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Розглянуто використання факторного аналізу для вивчення факторів ризику виникнення кризи в сімейних відносинах, які приводять до дисциркуляторної енцефалопатії. За допомогою факторного аналізу обґрунтовано розбиття системи показників на змістовні блоки. Виявлені фактори дозволяють визначити мішені психокорекції, які включають особистісні якості й фактори, умовно віднесені до блоку сімейної кризи

Ключові слова: сімейна криза, дисциркуляторна енцефалопатія, факторний аналіз, тіснота зв'язку, когнітивні та емоційні розлади

Рассмотрено применение факторного анализа для изучения факторов риска возникновения кризиса в семейных отношениях, которые могут привести к дисциркуляторной энцефалопатии. С помощью факторного анализа обосновано разбиение системы показателей на содержательные блоки. Выявленные факторы позволяют определить мишени психокорекции, которые включают личностные качества и факторы, условно отнесенные к блоку семейного кризиса

Ключевые слова: семейный кризис, дисциркуляторная энцефалопатия, факторный анализ, теснота связи, когнитивные и эмоциональные расстройства

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FACTOR ANALYSIS OF CRISIS EMERGENCE IN FAMILY RELATIONS, CONTRIBUTING TO THE DEVELOPMENT OF DYSCIRCULATORY ENCEPHALOPATHY

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1. Introduction

Today in Ukraine we may observe a considerable increase in negative phenomena in the sphere of marriage and family, namely a reduction in the quantity of new marriages, an increase in divorce rate, weakening family bonds and others [1].

The institute of family in the contemporary society, including Ukrainian, is subjected to significant changes. Its value-normative space is changing, the new types of families and family relations appear, and functional relations between the family and the society are transformed. The transitive nature of society development could not but affect

functioning of basic social institutes, and the institute of family was the first to experience complexities of the transitional society [2].

Frequently, family members who find themselves in "a socially dangerous situation", have biomedical deviations and even clearly pronounced diseases, which impede fully fledged functioning. Conditions and standards of living in such a family are estimated as hardly suitable or not suitable for living and development, where intra-family and external social connections are disrupted, which leads to the personal deformation of family members [1–4].

Different political, economic, cultural and social changes in Ukraine lead to worsening in the conditions of the larger part of the population. There is a whole group of diseases, which are called "psychogenic diseases". The mental factor comes out as a sufficiently active or influential factor of the disease appearance in the so-called psychosomatic diseases [5].

However, a disease or disorder proceeds not generally, but in a particular person, with a particular biography, and with particular life experience. To explain things happening to a person is rather difficult. This requires collection of both medical, psychological, and personal anamnesis, as well as the analysis of his life. To structure a person's world is difficult, very often behavior, psycho-emotional states, family, psychological and somatic problems seem difficult to understand and explain. Thus, there appears a need, first of all, for the diagnosis of psychological and somatic disorders.

Social conflict becomes the integral part of life of a contemporary person, provoking the formation of emotional social stress, which, in turn, causes disorders in the work of many organs and systems and leads to such illness as dyscirculatory encephalopathy (DE). DE, which appears as a result of the chronic stress, due to its high propagation and affection at the initial stage of people of working age, and due to severe medical and social consequences, occupies one of the key places in national neurology and psychiatry. Correct diagnosis and treatment of this disease relates to the range of priority tasks, directed toward prevention of the disease progression and reduction of the risk of developing stroke and dementia [6].

One of the leading syndromes at the initial stage of the disease is a disruption of cognitive and emotional sphere. Vascular cognitive and emotional disorders, even if they do not reach the manifestation of dementia, develop as a result of a lengthy flow of pathologic process and testify considerable cerebrovascular in terms of its manifestation. They indicate an essential disorder of blood supply of the brain and, therefore, must be examined as an indicator of high risk of developing a stroke or vascular dementia [6]. Disorders of psyche, first of all, cognitive and emotional, are one of the most frequent manifestations of organic diseases of the brain. The loss of psychological equilibrium under the influence of social stress and the loss of prospects in the family determine the probabilities of the development of depression, phobia, and anxiety and, finally, formation of the pathologic lesion of the brain vessels with the subsequent sharp disorder of cerebral blood circulation.

Emotional and cognitive disorders are one of the relevant problems of contemporary medicine and psychology. Studying the mechanism of their development, it is possible even at the early stages to reveal the risk factors, which lead to disorders of cerebral blood circulation. Emotional and cognitive disorders are minimally expressed in patients at the initial stages of DE; therefore, their diagnosis is a fairly complicated task. In this case, DE, including the one, which is sufficiently expressed, may be for a long time manifested only in the form of cognitive and emotional disorders. Therefore, in the diagnosis of chronic cerebrovascular insufficiency, one should pay special attention to the assessment of state of emotional sphere [6].

For detecting emotional and cognitive disorders on time, it is necessary to estimate the structure of connections between the existing variables. In the course of studying the effectiveness of diagnosis and subsequent treatment, a situation when the number of measured features is wide enough is typical; therefore, for substantiated and timely decision making, it is necessary to decrease the dimensionality of space of studied features, which, undoubtedly, will make it possible to reduce the time of diagnosis, due to cutting off the uninformative features. It is possible to solve the stated problem using one of the multidimensional statistical methods – factor analysis.

A specific feature of this method is the fact that during uniting parameters into factors, each factor accumulates in itself general regularities in all parameters, rejecting special features of each parameter individually, and allows representing the whole volume of the obtained data in the visual and compact form. In a study of complex objects, factor analysis makes it possible to reveal the concealed interrelations of an object and their structural special features, as well as to determine the measures of these connections, and to reveal the basic factors, which lie at the basis of the indicated changes [7].

Factor analysis at present is used in different areas of research activity – in statistics, neurophysiology, medicine, psychology, etc. together with other mathematical methods [8].

2. Literature review and problem statement

Using factor analysis, the authors in [9] focused their attention on studying the interrelation of properties of the nervous system and motivational characteristics and other qualities of personality, as well as with its adaptive connections. For conducting the study, we used a personality questionnaire, IQ indicators, indicators of the need for accomplishment, indicators by four scales of the tapping test, eight exponents of manifestation a degree of the symptom complexes of the BCD test, and four indicators of disadaptation. The obtained results made it possible to distinguish the criteria for determining "the risk group" among the people, subjected to disadaptation. However, the obtained factors do not allow revealing emotional and cognitive disorders, which lead to the development of DE.

