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PRINCIPAL APPROACHES TO DESIGN AND OPTIMIZATION OF A DIET FOR TARGETED CONSUMER GROUPS

Abstract. The nutritional status is one of the main factors determining health and preservation of the nation's gene pool. Experts consider 76% of people's deaths to be caused by noncommunicable diseases namely cardiac diseases (56,7%), different types of tumors (14,4%), lung diseases (3,7%) and diabetes (1,5%). Great part of the abovenamed diseases are associated with a deficiency or excess of certain components in the daily diet of a person. About half of the people deaths under the age of 70 linked to inadequate nutrition. One of the main prerequisites for the human health is its optimal diet, which should contain essential amino and fatty acids, vitamins and various trace elements. It is upon achievement of the optimal nutrition structure that high performance capabilities and primary prophylaxis of many diseases are ensured, immunoresistance is increased and organism defense against an impact of unfavorable environmental factors is strengthened. A solution to the problem of proper nutrition that corresponds to the requirements and possibilities of the human organism and is balanced by all indicators of nutritional and biological value is linked with the development and processing of big data and knowledge bases. They contain information that reflects the choice of individual (or personalized) diets and nutrition regimes with consideration for age factors, physiological status, medico-biological requirements, regional conditions, peculiarities in food consumption as well as for sources of disorders of the immune status. Difficulties in optimal decision-making solution is linked with many different factors. Firstly, with the probabilistic dispersion of characteristics and properties of biological raw material. Secondly, with individuality of the physiological peculiarities of the organism requiring in each case individual selection and correction of ration models taking into account structural relationships and restrictions at the component, elemental and monostructural levels. The paper shows the use of the information technologies realized by the methods of multi-criteria optimization and mathematical programming, which allow structuring the obtained set of alternatives, correct and/or construct an optimal diet.

Key words: diet, information technologies, computer programs, optimal diet, healthy nutrition.

Introduction. Nutrition is one of the main conditions of human existence. Quantity, quality and an assortment of consumed foods as well as timeliness and regularity of food intake decisively affect human life in all its manifestations.

Proper nutrition is the crucial factor of human health, performance capabilities and active life.

Among the environmental conditions that constantly affect the human body, nutrition, without doubt, has the highest specific weight. However, food has a principle difference from the other environmental factors as food is converted in the process of nutrition from the external factor into internal, and moreover, its elements are transformed into the energy of the physiological functions and structural elements of the human organs and tissues. That is why nutrition is the main factor in assurance of the normal growth and development of the human organism, its working capacity, adaptation to an exposure to different environmental agents and, finally, it can be considered that the nutrition factor has a determining effect on human longevity and activity [1].

It is well-known that the human organism is constantly negatively affected by different chemical, physical, social and other factors of a habitat, which leads to deterioration of a health condition on the individual level and an increase in morbidity, disability and mortality.

Diseases leading to high social costs, resulting in early deaths and depriving many people of full-value life, such as stroke, hypertension, cardiac ischemia, many types of cancer, diseases of oral cavity, anemia, goiter, liver cirrhosis, diabetes, presence of bile stones, obesity, diseases of the locomotor system in the elderly, can be prevented by proper nutrition, even if the detailed mechanism of the relationship between excessive or insufficient nutrition and these diseases is still unknown. According to the estimates of the WHO experts, the resources that are allocated to the treatment of these diseases significantly exceed the expenses necessary for their prevention [2].

According to the WHO data, in the Western European countries, noncommunicable diseases account for 77 % of all diseases, and they are the cause of deathin 86% cases with cardiovascular diseases occupying the first place [2]. The same trend is observed in Russia. For example, in 76% cases, the causes of death are noncommunicable diseases, among which are the circulatory system diseases (56.7%), neoplasms (14.4%), respiratory diseases (3.7%) and diabetes mellitus (DM) (1.5%).The main risk factors influencing mortality of the population of the Russian Federation are: arterial hypertension (35.5%), increased cholesterol level (23%), smoking (17.1%), insufficient intake of vegetables and fruit (12.9%), obesity (12.5%), excessive consumption of alcohol (11.9%), low physical activity (9%). It is obvious now that a decrease in mortality and an increase in life expectancy in Russia are possible, first of all, due to prevention of chronic noncommunicable diseases [3].

Several main noncommunicable diseases, including cardiovascular diseases, type 2 diabetes and certain cancer types, which accounts for more than half of deaths, diseases and disabilities, were identified as alimentary-dependent, that is, they can become more severe or be corrected by corresponding nutrition.

However, WHO identifies overweight (body mass index (BMI=25-29.9) and obesity (BMI=30 and higher) as the biggest unacknowledged problem of the public health in the world [2].

About half of deaths under the age of 70 are associated, to one extent or another, with malnutrition [4].

Several diseases are associated with deficiency or excess of certain components in human daily diets. The associations have been traced between fluorine and caries, iodine and goiter; essential fats and cardio-vascular diseases; dietary fibers and gastrointestinal diseases; calcium, fluorine, vitamin D and diseases of the locomotor system; iron, folic acid and anemia [5].

