INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 3, Issue 12 Dec. 2022

MATHEMATICAL MODEL - DIFFERENTIATED DIETARY NUTRITION - PERIOD OF PRENATAL DEVELOPMENT OF THE FETUS

Abdullaeva Zamira Shamshaddinovna
Doc. f. f.-m. Sciences, Associate Professor, Tashkent University of Information Technologies named after Muhammad al-Khwarizmi

Shikhnazarova Guzal Alisherovna
PhD Doctoral Student, Tashkent University of Information Technologies named after Muhammad al-Khwarizmi
Uzbekistan, Tashkent

Annotation
The influence of priority factors is considered as: vitamins during the development of the fetus in three trimesters. An analysis was made of the dynamics of fetal development, taking into account the saturation of nutrients and vitamins in food. Investigated about the main factors affecting the development of the fetus; The main types of nutrients in products that provide a rational diet for pregnant women have been identified. A mathematical model of differentiated dietary nutrition for the period of prenatal development of the fetus has been developed.

Key words: vitamins in food products, prenatal development of the fetus, rational diet, mathematical model, differentiated dietary nutrition.

Introduction

Rational nutrition is one of the main conditions for a favorable course and outcome of pregnancy and the normal development of the fetus. The body of a pregnant woman requires more than usual amounts of nutrients that are necessary not only for the mother herself, but also for the growing child [1-2]. The neonatal period is extremely important in terms of the final morphological and functional formation of the main organs and systems of the child. Changing the hemotrophic (umbilical) type of nutrition[3] to enteral requires an optimal product in terms of composition and properties that can provide the baby with all the necessary nutrients.

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The nutrition of the infant during this period, through epigenetic mechanisms, affects its further physical and intellectual development. Breast milk is recognized as the best nutrition for a child of the first year of life; it is an important component of human health programming through the stimulation of metabolic and immunological processes [1].

During pregnancy, many metabolic processes are activated and the unfavorable elements that are in food affect both the woman herself and the fetus and the health of the unborn child. Quantitative irrationality (consumption of too many or too few calories) and qualitative (imbalance in essential nutrients) leads to complications during pregnancy and impaired development of the fetus and newborn. Often unfavorable nutrition can lead to obesity and the development of various diseases. Obese pregnant women are at risk of developing preeclampsia , fetal macromas, gestational diabetes , and hypertension during pregnancy [1]. The manifestation of malnutrition in one form or another (protein energy, vitamin, mineral), according to various authors, ranges from 18–56%. Along with this, it should be noted that women with reduced nutrition most often have early chronicity and atypical course of various diseases of internal organs during pregnancy.

During pregnancy, physiological changes occur in the body of a woman and fetus, proper and balanced nutrition contributes to proper intrauterine development during pregnancy. The developing fetus is extremely in need of various nutrients, in accordance with this, a pregnant woman consumes them much more than before pregnancy. Often, a lack of proteins, fats, carbohydrates, and others can lead to various pathologies in the fetus (Table 1) [5].

table 1. The impact of malnutrition in pregnant women on the development of the fetus [6]

malnutrition	**Fetal Development Disorder**
Protein and energy deficiency	Intrauterine hypotrophy. delayed brain development
Deficiency of polyunsaturated fatty acids;	Violation of the development of the neuroretina and brain
folic acid deficiency	Neural tube defects: anencephaly, cleft palate
Vitamin A deficiency and excess	Congenital malformations: anencephaly,
iodine deficiency	Congenital malformations, cretinism , constipation
zinc deficiency	Congenital malformations, neural tube defects

