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MANAGEMENT AND  
SCIENTIFIC  
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## THE CONCEPT OF LIQUIDITY AND SOLVENCY MANAGEMENT OF AN AGRICULTURAL ORGANIZATION

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**Abstract.** *The globalization of capital markets and the imposition of economic sanctions, the improvement of production and information technologies, and innovations in resource management make it increasingly difficult for market actors to carry out normal business activities, to purchase inventories, to ensure the continuity of the production process, and to carry out timely settlements with their counterparties. This requires a complete restructuring of the management process, the development of effective financial technologies for business management, allowing the owners of the organization to ensure the prompt adaptation of the organizational mechanism to changing economic conditions. One of these technologies can be the organization and construction of an effective management system aimed at monitoring and strengthening the liquidity and solvency of the enterprise.*

**Keywords:** *Liquidity, solvency, asset liquidity, enterprise liquidity, cash flow, liquidity ratios, solvency ratio analysis, liquidity and solvency management concept.*

Modern business conditions dictate to an economic entity the need to possess a certain value potential in order to be able to instantly pay off the payment claims of potential counterparties, that is, in other words, to have the necessary liquid funds for this, the presence and condition of which will allow the entity to count on ensuring the conditions for the timely fulfillment of all their monetary obligations.

The general criterion characteristic of the presence of such a value potential in a market entity is liquidity, which serves as a prerequisite for the emergence of the organization's solvency. In the economic literature there are many scientific studies devoted to the study of liquidity analysis and management of the organization's solvency.

The usual approach to liquidity of an enterprise is to demonstrate its



ability to pay its current obligations at any time, and to solvency - the ability to timely pay off its short-term and long-term obligations.

The liquidity of an enterprise is judged by its balance sheet data. The liquidity of an enterprise can be different, since the composition of current assets includes heterogeneous circulating assets, characterized by varying degrees of liquidity to pay off short-term debt [5, p. 168]. The key characteristic of liquidity is the prevalence of the cost of the company's working capital over short-term liabilities [4, p. 136].

The assessment of solvency is carried out on the basis of an analysis of the liquidity of the organization's current assets, that is, their ability to turn into cash [8, p. 220; 9, p. 38]. An enterprise is considered solvent if the sum of current assets (stocks, cash, accounts receivable and other assets) is greater than or equal to its external debt (liabilities) [10, p. 583].

A.I. Doroshchuk writes that the terms "liquidity" and "solvency" are close in terms of their economic content. In the literature, when defining these categories, there are often such opposite judgments as liquidity is solvency, and vice versa, solvency is liquidity [3, p. 112].

The research carried out allows us to generalize the following conclusions and give the author's definition of the terms under study. Solvency and liquidity are independent economic categories, to a certain extent interconnected, but studied and evaluated in the practice of financial analysis and financial management on the basis of various methodological approaches.

**Liquidity** serves as an integral essential property of any object and means its ability to be sold at market value without significant losses for the shortest possible economically justified period for this object.

Liquidity of an individual, enterprise, bank, state, international liquidity, market liquidity, asset liquidity, liquidity level are distinguished [1, p. 551]. The liquidity level reflects an integrated comprehensive assessment of the property's ability to be sold on the market in the current specific conditions.

**Solvency** is considered in relation to the subject of the market - the solvency of the state, bank, enterprise, individual. It reflects the state of the subject, which is characterized by sufficient resistance to the claims of creditors in a dynamically changing market environment and testifies to the high viability of the subject.

The main difference between solvency and liquidity is as follows: as an economic category, solvency is a much broader and more diverse phenomenon, since it reflects not only the static ability to repay current obligations, but also allows you to track how this ability changes and will change over a long time period. In other words, liquidity, in its economic essence,

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reflects the static state of assets (the enterprise), the solvency of the enterprise acts as both a static and a dynamic phenomenon. The process of conducting analysis of liquidity and solvency also has a number of distinctive features:

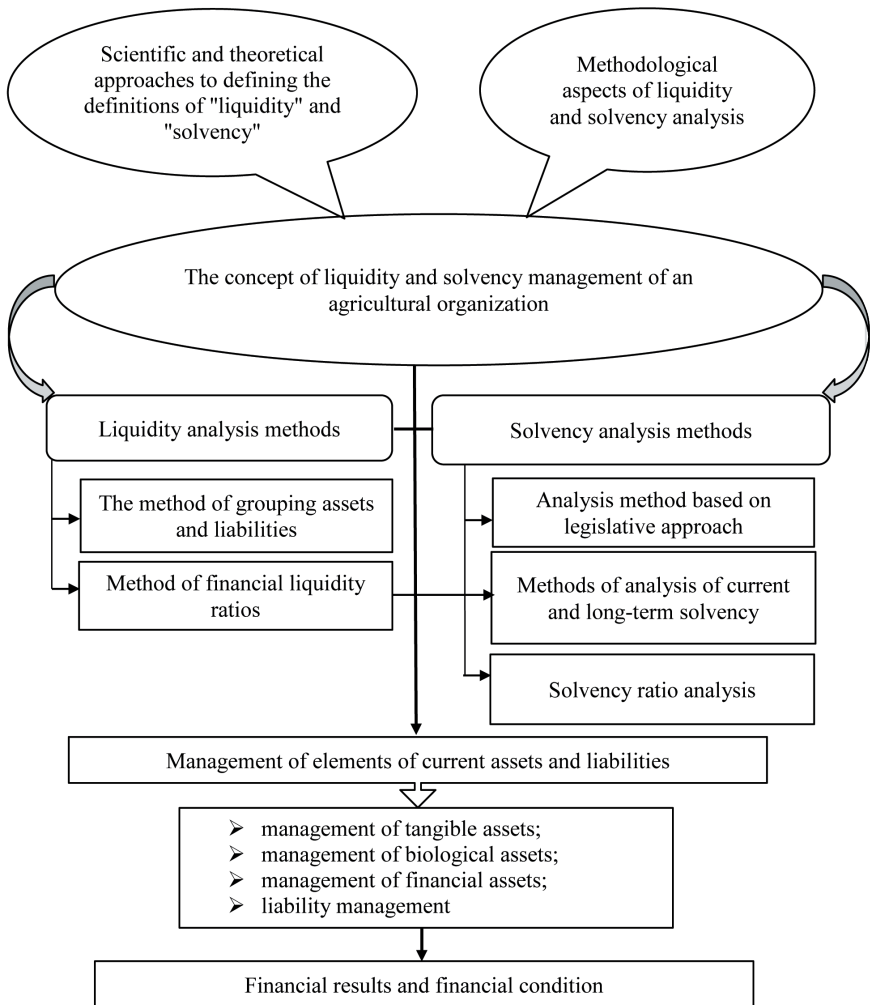
- when assessing liquidity, the relationship is analyzed for certain groups of assets and liabilities; when assessing solvency, cash inflows and outflows are assessed, and the company's ability to generate cash flows is determined;

- in the process of analysis, liquidity ratios give the primary characteristic of solvency, which is further supplemented by the calculation of indicators of cash flows and self-financing;

- to analyze liquidity, an information base in the form of a balance sheet is sufficient; to assess the solvency, the data of the statement of financial results, the statement of cash flows and explanations to the balance sheet and the statement of financial results are additionally required.

In our opinion, the general view of the logical scheme for the formation of the concept of liquidity and solvency management of an organization can be presented as follows (figure).

The study of theoretical approaches allows you to systematize the categorical and terminological apparatus and identify the economic essence of the studied scientific objects, determine the classification features and highlight their types, highlight the relationship between economic categories, and provide an information base for scientific research. Methodological aspects are aimed at disclosing the techniques and methods for studying liquidity and solvency, systematizing the necessary economic indicators, highlighting the approaches to analytical procedures existing in the literature, their critical understanding and the need to apply them in the analysis of the activities of an agricultural organization.



**Figure. The author's approach to the concept of liquidity and solvency management of an agricultural organization**

The practice in this concept represents a set of methods for analyzing liquidity and solvency, which are the main policy instruments for managing current assets and liabilities in order to improve the financial results of business and strengthen the financial condition of the entity.

The process of managing the liquidity and solvency of the organization is based on the methods of economic analysis of indicators that reflect the composition and structure of current assets and liabilities, the composition and structure of the company's cash flows. The main methods for analyzing indicators are statistical methods (summary, grouping, series of dynamics, average values); methods of complex economic analysis (vertical, comparative, financial ratios, factorial).

The results of the analysis of liquidity and solvency make it possible to identify problem areas of the functioning of circulating assets and liabilities at the enterprise and to develop management measures to improve the policy for managing borrowed funds and individual elements of circulating assets (material, biological, financial).

The goal of managing the liquidity and solvency of an agricultural organization is to ensure the optimal size and structure of current assets, the implementation of an uninterrupted and rhythmic production process, the timely fulfillment of its payment obligations, which ultimately is designed to help generate business profitability and strengthen the financial condition of the enterprise in the market.

There are various criteria for the analysis of the financial condition of enterprises, in the aggregate, allowing the generalizing integral assessment to define it as excellent, good, satisfactory, unsatisfactory, critical [2, p. 27]. In the generalizing assessment, the most important role is assigned to the liquidity ratios, the availability of own circulating assets, the circulating assets turnover, which determines the paramount importance and significance of developing a competent and balanced policy for managing current assets and liabilities at the enterprise.

The current asset management policy, as an integral part of the company's overall financial policy, consists in the formation of the required volume and composition of circulating assets, optimization of their structure and funding sources [6, p. 464]. Management of current assets and the sources of their formation belongs to the area of current (operational) decisions of the company. The result of a thoughtful and effective management of circulating assets and sources of their financing is a good financial condition of the company, characterized by liquidity, financial stability and growing business activity [11, p. 131].

For a comprehensive analysis of the liquidity and solvency of agricultural organizations, we suggest using the following system of financial ratios (table).

**Table. The author's approach to the system of indicators for analyzing liquidity and solvency of an agricultural organization**

Indicators	Calculation method	Normative boundaries
<b>Liquidity</b>		
Coefficient of the material liquidity	$C_{ML} = \frac{MCA}{CL}$	0,51 – 3,0
Coefficient of biological liquidity	$C_{BL} = \frac{BCA}{CL}$	0,51 – 3,0
Coefficient of financial liquidity	$C_{FL} = \frac{FCA}{CL}$	0,21 – 2,0
Coefficient of total liquidity	$C_{TL} = \frac{MCA + BCA + FCA}{CL + LTL}$	1,1 – 5,0
Coefficient of provision with own circulating assets	$C_{OWC} = \frac{OWC}{CA}$	0,4 – 0,6
<b>Solvency</b>		
Coefficient of general solvency	$C_{GS} = \frac{A}{CL + LTL}$	2,0 – 4,0
Degree of solvency for current liabilities	$D_{Sol} = \frac{CL}{R_{Mon}}$	< 3,0
Proceeds quality indicator	$Q_{Proc} = \frac{CR_{Sales}}{P}$	> 0,9
Coefficient of NCF sufficiency	$C_{NCF} = \frac{NCFC}{PLB + \Delta Res + Div}$	> 0,5
Beaver's coefficient	$C_{Beav} = \frac{NP + Dep}{BC_{Av}}$	0,6 – 0,8
<b>Asset efficiency</b>		
Capital return indicator of current assets	$C_C = \frac{I}{CA_{Av}}$	1,5 – 2,5
Return on assets indicator	$R_A = \frac{NP}{A_{Av}}$	≈ 10

where MCA, BCA, FCA – material, biological, financial current assets, rub.; CL, LTL – current, long-term liabilities, rub.; A – assets, rub.;  $R_{Mon}$  – average monthly revenue, rub.; OWC – own working capital, rub.; CA – current assets, rub.;  $CR_{Sales}$  – cash receipts from the sale of products (works, services), rub.; P – proceeds, rub.; NCFC – net cash flow from current activities, rub.; PLB – payments on loans and borrowings, rub.;  $\Delta Res$  – increase in reserves, rub.; Div – payment of dividends, rub.; NP – net profit, rub.; Dep – depreciation for the period, rub.;  $BC_{Av}$  – borrowed capital in average annual estimate, rub.; I – income, rub.;  $CA_{Av}$  – current assets in average annual estimate, rub.;  $A_{Av}$  – assets in average annual estimate, rub.