A degree of assimilability of diet components to a large extent depends on the accompanying sub-stances. For example, calcium is a substance that is hard to assimilate. Calcium is found in foods, mainly, in the form of poorly soluble salts (phosphates, carbonates, oxalates and others). Solubility of calcium salts increases in the acidic environment of the stomach; however, dissolved ions, to some extent, are again bound and precipitate in jejunum and ileum, where pH is closer to neutral. A deficiency of protein and an excess of dietary fibers and phytic acid negatively affect a degree of assimilability of calcium that is consumed with foods. Oxalic acid often prevents calcium absorption. Binding with oxalic acid, calcium gives water insoluble compounds, which are the components of kidney stones. These are dock, rhubarb, spinach and beet. Phytic acid (which is especially abundant in cereals) binds calcium to the insoluble form. An increase in the need for calcium upon increasing dietary fibers in a diet raises the risk of osteo-porosis [6, 7]; a growth in aggressiveness is possible upon decreasing fat consumption [8], which is necessary to consider when developing and adapting an individual diet (personalization in nutrition).

The human stomach at the age of 60 can produce only 25% of the gastric juice that it produces at the age of 20. With that, a proportion of consumption of cereals (rye, wheat, oat), which are rich in fibers, increases. Therefore, a need for calcium increases with age. Products with low content of oxalic acid (green head cabbage, broccoli, turnip) are good sources of calcium. Calcium assimilability from cabbage is as high as from milk.

A significant contribution to the mentioned problems can be made by the use of the modern infor-mation technologies, which allow prompt assessment of person's psycho-physiological peculiarities, including technological treatment and raw material preparation [9]; selection with consideration for this assessment of the individual full-value diets based on the optimized procedure; individual health nutrition education and dissemination of knowledge in this field using data (generalized and formalized in a form of databases/knowledge bases) about relationships between nutrition, health, age, individual characteristics of a person and ecological conditions; and control over the process of the diet use.

For human health, not only the full value of nutrition is important, but also its prophylactic, curative, detoxifying and geroprotective function. This, to a large extent, determines the modern requirements for

the structure of rational nutrition. At present, it is difficult to meet these requirements using the traditional approaches to formation of diets based on the dietitians' expert analysis as, when solving this problem, a person deals with quite a difficult combinatorial task of multi-parametric and multi-criteria optimization of a diet, which potentially can consist of many several hundreds of food products with different composition and properties. It is even physiologically difficult to a person to solve this task. In the general case, this task often does not have a solution and, therefore, there is a need for a step-wise iterative procedure of optimization in the course of the "human-computer" dialog [10].

The paper describes approaches to the development of the structural parametric models of adequate nutrition, formalization of the knowledge data and creation of the expert system of analysis and correction of the daily diet and nutrition regime for a certain group of people according to the scientifically substantiated norms and medico-biological requirements from available traditional food products in a particular region.

Principles for developing adequate human diet. It is known that human food should contain six hundred substances that are necessary for normal vital activities of the organism and occupy their place in the complex harmony of the biochemical processes. With that, 96% of the organic and inorganic compounds that come with food have certain curative properties [11]. Therefore, a human health condition ultimately depends on the quantity and ratios of these substances in a diet.

General approaches and methods for organization of nutrition are based on the principles of balance, individuality, rationality, functionality and adequacy [12].

The main tasks in organization of nutrition are:

- assurance of rational and balanced nutrition according to the age and physiological requirements in nutrients and energy;
- assurance of quality and safety of foods used in diets;
- prevention (prophylaxis) of communicable and noncommunicable diseases linked with the nutrition factor using enrichment of diets with main micronutrients (to prevent their deficiency).

Rational nutrition, which is adequate by quantitative and qualitative norms, as well as medico-biological requirements, is one of the main factors that predetermine health condition.

When formulating a diet, it is necessary to adhere to the principles of the rational, balanced adequate nutrition, which implies:

- satisfaction of the human needs for nutrients and energy, including macronutrients (proteins, fats, carbohydrates) and micronutrients (vitamins, microelements and others);
- balance of a diet by all nutrients, including amino acids, fatty acids, carbohydrates, vitamins, mineral substances;
- maximum variety in a diet, which is achieved by the use of a sufficient product assortment and different methods of cooking;
- adequate technological (culinary) processing of products that ensure high palatability of products and preservation of their nutritional value;
- consideration for the individual characteristics of a person (including intolerance to certain types of food products and meals);
- formation of a diet by qualitative and quantitative composition separately for different age groups in a population.

As was mentioned above, healthy food not only should be balanced by the content of proteins, fats and carbohydrates, but also should contain the whole complex of necessary minerals and vitamins. For creation of a proper diet, not only the presence of all nutrients is important, but also their compatibility, interrelatedness, synergism and so on.

Available variety of products leads to entropy of their choice. Among the main and most often used foods are bread, grits, pasta and sausages. Being mainly the suppliers of protein, they, at the same time, contain many co-occurring excessive ingredients that favor the development of obesity and alimentary-dependent diseases.

Difficulties in optimal decision-making are conditioned by the probabilistic dispersion of characteristics and properties of the initial components of the biological raw materials, individuality of the physiological peculiarities of the organism, which require in each case an individual choice and correction of diet models taking into account structural ratios and constraints on the component, element and monostructure levels. Therefore, the development of the computer technologies for the structural parametric modeling and optimization of the adequate nutrition system will allow knowledge-based selection of an optimal solution from a set of possible alternatives.