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An important role in the functioning of the central nervous system (CNS) and the development of the organs of vision of the fetus is played by polyunsaturated fatty acids (PUFAs). Sufficient content of PUFA in the blood of a pregnant woman reduces the risk of developing respiratory diseases in her child, incl . bronchial asthma, type 2 diabetes mellitus, obesity, arterial hypertension [7–11]. The role of folic acid in fetal development is difficult to overestimate. Its adequate consumption both before and during pregnancy reduces the risk of developing fetal neural tube defects [12, 13], prevents the development of Down syndrome, autism, schizophrenia, and anomalies of the urinary system. Iodine is necessary for the normal development of the brain and thyroid gland in the fetus. Vitamin D deficiency can cause rickets, preterm labor, and low birth weight babies [11]. For the formation of bones and teeth, the child needs calcium, the deficiency of which is replenished from the mother's body. This can lead to osteoporosis and dental damage in pregnant and lactating women [14]. Iron deficiency is one of the factors in the development of anemia in infants and their lag in psychomotor and mental development in the first years of life [2, 15, 16]. The laying and development of various organs and systems of the fetus occur in a certain genetically determined sequence and at strictly defined time intervals. There are critical periods in the formation of various embryonic structures, the so-called. spurts, i.e. periods of the most rapid development. They are called critical because these moments, the transition of the embryo from one type of metabolism, more simple, to another, more perfect and complex, is observed. Such a restructuring is fraught with developmental disorders and even death of the fetus. During these periods, the role of qualitative and quantitative usefulness of nutrition increases. Thus, pregnancy is a special situation in a woman's life, when a balanced diet is urgently needed for both the mother and the fetus, which requires early detection of malnutrition in pregnant women and differential correction at different stages of pregnancy.

The main recommendations for a pregnant woman in the field of nutrition are: a variety of diets; preference for foods rich in proteins, vitamins, and minerals, especially calcium and iron; avoiding drugs, smoking, alcohol, and excessive caffeine intake.

Before birth, the child depends solely on the mother's nutrition, so the diet and diet of a pregnant woman plays a very important role. Since the mother’s body primarily provides nutrition to the fetus, a mother who does not eat enough does not allow the fetus to develop normally, at the same time she herself loses weight, becomes anemic and loses the ability to cope with the stresses associated with childbirth, feeding and care for the child.

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Rational nutrition of a pregnant woman is a necessary condition for ensuring the health of the unborn child, the resistance of his body to the action of infections and other adverse factors, and the ability to learn at all ages. Deficiency of micronutrients in the diet of a pregnant woman is one of the important causes of the occurrence of alimentary-dependent conditions in an unborn child, which can include: in young children - iron deficiency anemia, food allergies, rickets, malnutrition [4]. Only a balanced diet can fully meet the nutritional needs of a pregnant woman. In the diet of a pregnant woman, it is recommended to use an adequate ratio of proteins, fats and carbohydrates.
Modeling the process of fetal development depending on nutrition.
To maintain a normal life, a pregnant woman needs to have a certain amount of nutrients.