With the help of factor analysis, authors in [10] studied special features of cognitive functions at different types of neuropsychological profile in people having DE. For conducting the study, we used 18 parameters, such as: orientation in time, orientation in place, contact, critical attitude to one's own state, critical attitude to task completion, fitness for work, exhaustion, direct memory, indirect memory, long-term memory, generalization level, understanding of logical-grammatical constructions, ability to distinguish the main idea, generalization of parts into the whole, understanding of logical connections, ability for analysis and synthesis, understanding figurative sense, skill to understand connections between events, dynamics of mnestic activity,

lability of thinking, and inertness of thinking. The obtained factors describe general cerebral activity and the processes, connected with the work of the I and III structural-functional blocks, but they do not make it possible to evaluate the emotional state of a patient and to prevent occurrence and development of DE.

Using the method of factor analysis, in [11] authors studied peculiarities of interrelations in married couples with a different term of family life using the questionnaire of satisfaction with marriage, procedure of defining the nature of interaction of spouses interaction in a conflict situation, procedure of diagnosing predisposition of personality to conflict behavior, the color test of relations. But the obtained factors do not explain emotional interrelations between spouses, which does not allow revealing the risk factors of destruction of family relations and preventing developing stress, leading to DE.

For the purpose of revealing the factors, which take part in the development of dementia, in [12] the authors carried out pathopsychological analysis of the patients with vascular psychoses. The study was conducted with the use of the MMPI method. The factors, obtained in the course of this study, made it possible to distinguish the features of cognitive disorders. The authors did not examine emotional disorders in this work, which did not allow obtaining the overall picture of the state of a person suffering from DE.

For conducting factor analysis in [13], authors carried out biochemical studies of blood, electro-cardiography, echocardiography, daily monitoring of arterial pressure, ultrasonic duplex scanning of the main vessels of head, computer tomography, spine roentgenography, rheoencephalography, and electroencephalography. As a result, they distinguished 14 factors, which influence the development of DE, which describe only 51 % of general dispersion, which is insufficient for correct diagnosis of the disease.

A factor analysis, conducted in [14], enabled the authors to determine the factors of stress formation in students-psychologists. However, these factors may point out to negative influence on the educational process, but it is impossible to reveal the factors, which influence the emotional state and cognitive function, using this method.

Using a factor analysis, in [15] authors conducted a study of emotions in the context of nonverbal communication. In this research, they used the procedure "Experimental assessment of nonverbal behavior of personality". The obtained factors do not allow examining interpersonal relations in married couples; therefore, it is impossible to identify emotional disorders on the background of a family crisis.

With the help of factor analysis in [16], authors carried out psycho-diagnosis of emotional schemes of R. Leahy with the manifestation of psychopathological symptomatology, difficult to adapt strategies of the cognitive regulation of emotions. In the work they used the Russian language version of the questionnaire "Brief version of the scale of emotional schemes of Robert Leahy", procedure "Diagnosis of early desadaptive schemes", and scales of the questionnaire of psychopathological symptomatology (SCL-90-R). Results of the study showed that the scale of emotional schemes correlates with anxiety, depression, interpersonal sensitivity and obsessive-compulsive symptomatology, strategies of cognitive regulation of emotions and early desadaptive schemes, gender special features and age. However these studies did not make it possible to reveal a degree of emotional and cognitive disorders, which subsequently will not allow preventing the appearance of DE.

By using the method of factor analysis, in [17] author showed its effectiveness in studying the influence of "early experience" on the resistance to the emotional stress and revealed differences in the studied groups. The factor model and the interpretation of the distinguished factors, proposed by the author, make it possible to determine the components of endocrine system, influenced by the emotional stress and to identify differentially the factors of environment, which have a selective effect on these components. However, obtained factors do not reveal emotional stress and cognitive disorders in spouses, living in crisis families, thus they do not make it possible to recognize the occurrence and development of DE in due time.

The carried out analysis of data in literature made it possible to reveal scarcity in studying the problems of the DE diagnosis. Factor analysis is actively applied in different fields of medicine and psychology; however, the application of this method for revealing emotional and cognitive disorders, which lead to a crisis in family relations and influence the appearance and the development of DE, was not revealed. Obviously, it is possible to consider that the cause of it may be the existence of actual problems, connected with the construction of a mathematical model of prediction of the crisis development in the family relations. First of all, we imply the problem of multidimensionality of feature space and the need for distinguishing from it of the factors, which are the most essential in terms of informativeness.

3. The aim and tasks of the study

The aim of present work is the detection of latent variables, an analysis of connections between the existing variables, the study of risk factors in the occurrence of crisis in family relations, which can lead to dyscirculatory encephalopathy.

To achieve the set goal, the following tasks were to be solved:

– to build a mathematical model of emerging crisis in family relations;

– to decrease the information space of indicators, used in the study, and to reveal factors, which will make it possible to determine the targets for psycho-correction.

4. Materials and methods of the studies

648 people took part in the study. The tests and questionnaires were divided into five blocks:

– the block of satisfaction with marriage – test "Satisfaction with marriage";

– the block of the family crisis – diagnosis of possible styles of behavior in conflict situations according to Thomas (5 scales), the questionnaire of dispositions to sex (14 scales), the scale of love and sympathy (2 scales), the UEA questionnaire (understanding, emotionalism, authoritativeness) (3 scales);

– the block of psycho-emotional state – the questionnaire of manifestation of the psychopathological symptomatology (11 scales), the scale of psycho-social stress, the hospital scale of anxiety and depression (2 scales);

– personality block – the personality questionnaire of Cattell (16+4 the scales), a way out from difficult life situations, the life style index (8 scales), the level of the subjective control (7 scales);

– the block of self–realization – the self –actualization test (14 scales).