Intellectual component of the software. When developing software for assessment and optimization of a diet, it is necessary to take into account several requirements:

- addition of products and meals to a menu, and a possibility to edit a chemical composition;
- the use of the reference values for different population groups (healthy, curative, curative-prophylactic, dietetic nutrition and so on).

The functional structure of the developed system (figure 1) consists of the information database and a set of program modules that realize the control system of the information database, modeling and analysis of a diet, and the highly developed object-oriented user interface.

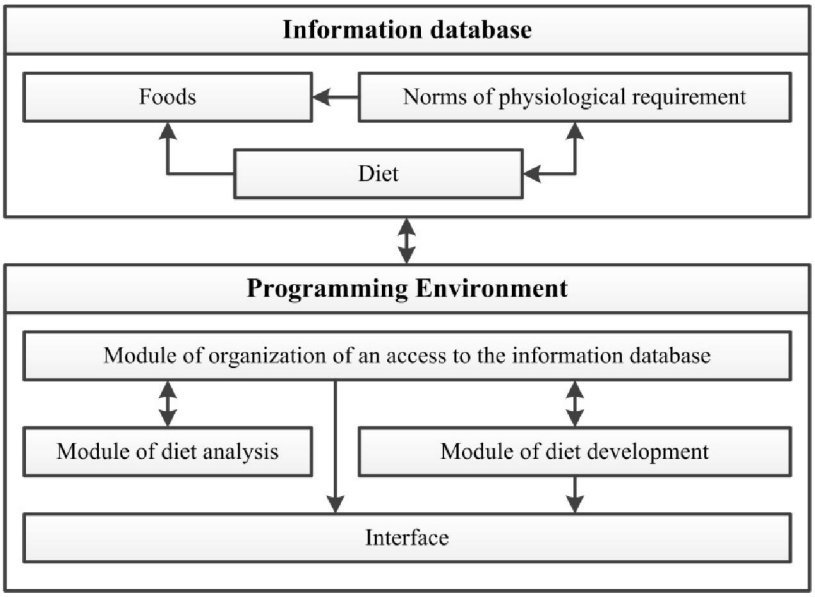
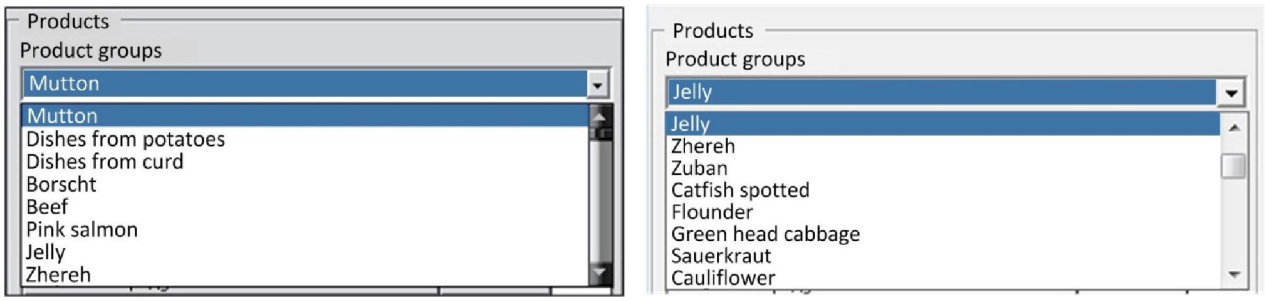


Figure 1 – The functional structure of the system

The information basis of the system is a database that reflects, in the structural manner, the physico-chemical indicators, functional-technological and structural-mechanical properties of products of animal and plant origin in a meal, atherogenic index of a food product, dietetic diets and menus, criteria of optimization and adequacy assessment, recommendations and norms of the physiological requirements in energy and nutrients for different population groups.

The main task of the system is the development and optimization of the nutrition menu for differentiated population groups according to the scientifically substantiated norms and medico-biological characteristics from available traditional products in a certain region of the Russian Federation. The decision is made in the module "Diet", which is intended to create new diets and correct the existing ones by addition of new meals and/or foods.

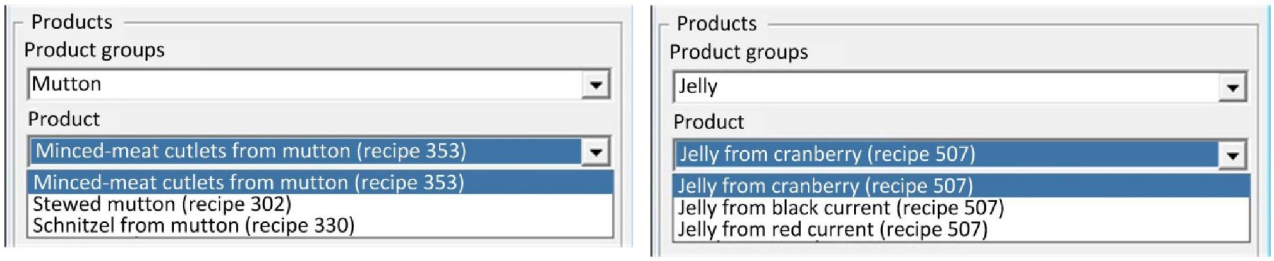
Figure 2 presents the dialog window of the database visually reflecting the group of products in the dropdown menu.