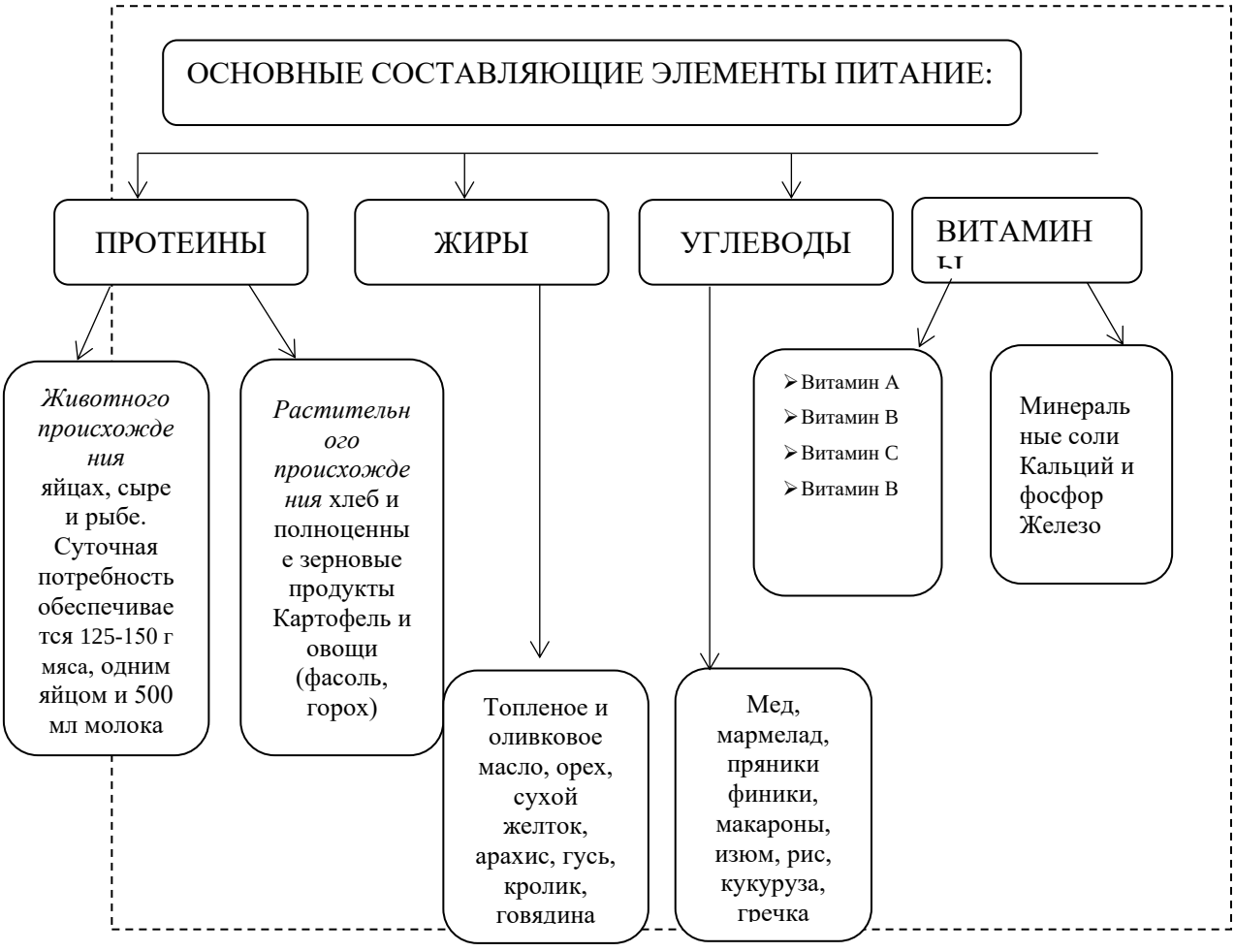

Fig.1. The main constituent elements of nutrition and receive a certain energy value, expressed in calories, necessary for the assimilation of food [5].

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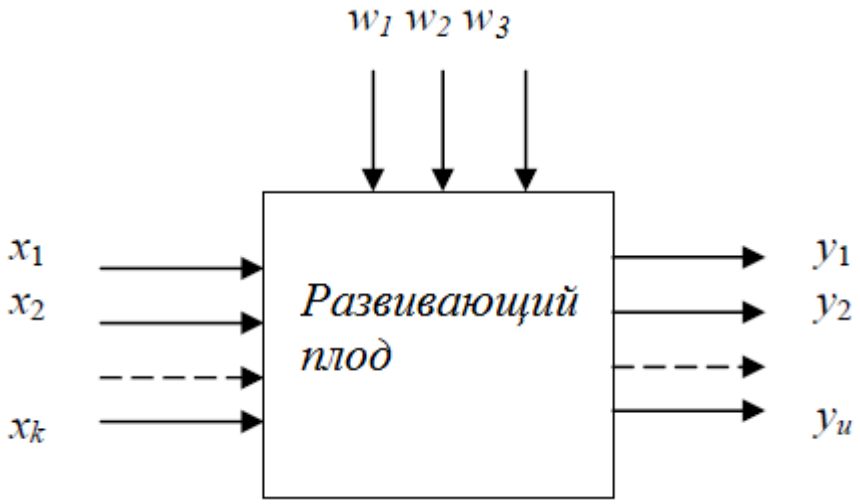

Fig. 2 Model of the process of prenatal development of the fetus

The mathematical model of the prenatal development of the fetus, the output parameters are associated with the variables $x_1, x_{2,\ldots}, x_k$

The mathematical model of the object is a response function that causes an output parameter that characterizes the results of the experiment, with variables that vary during the experiments:

$$y = \varphi(x_1, \ldots x_k)$$

It is customary to call independent variables $x_1, \ldots, x_k$ factors, the space with coordinates $x_1, \ldots, x_k$ is the factor space, and the geometric representation of the response function in the factor space is the response surface.