Thus, at the stage of the study, 89 psychological indicators were analyzed: X_1 – rivalry, X_2 – cooperation, X_3 – compromise, X_4 – avoidance, X_5 – adjustment, X_6 – way out from difficult situations, X_7 – understanding, X_8 – emotional attraction, X_9 – authoritativeness, X_{10} – denial, X_{11} – suppression, X_{12} – regression, X_{13} – compensation, X_{14} – projection, X_{15} – replacement, X_{16} – intellectualization, X_{17} – hypercompensation, X_{18} – reserve/amiability, X_{19} – intellect, X_{20} – emotional instability/emotional stability, X_{21} – subordination/dominance, X_{22} – restraint/expressiveness, X_{23} – low normativeness of behavior /high normativeness of behavior, X_{24} – shyness/courage, X_{25} – severity/sensitivity, X_{26} – trustfulness/suspiciousness, X_{27} – practicality/dreaminess, X_{28} – straightforwardness/diplomacy, X_{29} – calmness/anxiety, X_{30} – conservatism/radicalism, X_{31} – conformism/non–conformism, X_{32} – low self-control/high self–control, X_{33} – relaxation/tension, X_{34} – anxiety/adaptability, X_{35} – introversion/extroversion, X_{36} – emotionalism/steadiness, X_{37} – subordination/independence, X_{38} – satisfaction with marriage, X_{39} – permissibility, X_{40} – actualization, X_{41} – sexual neuroticism, X_{42} – impersonal sex, X_{43} – pornography, X_{44} – sexual shyness, X_{45} – chastity, X_{46} – sexual aversion, X_{47} – sexual excitability, X_{48} – physical sex, X_{49} – aggressive sex, X_{50} – sexual libido, X_{51} – sexual satisfaction, X_{52} – masculinity/femininity, X_{53} – competence in time, X_{54} – support scale, X_{55} – value orientations, X_{56} – flexibility of behavior, X_{57} – sensitivity, X_{58} – spontaneity, X_{59} – self–respect, X_{60} – self–acceptance, X_{61} – human nature, X_{62} – synergy, X_{63} – acceptance of aggression, X_{64} –contactness, X_{65} – the scale of cognitive needs, X_{66} – creativity, X_{67} – somatization, X_{68} – obsessive disorder, X_{69} – interpersonal sensitivity, X_{70} – depression, X_{71} – anxiety, X_{72} – hostility, X_{73} – phobia, X_{74} – paranoia, X_{75} – psychotism, X_{76} – additional questions, X_{77} – the level of mental distress, X_{78} – love, X_{79} – sympathy, X_{80} – anxiety, X_{81} – depression, X_{82} – the scale of general internality, X_{83} – internality in the sphere of accomplishment, X_{84} – internality in the sphere of failures, X_{85} – internality in the sphere of family relations, X_{86} – internality in the sphere of interpersonal relations, X_{87} – internality in the sphere of production relations, X_{88} – internality in the sphere of health, X_{89} – psycho-social stress indicators.

5. Results of studies into the factors that influence a crisis development in a family

Before conducting the factor analysis by the correlation matrices, the expediency of using the factor model for investigating the results of the tests and questionnaires was tested. The null hypothesis about the absence of correlations between all indicators was verified with the help of the Bartlett sphericity test. If the probability of such values is lower than the threshold (r=0.05), the null hypothesis should be rejected, that is, conducting the factor analysis is expedient. In our case, the null hypothesis is rejected, since $p<0.001$. For evaluating the significance of the entire Bartlett correlation criterion, improved by Wilkes, was proposed (1).

$$\chi^2 = -\left[n - \frac{1}{6}(2m+5) \times \ln|R| \right], \quad (1)$$

where n is the volume of sample, m is the number of variables, ln is the natural logarithm, |R| is the matrix determinator. The approximate value of statistics χ^2 is equal to 9026.417.

We also used the method of verifying the sample adequacy criterion of Kaiser- Meyer-Olkin (KMO). A factor analysis is expedient when the KMO value exceeds 0.5. The KMO criterion of our sample comprised 0.806 that indicates high adequacy [18].

After verification of hypothesis of expediency of applying the factor model for the data analysis at the following stage, for isolation of the factors, we used the method of the main components (MMC). The sense of the method of the main components is to maximally reduce the number of uniting variables to the most substantially contributing factors.

For the purpose of the best separation of features by the factors, we carried out factor rotation by the varimax method with the Kaiser normalization for the initial factor loads. Thus, 18 factors, that explain 68.340 % of general dispersion of initial features, were obtained.

Validation of the model was conducted with the use of the method of maximum likelihood (MML). Being an iterative process, MML showed convergence for only thirty-six indicators. 53 indicators disrupted stability of MML. The factors, obtained by the MML, proved to be identical to eight factors, obtained with the help of the MMC.

All this makes it possible to assume the existence of the objective nature of the obtained factors and gives specific grounds to use the obtained results for calculating the integral indicator of a crisis in family relations.

Table 1 represents the eigenvalues of the feature correlation matrix, higher that 1, the percentage of general dispersion, explained by each factor and the cumulative sum of percentages, explained by the factors of general dispersion.

Table 1

Eigenvalues of factors

Component	Initial eigenvalues	% of dispersion	Total %
1	6,732	18,699	18,699
2	3,939	10,941	29,640
3	3,009	8,360	38,000
4	2,167	6,020	44,020
5	2,031	5,642	49,661
6	1,485	4,125	53,786
7	1,364	3,789	57,576
8	1,296	3,601	61,177

It follows from results of Table 1 that the number of the chosen factors is equal to 8, and they explain 61.177 % of the general dispersion of initial features.

For checking the selection adequacy of the quantity of factors, we used the so-called Cattell criterion, the idea of which is that on the graph of eigenvalues one should find such a point, where the graph loses its steepness. In Fig.1, it is evident that this is the eighth point.

For the purpose of the best separation of features by the factors, we carried out rotation of factors by the varimax method with the Kaiser normalization for the initial factor loads. Table 2 represents factor loads for eighteen factors. Significant factor loads larger in absolute value than 0.4 are highlighted by medium boldface [7, 18–20].