The recommended normative boundaries of the proposed indicators are established based on the actual values of financial ratios determined for fourteen agricultural organizations of the agro-industrial complex of the Leningrad Oblast for the period from 2015 to 2019. At the same time, the lower limit of the liquidity ratios is fixed by the lower level of the middle class of liquidity, the upper limit is the upper level of the class above the average.

For individual solvency ratios, the class of the enterprise has not been established, the excess of the actual values of enterprises above or below the recommended limits is undesirable, since it will indicate significant leaps in the development of the current activities of the subjects. It is appropriate to further analyze the analysis of the return on assets indicator in a comparative aspect with the industry average profitability indicator.

The proposed system of indicators is designed to provide a detailed and comprehensive analysis of the liquidity and solvency of agricultural organizations, which will allow to identify the most problematic aspects in the management of current assets and liabilities, develop management measures to improve the efficiency of economic activities and strengthen the financial condition of organizations.

The process of working capital management is a combination of various techniques and tools with the help of which managers must rationally form and efficiently use current assets at each cycle of the enterprise's economic activity [7, p. 137]. Management decisions should be aimed at ensuring in economic activity a reasonable combination of individual elements of circulating assets and their growth in dynamics, taking into account inflationary processes in the economy, increasing production capacity while fulfilling the prerequisite for maintaining stable liquidity and solvency of agricultural organizations.

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**PUBLIC DEBT MANAGEMENT PRACTICE IN POST-SOVIET  
REPUBLICS BASED ON THE DEMPA STANDARD**

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**Abstract.** *The analysis of the effectiveness of public debt management in the post-Soviet countries of Moldova, Armenia, Kazakhstan, Kyrgyzstan is carried out on the basis of the World Bank DeMPA methodology, which uses a set of 14 indicators of the effectiveness of debt management, covering the entire spectrum of public debt management activities and the general conditions for conducting this activity.*

*As a result of the analysis, the individual and general features of public debt management in these countries were identified, reflecting the strengths and weaknesses of the quality of public debt management and the corresponding directions for improving the efficiency of debt management.*

*The conclusion is substantiated that for effective public debt management it is very important to have mechanisms to ensure consistency at a high level of monetary and fiscal policies, as well as debt management policies, in particular, coordination of operations and cooperation between the Central Bank and the Treasury responsible for debt and cash management.*

**Keywords:** *public debt management, DeMPA methodology.*

**JEL: H63**

The World Bank, the International Monetary Fund (IMF), UNCTAD and other international organizations provide extensive technical assistance and help in addressing debt management challenges in countries with different per capita income levels, from improving institutional and debt management mechanisms to preparing medium-term debt management strategies and debt sustainability analysis [1]. In particular, the World Bank has developed a methodology and standard for assessing the effectiveness of debt management - Debt Management Performance Assessment (DeMPA), using a comprehensive set of performance indicators covering the entire range of functions in public debt management, allowing you to



see the strengths and weaknesses of public debt management practices in each country and contributing to more effective public debt management and related economic policies, helping to reduce financial vulnerability and making a significant contribution to macroeconomic stability. Effective public debt management can reduce a country's financial vulnerability, contribute to its macroeconomic stability, maintain debt sustainability, and protect the government's reputation among investors [2]. The volatility of interest rates, exchange rates and debt flows requires debt managers to properly assess risks and mitigate them by relying on a variety of funding sources while keeping borrowing costs low. The global financial crisis of 2007-2009 significantly complicated the tasks of managing the national debt by increasing the need for financing. Moreover, the cost and risk characteristics of many financing options have changed, necessitating a reassessment of existing debt management strategies, especially for developing countries, which face different economic, institutional and operational challenges due to weak debt management capacity and a lack of efficient debt securities markets [3].

DeMPA provides significant assistance to developing countries to improve the efficiency of debt management through a series of diagnostic assessments designed to strengthen governance and institutional frameworks. [4] DeMPA helps developing countries improve central government debt management capacity by comprehensively assessing the strengths and weaknesses of current debt management performance, identifying areas where institutions, legislation, practice and capacity gaps contribute to better public debt management and related economic policies. DeMPA focuses on central government debt management functions and closely related activities such as loan guarantees and lending, cash flow forecasting and cash balance management, as well as related aspects of macroeconomic management more broadly.

The DeMPA scoring methodology is similar to the methodology for calculating indicators of the Public Expenditure and Financial Accountability (PEFA) system [5]. While PEFA scores cover critical issues across the spectrum of public financial management practice, DeMPA focuses exclusively on public debt management, but in more depth. In this context, PEFA and DeMPA scores may differ even in areas where there is a direct overlap between the two instruments. Areas of overlap include the management structure for contracting loans, issuing loan guarantees, and recording and reporting debt. Strong links were also found between PEFA's audit and budget planning performance and DeMPA's performance on audit and macroeconomic policy coordination.

The 2009 DeMPA Methodology and Application Guidelines merged into a single methodology in 2015. The revised DeMPA program (2015) includes five main areas, 14 debt management metrics (DMM) and 33 dimensions (aspects), which are used to assess the ability of a sovereign borrower to manage a public debt portfolio. In the revised DeMPA methodology, guidance for assessing each aspect of public debt management practices includes: rationale and background information (by aspect); directions to be assessed; scoring criteria; supporting documentation; indicative questions to ask.

DeMPA uses the {"A", "B", "C", "D"} scale to assess the quality of the selected management option, with a "C" score indicating that the minimum requirements for this measurement have been met; a "D" score indicates non-compliance with the minimum requirements; an "A" score indicates compliance with best practice, and a sub-score "B" indicates a more detailed analysis. In addition to these points, estimates are used: "N/R" - *not applicable*, if a specific activity has not been carried out (for example, no loan guarantees have been issued in the last five years) and "N/A" - *not assessed*, if it is not possible to make an assessment.

*Analysis of modern public debt management practices in foreign countries based on the public debt management standard DeMPA*

Public debt management practices based on the DeMPA Public Debt Management Standard track progress in improving debt performance over time, and help align a country's performance and potential with prudent practice and minimum debt management requirements. Reports *on the effectiveness of debt management* under the DeMPA program for different countries are published on the World Bank website [6].

From post-Soviet countries, DeMPA reports *on the effectiveness of debt management* have been published for Armenia, Kazakhstan, Kyrgyzstan, Moldova, Georgia, Tajikistan, Belarus.

The table presents the results of assessing the effectiveness of debt management in accordance with the DeMPA standard in post-Soviet countries: Kyrgyzstan [7], Armenia [8], Moldova (in 2008 [9] and 2018 [10]), Kazakhstan [11].

As can be seen from the results presented in the table, reflecting the performance indicators of debt management, in accordance with the DeMPA methodology, in the countries of Moldova, Armenia, Kazakhstan, Kyrgyzstan, the most significant progress in debt management was achieved in Moldova in 2018.

*Individual characteristics of public debt management in the post-Soviet countries of Moldova, Kazakhstan, Armenia, Kyrgyzstan based on the DeMPA public debt management standard*

**Moldova.** Compared to the previous DeMPA assessment in 2008, impressive progress has been made in 2018 in a number of DM areas, which include quality and annual renewal of the Medium Term Debt Management Strategy (DMM-3: 1. *Debt Management Strategy*, score D in 2008; score A in 2018, DMM-3: 2. *Debt Management Strategy*, score D in 2008; score A in 2018), and borrowing plans and procedures for external borrowing (DMM-9: 1. *External borrowing*: score in 2008 D, in 2018 A; DMM-13: 2. *Separation of duties, human resources and business continuity*, score D in 2008, score A in 2018). Areas that did not improve in 2018 when assessing the effectiveness of Moldova's public debt management in accordance with the DeMPA 2015 standard include coordination with fiscal policy (DMM-6: *Consistency with fiscal policy*), score C in 2008 dropped to score D in 2018) and Debt Sustainability Analysis and Cash Flow Forecasting and Cash Management (DMM-11: *Cash flow forecasting and cash balance management*, score C in 2008 dropped to the D score in 2018).

**Armenia.** For Armenia, one can note quite high estimates of the effectiveness of DM in accordance with the DeMPA methodology, A score for the following DMMs:

DMM-3:2. *Debt management strategy*: DM strategy decision and publication process;

DMM-6:2. *Consistency with fiscal policy*: Availability of key macroeconomic variables, debt sustainability analysis and frequency of its implementation;

DMM-7:2. *Monetary policy consistency*: Coordination with the central bank through regular exchange of information on current and future debt-related transactions and on central government cash flows;

DMM-9:3. *External borrowing*: The presence and degree of participation of legal advisers prior to signing the loan agreement.

Areas that have low DeMPA scores, D scores, and need significant improvement in DMM are:

DMM-1: 1. Legal framework;

DMM-2: 2. *Management structure*: Governance structure for preparing and issuing central government loan guarantees;

DMM-6: 1. *Consistency with fiscal policy*:

DMM-10: 1. *Loan guarantees, on-lending and financial derivatives*.

**Kazakhstan.** The highest DeMPA scores for Kazakhstan, A scores, are for the following DMMs:

DMM-2: *Management structure*: Governance structure for preparing and issuing central government loan guarantees;

DMM-6: 1. Fiscal Consistency;

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DMM-6: 2. *Fiscal Consistency*;

DMM-8: 2. *Internal borrowing*: Availability and quality of documented procedures for borrowing in the domestic market and interaction with market participants;

DMM-9: 3. *External borrowing*: The presence and degree of participation of legal advisers prior to signing the loan agreement.

Areas in need of significant DMM improvement and having low DeMPA scores, D scores:

DMM-3: 1. *Debt management strategy*: Quality of the DM strategy document;

DMM-5: 2. *Audit*: Degree of interest in solving problems revealed as a result of audits;

DMM-9: 1. *External borrowing*: A documented assessment of the most favorable or optimal borrowing conditions (lender or source of funds, currency, interest rate and term) and borrowing plan;

DMM-11: 2. *Cash flow forecasting and cash balance management*;

DMM-13: 3. *Separation of duties, human resources and business continuity*.

**Kyrgyzstan**. Few high DeMPA scores for Kazakhstan, A scores, are typical for the following DMMs:

DMM-7: 3. *Monetary policy consistency*: The extent to which direct access to central bank funds is restricted;

DMM-12: 4. *Debt administration and data security*: Frequency of data copying and secure storage of backups of the debt accounting and management system outside the building where this system is located;

DMM -14: 2. *Debt and related records*: Completeness and relevance of records of all holders of government securities in a secure securities registry system (if applicable).

Unsatisfactory DeMPA score, D score, are typical for a large number of DMMs: out of 14 DMMs, 9 have D score, which indicates the low effectiveness of DM in Kyrgyzstan and are associated with such DMMs as: *Debt management strategy*; *Debt reporting and assessment of debt management operations*; *Consistency with fiscal policy*; *Consistency with monetary policy*; *Internal borrowing*; *External borrowing*; *Cash flow forecasting and cash balance management*; *Debt administration and data security*; *Separation of duties, human resources and business continuity*.