a) b)

Figure 2 – Window of the database with the list of the product groups:
a) "Mutton" group; b) "Jelly" group

When choosing the necessary group of products in the following box (text field), the products and meals of this group will be presented (figure 3).



a) b)

Figure 3 – Window of the database: choice of products (meals) from the chosen product category:
a) Choice of meals from the "Mutton" group; b) Choice of meals from the "Jelly" group

The development of an optimal diet comes down to the dialog algorithm (figure 4) [13] of detection of the product composition, their quantity and ratios by the set criteria and constraints. The first stage begins with entering information about existing daily diet of a patient with consideration for taste characteristics, ethical traditions, region of residence and so on.

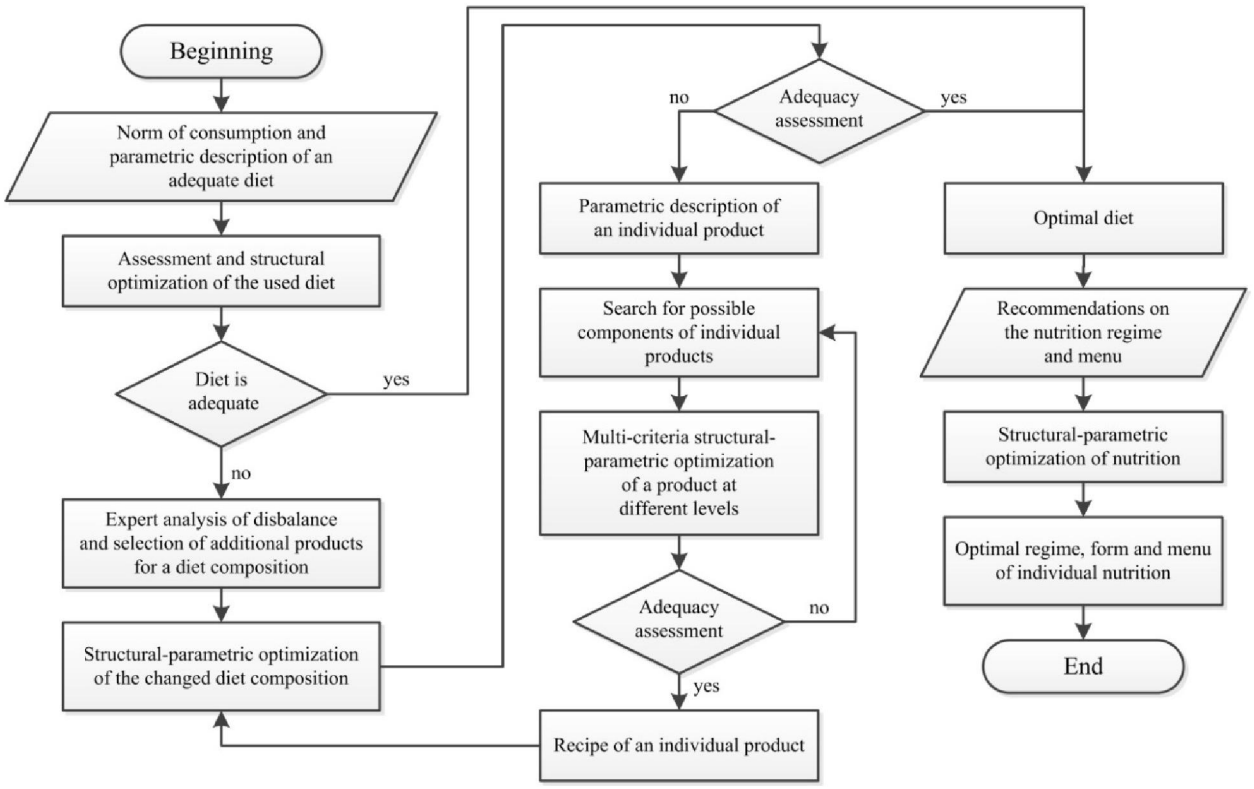


Figure 4 – Dialog algorithm of the structural-parametric optimization of the adequate nutrition

Using the described medico-biological status of a person, a parametric model of his/her adequate nutrition is formed in the expert system as specific parameters, norms and ratios of the nutrients and components that are required daily. On this basis, the assessment and structural optimization of the existing daily diet is carried out, which is linked with changes in the ratios and proportions of consumed foods by the criteria of the minimum deviation from the normative parametric structure of the indicators of the adequate nutrition.

The hierarchy of the quadratic criteria [14] of the minimal deviation from the reference structure of the set of indicators for nutritional, biological and/or energy values, as well as the criteria of the protein

digestibility, adequacy of protein intake, deficiency of albumin, transferrin, lymphocytes and others is used as a targeted function.

Minimization of the possible noncoincidence between parameters of the "standard" and proposed diets is linked with multi-criteria optimization and formation of the Pareto-optimal set of solutions by formalized criteria.