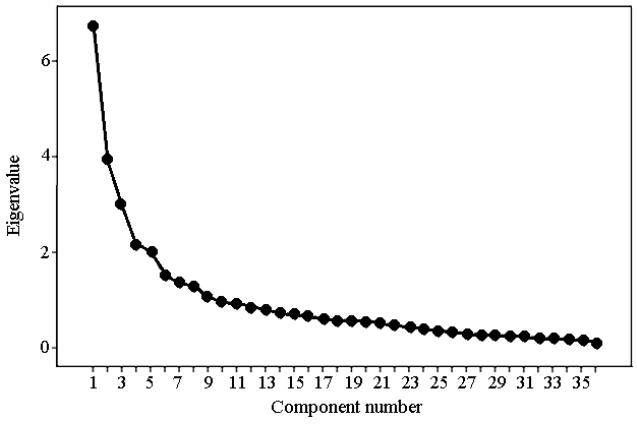

Fig. 1. Graph of eigenvalues

Table 2

Matrix of factor loads, obtained by the normalized varimax rotation method

	Component							
	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8
X_{54}	**0,866**	0,132	0,046	0,056	–0,127	0,082	0,079	0,034
X_{55}	**0,785**	0,038	0,009	0,138	–0,104	0,036	0,002	0,048
X_{59}	**0,748**	0,206	0,074	0,099	–0,117	0,022	0,105	0,151
X_{58}	**0,721**	0,017	–0,012	0,047	0,076	0,045	–0,013	–0,186
X_{63}	**0,668**	0,113	0,173	–0,031	0,019	–0,035	–0,052	–0,061
X_{64}	**0,653**	–0,019	0,053	–0,120	–0,081	0,068	0,012	–0,128
X_{60}	**0,652**	0,250	0,064	0,076	–0,154	–0,019	0,222	0,269
X_{56}	**0,639**	0,151	–0,032	0,050	–0,111	0,151	0,103	0,256
X_{57}	**0,597**	–0,018	0,118	–0,022	0,000	–0,085	–0,126	**–0,449**
X_{66}	**0,593**	0,009	0,026	–0,019	0,020	0,094	–0,219	–0,333
X_{53}	**0,541**	0,074	–0,017	0,078	–0,287	0,147	0,188	0,363
X_{82}	0,185	**0,908**	0,013	0,087	–0,146	–0,101	–0,059	0,020
X_{83}	0,165	**0,885**	–0,010	0,129	–0,079	–0,019	–0,010	0,011
X_{85}	0,103	**0,833**	–0,014	0,076	–0,098	–0,136	–0,069	0,029
X_{87}	0,144	**0,828**	0,040	0,001	–0,148	–0,062	0,003	0,014
X_{86}	–0,003	0,344	0,008	0,140	0,106	0,185	0,075	–0,161
X_{50}	0,079	–0,033	**0,877**	–0,021	0,049	0,190	0,042	–0,005
X_{42}	0,034	–0,055	**0,741**	–0,031	0,082	0,285	0,025	0,030
X_{39}	0,047	0,019	**0,710**	0,054	–0,109	–0,099	0,093	0,106
X_{43}	0,020	0,079	**0,699**	0,064	–0,031	0,105	–0,038	–0,104
X_{52}	0,176	0,010	**0,669**	0,108	–0,014	0,325	–0,099	0,029
X_8	0,051	0,028	–0,080	**0,825**	–0,070	0,043	0,028	–0,113
X_9	0,034	0,060	0,037	**0,771**	–0,005	–0,050	–0,109	0,064
X_{38}	0,086	0,108	0,100	**0,767**	–0,024	0,039	–0,009	0,063
X_7	–0,005	0,108	0,082	**0,590**	–0,102	–0,057	0,060	–0,030
X_{12}	–0,112	–0,132	0,072	–0,090	**0,761**	0,028	0,014	–0,099
X_{13}	–0,193	–0,052	–0,007	0,032	**0,727**	0,097	–0,112	–0,007
X_{15}	0,012	–0,077	0,061	–0,089	**0,683**	–0,091	0,254	–0,024
X_{14}	–0,129	–0,108	–0,227	–0,106	**0,654**	–0,081	0,191	0,128
X_{47}	0,088	0,004	0,386	0,088	–0,030	**0,754**	–0,044	0,001
X_{48}	0,168	–0,023	0,077	–0,008	0,063	**0,752**	–0,093	–0,044
X_{46}	–0,025	0,074	–0,128	–0,037	0,250	**–0,604**	–0,106	–0,081
X_{41}	0,010	–0,109	0,192	–0,210	0,139	**0,507**	0,085	–0,026
X_1	0,030	–0,007	–0,028	–0,095	0,185	0,001	**0,806**	–0,338
X_5	–0,090	0,048	–0,056	–0,042	–0,082	–0,035	**–0,766**	–0,049
X_4	–0,029	–0,054	0,068	–0,043	0,024	–0,021	–0,253	**0,730**
λ^2	5,410	3,371	3,123	2,440	2,411	2,180	1,675	1,422

In each line of the rotated factor matrix, we marked factor loads with the highest absolute value. Their value should be understood as correlation coefficients between the variables and the factors. The first factor is closely connected with variables X_{54}, X_{55}, X_{59}, X_{58}, X_{63}, X_{64}, X_{60}, X_{56}, X_{57}, X_{66}, X_{53}

(corr(F1; X_{54})=0,866, corr(F1; X_{55})=0,785, corr(F1; X_{59})=0,748, corr(F1; X_{58})=0,721, corr(F1; X_{63})=0,668, corr(F1; X_{64})=0,653, corr(F1; X_{60})=0,652, corr(F1; X_{56})=0,639, corr(F1; X_{57})=0,597, corr(F1; X_{66})=0,593, corr(F1; X_{53})=0,541).

The second factor is closely connected with variables X_{82}, X_{83}, X_{85}, X_{87}

(corr(F2; X_{82})=0,908, corr(F2; X_{83})=0,885, corr(F2; X_{85})=0,833, corr(F2; X_{87})=0,828).

The third factor is closely connected with variables X_{50}, X_{42}, X_{39}, X_{43}, X_{52}

(corr(F3; X_{50})=0,877,corr(F3; X_{42})=0,741, corr(F3; X_{39})=0,710, corr(F3; X_{43})=0,699, corr(F3; X_{52})=0,669).

The fourth factor is closely connected with variables X_8, X_9, X_{38}, X_7

(corr(F4; X_8)=0,825, corr(F4; X_9)=0,771, corr(F4; X_{38})=0,767, corr(F4; X_7)=0,590).

The fifth factor is closely connected with variables X_{12}, X_{13}, X_{15}, X_{14}

(corr(F5; X_{12})=0,761, corr(F5; X_{13})=0,727, corr(F5; X_{15})=0,683, corr(F5; X_{14})=0,654).

The sixth factor is closely connected with variables X_{47}, X_{48}, X_{46}, X_{41}

(corr(F6; X_{47})=0,754, corr(F6; X_{48})=0,752, corr(F6; X_{46})=–0,604, corr(F6; X_{41})=0,507).

The seventh factor is closely connected with variables X_1, X_5

(corr(F7; X_1)=0,806, corr(F7; X_5)=–0,766).

The eighth factor is closely connected with variables X_4, X_{57} (corr(F8; X_4)=0,730, corr(F8; X_5)=–0,449).