**Table – Indicators of the effectiveness of public debt management, in accordance with the DeMPA standard, in post-Soviet countries Moldova, Armenia, Kazakhstan, Kyrgyzstan**

Number	Name	Moldova		Armenia	Kazakhstan	Kyrgyzstan
		Score 2008 DeMPA 2009	Score 2018 DeMPA 2015	Score 2013 DeMPA 2009	Score 2011 DeMPA 2009	Score 2015 DeMPA 2009
<i>Management and strategy development</i>						
DMM-1	1. Legal framework	B	A	D	C	C
DMM-2	1. Management structure	A	A	B	C	C
	2. Management structure	NR	A	D	A	N/A
DMM-3	1. Debt management strategy	D	A	C	D	D
	2. Debt management strategy	D	A	A	N/R	C
DMM-4	1. Debt reporting and assessment of debt management operations	C	B	C	C	D
	2. Debt reporting and assessment of debt management operations	-	B	-	-	C
DMM-5	1. Audit	D	C	C	C	C
	2. Audit	NR	B	C	D	B
<i>Macroeconomic policy coherence</i>						
DMM-6	1. Consistency with fiscal policy	C	D	D	A	C
	2. Consistency with fiscal policy	C	D	A	A	D
DMM-7	1. Consistency with monetary policy	A	A	B	C	B
	2. Consistency with monetary policy	A	B	A	C	D

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DMM-7	3. Consistency with monetary policy	A	A	A	A	A
<i>Borrowing and related financial activities</i>						
DMM-8	1. Internal borrowing	A	A	A	D	D
	2. Internal borrowing	A	A	A	A	D
DMM-9	1. External borrowing	D	A	D	D	D
	2. External borrowing	C	C	D	D	D
	3. External borrowing	B	A	A	A	B
DMM-10	1. Loan guarantees, on-lending and financial derivatives	N/R	N/R	D	B	N/A
	2. Loan guarantees, on-lending and financial derivatives	C	C	C	N/R	C
	3. Loan guarantees, on-lending and financial derivatives	N/R	N/R	N/R	N/R	N/A
<i>Cash flow forecasting and cash balance management</i>						
DMM-11	1. Cash flow forecasting and cash balance management	B	D	C	C	D
	2. Cash flow forecasting and cash balance management	C	D	D	D	D
<i>Debt Accounting and Operational Risk Management</i>						
DMM-12	1. Debt administration and data security	D	D	D	C	D
	2. Debt administration and data security	D	C	D	C	D

DMM-12	3. <i>Debt administration and data security</i>	D	C	D	B	D
	4. <i>Debt administration and data security</i>	B	B	D	C	A
DMM-13	1. <i>Separation of duties, human resources and business continuity</i>	D	D	D	C	D
	2. <i>Separation of duties, human resources and business continuity</i>	D	A	C	C	C
	3. <i>Separation of duties, human resources and business continuity</i>	D	D	D	D	D
DMM-14	1. <i>Records on debt and related matters</i>	A	A	D	B	B
	2. <i>Records on debt and related matters</i>	A	C	C	B	A

Source: author's calculations based on the results of works [7-11]

*General patterns in public debt management in the post-Soviet countries of Moldova, Kazakhstan, Armenia, Kyrgyzstan based on the DeMPA public debt management standard*

Best practices, highest grade A, in public debt management in all post-Soviet countries Moldova, Kazakhstan, Armenia, Kyrgyzstan based on the DeMPA public debt management standard were identified for the following debt management performance indicators:

*DMM-7:3. Consistency with monetary policy*, associated with the degree of restriction on direct access to central bank funds;

*DMM-8:2. Internal borrowing*, associated with the availability and quality of documented borrowing procedures in the domestic market and interaction with market participants.

Non-compliance with the minimum requirements, performance assessment D, in public debt management in all post-Soviet countries of Moldova, Kazakhstan, Armenia, Kyrgyzstan based on the DeMPA public debt management standard were identified for the following indicators of debt management performance:

DMM-9:1. *External borrowing*: which documents the assessment of the most favorable or optimal borrowing conditions (lender or source of funds, currency, interest rate and term) and borrowing plan;

DMM-11:2. *Cash flow forecasting and cash balance management*, which reflects the decision to maintain an appropriate level of cash balances (liquidity ratio) and the efficiency of management of these cash balances in the government's bank accounts (including, if necessary, integration with the domestic borrowing program);

DMM-13:3. *Separation of duties, human resources and business continuity*, which is associated with having an operational risk management plan, including business continuity and disaster recovery plans.

It should be noted that the indicator of the effectiveness of public debt management, DMM-11. *Cash flow forecasting and cash balance management*, reflects the level of efficiency of interaction, coordination and integration of debt and cash management and has two main areas of assessment:

1. *Forecasting cash flows* – this function usually falls within the purview of the Treasury (taking into account the effectiveness of forecasting the aggregate level of cash balances in government bank accounts);

2. *Cash balance management* – this function is usually carried out by the debt management unit or the Treasury (taking into account the efficiency of making decisions on the appropriate amount of cash balance (liquidity buffer), as well as the efficiency of managing the cash balance in government bank accounts (including, if necessary, the issue of integration with the domestic borrowing program).

The most significant problems, according to the World Bank experts, leading to a decrease in the effectiveness of DMM-11, are associated with:

- the quality of forecasts;
- lack of coordination within the ministry;
- poorly developed money (financial) markets;
- problems of interaction with the Central Bank, discrepancies in the principles of policy;
- the restrictive nature of the legislative or regulatory framework;
- organizational mechanisms;
- insufficient level of commitment and understanding on the part of top management;
- lack of resources (scattered information systems, lack of personnel and the problem of retaining qualified personnel).

All these problems, of course, reflect the lack of coordination of debt management and liquidity management functions.



In addition, it should also be noted that the development of more active cash management involves a transition from a traditional, passive approach, which monitors cash balances, maintains a cash buffer to solve problems associated with volatility and unforeseen outflows of funds; when necessary, limiting/slowing down expenses or delaying payments on accounts is carried out - “rationing” of cash, rather than managing it, to a *modern, proactive approach*, which reflects the desire to equalize weekly or daily cash flows through increased borrowing and lending in the short-term capital market, and which allows you to have, on average, a smaller cash buffer - which gives advantages to other areas of work, and also provides tools to protect the planned expenses from the volatility of cash flows.

The requirements for modern cash management are related to;

- monitoring of public funds and access to them:
  - development of TSA, identification of other available resources;
  - monitoring of cash balances;
  - development of a policy for the use of surplus and cash buffer.
- forecasting cash flows:
  - formation of opportunities and means for monitoring and forecasting (at least 3 months ahead) of changes in balances on the Treasury Single Account;
- interaction with the financial market:
  - identification of options for cost-effective management of net deficits and surpluses of public funds;
  - introduction of short-term mechanisms (protection systems) to resolve problems associated with an unforeseen shortage of funds;
  - [in due time] execution of operations on short-term borrowing and lending.

**Conclusion.** As a result of the analysis of the effectiveness of public debt management in the post-Soviet countries of Moldova, Armenia, Kazakhstan, Kyrgyzstan based on the methodology of the World Bank DeMPA, individual and general features in public debt management in these countries were identified, reflecting the strengths and weaknesses of the quality of public debt management and the corresponding directions. Improving the efficiency of debt management. In particular, for Moldova in 2018, during the assessment of the effectiveness of public debt management in accordance with the DeMPA-2015 standard compared to the previous DeMPA assessment conducted in 2008, significant progress has been observed in a number of areas of public debt management, which include quality and an annual update of the medium-term debt

management strategy, and borrowing plans and procedures for external borrowing. Areas that deteriorated in 2018 compared to the 2008 debt management performance assessment include coordination with fiscal policy, debt sustainability analysis, and cash flow forecasting and cash management.

The public debt management efficiency indicator, which reflects the quality of cash flow forecasting and the efficiency of cash management, also reflects the level of efficiency of interaction, coordination and integration of debt and cash management and has two main areas of assessment:

*Cash flow forecasting* – this function usually falls within the purview of the Treasury (taking into account the effectiveness of forecasting the aggregate level of cash balances in government bank accounts);

*Cash balance management* – this function is usually carried out by the debt management unit or the Treasury (taking into account the efficiency of making decisions on the appropriate amount of cash balance (liquidity buffer), as well as the efficiency of managing the cash balance in government bank accounts (including, if necessary, the issue of integration with the domestic borrowing program).

In addition, it should also be noted that the *development of more active cash management* involves a transition from the *traditional, passive approach*, in which cash balances are monitored, a cash buffer is maintained to solve problems associated with volatility and unforeseen outflows of funds, and if necessary, a limitation/deceleration is carried out, spending or delaying payments on accounts – "rationing" cash, not managing it, to a *modern, proactive approach*, which reflects the desire to equalize weekly or daily cash flows through increased borrowing and lending in the short-term capital market and which allows for a less voluminous cash buffer on average - which benefits other areas of work, as well as provides tools for protection of projected costs from cash flow volatility.

Non-compliance with the minimum requirements based on the DeMPA public debt management standard, performance score D, for the debt management indicator: *Cash flow forecasting and cash balance management*, which reflects the decision to maintain an appropriate level of cash balances (liquidity ratio) and the effectiveness of managing these cash balances funds in government bank accounts (including, if necessary, integration with the internal borrowing program) is typical for all the post-Soviet countries considered in the work: Moldova, Kazakhstan, Armenia, Kyrgyzstan.

The solution to this problem touches upon, among other things, the problem of coordination between the Central Bank and the Treasury

in matters of central government debt management and liquidity management, including in matters of banking services to the central government. For effective public debt management, it is essential to have mechanisms to ensure high-level coherence between monetary and fiscal and debt management policies, in particular coordination of operations and cooperation between the Central Bank and Treasury responsible for debt and cash management.

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## PROBLEMS OF FORMATION AND EXECUTION OF LOCAL BUDGET EXPENDITURES

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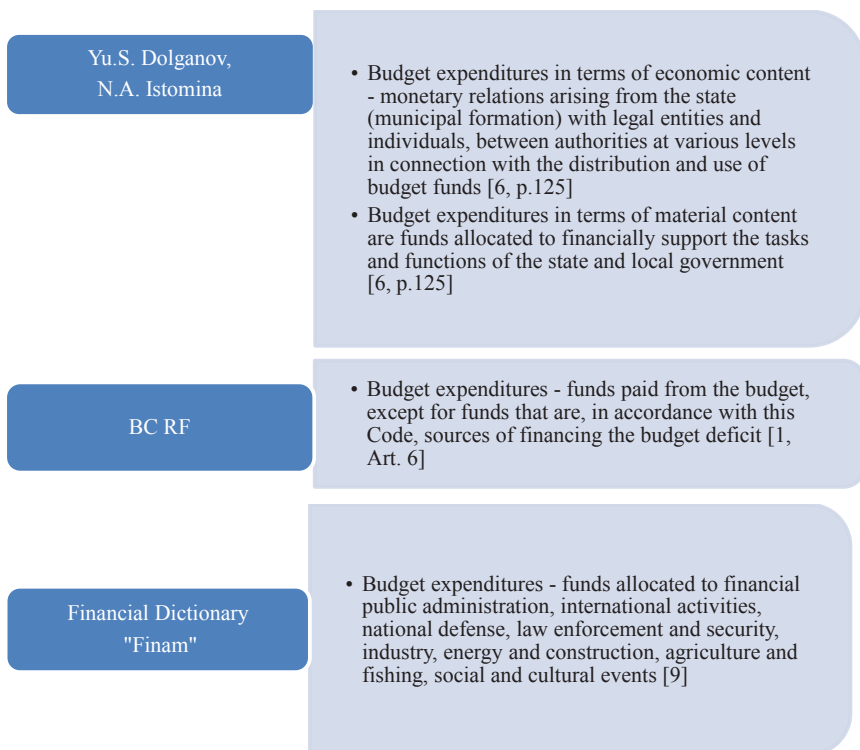
**Abstract.** *An effective budgetary policy at the level of local self-government largely depends on the solution of most issues of life support of the population, and ultimately - social and economic stability in the municipality. The development of not only municipalities, but also the development of the constituent entities of the Russian Federation, as well as the country as a whole, depends on well-formed budgets. This article discloses the concept of "budget expenditures", analyzes the execution of the expenditure side of the budget of the Municipal formation "city of Yekaterinburg" for the period 2017 - 2019, and also, on the basis of the analysis, identifies the problems of execution of the local budget for expenditures.*

**Keywords:** *expenses, local budget, problems of local budget execution, increasing the efficiency of using local budget expenditures.*

The local budget (the budget of the municipal formation) is a form of spending and the formation of funds that will be used to spend the obligations of municipalities. It forms the basis of the financial resources of local self-government and determines the foundation of the socio-economic development of municipalities. In conditions of an unstable and insufficient financial base with a simultaneous growth of social obligations, optimization of the budget execution process is becoming an increasingly important task for both federal and regional authorities and local governments.

The main purpose of any budget is to provide financial support for the performance of the functions assigned to the authorities of the relevant public-law entity, which is implemented through budget expenditures.