By the diagnostic algorithm for the medico-biological status of a person (figure 5), a vector of deviation of specific parameters of nutrients and components that are required daily is formed in the expert system relative to the established norms and ratios of adequate nutrition that allows to carry out the initial selection of products into the recommended diet that compensate existing deviations with consideration for individual characteristics of a person and social conditions (personal perception of one or another product, allergy, as well as availability of certain products due to a financial or geographical factor).

Upon insufficient compensation of deviations by selection of desired products and meals that are constituents of a diet, a search for their optimal qualitative ratios (structural optimization) is then carried out by possible incorporation of additional products and meals dependent on current deviations of

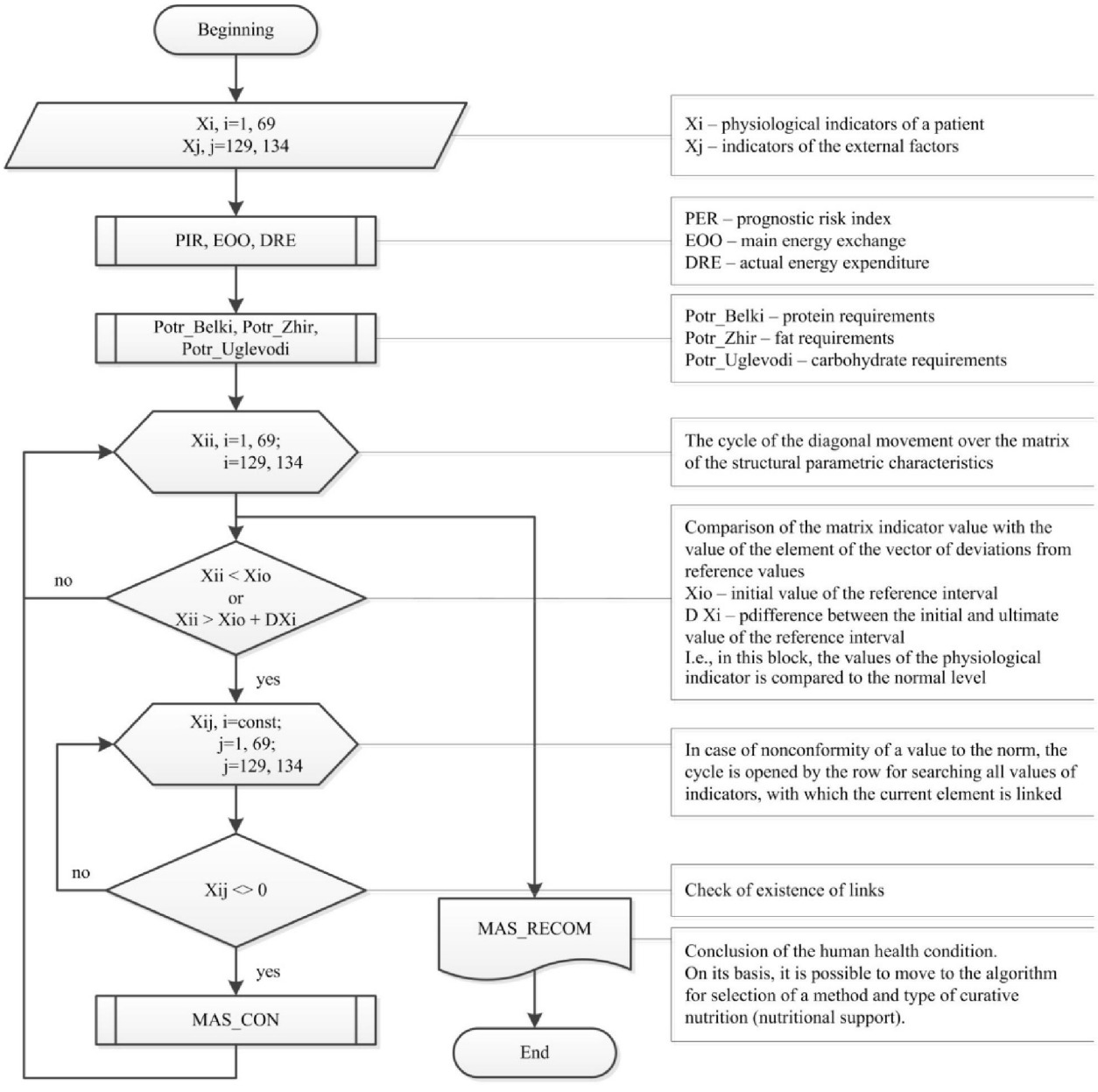


Figure 5 – Algorithm of diagnostics of human health condition

parameters from norms (the 3rd stage) or the development of the individual combined product (the 4th stage) that minimizes residual deviations.