Factor loads made it possible to determine what part of the total dispersion of variables is explained by each factor Fi (λ_i^2). For this purpose, the eigenvalues were calculated (2):

$$\lambda_i^2 = \sum_{j=1}^{m} a_{ji}^2, \quad (2)$$

where a is the factor loads, m is the number of variables; after dividing the eigenvalues of factors by number m, we will obtain the portion of the total dispersion of variables, explained by each general factor, and will be able to estimate their relative significance [21, 22]. Table 2 represents obtained values λ_i^2.

In fact, each factor represents a new latent variable, which integrates in itself the information of several primary indicators and may be calculated for further use.

Graphic visualization of belonging of the output factors to the specific main component is provided by the construction of a three-dimensional diagram of factor loads of the main components (Fig. 2).

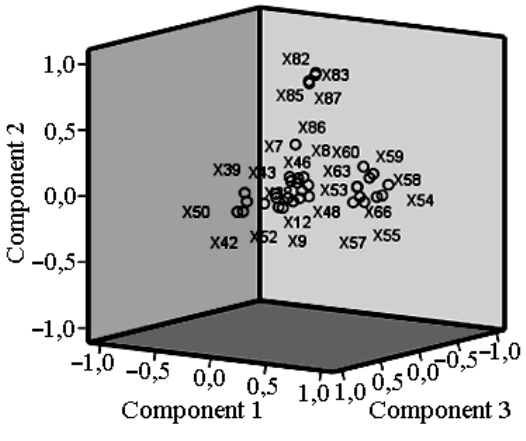

Fig. 2. Diagram of component in the rotatable space

A model of component analysis (3) indicates that it is possible to describe any value Z_j by the combination of main components F_i in the form [18, 23]:

$$Z_j = a_1F_1 + a_2F_2 + ... + a_{nj}F_n, \quad (3)$$

where $F_{1,...,}F_n$ is the main component, a_{ij} is the weight of *i*th main component in jth variable. Therefore, linear equations of dependent factors Z_j and main components F_n will take the form:

$$Z_1 = 0,866F_1 + 0,132F_2 + 0,046F_3 + 0,056F_4 - \\ -0,127F_5 + 0,082F_6 + 0,079F_7 + 0,034F_8,$$

$$Z_2 = 0,785F_1 + 0,038F_2 + 0,009F_3 + 0,138F_4 - \\ -0,104F_5 + 0,036F_6 + 0,002F_7 + 0,048F_8,$$

$$Z_3 = 0,748F_1 + 0,206F_2 + 0,074F_3 + 0,099F_4 - \\ -0,117F_5 + 0,022F_6 + 0,105F_7 + 0,151F_8,$$

$$Z_4 = 0,721F_1 + 0,017F_2 - 0,012F_3 + 0,047F_4 + \\ +0,076F_5 + 0,045F_6 - 0,013F_7 - 0,186F_8,$$

$$Z_5 = 0,668F_1 + 0,113F_2 + 0,173F_3 - 0,031F_4 + \\ +0,019F_5 - 0,035F_6 - 0,052F_7 - 0,061F_8,$$

$$Z_6 = 0,653F_1 - 0,019F_2 + 0,053F_3 - 0,120F_4 - \\ -0,081F_5 + 0,068F_6 + 0,012F_7 - 0,128F_8,$$

$$Z_7 = 0,652F_1 + 0,250F_2 + 0,064F_3 + 0,076F_4 - \\ -0,154F_5 - 0,019F_6 + 0,222F_7 + 0,269F_8,$$

$$Z_8 = 0,639F_1 + 0,151F_2 - 0,032F_3 + 0,050F_4 - \\ -0,111F_5 + 0,151F_6 + 0,103F_7 + 0,256F_8,$$

$$Z_9 = 0,597F_1 - 0,018F_2 + 0,118F_3 - 0,022F_4 + \\ +0,000F_5 - 0,085F_6 - 0,126F_7 - 0,449F_8,$$

$$Z_{10} = 0,593F_1 + 0,009F_2 + 0,026F_3 - 0,019F_4 + \\ +0,020F_5 + 0,094F_6 - 0,219F_7 - 0,333F_8,$$

$$Z_{11} = 0,541F_1 + 0,074F_2 - 0,017F_3 + 0,078F_4 - \\ -0,287F_5 + 0,147F_6 + 0,188F_7 + 0,363F_8,$$

$$Z_{12} = 0,185F_1 + 0,908F_2 + 0,013F_3 + 0,087F_4 - \\ -0,146F_5 - 0,101F_6 - 0,059F_7 + 0,020F_8,$$

$$Z_{13} = 0,165F_1 + 0,885F_2 - 0,010F_3 + 0,129F_4 - \\ -0,079F_5 - 0,019F_6 - 0,010F_7 + 0,011F_8,$$

$$Z_{14} = 0,103F_1 + 0,833F_2 - 0,014F_3 + 0,076F_4 - \\ -0,098F_5 - 0,136F_6 - 0,069F_7 + 0,029F_8,$$

$$Z_{15} = 0,144F_1 + 0,828F_2 + 0,040F_3 + 0,001F_4 - \\ -0,148F_5 - 0,062F_6 + 0,003F_7 + 0,014F_8,$$

$$Z_{16} = -0,003F_1 + 0,344F_2 + 0,008F_3 + 0,140F_4 + \\ +0,106F_5 + 0,185F_6 + 0,075F_7 - 0,161F_8,$$

$$Z_{17} = 0,079F_1 - 0,033F_2 + 0,877F_3 - 0,021F_4 + \\ +0,049F_5 + 0,190F_6 + 0,042F_7 - 0,005F_8,$$

$$Z_{18} = 0,034F_1 - 0,055F_2 + 0,741F_3 - 0,031F_4 + \\ +0,082F_5 + 0,285F_6 + 0,025F_7 + 0,030F_8,$$

$$Z_{19} = 0,047F_1 + 0,019F_2 + 0,710F_3 + 0,054F_4 - \\ -0,109F_5 - 0,099F_6 + 0,093F_7 + 0,106F_8,$$

$$Z_{20} = 0,020F_1 + 0,079F_2 + 0,699F_3 + 0,064F_4 - \\ -0,031F_5 + 0,105F_6 - 0,038F_7 - 0,104F_8,$$

$$Z_{21} = 0,176F_1 + 0,010F_2 + 0,669F_3 + 0,108F_4 - \\ -0,014F_5 + 0,325F_6 - 0,099F_7 + 0,029F_8,$$

$$Z_{22} = 0,051F_1 + 0,028F_2 - 0,080F_3 + 0,825F_4 - \\ -0,070F_5 + 0,043F_6 + 0,028F_7 - 0,113F_8,$$

$$Z_{23} = 0,034F_1 + 0,060F_2 + 0,037F_3 + 0,771F_4 - \\ -0,005F_5 - 0,050F_6 - 0,109F_7 + 0,064F_8,$$

$$Z_{24}=0,086F_1+0,108F_2+0,100F_3+0,767F_4-$$
$$-0,024F_5+0,039F_6-0,009F_7+0,063F_8,$$

$$Z_{25}=-0,005F_1+0,108F_2+0,082F_3+0,590F_4-$$
$$-0,102F_5-0,057F_6+0,060F_7-0,030F_8,$$

$$Z_{26}=-0,112F_1-0,132F_2+0,072F_3-0,090F_4+$$
$$+0,761F_5+0,028F_6+0,014F_7-0,099F_8,$$

$$Z_{27}=-0,193F_1-0,052F_2-0,007F_3+0,032F_4+$$
$$+0,727F_5+0,097F_6-0,112F_7-0,007F_8,$$

$$Z_{28}=0,012F_1-0,077F_2+0,061F_3-0,089F_4+$$
$$+0,683F_5-0,091F_6+0,254F_7-0,024F_8,$$

$$Z_{29}=-0,129F_1-0,108F_2-0,227F_3-0,106F_4+$$
$$+0,654F_5-0,081F_6+0,191F_7+0,128F_8,$$

$$Z_{30}=0,088F_1+0,004F_2+0,386F_3+0,088F_4-$$
$$\_0,030F_5+0,754F_6-0,044F_7+0,001F_8,$$

$$Z_{31}=0,168F_1-0,023F_2+0,077F_3-0,008F_4+$$
$$+0,063F_5+0,752F_6-0,093F_7-0,044F_8,$$

$$Z_{32}=-0,025F_1+0,074F_2-0,128F_3-0,037F_4+$$
$$+0,250F_5-0,604F_6-0,106F_7-0,081F_8,$$

$$Z_{33}=0,010F_1-0,109F_2+0,192F_3-0,210F_4+$$
$$+0,139F_5+0,507F_6+0,085F_7-0,026F_8,$$

$$Z_{34}=0,030F_1-0,007F_2-0,028F_3-0,095F_4+$$
$$+0,185F_5+0,001F_6+0,806F_7-0,338F_8,$$

$$Z_{35}=-0,090F_1+0,048F_2-0,056F_3-0,042F_4-$$
$$-0,082F_5-0,035F_6-0,766F_7-0,049F_8,$$

$$Z_{36}=-0,029F_1-0,054F_2+0,068F_3-0,043F_4+$$
$$+0,024F_5-0,021F_6-0,253F_7+0,730F_8.$$

Main components F_n (4) are the dimensionless variables, uncorrelated between themselves, which present a linear combination of n-variables [18, 23]:

$$F_i=\frac{1}{\lambda_i}\left(a_{i1}Z_1+a_{i2}Z_2+...+a_{in}Z_n\right). \quad (4)$$

A dependence of values of the main components on the values of dependent indicators takes the following form:

$$F_1=\frac{1}{6,732}\begin{pmatrix}0,866Z_1+0,785Z_2+0,748Z_3+0,721Z_4+\\+0,668Z_5+0,653Z_6+0,652Z_7+0,639Z_8+\\+0,597Z_9+0,593Z_{10}+0,541Z_{11}+0,185Z_{12}+\\+0,165Z_{13}+0,103Z_{14}+0,144Z_{15}-0,003Z_{16}+\\+0,079Z_{17}+0,034Z_{18}+0,047Z_{19}+0,020Z_{20}+\\+0,176Z_{21}+0,051Z_{22}+0,034Z_{23}+0,086Z_{24}-\\-0,005Z_{25}-0,112Z_{26}-0,193Z_{27}+0,012Z_{28}-\\-0,129Z_{29}+0,088Z_{30}+0,168Z_{31}-0,025Z_{32}+\\+0,010Z_{33}+0,030Z_{34}-0,090Z_{35}+0,029Z_{36}\end{pmatrix},$$

$$F_2=\frac{1}{3,939}\begin{pmatrix}0,132Z_1+0,038Z_2+0,206Z_3+0,017Z_4+\\+0,113Z_5-0,019Z_6+0,250Z_7+0,151Z_8-\\-0,018Z_9+0,009Z_{10}+0,074Z_{11}+0,908Z_{12}+\\+0,885Z_{13}+0,833Z_{14}+0,828Z_{15}+0,344Z_{16}-\\-0,033Z_{17}-0,055Z_{18}+0,019Z_{19}+0,079Z_{20}+\\+0,010Z_{21}+0,028Z_{22}+0,060Z_{23}+0,108Z_{24}+\\+0,108Z_{25}-0,132Z_{26}-0,052Z_{27}-0,077Z_{28}-\\-0,108Z_{29}+0,004Z_{30}-0,023Z_{31}-0,074Z_{32}-\\-0,109Z_{33}-0,007Z_{34}+0,048Z_{35}-0,054Z_{36}\end{pmatrix},$$

$$F_3=\frac{1}{3,009}\begin{pmatrix}0,046Z_1+0,009Z_2+0,074Z_3-0,012Z_4+\\+0,173Z_5+0,053Z_6+0,064Z_7-0,032Z_8+\\+0,118Z_9+0,026Z_{10}-0,017Z_{11}+0,013Z_{12}-\\-0,010Z_{13}-0,014Z_{14}+0,040Z_{15}+0,008Z_{16}+\\+0,877Z_{17}+0,741Z_{18}+0,710Z_{19}+0,699Z_{20}+\\+0,669Z_{21}-0,080Z_{22}+0,037Z_{23}+0,100Z_{24}+\\+0,082Z_{25}+0,072Z_{26}-0,007Z_{27}+0,061Z_{28}-\\-0,227Z_{29}+0,386Z_{30}+0,077Z_{31}-0,128Z_{32}+\\+0,192Z_{33}-0,028Z_{34}-0,056Z_{35}+0,068Z_{36}\end{pmatrix},$$