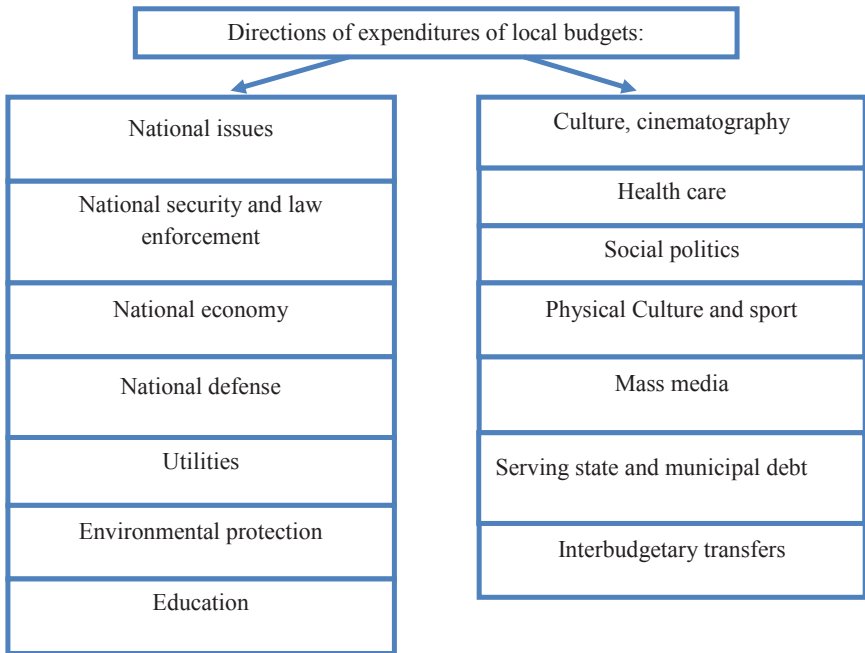
The article on this topic gives different definitions of the concept of "budget expenditures", presented in figure 1.



**Figure 1– Some approaches to defining the concept of “budget expenditures**

Thus, budget expenditures in a broad sense are understood as expenditure obligations due to a special regulatory legal act, funds paid from the budgets of the budget system of the Russian Federation in a certain amount and effectively used by authorized bodies for strictly defined purposes, within the framework of financing the tasks and functions of the state.

First of all, the expenses of the budgets of municipalities are determined in accordance with forecasts of the economic and social development of the territory. The costs are allocated in the following areas, which are presented in figure 2.



**Figure 2- Directions of expenditures of local budgets [1, Art. 21].**

Competent management of financial resources of the local budget, competent distribution of funds for expenditure obligations is one of the most acute and urgent problems of municipalities. Since we want to develop all sectors of the city's social life, but the amount of budget funds is limited and, as a rule, they are not at the level we would like, as a result of which a kind of "tug of war" process arises.

In accordance with the latest revision of the Duma's decision on the budget for 2019, planned appointments for the expenditure side of the budget of the municipal formation "city of Yekaterinburg" amounted to 51,336,758.0 thousand rubles, which is 7,522,108.0 thousand rubles more than planned in 2018. Next, let's move on to the analysis.

Let us present the percentage of execution of the expenditure side of the local budget for the period 2017 - 2019 (table 1).

**Table 1 – Percentage execution of the expenditure side of the budget of the Municipal Formation "city of Yekaterinburg" for the period of 2017 - 2019 [2; 3; 4].**

Year	Execution plan, thousand rubles	Executed, thousand rubles	Percentage of execution, %
2017	40 803 183,0	38 948 798,0	95,5
2018	43 814 650,0	42 128 929,0	96,2
2019	51 336 758,0	49 187 560,0	95,8

According to table 1, at the end of 2019, the expenditure side of the budget was executed in the amount of 49,187,560.0 thousand rubles, which is 95.8% of the planned assignments. This indicates the presence of risks of non-fulfillment of expenses in full. In 2017-2018, this indicator was 95.5% and 96.2%, respectively. The procedure for the execution of the expenditure of the local budget is determined by the charter of the municipality or other regulatory legal act of local government bodies and is determined by the current socio-economic situation of the area.

According to the data in table 2, in 2019 the plan was executed only in such sections as education and health care. For the rest of the sections, the plan was not fulfilled in full, therefore, the percentage of fulfillment was low.

**Table 2 - Execution of the budget of the Municipal formation "city of Yekaterinburg" in terms of expenditure for the period 2017-2019. [2; 3; 4].**

Section name	Plan 2019, thousand rubles.	Execution 2019, thousand rubles.	Deviation, thousand rubles.	% ex. to the plan	% ex. 2018	% ex. 2017
TOTAL	51 336 758,0	49 187 560,0	2 149 198,0	95,8	96,2	95,5
General government issues	3 152 913,0	2 961 743,0	191 170,0	93,9	91,0	95,9
National security and law enforcement	164 789,0	164 102,0	687,0	99,6	99,5	96,8
National economy	11 650 040,0	10 051 550,0	1 598 490,0	86,3	92,3	88,1



## Process Management and Scientific Developments

Utilities	3 412 962,0	3 033 015,0	379 947,0	88,9	88,3	89,6
Environmental protection	148 464,0	128 274,0	20 190,0	86,4	91,8	97,8
Education	24 366 776,0	24 599 310,0	-232 534,0	101,0	99,6	99,5
Culture, cinematography	1 549 445,0	1 469 779,0	79 666,0	94,9	100,4	98,5
Health care	1 906 643,0	1 932 848,0	-26 205,0	101,4	99,6	97,7
Social politics	4 095 149,0	4 014 503,0	80 646,0	98,0	95,2	92,3
Physical Culture and sport	783 990,0	766 392,0	17 598,0	97,8	90,7	99,9
Mass media	104 660,0	66 044,0	38 616,0	63,1	101,0	100
Serving state and municipal debt	927,0	0,0	927,0	0,0	0,0	0,0

Based on the data in table 2, in the section "Servicing the State and Municipal Debt" for a three-year period, there was a performance of 0%, which means that expenses were not planned.

The lowest execution of the budget in the reporting period is observed in the section "Mass media" - 63.1% of the approved target. This is due to the low implementation of municipal programs. In 2018, the plan was overfulfilled by 1.0% and amounted to 101.0%, and in 2017 there was full implementation, which amounted to 100.0%.

In 2017, the execution of the budget for the section "National issues" amounted to 95.9%. In 2018, this indicator decreased by 4.9% due to low performance in such subsections as "Reserve funds" and "Other general government issues." But, in the reporting year, this figure increased by 2.0% compared to the previous year and amounted to 93.9%.

For the section "National Security and Law Enforcement Activities" in the reporting year there is a deviation from the plan by 687.0 thousand rubles less than planned. The reason for this is the low execution of expenses for the construction of fire ponds and a fire station under the subsection "Fire safety" at the expense of the local budget. For the analyzed period, the execution was slightly low in 2017, it amounted to 96.8%.

In the section "National Economy", the execution in the reporting year was 86.3%, which is 6.0% less than in 2018. The decrease was due to the low execution in the subsection "Road facilities (road funds)". Deviation from the plan amounted to 1,598,490.0 thousand rubles.

In the section "Housing and communal services" in the reporting year - 88.9%, which is due to the low execution of the MP "Development of housing and communal services, increasing energy efficiency in the municipality" Yekaterinburg "", according to the MP "Formation of a modern urban environment in the municipality "city of Yekaterinburg", according to the MP "Enhancement of the improvement of the territory of the municipality" city of Yekaterinburg ". Deviation from the plan was 379 947.0 thousand rubles.

The data for the section "Environmental protection" are decreasing every year, and in the reporting year they amounted to 86.4%. This is due to the low performance of MP "Ecology and Environmental Protection in the Municipal Formation" Yekaterinburg City ", MP" Management of Municipal Property of the Municipal Formation "Yekaterinburg City".

In the "Education" section, in the reporting year, the fulfillment to the plan was 101.0%, and the deviation from the plan was 232,534.0 thousand rubles. In 2017-2018, non-fulfillment was from 0.5% to 0.4%.

Deviation in the section "Culture, cinematography" in 2019 compared to the plan amounted to 79,666.0 thousand rubles, and failure to fulfill 5.4%. In 2018, the plan was overfulfilled by 0.4% due to the excess costs of subsidies to budgetary and autonomous institutions.

The "Healthcare" section, like the "Education" section, has overfulfilled the plan in the reporting year by 1.4%, and the deviation from the plan amounted to 26,205.0 thousand rubles.

Deviation from the plan for the section "Social Policy" amounted to 80 646.0 thousand rubles. Low performance for the analyzed period is observed in 2017 - 92.3% due to non-fulfillment of the plan for expenditures due to interbudgetary transfers for the implementation of the state authority of the Sverdlovsk Oblast to provide citizens with subsidies for paying for housing and utilities, as well as for some municipal programs.

In the section "Physical culture and sports", the performance in the reporting year was 97.8%, which is 7.1% more compared to the previous year.

It should also be noted that, compared to the same reporting period in 2018, a significant decrease in budget execution indicators occurred in the section "Mass media" - 37.9%.

Based on the analysis and data in table 2, it can be noted that annually in many sections the execution of the expenditure side of the local budget is carried out in incomplete volume. Consequently, there is a problem of inefficiency in spending budget funds.

Based on the analysis, we identified and systematized the problems of formation and execution of local budget expenditures in Russia, and considered measures aimed at their solution (table 3).

**Table 3 – Problems of formation and execution of local budgets in Russia and ways to solve them [5; 7, p. 58; 8 p. 96].**

<b>Problems of formation and execution of local budgets for education</b>	<b>Activities proposed in order to solve problems</b>
The discrepancy between the scope of powers of local self-government bodies and material and financial resources available at their disposal	1) optimization of budget expenditures 2) taking measures to increase budget revenues (increasing the tax base, increasing investment attractiveness of the municipality, optimization of municipal property management).
Achievement of optimization of the expenditure side of the local budget	1) development, improvement and use of mechanisms for assessing the effectiveness of certain costs 2) concentration of resources on socially significant priorities, avoiding their distribution in small amounts between many problems 3) ensuring the discussion of problems with stakeholders, creating an opportunity for everyone to speak, in order to identify especially acute problems and innovative ideas for ways to solve them.
Difficulty defining forecast data for calculating planned costs	1) improving planning methods 2) introduction of innovative technologies 3) conducting training courses and refresher courses
The problem of incomplete execution of the expenditure side of the local budget	1) improving the mechanisms and methods for assessing budgetary possibilities 2) reducing the influence of the human factor 3) borrowing from another budget or from commercial banks to cover this gap 4) reforming the budget process.
The problem of the complexity of determining cost standards	1) solving the problem of difficulty in determining forecast data 2) improving methods of planning budget expenditures and using them in a comprehensive manner

Thus, we drew attention to the main problems that arise in the formation and execution of the local budget for expenditures and I would like to note that these problems are rather extensive and are quite common for almost all municipalities. This is due to the fact that at the moment there is a situation in which planning and achieving budget targets, from which, one might say, other problems arise, is a complex process that requires a thorough analysis of the region and the municipality, in particular. All the problems, although they are significant, are quite solvable when the proposed measures are taken to eliminate them. The main task in solving the problems identified by us is to optimize budget expenditures. Improving the efficien-

cy of budget expenditures is becoming one of the most important tasks of the governments of many countries, and Russia is no exception, and it is in this direction that national budget legislation should be developed.

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## NEURAL NETWORKS AS A TOOL FOR PREDICTING INFORMATION

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**Abstract.** *The article deals with the problem of predicting information using feedforward neural networks. On the example of the dynamic series "Average monthly wages of workers for the full range of organizations in the Murmansk region" forecasting is carried out using such neuron activation functions as sigmoid, ReLU and SoftSigh. The article compares the forecast results and the obtained average absolute percentage forecasting errors.*

**Keywords:** *neural network, digital transformation, predictive information.*

### **Introduction**

Currently, society is undergoing digital transformation processes. Methods and means of data processing are changing. More recently, the problem of forecasting information has been successfully solved using various mathematical software packages, ranging from Microsoft Excel, IBM SPSS and ending with MATLAB, STATISTICA. With the advent of the era of the information society [1], more and more processes acquire an electronic form, form their own unique digital footprint and, as a result, accumulate large amounts of data that cannot be handled by mathematical packages.

It is obvious that the development of digital transformation processes contributes to the formation of new information technologies and opportunities for their effective use. Today, many scientists agree that one of the effective tools for working with Big Data is currently neural networks, which are an end-to-end technology of the national program of the Russian Federation "Digital Economy" [2].

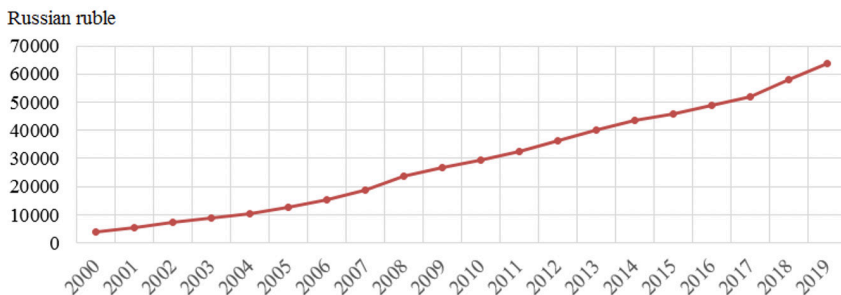
The aim of the research carried out by the authors is to determine the efficiency of using neural networks in the formation of predictive (predictable) information.