When using statistical methods, the mathematical model of process statics is often represented as a polynomial - a segment

Taylor series into which the unknown function (1.1) expands:

$$y = \beta_0 + \sum_{j=1}^{k} \beta_j x_j + \sum_{u,j=1}^{k} \beta_{uj} x_u x_j + \sum_{j=1}^{k} \beta_{jj} x_j^2 + \ldots,$$

where $\beta_0 = \varphi(0);\ \beta_j = \frac{\partial \varphi(0)}{\partial x_j};\ \beta_{uj} = \frac{\partial^2 \varphi(0)}{\partial x_u\, \partial x_j};\ \beta_j = \frac{\partial^2 \varphi(0)}{2\, \partial x_j^2} \ldots$

The need to conduct an experiment on the object of research is due to the fact that it is necessary to eliminate some uncertainty inherent in the knowledge about the object before conducting this experiment. The result of an experiment on a complex object is usually a random value. There are many reasons leading to the fact that the results of observations and measurements

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made in experiments turn out to be random variables. Sometimes randomness is predetermined by the very physical essence of phenomena: processes occur at the molecular or atomic levels, but are measured by macroscopic instruments.

The organization of the experiment and the processing of experimental data determine the degree of decrease in the uncertainty of knowledge about the object of research and must proceed from the nature, essence and cause of uncertainty. Speaking about random phenomena, first of all, they pay attention to their unpredictability, they oppose randomness to determinism, randomness to orderliness. Having a certain meaning, such opposition is one-sided, as it leaves in shadow the fact that randomness is understood as a kind of uncertainty, subject to a strict pattern, which is expressed by a probability distribution[16]. Knowing the distribution (for example, the density p(x)) of probabilities, one can answer any question about a random variable: in what interval are its possible values (we define the carrier of the distribution X - the set of elements x for which p(x) > 0); around what value its realizing values scatter (we find the distribution position parameter, for example, the mean, modulus or median); how widely these values are scattered (we find the scale parameter - variance or standard deviation, mean modulus of difference, entropy); what is the relationship between different implementations (compute a given measure of dependence), etc.

Therefore, when processing and analyzing experimental data, methods of mathematical statistics are used. So, for the polynomial model (1.2), the so-called sample regression coefficients are obtained b_0, b_j, b_{uj}, b_{jj}, which are estimates of theoretical coefficients $\beta_0, \beta_j, \beta_{uj}, \beta_{jj}$. The regression equation obtained on the basis of experimental data will be written as follows:

$$y = b_0 + \sum_{j=1}^{k} b_j x_j + \sum_{u,j=1}^{k} b_{uj} x_u x_j + \sum_{j=1}^{k} b_{jj} x_j^2 + \ldots + \sum_{i,u,j=1}^{k} b_{iuj} x_i x_u x_j \ldots,$$

where b_0 is the free term of the regression equation; b_j – linear effects, j = 1, 2, …, k ; b_{uj} – quadratic effects; b_{jj} – effects of pair interaction; b_{iuj} are the effects of triple interaction.