$$F_4=\frac{1}{2,167}\begin{pmatrix}0,056Z_1+0,138Z_2+0,099Z_3+0,047Z_4-\\-0,031Z_5-0,120Z_6+0,076Z_7+0,050Z_8-\\-0,022Z_9-0,019Z_{10}+0,078Z_{11}+0,087Z_{12}+\\+0,129Z_{13}+0,076Z_{14}+0,001Z_{15}+0,140Z_{16}-\\-0,021Z_{17}-0,031Z_{18}+0,054Z_{19}+0,064Z_{20}+\\+0,108Z_{21}+0,825Z_{22}+0,771Z_{23}+0,767Z_{24}+\\+0,590Z_{25}-0,090Z_{26}+0,032Z_{27}-0,089Z_{28}-\\-0,106Z_{29}+0,088Z_{30}-0,008Z_{31}-0,037Z_{32}-\\-0,210Z_{33}-0,095Z_{34}-0,042Z_{35}-0,043Z_{36}\end{pmatrix},$$

$$F_5=\frac{1}{2,031}\begin{pmatrix}-0,127Z_1-0,104Z_2-0,117Z_3+0,076Z_4+\\+0,019Z_5-0,081Z_6-0,157Z_7-0,111Z_8+\\+0,000Z_9+0,020Z_{10}-0,287Z_{11}-0,146Z_{12}-\\-0,079Z_{13}-0,098Z_{14}-0,148Z_{15}+0,106Z_{16}+\\+0,049Z_{17}+0,082Z_{18}-0,109Z_{19}-0,031Z_{20}-\\-0,014Z_{21}-0,070Z_{22}-0,005Z_{23}-0,024Z_{24}-\\-0,102Z_{25}+0,761Z_{26}+0,727Z_{27}+0,683Z_{28}+\\+0,654Z_{29}-0,030Z_{30}+0,063Z_{31}+0,025Z_{32}+\\+0,139Z_{33}+0,185Z_{34}-0,082Z_{35}+0,024Z_{36}\end{pmatrix},$$

$$F_6 = \frac{1}{1{,}485}\begin{pmatrix} 0{,}082Z_1 + 0{,}036Z_2 + 0{,}022Z_3 + 0{,}045Z_4 - \\ -0{,}035Z_5 + 0{,}068Z_6 - 0{,}019Z_7 + 0{,}151Z_8 - \\ -0{,}085Z_9 + 0{,}094Z_{10} + 0{,}147Z_{11} - 0{,}101Z_{12} - \\ -0{,}019Z_{13} - 0{,}136Z_{14} - 0{,}062Z_{15} + 0{,}185Z_{16} + \\ +0{,}190Z_{17} + 0{,}285Z_{18} - 0{,}099Z_{19} + 0{,}105Z_{20} + \\ +0{,}325Z_{21} + 0{,}043Z_{22} - 0{,}050Z_{23} + 0{,}039Z_{24} - \\ -0{,}057Z_{25} + 0{,}028Z_{26} + 0{,}097Z_{27} - 0{,}091Z_{28} - \\ -0{,}081Z_{29} + 0{,}754Z_{30} + 0{,}752Z_{31} - 0{,}604Z_{32} + \\ +0{,}507Z_{33} + 0{,}001Z_{34} - 0{,}035Z_{35} - 0{,}021Z_{36} \end{pmatrix},$$

$$F_7 = \frac{1}{1{,}364}\begin{pmatrix} 0{,}079Z_1 + 0{,}002Z_2 + 0{,}105Z_3 - 0{,}013Z_4 - \\ -0{,}052Z_5 + 0{,}012Z_6 + 0{,}222Z_7 + 0{,}103Z_8 - \\ -0{,}126Z_9 - 0{,}219Z_{10} + 0{,}188Z_{11} - 0{,}059Z_{12} - \\ -0{,}010Z_{13} - 0{,}069Z_{14} + 0{,}003Z_{15} + 0{,}075Z_{16} + \\ +0{,}042Z_{17} + 0{,}025Z_{18} + 0{,}093Z_{19} - 0{,}038Z_{20} - \\ -0{,}099Z_{21} + 0{,}028Z_{22} - 0{,}109Z_{23} - 0{,}009Z_{24} + \\ +0{,}060Z_{25} + 0{,}014Z_{26} - 0{,}112Z_{27} + 0{,}254Z_{28} + \\ +0{,}191Z_{29} - 0{,}044Z_{30} - 0{,}093Z_{31} - 0{,}106Z_{32} + \\ +0{,}085Z_{33} + 0{,}806Z_{34} - 0{,}766Z_{35} - 0{,}253Z_{36} \end{pmatrix},$$

$$F_8 = \frac{1}{1{,}296}\begin{pmatrix} 0{,}034Z_1 + 0{,}048Z_2 + 0{,}151Z_3 - 0{,}186Z_4 - \\ -0{,}061Z_5 - 0{,}128Z_6 + 0{,}269Z_7 + 0{,}256Z_8 - \\ -0{,}449Z_9 - 0{,}333Z_{10} + 0{,}363Z_{11} + 0{,}020Z_{12} + \\ +0{,}011Z_{13} + 0{,}029Z_{14} + 0{,}014Z_{15} - 0{,}161Z_{16} - \\ -0{,}005Z_{17} + 0{,}030Z_{18} + 0{,}106Z_{19} - 0{,}104Z_{20} + \\ +0{,}029Z_{21} - 0{,}113Z_{22} + 0{,}064Z_{23} + 0{,}063Z_{24} - \\ -0{,}030Z_{25} - 0{,}099Z_{26} - 0{,}007Z_{27} - 0{,}024Z_{28} + \\ +0{,}128Z_{29} + 0{,}001Z_{30} - 0{,}044Z_{31} - 0{,}081Z_{32} - \\ -0{,}026Z_{33} - 0{,}338Z_{34} - 0{,}049Z_{35} + 0{,}730Z_{36} \end{pmatrix}.$$

Using the values of indicator reliability, we determined dispersions of all variables, explained by all factors at once (Table 3).