To assess adequacy and quality of a diet, a functional [13] is proposed that reflects the average weighted total deviation of actual values of condition parameters from the norm. With consideration for weighted coefficients and selection of certain groups of factors, the quality functional has a form:

$$F(x) = 1 - \sqrt{\frac{1}{n}\sum_{i=1}^{n} a_i \sum_{j=1}^{n_i} b_{ij}\left(\frac{x_{ij} - x_{ij}^0}{\Delta x_{ij}^k}\right)} \to \max \quad (1)$$

where n – is the number of combined indicators; x_{ij}, x_{ij}^0 – the actual and desirable value; Δx_{ij}^k – the extreme deviation from the desirable value for the k[th] level of quality; b_{ij} – the weighted coefficient of the j[th] parameter in the i[th] group; a_i – the coefficient of group significance.

The value of quality coefficient changes from 1 in case of full coincidence of the obtained values with the recommended (the best quality) to 0 when reaching the boundary of the quality level (the ultimate value), so that at negative values of the functional, a diet does not correspond to the targeted quality level.

To detect the weighted coefficients, the method of the full factorial experiment can be used, at which the following values are entered into the columns of the response function y_{kr} of the r[th] replicate in the k[th] experiment: 1-0.7 – when assigning a product to a very good quality level; 0.7-0.3 – to good; 0.3-0 – to satisfactory; 0-(-0.2) –to bad; lower than (-0.2) – to a very bad quality level.

The mathematical model and algorithm for individual menu formation with consideration for taste preferences of people, their financial possibilities as well as individual physical and physiological characteristics come down to minimization of the discrepancy between taste preferences of a person and prescriptions of a dietitian by the criterion:

$$\sum_k (D_{KP} + D_{KD})\delta_k \to \max \quad (2)$$

where D_{KP} – the score value of the functional of patient's "taste" preferences of the k[th] meal; D_{KD} – the value of the functional of "curative" preference by the k[th] meal; $\delta_k = \begin{Bmatrix} 0 \\ 1 \end{Bmatrix}$ – logical variable of the component inclusion into the meal or diet composition upon constraints:

- for non-repeatability of meals in a daily diet
- for financial possibilities of a patient
- by mass of the k[th] meal
- for the ultimate caloricity at breakfast, dinner and supper
- for the ultimate volume of breakfast, dinner and supper
- by the upper and lower limits of the content of the i[th] chemical element

At the first stage, an assessment and analysis of the existing dietis carried out linked with calculation of the nutritional value (moisture, protein, fat, carbohydrates), vitamin and mineral composition (A, β-carotene, B_1, B_2, PP, C, Na, K, Ca, Mg, P, Fe) and the energy value of each i[th] meal/product in a diet.

After consecutive calculations for each component, all determined indicators for the first meal are obtained. Then, the value of the i variable is increased by one $i+1$; that is, we turn to the following meal in the menu. At each transition, the file is checked for its end.

After meeting this condition, we turn to the following stage linked with analysis and assessment of the existing diet.

At this stage, a gender and age group of a respondent (a person, patient, individual) is determined and the physical activity level is chosen. On the basis of the presented data, the norms of the physiological requirements in energy and nutrients for different groups of the population of the Russian Federation adopted by the Federal Service for Supervision of Consumer Protection and Welfare (Rospotrebnadzor) are uploaded.

The obtained calculated data on the physico-chemical indicators are compared with the regulatory indicators at two levels – minimum and maximum.

When there is a deficiency of one or more basic indicators (protein, fat, carbohydrates), the percent deviation from the norm is calculated and a product and/or meal that contain the lowest value of this indicator is found in a respondent's diet. In case of excess, a deviation from the limit for this indicator is calculated in a similar manner and a product and/or meal that contains the highest value of this indicator is found.

"Correction of a diet" is associated with replacement of an "undesirable" product by a similar one from this category of meals in order not to disrupt the balance of meals in a menu. A request to the database is made with the condition to display all meals in the same group category as a meal intended to be replaced. Among them, a meal with the maximum or minimum value of the targeted component is chosen.

Then, the other indicators of a diet are checked in terms of the correspondence to the minimum and maximum norms of consumption, and in case of misbalance, similar recalculation of products and meals in a diet is carried out.

As a result of the performed mathematical operations, the results are displayed showing the main physico-chemical indicators of a diet as well as the comparative analysis of deviations and options of their elimination.

Figure 6 presents the results of analysis of deviations from the reference norms and the proposed methods for diet improvement.