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The construction of a mathematical model of spruce and its analysis in the processes of isotope separation is carried out in the following sequence [12]:
1) preliminary study of the process,
2) drawing up a model based on the results of research,
3) interpretation of the model and its use.
The main causes of anemia in pregnancy are hemodilution , caused by an increase in blood volume, and a true deficiency of dietary iron. If "nutritional" anemia develops, then the following reasons for its development should be considered:
- inadequate intake of products containing iron, folic acid, vitamin B_{12};
- the presence of bleeding;
- inadequate content of iron stores, necessary to maintain a certain level of hemoglobin;
- increased consumption of iron;
- malabsorption in the intestines (malabsorption);
- insufficient content of it in the usual diet;
- a method of processing food with a loss of vitamins necessary for assimilation (folic acid, vitamins B_{12}, B_6, C);
- inadequate content of folate reserves to maintain erythropoiesis ;
- increased iron requirements in a pregnant woman or fetus with adequate intake.
Magnesium deficiency predisposes to the destruction of tooth enamel and the development of caries. Phosphorus , like calcium , is involved in the formation of fetal bone tissue and its normal growth. The ratio of calcium and phosphorus in the diet of a pregnant woman should be 1:1.5. Insufficient calcium in the diet of a pregnant woman and increased calcium intake by the fetal body often leads to the development of its deficiency in a pregnant woman with bone demineralization. Calcium and zinc improve maternal reproductive function. Additional administration of calcium (2000 mg) per day reduces systolic and diastolic blood pressure, as well as the development of toxicosis of pregnant women. Healthy nutrition of a pregnant woman helps to prevent the development of anemia in a future mother, dental problems, alleviate toxicosis and reduces the risk of infectious diseases. Vitamins maintain a certain level of metabolism in the body, improve well-being, perform a protective function and are necessary for growth and tissue

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renewal [10]. The daily norm of vitamins and microelements for pregnant women (Fig. 2.3):

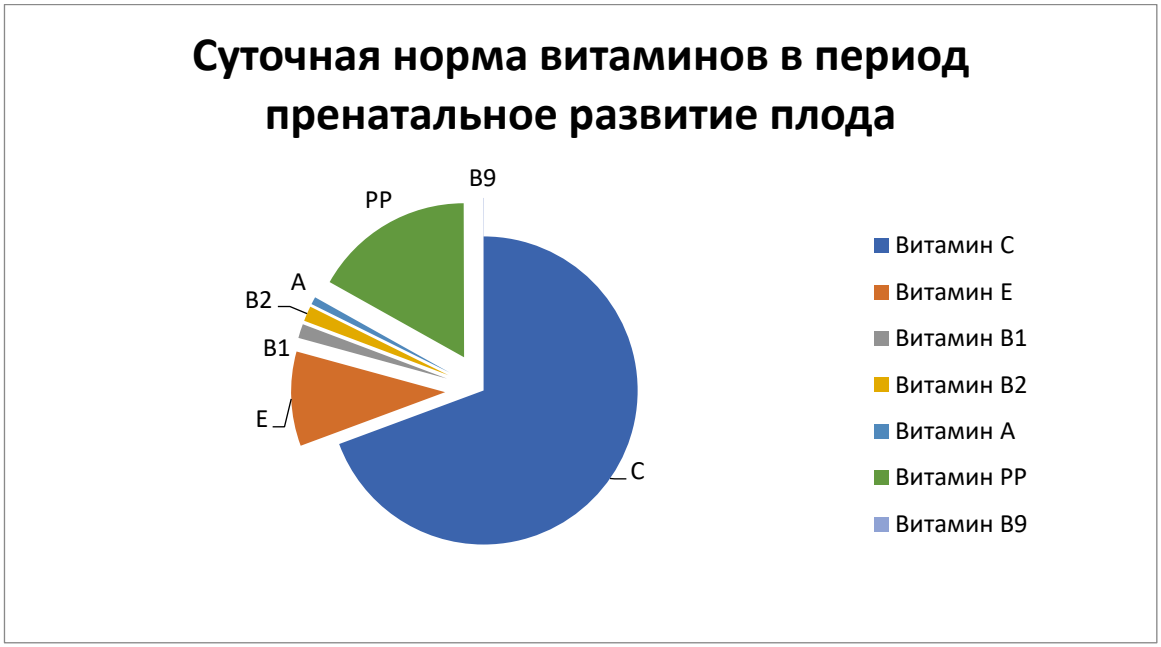

Fig.3. Daily intake of vitamins.