Table 3

Dispersions of variables, explained by the obtained factors

Variable	Initial	Extraction	Variable	Initial	Extraction
X_{54}	1,000	0,803	X_{43}	1,000	0,524
X_{55}	1,000	0,651	X_{52}	1,000	0,606
X_{58}	1,000	0,565	X_{38}	1,000	0,624
X_{59}	1,000	0,665	X_{39}	1,000	0,551
X_{60}	1,000	0,644	X_7	1,000	0,385
X_{63}	1,000	0,497	X_8	1,000	0,711
X_{64}	1,000	0,471	X_9	1,000	0,619
X_{66}	1,000	0,521	X_{12}	1,000	0,633
X_{53}	1,000	0,575	X_{13}	1,000	0,591
X_{56}	1,000	0,546	X_{14}	1,000	0,578
X_{57}	1,000	0,595	X_{15}	1,000	0,558
X_{82}	1,000	0,901	X_{41}	1,000	0,377
X_{83}	1,000	0,835	X_{46}	1,000	0,469
X_{85}	1,000	0,743	X_{47}	1,000	0,735
X_{86}	1,000	0,214	X_{48}	1,000	0,615
X_{87}	1,000	0,734	X_1	1,000	0,808
X_{42}	1,000	0,643	X_4	1,000	0,608
X_{50}	1,000	0,817	X_5	1,000	0,612

The following indicators are mostly explained by the extracted factors: general internality (X_{82}) – 90.1 %; support scale (X_{54}) – 80.3 %; sexual libido (X_{50}) – 81.7 %; rivalry (X_1) – 80.8 %. The following indicators have the smallest explained dispersion: internality of interpersonal relations (X_{86}) – 21.4 %; understanding (X_7) – 38.5 %; sexual neuroticism (X_{41}) – 37.7 %.

6. Discussion of risk factors of crisis development in a family, which contribute to the occurrence and development of dyscirculatory encephalopathy

The model of main components, constructed in the process of experiment, made it possible to transform an 89-dimensional exponential space into an eight– dimensional space of the united factors. The factors obtained affect the development of cerebrovascular disorders and explain 61.177 % of general dispersion.

The formed factors made it possible to reveal the reasons, which influence the crisis development in relations between spouses, which, undoubtedly, contributes to the development of DE.

As we can see, the first factor "Self-actualization" explains 18.699 % of the general dispersion.

The second factor "Internality" explains 10.941 % of the general dispersion.

The third factor "Sexual liberation" explains 8.360 % of the general dispersion.

The fourth factor "Family relations" explains 6.020 % of the general dispersion.

The fifth factor "Psychological protection" explains 5.642 % of the general dispersion.

The sixth factor "Sex relations" explains 4.125 % of the general dispersion.

The seventh factor "Behavior during a conflict" explains 3.789 % of the general dispersion.

The eighth factor "Sensitivity, avoidance" explains 3.601 % of the general dispersion.

These factors allowed the estimation of the crisis probability on the basis of determination of different psychological indicators of a family. The timely detection of the factors, which determine the crisis probability in family relations, will make it possible to forecast the occurrence and development of DE, which leads to infarctions and strokes of the brain.

The results, obtained in this study may be useful for neuropathists, psychiatrists and psychologists, who work with the crisis families, as well as for specialists in the field of mathematical simulation of processes, which may be determined as "weakly formalized".

The simulation of diagnostic process is exceptionally important both for the support of clinical solutions and for performing psycho-correction work. The developed mathematical model makes it possible to create optimum psycho-diagnostic set of instruments and to develop the system of psycho-correction, directed toward the personal growth, positive psycho-emotional state, mental and somatic health, which contributes to the prevention of appearance and development of DE.

The next stages of our study imply:

– developing a special program of psycho-correction, the purpose of which is: primary removal of negative psycho-emotional states, further work with personal specific

features of the subjects, who provoke family crisis, emotional, cognitive and somatic disorders;

– conducting control analysis after psycho-correction work of the groups of those tested, who participated in psycho-correction measures and those, who refused to work with a psychologist;

– further processing and analyzing the results of the study, determining the significance of differences in the indicators of the compared groups and the determination of effectiveness of correction program for its introduction to medical practice.

7. Conclusions

1. We built a mathematical model, which makes it possible to predict a crisis development in family relations, personal growth and self-actualization or disadaptation, disorders of psycho-emotional state, mental and somatic disorders, which lead to DE. It was shown that a similar approach to mathematical modeling of the process, which may be defined as "weakly formalized", makes it possible to determine the factors and criteria of forecasting a family crisis, somatic and psychological disorders, to identify psycho-correction targets and, as a result, to develop a psycho-correction system, directed toward personal growth, positive psycho-emotional state, mental and somatic health, to prevent the occurrence and/or development of DE.

2. The information feature space, used in the study, was decreased; the basic factors, which explain personal growth of a patient under conditions of family crisis or lead to mental disadaptation and destructive reaction, mental and/or somatical disorders, were revealed. A procedure for the extraction of main components, used in this case, confirmed validity of the hypothesis on the possibility of identifying the features, most essential in terms of informativeness, without substantial worsening of accuracy of determining the disorders of psycho-emotional state, mental and somatic disorders, which lead to cerebrovascular disorders, in particular, DE.

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Розглянуто задачу формування портфеля цінних паперів. За результатами аналізу відомих підходів до розвязання задачі запропонована математична модель, в якій параметри задачі задані нечітко. Задача формування портфеля вирішена в припущенні про найгіршу щільність розподілу випадкових значень вартостей активів. Запропонований метод відшукування найгіршої щільності розподілу для випадку, коли математичне очікування і дисперсія випадкової вартості задані нечіткими числами. Обгрунтований вибір раціонального значення математичного очікування доходності портфеля

Ключові слова: портфель цінних паперів, нечіткі вартості активів, мінімаксна модель, імовірнісний дробово-лінійний крітерій

Рассмотрена задача формирования портфеля ценных бумаг. По результатам анализа известных подходов к решению задачи предложена математическая модель, в которой параметры задачи заданы нечетко. Задача формирования портфеля решена в предположении о наихудшей плотности распределения случайных значений стоимостей активов. Предложен метод отыскания наихудшей плотности распределения для случая, когда математическое ожидание и дисперсия случайной стоимости заданы нечеткими числами. Обоснован выбор рационального значения математического ожидания доходности портфеля

Ключевые слова: портфель ценных бумаг, нечеткие стоимости активов, минимаксная модель, вероятностный дробно-линейный критерий

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FORMATION OF SECURITIES PORTFOLIO UNDER CONDITIONS OF UNCERTAINTY

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1. Introduction

The task on the formation of securities portfolio belongs to a broad class of problems on rational allocation of resources [1–4]. A mathematical statement of similar tasks leads to the standard technique: to find a set of variables that assigns the required allocation of resources, which renders an extreme value to nonlinear criterion and satisfies linear constraints. Problems of this type are solved by the known methods of mathematical programming [4–6]. A specific character of the resource allocation problems in contemporary setting manifests itself in taking into account the uncertain character of initial data. Traditional approaches to the statement and solution of such problems employ the theoretical and probabilistic interpretation of uncertainty in the parameters of the problem, which leads to the models