The predicted reality is multivariate and has a probabilistic nature, and it is all the more interesting how neural networks will cope with the forecasting task. Within the framework of the study, the authors set the task of studying the influence of the neuron activation function on the quality of the forecast.

### Discussion

To implement the goal and objectives of the study, a software module "Neurostat" was developed, which implements a single-layer neural network (50 neurons) of direct propagation with two input neurons and one output.

For forecasting, the time series "Average monthly wages of workers for the full range of organizations in the Murmansk Oblast" [3], Figure 1, was selected.



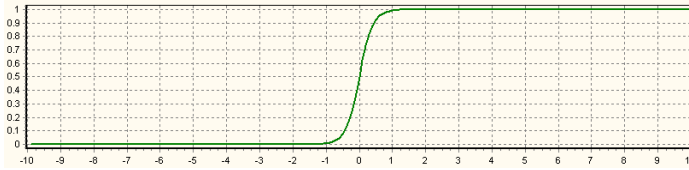
**Fig. 1. Average monthly wages of employees for the full range of organizations in Murmansk Oblast**

Three neurons were selected as the function of activating neurons: sigmoid, ReLU (Rectified linear unit) and SoftSigh. Activation function graphs are presented in table №1.

The sigmoid is a smooth monotonically increasing nonlinear function. SoftSigh belongs to the family of functions of the sigmoid class and represents the so-called rational sigmoid. ReLU function is a linear rectifier.

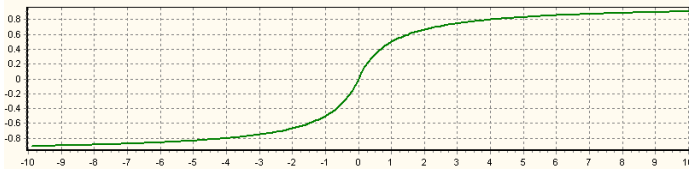
**Table № 1 – Neuron activation functions**

**Sigmoid**



$$f(x) = \frac{1}{1 + e^{-x}}$$

**SoftSigh**



$$f(x) = \frac{x}{1 + |x|}$$

**ReLU**



$$f(x) = \begin{cases} 0 & x < 0 \\ x & x \geq 0 \end{cases}$$

In our research using the Windowing method, a given time series was transformed into a training DataSet for a neural network. The neural network was trained using the supervised learning method, the synapse weights were adjusted using the error backpropagation method. The criterion for the training of the neural network is 0.01 by the least squares method.

The forecast base period is set at 10 years, the forecasting horizon is 1 year (due to the use of one output neuron). Thus, the correlation of the predicted value with the actual is possible in the range from 2010 to 2019.

To assess the performed forecast, the work uses the mean absolute percentage forecasting error MAPE (Mean Absolute Percent Error).

The results of the study are presented in table 2. The sigmoid activation function showed prediction efficiency with an error ranging from 0.17% to 8.49%. Forecasts with similar values were formed by a neural network using the SoftSigh function, where the forecast error ranged from 1.81% to 7.53%.

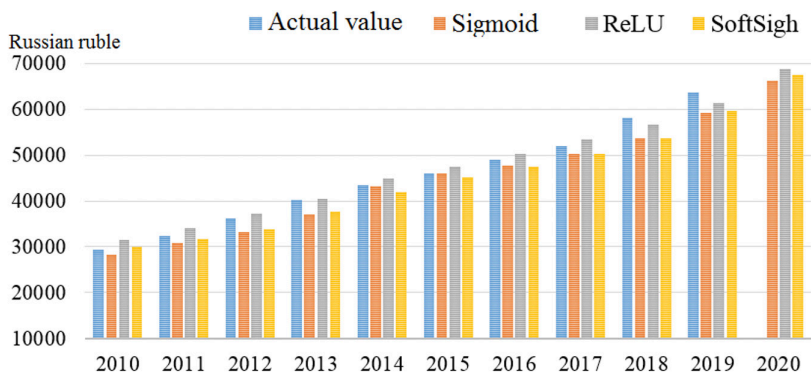
The best prediction results were shown by a neural network, in which a casting rectifier was used as a function of neuron activation. The prediction error in this case ranged from 0.26% to 7.20%.

**Table № 2 – Prediction results for compared neuron activation functions**

Year	Actual value, rubles	Forecasted value, rubles					
		Sigmoid	MAPE, %	ReLU	MAPE, %	SoftSigh	MAPE, %
2010	29308	28234	3.66	31418	7.20	30078	2.63
2011	32342	30826	4.69	34044	5.26	31757	1.81
2012	36188	33117	8.49	37287	3.04	33749	6.74
2013	40225	36978	8.07	40329	0.26	37736	6.19
2014	43378	43121	0.59	44881	3.46	41918	3.37
2015	45989	45910	0.17	47505	3.30	45142	1.84
2016	48986	47654	2.72	50211	2.50	47428	3.18
2017	51932	50322	3.10	53473	2.97	50213	3.31
2018	58045	53618	7.63	56624	2.45	53674	7.53
2019	63715	59101	7.24	61239	3.89	59612	6.44
2020	unknown	66239	<b>4.64</b>	68784	<b>3.43</b>	67563	<b>4.30</b>

Taking into account the assessment of all forecasting iterations, it can be assumed that the value of the average salary for Murmansk Oblast for 2020 by a trained neural network using the ReLU activation function will predict with an error of 3.43%. The sigmoid and SoftSigh functions will show results with errors of 4.46% and 4.30%, respectively.

Figure 2 shows the prediction results for the compared neuron activation functions.

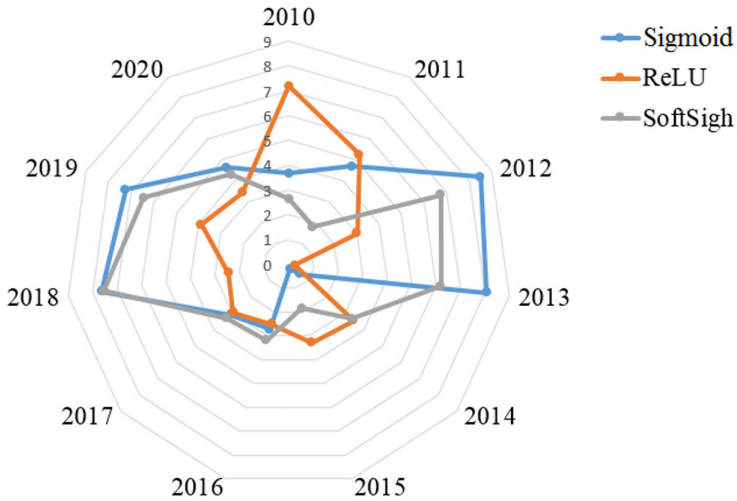


**Fig. 2. The results of predicting the compared functions of neuron activation**



It should be noted that in most cases the ReLU function makes a forecast with a certain margin, while the sigmoid and SoftSigh functions, on the contrary, predict values that are less than the actual ones.

Figure 3 shows a radial diagram showing the scatter of the mean absolute percentage prediction errors for the compared neuron activation functions.



**Fig. 3. Average absolute percentage prediction error for compared neuron activation functions**

The diagram in Figure 3 shows that the prediction errors using the sigmoid and SoftSigh activation functions are almost identical. However, it is still desirable to give preference to SoftSigh, since the convergence of the neural network when using it required fewer learning epochs.

**Conclusion**

Thus, the study has shown the effectiveness of using neural networks in the formation of predictive (predictable) information. The prediction error when using sigmoid, ReLU and SoftSigh is below the generally accepted range of 5% and amounts to 4.46%, 3.43% and 4.30%, respectively.

The neural network with the investigated functions of neuron activation gave a forecast for the average monthly wages of employees for the full range of Murmansk Oblast organizations in the range from 66,239 ru-

bles to 68,784 rubles. Of course, these numbers may not give an accurate forecast, at least due to the fact that 2020 passed in the context of the COVID-19 pandemic, which affected the financial and economic results.

Further research into the use of neural networks is needed and planned by the authors.

The results can be useful for Data Driven analysts, Oblast machine learning specialists, and Data Science specialists.

We hope that this publication will be useful and interesting for sociologists, economists, researchers, teachers and students, all interested in forecasting and predictive analytics.

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**DEVELOPMENT AND IMPLEMENTATION OF A MODEL  
FOR THE FORMATION OF INTEGRATED COMPETENCIES  
OF A UNIVERSITY STUDENT**

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**Abstract.** *the article gives the author's definition of the concept of "integrated competence", identifies three integrated competencies and gives their essential characteristics. Developed and implemented a model for the formation of integrated competencies of University students, the main means of formation of which are selected educational tasks. The results of the research proving the effectiveness of the developed and implemented model are presented.*

**Keywords:** *competence, competence, integrated, model, modeling, learning objectives.*

The rapid development of economy, introduction of innovative technologies, modernization approaches, digitalisation and automation of production processes, robotics, artificial intelligence, graduates require more advanced skill level. A modern specialist must have critical thinking, synthesize and structure information data, design, implement, actively and meaningfully apply new algorithms and technologies in an ever-changing production environment.

One of the social institutions of the information society, which plays a major role in personnel training, is the higher education system, the improvement of which will stimulate the technological and economic progress of the state [5]. The approval of The national project " Education "(2019-2024) within the framework of the Federal project "Young professionals"

of TOP-50 specialties, the creation of competence centers of differentiated level, the organization of competitions and Olympiads of professional skills – this set of measures, on the one hand, indicates the prestige of higher education, and on the other - sets serious tasks for educational systems to improve the content and technologies of educational processes, including in the field of formation of educational results [2].

Despite the abundance of literature on the formation and development of integrated competencies in higher education students, issues related to the content of integrated competencies as potential personal characteristics of a future professional, algorithms for their generation, diagnostics, and the design of appropriate diagnostic tools for the implementation of qualimetric accompaniment of the educational process still seem unresolved.

Integrated competencies of students of higher education institutions as the ability and readiness of graduates to use knowledge, skills and abilities in the process of personal and social adaptation and self-realization in various areas of educational and professional activities can be represented as a complex of cognitive, activity and value-semantic components; systems of epistemological, orientation-axiological, communicative, technical and technological competencies of personal evolution. The main properties of integrated competencies include: reflexivity, duality, integrativity, diagnostics, visualizability, stability, potential for improvement in the process of educational and professional activities.

The formation of integrated competencies of higher education students is a unitary process of communication between the subject and the object of educational activity, focused on the formation of the main characteristics of the individual that determine the ability of a professional to transform their experience to solve irregular problems.

Integrated competencies of a higher education student are represented by a system of personal characteristics that are directly related to competitiveness in the professional sphere, which characterize the specialist's ability to construct empirical skills for the ability and ability to solve problems in various conditions [1,3].

In this study, the main characteristics of integrated competencies include:

- reflexivity, which shows integrated competencies of students only in conditions of purposeful cognitive activity;
- duality, manifests itself as an understanding of the significance of progress in the personal and professional aspects of the object of education;

- universality, i.e. the ability of the subject of education to apply a system of knowledge, skills, and interdisciplinary Outlook in solving specific problems;
- diagnostics, which determines the vector of goal attainment, is manifested in the behavior and epistemological activity of the object of education;
- visualizability, representation of the formed goal through a certain activity of the object of education in the conditions of manifestation of any level of formation of integrated competencies of students;
- stability, reflects the essence of axiological foundations and their personal relevance in the process of educational and professional activities;
- progressivity characterizes the ability to self-develop.

The process of forming integrated competencies has a consistent, systematic (multi-stage), developing, creative (transforming), purposeful, conscious nature and is defined as an integral, educational process carried out with direct communication between the teacher and the student, aimed at developing personal qualities related to their competitiveness in the professional sphere, determining the specialist's ability to transform the existing experience to solve problems in any conditions [4].

The process of formation of integrated competencies of students occurred through the solution of educational tasks, which are a system of three-level tasks with the following features

- the potential for parallel implementation of differentiated educational results, including multicomponent elements;
- feasibility of implementing joint cognitive and educational activity of subjects of the educational process;
- regularity both in the implementation of the predicted exact result, and in the demonstration of new results of General activity (rules, laws, values, etc.); our
- proposed model for the formation of integrated competencies of higher education students by means of educational tasks includes the following blocks:

The conceptual-target block is represented by the principles of unitary interrelation of components in the process of applying educational tasks, systematization of educational information, formation of professionally significant values, decision-making based on existing experience in accordance with the main concepts of system-activity and competence approaches.