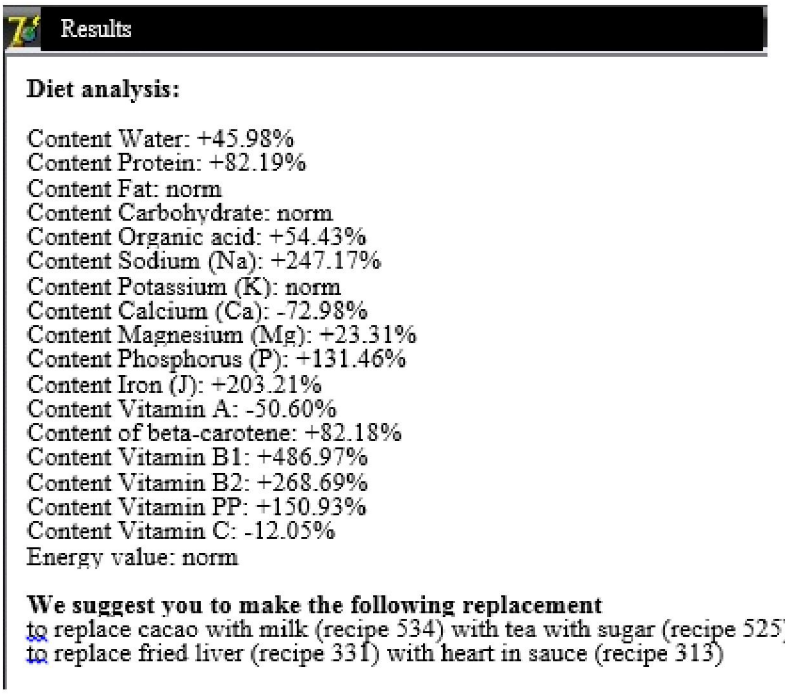


Figure 6 – Results of the program execution.

Analysis of IT solutions for human diet in the market. At present, several programs that are similar to the program under development are available on the market.

For example, the program "Assessment of actual nutrition by the Institute of Nutrition RAS" permits calculating a level of the main metabolism, giving recommendations on caloricity and the structure of nutritional value indicators by product groups, as well as visually reflecting nutritional value characteristics relative to norms. However, the proposed program does not allow taking into consideration a level of assimilability of food substances and a volume of actually consumed products, as well as product compatibility.

The apparatus-program complex "*Health Sources*" [15] (certificate of Rospatent No. 2004610012) consists of 4 modules (health assessment; analysis of factors influencing health; analysis of nutrition; dynamics) and allows screening a level of psychophysiological and somatic health, functional and adaptive reserves of the organism, assessing parameters of the physical development, making recom-

mendations on nutrition correction, physical activity, sport, sleeping regime, living, working and resting conditions. Analysis of the program complex showed that the main target audience is sportsmen, people having difficult professions (engine drivers, military personnel, shift workers). APC "Health Sources" allows giving a qualitative assessment of the health reserves that are taken into consideration upon development of the health improvement and training programs for correction of the revealed adaptation disorders. The system also allows assessing the actual diet by 27 nutrients and giving recommendations with consideration for gender and age groups. A diet is not corrected automatically by the program, but a dietitian makes changes in the current diet and nutrient composition of daily nutrition.

In the United Kingdom, the program *DietPlan* [16] was developed , which is integrated with the databases of McCance and Widdowson, USDA NDB, Australian NUTTAB, Danish, Canadian and New Zealand nutrient databases. In several databases, the nutrient composition exceeds a hundred of indicators. The developers of the software ensured harmonization of the nutritional value characteristics allowing the use of the initial data from significantly different sources. However, the English interface requires special learning and an unprepared user cannot use all options of the software without assistance. The program allows forming the individual and group reports, editing reference values for a category of patients under investigation.

The program *NutriSurvey*(Germany) [17] realizes the classical reference frequency method of consumption surveys, contains the database of products and nutritional value characteristics and normative values by different food categories. The program *NutriBase* (USA) [18] is intended for executing individual plans for clients of fitness centers or clinics and contains the nutrient databases USDA SR (USA) and CNF (Canada).

The output data of the program are graphs and tables about the condition and dynamics of consumption. The *NUT program* (USA) [19] contains the data about 8194 products and 146 nutrients, and enable execution of different nutrition plans, including ketogenic, low carb and other diets.

The principle disadvantages of the foreign computer programs are the following: they do not take into consideration the specifics of diseases, peculiarities of the organism and mentality of the Russians; there is no information about Russian foods and meals, they do not take into consideration the requirements of the Russian legislation for the composition, quality and safety of foods and meals. In additions, the interface in the Russian language is not envisaged in these programs.

Conclusions. At present, when constructing diets, it is necessary to take into account not only nutritional and biological values, but also other multiple factors: medical, technological, economic, social and so on. The solution to the problem of individual (personalized) adequate nutrition of a certain person should be considered trough many different factors. Status parameters, alternatives and criteria, different constraints and conditions should be taken into account. Information technologies for data and knowledge processing and formalization by optimal decision-making processes based on the complex models of multi-criteria structure-parametric optimization and objective assessment of the suggested options should be applied.

Information technologies can play a special role for representatives of different professions, population in the ecologically unfavorable regions, people with increased emotional and intellectual burden as they can not only present reliable and comprehensive information about peculiarities of nutrition, but also select an individual diet.

In contrast to the Russian and foreign analogues of computer programs for analysis of actual nutrition that are available on the market, the program under development enables simple and easy assessment and correction of a diet for a certain person with consideration for the physiological requirements, regional peculiarities of life and curative and prophylactic properties.