Vitamins: Vitamin A-800mcg, Vitamin D-10mcg, Vitamin K-65mcg, Vitamin E-10mg, Vitamin C-70mg, Vitamin B 1-1.5mg, Vitamin B 2-1.6mg, Vitamin D-10mcg Vitamin B 6 -1.2mg, Vitamin PP -17mg, Folic acid-400mcg.

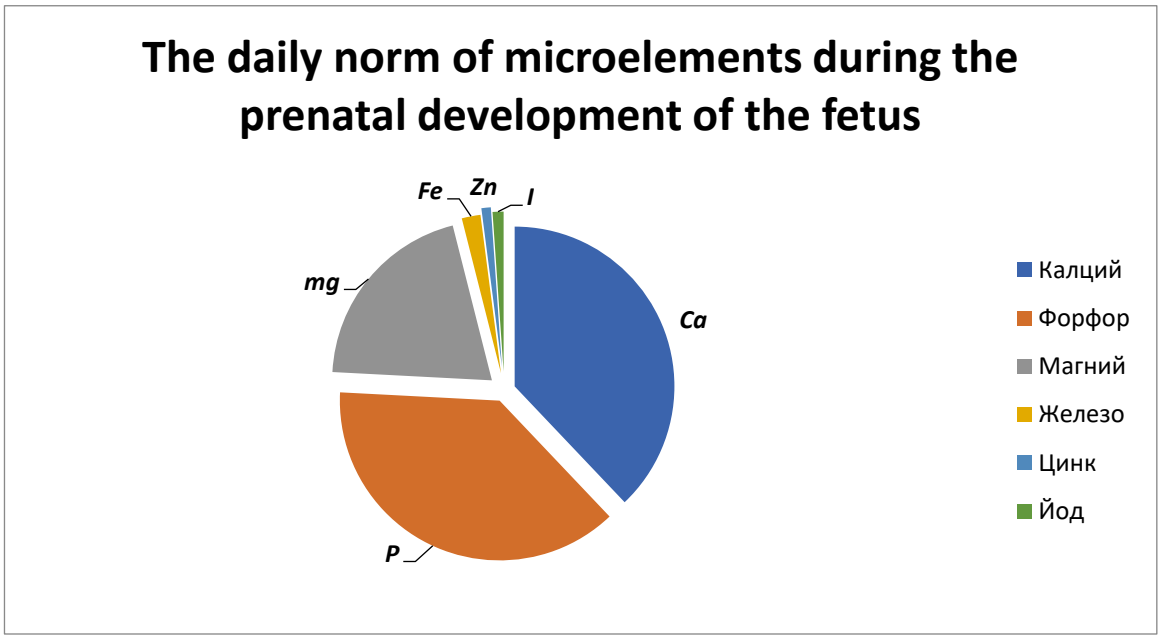

Fig . 4. Daily norm trace elements .

Microelements : Ca - calcium -1200 mg , P -forfor -1200 mg , Mg - magnesium -320 mg , Fe - iron -30 mg , Zn - zinc -15 mg , I - iodine -175 mcg , Se - selenium -65 mcg ,

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To date, it remains one of the most important socio-economic problems associated with the healthy development of the physical and intellectual population of the country, providing the country's population with a full-fledged balanced diet, which determines the normal life of each person in the environment. Problems of organizing and providing food for the population, especially in the country, due to the large number of regions, climatic zones, the diversity of ethnic groups of people with national traditions, occupation and physiological characteristics.

Conclusion

The problems of rational nutrition during the period of prenatal development of the fetus in the modern world occupy their niche in the list of issues of general health of the population. Insufficient and unbalanced nutrition causes a number of deviations in the development of the fetus, the born child, as well as the mother. Avoid the vices and ill health of specialized maternity foods. The influence of priority factors is considered as: vitamins during the development of the fetus in three trimesters. An analysis was made of the dynamics of fetal development, taking into account the saturation of nutrients and vitamins in food. Investigated about the main factors affecting the development of the fetus; The main types of nutrients in products that provide a rational diet for pregnant women have been identified. A mathematical model of differentiated dietary nutrition for the period of prenatal development of the fetus has been developed.

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