The content component provides for the process of developing educational tasks and their systems for the formation of integrated competencies

of higher education students based on a system of principles (achieving both immediate and remote educational goals, determining functions for each individual task, introducing tasks for reflection, etc.), rules (uniformity, diversity in form, content and algorithm of solution, opposition, unambiguity of wording, relevance), as well as system features (integrity, hierarchy, structuring, multiplicity, and, focus on predictable outcomes, the prospect of teaching the fullness, the single context).

The process of developing learning objectives based on the following algorithm of educational activity of subject of activity: the preconceptual stage (diagnosis of the probability and circumstances for the use of a training task, given the selection means analyze learning tasks integrated competence and their decomposition); level of goal setting (setting goals and objectives; initial diagnosis; analyzing the previous activity of the object of educational activities; evaluation of real state of development of the integrated competencies; determining the composition of actions for the potential application of tasks in the educational process; creating criteria for evaluating the formed results); design stage (determination of the task context; designing tasks; integrating them into a unitary complex task based on the principles of level; integration in a single structure of cognitive, activity and value-semantic tasks; testing their effectiveness on a separate group of students; if necessary, clarification; development of recommendations for the application of tasks and their systems).

The technological component is represented by a system of interconnected sequential stages of development and application of training systems for setting and solving problems. It determines the content of the modeled process in accordance with the orientation and stages of work, the circumstances of its effectiveness, as well as the principles implemented in the activity.

The performance-evaluation block determines the system of criteria for diagnosing the formation of integrated competencies of students: cognitive, activity, and value-semantic (levels of formation: low, medium, and high).

Thus, in the study we define an integrated competence as the competence of self-organization of personality, which is a complex cognitive activity and value-semantic component expressed by the system epistemological, value-orientation, communication, technological competence personal development, which reflects the ability and willingness to cognitive activity and to the use of knowledge and skills in the social - personal adjustment and further self-realization in professional activity

The cognitive component is the intellectual sphere of the student's con-

sciousness, which includes, among other things, theoretical knowledge about the overall qualities of the specialty.

The activity component is characterized by the application of theoretical knowledge in practice.

The value-semantic component is manifested as an awareness of the personal, social, and social significance of the profession and motivation.

As a result, it can be concluded that integrated competencies contain the potential of higher education students for the future use of knowledge, skills and abilities in the course of socio-psychological adaptation and professional implementation in any conditions of activity

We have formulated and justified the following competencies:

Integrated competence-1 "Perception and awareness of the essence and social significance of your future profession, showing a stable interest in it".

Integrated competence-2 "Organization of own activity, definition of standard methods and ways of solving problems in professional activity, evaluation of efficiency and quality".

Integrated competence-3 "making informed decisions in standard and non-standard circumstances and the ability to take responsibility for the decisions made".

In the process of implementing the model for the formation of integrated competencies of higher education students, the experimental base of the study was the Nevinnomysk state humanitarian and technical Institute AND the North Caucasus Federal University. 150 students participated in the study.

In the course of the ascertaining experiment, we established criteria, corresponding indicators, and levels of formation of cognitive, activity, and value-semantic components of students' integrated competencies. The achievement levels of these components were recorded at all three stages of the experiment.

The ascertaining stage recorded a low level of initial formation of all components in the majority of students in the field of Integrated competence-1; pre-threshold level of formation of the cognitive component in five groups, activity-in two groups, and a low level in all other cases in the field.

The level of formation of the cognitive component in three groups, as well as the low level of formation of the other two components within the framework of the formation of the Integrated competence-3.

This allowed us to conclude that the overwhelming majority of students at this stage have a superficial idea of the social significance of their future

profession, and are not sufficiently capable of organizing their professional activities and making decisions on its implementation.

The formative stage allowed us to establish that the process of solving systems of educational tasks contributes to the formation and further development of integrated competencies in students and is focused on integrating previously obtained experience and acquiring new ones in the process of joint activities with the teacher. This is confirmed by specific quantitative indicators that demonstrate their gradual growth, which, by the end of the experiment, differ significantly from the initial ones.

A comparison of the performance checklist and summative stages of the experiment this allows to make a conclusion about the effectiveness of the developed model:

- decrease in subthreshold indicators of the cognitive component of 18.2%, 35.5% and 48.4 per cent (Integrated competence - 1,2,3), activity – 22.5%, 34.0% and 34.1 per cent, axiological – by 29.3%, 42,1% and 31.9%, respectively;

- changes in indicators of low level with a decrease in the values of the cognitive component, on average by 6 % (Integrated competence - 1) and increased by 13.6% and 37.6% (Integrated competence 1 and 2); the decrease in the values of the action component of 8.4 % (Integrated competence - 1) and its growth by 13.0% and 26.1% (Integrated competency 2 and 3): increase values, value-semantic component of 0.4% and 19.5 % (Integrated competence 1 and 2) and decrease by 1.5% (Integrated competence 3);

- changes in the values of the average level, including an increase in the indicators of the cognitive component by 21.6%, 12.7% and 1.6% (Integrated competence 1,2,3); activity – by 22.9%, 12.7%, 5.5% (Integrated competence 1,2,3); value-semantic-by 20,0 %, 17,7%,15,8% (Integrated competence 1,2,3);

- increase in high-level values for the cognitive component by 3.2%, 9.5%, 1.6 %; for the activity component – 8.0 %, 9.5% and 2.5 %; value-semantic – 16.1%, 21.7%, 4.7% for all three integrated competencies, respectively. At the same time, the levels of achievement in the control group within the components of all three competencies remain consistently low, without revealing a significant difference in comparison with the indicators of the initial diagnosis.

Thus, the results of the experiment proved that the use of educational tasks is an effective means of forming integrated competencies of students of higher education institutions, which was confirmed by an experimental study.



It should be noted that the study does not cover all the nuances associated with the application of the task method for the diagnosis of integrated competencies of higher education students. Directions for further research can be associated with an in-depth analysis of the capabilities of the problem method, as well as with the creation of appropriate theoretical and methodological recommendations for their use in the educational process.

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## INFORMATION AND EDUCATIONAL ENVIRONMENT OF AN EDUCATIONAL ORGANIZATION

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**Abstract.** *The article discusses the development of the information and educational environment of an educational organization, the transformation of teacher competencies related to the use of EEE and the design of the educational environment using digital tools. The challenges of our time require the educational system to be ready for the full implementation of all educational functions in the context of distance interaction. The article describes the experience of optimizing the scientific and methodological work of the department, for which the authors have developed a chatbot. The created bot has established itself as one of the most successful tools for assisting in administrative and advisory activities. The successful introduction of artificial intelligence technologies into the educational process shows the prospects for the further development of digital educational technologies. Teachers need to improve not only their knowledge and skills, but also methods of working with students to further improve the educational process.*

**Keywords:** *information and educational environment, chatbot, digital transformation of education, digital technologies, communication.*

Today, education is one of the links in the digital economy that faces the challenges of the modern world [1]. The teacher must have competencies that provide, on the one hand, high-quality preparation of students for professional activities in the digital economy, and on the other hand, must be able to integrate himself into the digital educational process with new

pedagogical tools [2]. The formation of competencies that make it possible to carry out professional pedagogical activity in the information educational environment (IEE) in the conditions of a distance, mixed and full-time educational process should be oriented primarily towards pedagogical goals, but in no case should we forget about the correspondence of education to the present and its orientation towards the future. Professional activity in the modern educational environment consists not only in structural and substantive changes in this environment and the inclusion of new digital components in its composition, but also in focusing on the creation and application of new pedagogical technologies to achieve effective educational results. This requires a renewed view of the functions of the traditional components of the educational environment, the development of the digital structure of the learning environment and the relationship between its elements. At the moment, a large number of different digital educational publications have been developed, services are offered that allow the teacher to create their own or edit existing e-learning resources for specific educational purposes. Consider the fundamental issues of design, creation and use of information and communication educational environment, formed on the basis of digital educational resources and network services. The main professional competencies of teachers, which are now undergoing global changes:

- methodological competence is transformed with the advent of digital technologies, supplementing pedagogical technologies with new methodological possibilities based on the synthesis of digital and pedagogical technologies, the ability to receive updated information on their subject area directly from the professional community online, to improve their professional level and training content; creative and fruitful rethinking of ideas and methodological findings discussed in networked pedagogical communities, testing their own findings and introducing digital services into the educational process;
- information (digital) competence improves as you master new technologies, become familiar with different programs, tools, network projects and services, critically understand their advantages and disadvantages for different forms of education, different groups of students, differing in educational goals and opportunities; manifests itself in the ability to independently use new digital technologies: to search, analyze, visualize, broadcast new information;
- communicative competence acquires new opportunities with the advent of digital communication tools, it is necessary to take into account the peculiarities of the communicative culture when interacting with people and working in groups in digital online and offline services;

- educational competence, realized as professional and personal growth throughout life, is transformed in digital information and communication conditions due to the expansion of time and geographic boundaries.

Global technological changes and challenges of the world economy, and epidemic threats require the modern educational system to be ready for the full implementation of all educational functions in the system of information and educational environment and digital competencies of teachers. Digitalization of education makes it possible to solve these problems, but improving the quality of education is impossible without the personal interest of teachers and the administration of educational organizations in the results, since the issue of motivation and creativity is a decisive factor for education in a constantly changing learning environment.

Information resources, communication services and opportunities for interaction during training with new digital educational technologies develop the creative and intellectual potential of students, form the ability to use the means of collecting, analyzing and transmitting information in all areas of life adequate to the digital transformation of education [3].

Educational standards include requirements for the information and educational environment, technological aspects of the complex of digital educational resources and technologies.

The structure of the educational information environment should methodically correspond to the following principles: multicomponent (educational and methodological materials, software, training systems, knowledge control systems, information and reference systems, information storage); Integrity (the information component relies on the necessary set of basic knowledge, specialized world resources, interdisciplinary communications, information and reference base); distribution (information and communication components are optimally distributed over information storages and modern communication services); adaptability (information and educational environment is harmoniously transformed by the existing education system).

The formulated principles of building the IEE make it necessary to introduce new digital technologies for the interaction of participants in the educational process.

Educational standards meant until the last moment and live interaction of all participants in the educational process. Nevertheless, in a fully distance learning format, a vacuum of human direct participation arises; the lack of feedback and live interaction is overcome with the help of digital communication tools with elements of artificial intelligence. At the Department of Information Technologies in Education of the Institute of Math-

ematics and Informatics of the Moscow Pedagogical State University, a new digital pedagogical technology is being introduced to adapt the educational process in conditions of quarantine and distance learning, and the educational adiabatic process is corrected using the "Tsifra" chatbot. The educational process acquires a lively format of online interaction, creates comfortable conditions for access to information, reference, and educational resources - the entire information and educational environment is always in hand, since access is organized using a messenger installed on any smartphone. It should be noted that such an activity on the introduction of a chatbot into the educational process creates an addition to the already familiar information and educational environment, traditionally organized through the site for managing distance educational activities and communication using e-mail. In this case, there is an opportunity for online communication, structuring and transfer of information are organized with the illusion of full-time assistance from the teacher on every issue that the student has.

The information and educational system should be an open pedagogical system aimed at the formation of a comprehensively developed creative and social personality [4]. The need for the formation of so-called soft skills and the individualization of the educational process, aggravated by the distance of this process, require new solutions, and we would like to bring one of them to your attention.