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ТҰТЫНУШЫЛАРДЫҢ НЫСАНАЛЫ ТОПТАРЫ ҮШІН ТАҒАМ РАЦИОНЫН ЖАСАУ ЖӘНЕ ОҢТАЙЛАНДЫРУ ПРИНЦИПТЕРІ

Аннотация. Тамақтану жағдайы – денсаулықты анықтайтын және ұлт гендік қорын сақтайтын маңызды факторлардың бірі. Ресейде 76% жағдайда өлімнің себептері жұқпалы емес аурулар екені көрсетілген, олардың арасында қан айналымы жүйесінің аурулары (56,7%), ісіктер (14,4%), тыныс алу органдарының

аурулары (3,7%), қант диабеті (ҚД) (1,5%). Бірқатар аурулар күнделікті адамның тамақтану рационында белгілі бір компоненттердің жеткіліксіздігіне немесе артық мөлшерде болғанына байланысты. 70 жасқа дейінгі өлім жағдайларының жартысының жуығы белгілі бір дәрежеде дұрыс тамақтанбауға байланысты. Адам денсаулығын сақтау үшін басты алғышарттар болып құрамында ағзаға қажетті амин қышқылдар, май қышқылдар, витаминдер және әр түрлі микроэлементтер бар оның оңтайлы тамақтану рационы табылады. Тамақтанудың оңтайлы құрылымына дәл жеткен кезде, жоғары жұмыс қабілеттілігі қамтамасыз етіледі және алғашқы көптеген аурулардың алдын алады, иммундық резистенттілік жоғарылайды, ағзаны қоршаған ортаның қолайсыз факторларының әсер етуінен қорғау күшейеді. Адам ағзасының тиісті қажеттіліктеріне және мүмкіндіктеріне сәйкес, тағамдық және биологиялық құндылықтарды көрсеткіштер бойынша теңдестірілген адекватты тамақтану мәселесін шешу үлкен деректер мен білім базасын құрумен және өңдеумен байланысты. Оларда жеке (немесе арнайы) рациондарды және жас ерекшеліктері бойынша факторларды ескере отырып тамақтандыру режимдерін таңдауын көрсететін, сонымен қатар физиологиялық жай-күйіді, медициналық-биологиялық талаптарды, аймақтық талаптарды, тағамды тұтыну ерекшеліктерді және де иммундық жүйенің бұзылған көзін көрсететін ақпарат бар. Бірінші кезекте, сипаттамалардың шашылу ықтималдылығымен және биологиялық шикізаттың бастапқы компоненттерінің қасиеттерімен. Екіншіден, ағзаның өзіндік физиологиялық ерекшеліктерімен әрбір нақты жағдайда жеке таңдауды талап ететін және компонентті, элементті және моноқұрылымды деңгейде шектеулер мен құрылымдық қатынастарды ескере отырып рациондар үлгілерін түзетумен ерекшеленеді. Мақалада көпкритерияларды оңтайландыру әдістерімен және математикалық бағдарламалаумен асырылатын ақпараттық технологияларды қолдану көрсетілген, ол көптеген алынған баламаны құрылымдауға, тамақтанудың оңтайлы рационын түзету мен орнатуға мүмкіндік береді.

Түйінді сөздер: тамақтану рационы, ақпараттық технологиялар, компьютерлік бағдарламалар, нақты тамақтануды бағалау, деректер базасы, білім базасы.

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ПРИНЦИПЫ РАЗРАБОТКИ И ОПТИМИЗАЦИЯ РАЦИОНОВ ПИТАНИЯ ДЛЯ ЦЕЛЕВЫХ ГРУПП ПОТРЕБИТЕЛЕЙ

Аннотация. Состояние питания – один из важнейших факторов, определяющих здоровье и сохранение генофонда нации. В России в 76% случаев причинами смерти оказываются неинфекционные заболевания, среди которых болезни системы кровообращения (56,7%), новообразования (14,4%), болезни органов дыхания (3,7%) и сахарный диабет (СД) (1,5%). Ряд заболеваний связаны с недостаточностью или избытком определенных компонентов в каждодневном рационе питания человека. Около половины случаев смертности в возрасте до 70 лет в той или степени связаны с неправильным питанием. Одной из главных предпосылок сохранения здоровья человека является его оптимальный рацион питания, содержащий необходимые для организма аминокислоты и жирные кислоты, витамины и различные микроэлементы. Именно при достижении оптимальной структуры питания обеспечиваются высокая работоспособность и первичная профилактика многих заболеваний, повышается иммунная резистентность и усиливается защита организма от воздействия неблагоприятных факторов окружающей среды. Решение вопроса адекватного питания, соответствующего потребностям и возможностям организма человека и сбалансированного по всем показателям пищевой и биологической ценности, связано с созданием и обработкой больших баз данных и знаний. В них содержится информация, отражающая выбор индивидуальных (или персонализированных) рационов и режимов питания с учетом возрастных факторов, физиологического состояния, медико-биологических требований, региональных условий, особенностей потребления пищи, а также источника нарушения иммунного статуса. Сложность принятия оптимальных решений обуславливается множеством факторов. В первую очередь, вероятностным разбросом характеристик и свойств исходных компонентов биологического сырья. Во-вторых, индивидуальностью физиологических особенностей организма, требующих в каждом конкретном случае индивидуального выбора и коррекции моделей рационов с учетом структурных соотношений и ограничений на компонентном, элементном и моноструктурном уровнях. В статье показано применение информационных технологий, реализуемых методами многокритериальной оптимизации и математического программирования, позволяющие структурировать полученное множество альтернатив, скорректировать и установить оптимальный вариант рациона питания.

Ключевые слова: рацион питания, информационные технологии, компьютерные программы, оценка фактического питания, база данных, база знаний.

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