2 ± 1,4	64,7
Mono unsaturated fatty acids	5,2 ± 0,6	72,7 ± 1,3	73,3
Poly unsaturated fatty acids, mg	36,4 ± 1,4	2,6 ± 0,5	106,8
Triglycerides, mg	0,0 ± 0,1	98,7 ± 0,3	200,4
Phospholipids, mg	15,6 ± 1,0	43,0 ± 1,4	52,3
Linoleic acid (w-6), mg	2,6 ± 0,5	61,0 ± 1,4	190,9
Linolenic acid (w-3), mg	10,4 ± 0,9	19,5 ± 1,1	170,9
Arachidonic acid (w-6), mg	35,1 ± 1,4	9,1 ± 0,8	200,4
w-6 / w-3 ratio	11,7 ± 0,9	64,9 ± 1,4	111,9

Vitamin consumption in the examined group was higher than on average for population of the Urals and Siberia [11]. It was due to the necessity to compensate for considerable energy consumption caused by high physical activity. However, we should point out that specific weight of people who didn't consume enough A vitamin amounted to 64.9%; folic acid, 80.5% (deficiency value being 58.0%); D vitamin, more than 90.0%/

If we take essential macro- and microelements, then special attention should be paid to insufficient calcium consumption (33.8% respondents) and Ca/P recommended ratio violation related to that (practically 1:1.4).

Research of food status in separate MMP workers' groups revealed that clinical symptoms of vitamin deficiency occurred quite rarely and it corresponded to the data obtained via actual nutrition assessment.

The figure below represents food status assessment for workers employed at metallurgic production as per body mass index.

Such data coincide with the results of workers' actual nutrition assessment. We performed epidemiologic analysis of morbidity and a set of its outcomes (morbidity with temporary incapacity, disability, untimely deaths); the results

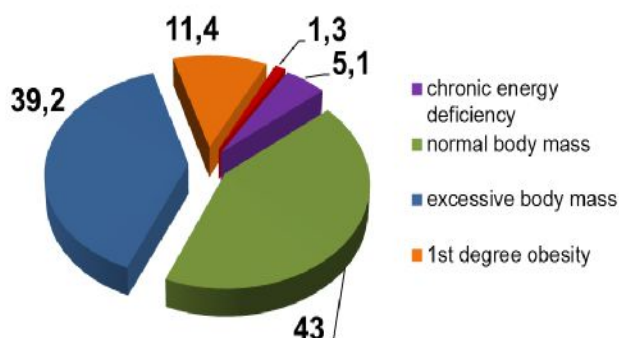


Figure. Food status assessment for workers employed at metallurgic production as per body mass index (%).

correlated with the data obtained via hygienic assessment of nutrition which workers employed at metallurgic production received.

Diseases with etiology wholly dependent on nutrition factor were characterized with apparent and statistically significant growth trend in overall morbidity dynamics for MMP workers ( $T_{pr}$  was equal to +6.6;  $p < 0.001$ ). Alimentary -dependent diseases were on average equal to 21.6% in overall morbidity structure in 2010-2015.

We worked out several model menus for the metallurgic plant canteens and recommended to adopt them in full conformity with sanitary regulations. We allowed for seasonality, necessary quantities of basic nutrients, and required caloric value of daily ration. Menus included foodstuffs which could help to prevent diseases caused by micro-nutrients deficiency. We also grounded our

recommendations on reduction in consumption of animal saturated fats and growth in omega-3-fatty acids consumption.

All this helped to make range of meat and vegetable dishes in the metallurgic plant canteens wider, increase number of workers who ate 2 or 3 times, to introduce hot breakfast and lunch, and to organize dietetic nutrition.

**Conclusions.** Hygienic assessment of nutrition revealed that actual nutrition which certain workers' groups employed at metallurgic production received was irrational, imbalanced, and it didn't satisfy physiological needs. So, a risk of deviations in food status and alimentary-dependent diseases evolvement occurred.

Clinically significant symptoms of skin damage related to insufficient provision with micro-nutrients didn't occur frequently. More than a half of the examined workers had excessive body mass (12.7% suffered from obesity with the 1st and 2nd degree).

On average, alimentary-dependent diseases amounted to 21.6% in the structure of overall morbidity in 2010-2015. Diseases caused mostly by nutrition factor amounted to 10.0% of all diseases with temporary incapacity. Epidemiologic analysis of morbidity caused by diseases related to irrational nutrition allowed us to determine priority nosologies, risk groups, as well as risk factors. This information was essential for creating a set of preventive activities for workers employed at metallurgic production.

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