The "Tsifra" chatbot, created by the authors of the article and used in the educational process of the MSPU, allows:

- to provide students with convenient access from a smartphone to educational materials at any convenient time in two formats - text and video (figure 1);

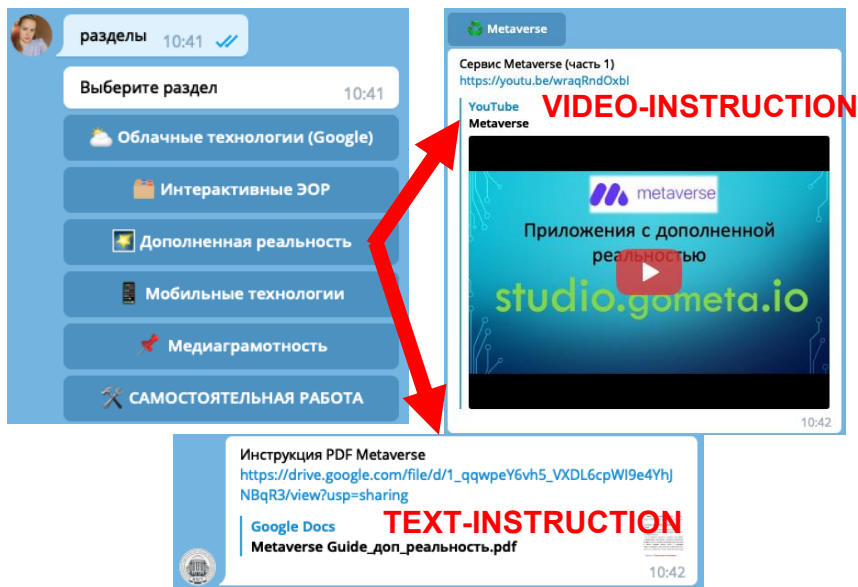


Figure 1 - Access to materials

- free teachers from standard, often repeated questions from students, for example, the schedule of classes, the deadlines for passing intermediate tests, recommended literature, etc. (figure 2);

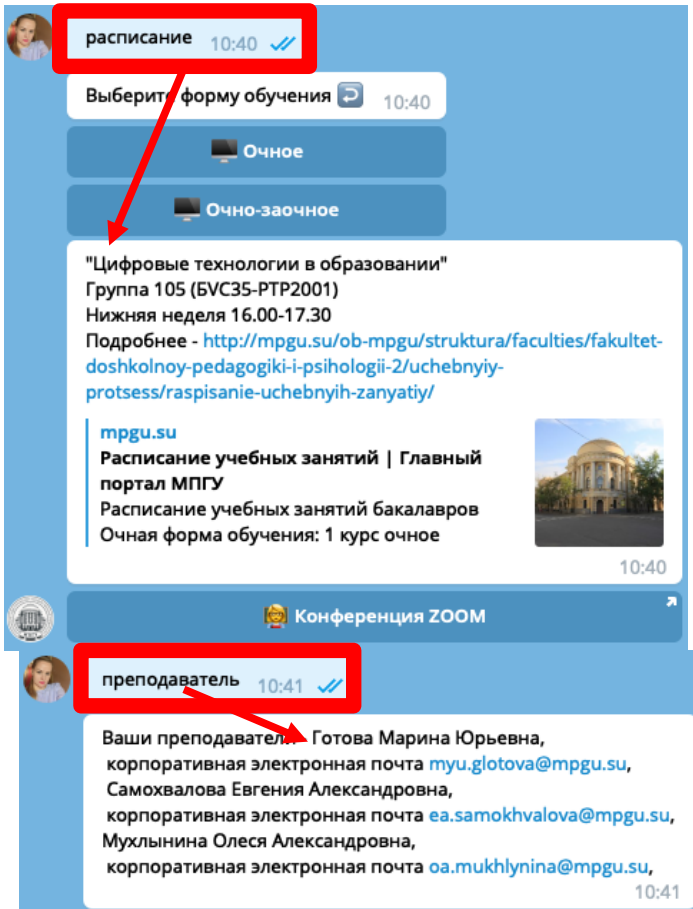
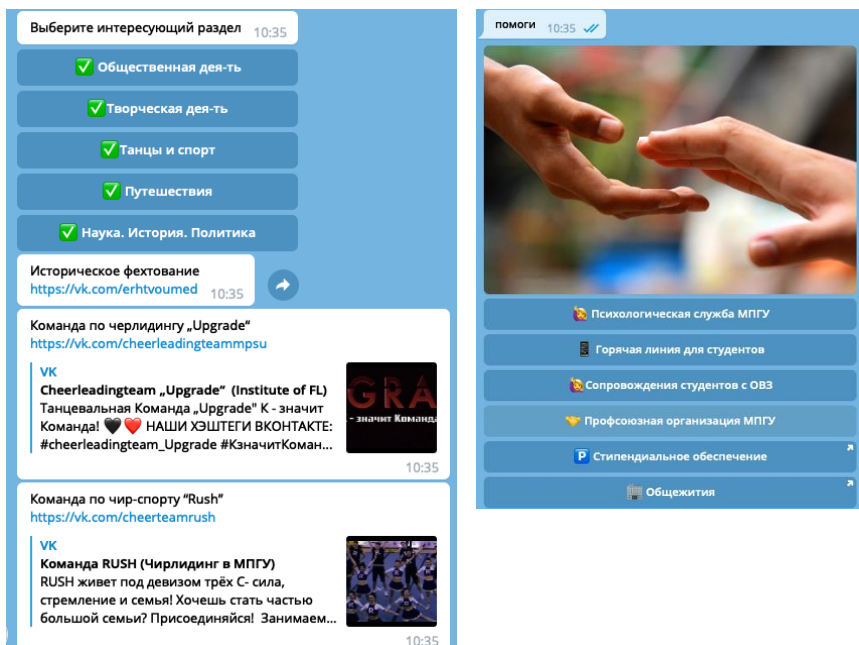


Figure 2 - Answers to questions

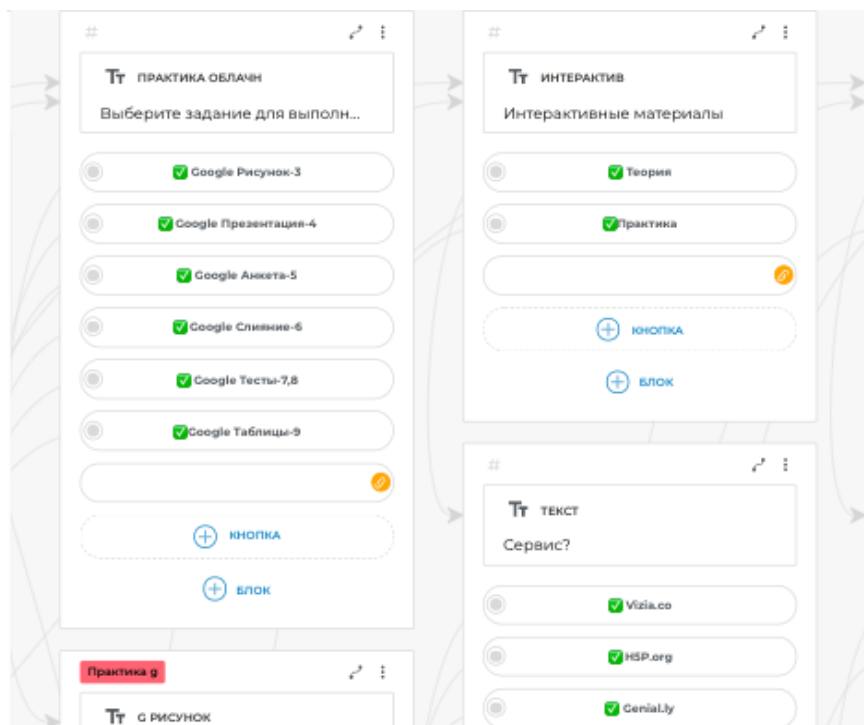
- provide information support to students about possible additional activities and associations in the educational institution, mutual aid organizations, etc. (figure 3).



**Figure 3 - Information support and mutual assistance**

The creation of a chatbot does not require special knowledge in the field of digital technologies, there are various constructors that allow you to create bots and modify them in the process of operation to the required functionality. Chatbot "Tsifra" was created using the visual constructor Aimylogic, which is designed to create smart chatbots that understand user requests in natural language [5]. With the chatbot "Tsifra" you can speak with text, voice or interact using interface elements (buttons). The chatbot logic is created in the form of a state transition diagram (figure 4). The bot processes the user's request based on the current context of the conversation.





**Figure 4 - Chatbot logic**

The developed chatbot made it possible to significantly improve the interaction between students and teachers at the department. According to the results of a survey of 123 first-year undergraduate students in the pedagogical direction of training, from the point of view of the efficiency of interaction, communication through a chatbot in a messenger was preferable for 77.6% of students (fig. 5).



**Fig. 5 - Communication method**

The successful introduction of artificial intelligence technologies into the educational process shows the prospects for the further development of digital educational technologies. In educational, methodological and management activities related to education, further improvement of existing pedagogical technologies, the development and implementation of new ones are required. Chatbots have already established themselves as one of the most successful tools for assisting in administrative and advisory activities [6]. The initial steps in introducing chatbots into the educational process were very successful and proved the prospects for further developments in this area.

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## MODEL CHARACTERISTICS OF THE PSYCHOEMOTIONAL STATE OF SHORT-DISTANCE RUNNERS

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**Abstract.** *This paper presents a model characteristic of the state of mental readiness of short-distance runners. The state of mental readiness of short distance runners is considered as a condition for effective psychological training. The management of the training process of short-distance runners can be improved by creating profiles of the psycho-emotional state, as a condition for the correction of training influences of various orientations. Determination and analysis of the positive and negative influence of training and competitive influences on the runners' organism acquires special importance especially before the main starts. With good physical and functional readiness, runners may have a breakdown in the main starts, due to untimely self-regulation of the mental state. Being motivated for a high result for a runner requires the promptness of the receipt of information not only of a physical, but also of a mental state. For this, it is important to conduct express diagnostics. The development of an integral indicator of the state of mental readiness of runners helps prevent injuries in running for short distances. Sports practice has shown that with a high level of preparedness, sometimes athletes show a high level of emotional state and at the same time neglect the main warm-up, which*

*can lead to injuries of the musculoskeletal and neuromuscular system. As the basis for the structural components of the state of mental readiness of short-distance runners, we have chosen an activatiometer (apparatus "AC-9K").*

**Keywords:** *model characteristics; short distance running; psycho-emotional state, state of mental readiness, competitive activity.*

### **The relevance of research**

The theoretical analysis of the authors' works we carried out showed that it is important to individualize the means of self-regulation of athletes, as a factor in increasing the efficiency and effectiveness of competitive activity [1, 2, 3,4].

The modern level of training in speed-strength types of athletics today requires a revision of the planning of fixed assets and the development of innovative technologies of psychological support, starting from the training stage of preparation. In connection with an increase in calendar starts and an increase in the political significance of elite sport, the psychological responsibility for performances has increased. The increased level of responsibility for their performance leads to the tension of sports training, not only physical, functional, but also psychological.

Analyzing the content of dissertation research devoted to cyclic sports, the interest of scientists to pedagogical issues of sports training of athletes of various qualifications was revealed. A significant place is occupied by the topic of dissertations in the field of physiological and psychological sciences. The most widely studied issues of medical and biological support of the training process in theses on general problems of training in sports, as well as in water and winter sports. The smallest number of dissertations on psychological topics in athletics, especially in sprint.

In research works on the problem of training short distance runners, the proportion of works on general issues has significantly decreased. At the same time, during this period, the number of doctoral works devoted to general issues of training in athletics and endurance running increased. Single doctoral theses are prepared in sprint running. More work on the material of highly qualified athletes has been prepared in endurance running and all-around events. Theses of psychological support of the training process in sprint running are practically not considered [1, 4].

Leading experts consider the model characteristics of the athletic training of runners, but at the same time there are no model indicators of the psychoemotional state. In this regard, an attempt was made to develop a profile of the state of mental readiness of runners. In the future, the issues

of the state of mental readiness of runners and the formation of their training process in the macrocycle due to the implementation of individually selected means of psycho regulation will be considered more broadly.

The purpose of the work was to consider the structural components of the state of mental readiness of short-distance runners in the sports season 2015-2019.

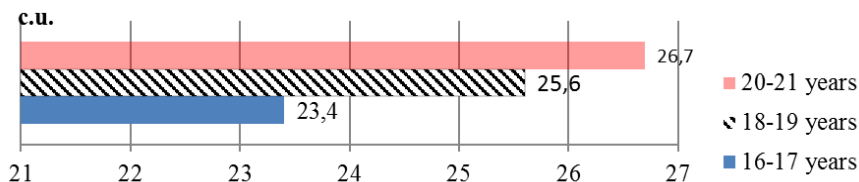
Research objectives:

1. Study the indicators characterizing the psycho-emotional state of short-distance runners.
2. Determine the profiles of the psycho-emotional state of the short distance runners.

### Research methods and organization

The study involved university students involved in sprinting in sports schools in the city of Naberezhnye Chelny, Elabuga, Nizhnekamsk, Republic of Tatarstan. The results obtained are not presented in the publications of the authors. The study involved 25 short-distance runners with the athletic qualifications of the first adult, Candidates for Master of Sport and above. The age range of the studied runners was from 16 to 22 years old. The assessment of the psychoemotional standing of short-distance runners was carried out according to the following indicators: accuracy of reaction to a moving object; coefficient of strength of the nervous system; number of movements in 5 sec time intervals; general indicator of motor memory; rate sense ratio; coordination of the extensor and flexor muscles using the "AC-9K" apparatus [5].

Figures 1-6 clearly show the age dynamics of the indicators of the psychoemotional state of short distance runners before the main starts (Championship of the Volga Federal District, and the Tatarstan Championship in athletics).



**Figure 1. Age dynamics of indicators "Accuracy of reaction to a moving object" during the main starts.**

Accuracies of reaction to a moving object, for short-distance runners in the age aspect, differ in absolute mean values.

In the group of 16-17 year old runners, the initial TRDO indicator was  $27.4 \pm 1.31$  c.u., and before the main start after pre-competition training it was  $23.4 \pm 2.01$  c.u.

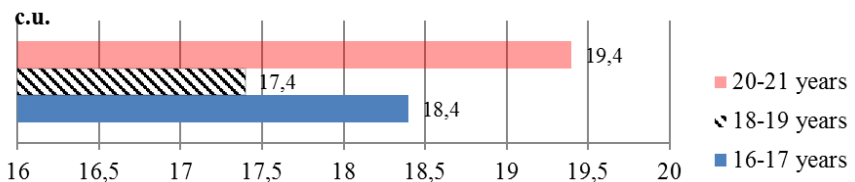
In the group of runners 18-19 years old, the initial TRDO indicator was  $34.1 \pm 2.11$  c.u., and before the main start changed significantly and was equal to  $25.6 \pm 1.33$  c.u.

In the group of 20-21 year old runners, the initial TRDO indicator was  $32.3 \pm 2.23$  c.u., and before the main start it changed significantly and was equal to  $26.7 \pm 2.03$  c.u.

Consequently, the accuracy of the reaction to a moving object is associated with the manifestation of the ability to orientate in space and in time can be used in a comprehensive assessment of the psycho-emotional state of athletes. In sprint distances, the stability of the improvement of this indicator is characterized by self-confidence, striving for high results. The decrease in the level of the state of mental readiness of runners can be considered in the dynamics of changes in the studied indicators.

The coefficient of strength and weakness of the nervous system characterizes the manifestation of the dominant inhibition or excitation in short-distance runners. It is noted that in short-distance runners, a weak and medium nervous system prevails with a high level of manifestation of excitement and mobility of nervous processes during motor activity.

Figure 2 clearly shows the age-related dynamics of the indicators of the "Coefficient of strength and weakness of the nervous system" in the period of the main starts.



**Figure 2. Age dynamics of the indicators of the "Coefficient of strength and weakness of the nervous system" in the period of the main starts.**

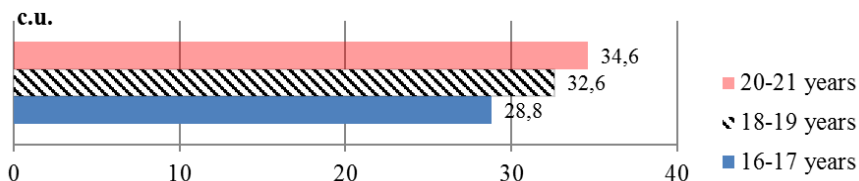
Figure 2 shows that in the age dynamics in this indicator there is a change in the coefficient of strength and weakness of the nervous system in the process of correction in the direction of increase.

In the group of 16-17 year old runners, the initial indicator of the coefficient of strength and weakness of the nervous system was  $15.41 \pm 1.41\%$ , and before the main start after pre-competition training it was  $18.4 \pm 2.11\%$ .

In the group of runners 18-19 years old, the initial indicator of the coefficient of strength and weakness of the nervous system was  $14.41 \pm 2.31\%$ , and before the main start after pre-competition training it was  $17.4 \pm 1.67\%$ .

In the group of 20-21 year old runners, the initial indicator of the coefficient of strength and weakness of the nervous system was  $15.41 \pm 1.41\%$ , and before the main start after pre-competition training it was  $19.4 \pm 2.11\%$

The number of movements in a certain period of the tested time allows to characterize the manifestations of strength and weakness of the nervous system of short-distance runners. In age-related runners, there is an increase in the number of movements. Consequently, this is due, first of all, to the orientation of the training influences of a speed nature and training in the speed of reaction to various signals.



**Figure 3. Age dynamics of indicators of the number of movements during the main starts.**

Figure 3 shows that age dynamics in the number of movements tends to increase with age. This, first of all, proves that this indicator lends itself to training and improves with the correction of the psycho-emotional state of the runners.

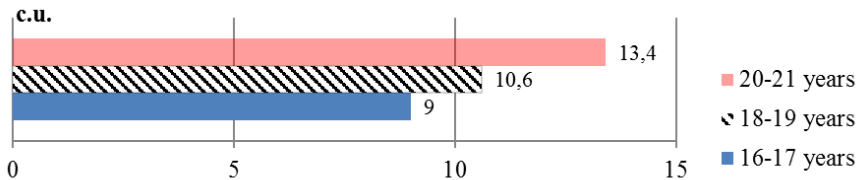
In the group of 16-17 year old runners, the initial indicator of the number of movements was  $27.41 \pm 2.41$  c.u., and before the main start after pre-competition training it was equal to  $28.8 \pm 2.11$  c.u.

In the group of runners 18-19 years old, the initial indicator of the number of movements was  $29.41 \pm 3.31$  c.u., and before the main start after pre-competition training it was equal to  $32.6 \pm 2.37$  c.u.



In the group of 20-21 year old runners, the initial indicator of the number of movements was  $30.81 \pm 3.41$  c.u., and before the main start after pre-competition training it was  $34.6 \pm 2.09$  c.u.

The general indicator of motor memory characterizes the volume, capacity, and coordination of runners' motor memory, which can be used to assess the psycho-emotional state of short distance runners. It varies depending on the readiness and experience of participation in competitions among short distance runners.



**Figure 4. Age dynamics of the general indicator of runners' motor memory during the main starts.**

Figure 4 shows that the age-related dynamics of the general indicator of motor memory tends to increase with age.

In the group of 16-17 year old runners, the initial motor memory index was  $8.41 \pm 2.21\%$ , and before the main start after pre-competition training it was equal to  $9.0 \pm 2.11\%$ .

In the group of 18-19 year old runners, the total motor memory index was  $9.31 \pm 2.31$  c.u., and before the main start after pre-competition training it was equal to  $10.6 \pm 2.45$  c.u.

In the group of 20-21 year old runners, the total motor memory index was  $12.21 \pm 2.41$  c.u., and before the main start after pre-competition training it was  $13.4 \pm 2.09$  c.u.

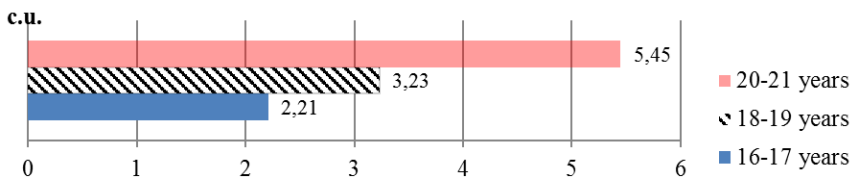
In diagnostics, the indicator of the coefficient of coordination of the flexor and extensor muscles of short-distance runners, the main thing is the need to perform movements at maximum speed while maintaining coordination of movements.

Figure 5 shows that the age-related dynamics of the coefficient of coordination of the flexor and extensor muscles in short-distance runners tends to increase with age.

In the group of 16-17 year old runners, the initial indicator of the coefficient of coordination of flexor and extensor muscles was  $3.21 \pm 2.01$  c.u., and before the main start after pre-competition training it was  $2.0 \pm 2.11$  c.u.

In the group of 18-19 year old runners, the initial indicator of the coefficient of coordination of the flexor and extensor muscles was  $3.27 \pm 2.41$  c.u., and before the main start after pre-competition training it was  $19.4 \pm 2.07$  c.u.

In the group of 20-21 year old runners, the initial indicator of the coefficient of coordination of flexor and extensor muscles was  $4.27 \pm 2.41$  c.u., and before the main start after pre-competition training it was  $5.45 \pm 2.57$  c.u.



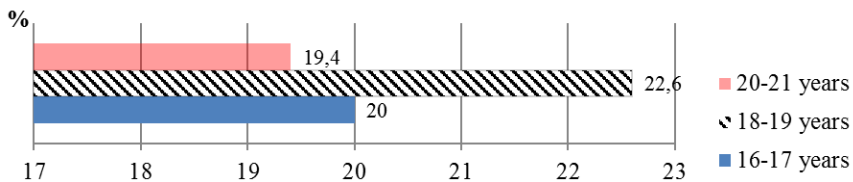
**Figure 5. Age-related dynamics of the indicators of the coefficient of coordination of the flexor and extensor muscles of runners during the main starts.**

Figure 6 shows the age-related dynamics of the runners' tempo sense coefficient during the main starts.

In the group of 16-17 year old runners, the initial indicator of the tempo sense coefficient was  $19.41 \pm 3.31$  c.u., and before the main start after pre-competition training it was equal to  $20.0 \pm 2.11$  c.u.

In the group of runners 18-19 years old, the initial indicator of the coefficient of the sense of pace was  $19.31 \pm 2.51$  c.u., and before the main start after pre-competition training it was  $22.6 \pm 2.03$  c.u.

In the group of 20-21 year old runners, the initial indicator of the tempo feeling coefficient was  $18.21 \pm 1.41$  c.u., and before the main start after pre-competition training it was  $19.4 \pm 2.07$  c.u.



**Figure 6. Age-related dynamics of the coefficient of the runners' sense of pace during the main starts.**

The results obtained, characterizing the psychoemotional state of short-distance runners, can be used to model the characteristics of the psychoemotional state of runners, taking into account age. The data presented is based on repeated studies in each age group of short distance runners. It is noted that, provided that the results are less than the presented range of indicators by age, then there is a low level of manifestation of the state of mental readiness before the start.

In the future, we will develop a three-dimensional model of the state of mental readiness of short-distance runners in the age aspect.

### **Conclusion**

Thus, the psycho-emotional state of short-distance runners depends on the age and stages of pre-competition training.

Taking into account the model level of the runners' fitness allows planning training in different zones of intensity and orientation.

The requirements for the preparedness of short-distance runners are becoming higher every year, and the range of permissible model values is getting narrower.

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**STRUCTURAL AND MODAL FEATURES OF INDIRECT  
INTERROGATIVE SENTENCES IN ANCIENT GREEK AND THE  
GREEK LANGUAGE OF THE GOSPELS**

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**Abstract.** *The article examines the structural and modal features of indirect interrogative sentences in ancient Greek and the Greek language of the Gospels (Koine) and analyzes the variants of their interpretation into Russian. In the course of the study, it is possible to establish that both in ancient Greek and in the Greek language of the Gospels, indirect-interrogative adjectives were more often introduced by interrogative and indefinite-interrogative pronouns, but in the late Koine, many of these conjunctive words gradually fall out of use. The tendency to lose a number of indirect interrogative conjunctive words can be explained by the translated nature of the Gospels (not all texts were originally written in Greek), the stylization of the narrative under the "book" style (in folk speech, multifunctional semantic conjunctions and conjunctive words are rarely used due to the difficulty of perceiving the meaning of the utterance), as well as the author's lack of clear differentiation of conjunctions and conjunctive words by meaning (Greek was not his native language). The gradual replacement of relative polyfunctional pronouns and pronominal adverbs in indirect interrogative constructions with interrogative ones could only be carried out in those languages of the Indo-European family that distinguish the grammatical forms of interrogative and relative pronouns. This tendency to replace conjunctive words at a certain stage of language development is caused by the need to differentiate complex sentences with attributive and object subordinate constructions by semantics.*

**Keywords:** *ancient Greek, Koine Greek, the gospel of the indirect interrogative sentences.*

**Introduction**

Indirectly interrogative subordinate clauses are single-term constructions, since, like all explanatory subordinate clauses, verbs, verbal nouns

and impersonal expressions with the meaning of *speaking, perception, thought* and *feeling* are explained in the main part. This is a special category of complex sentences, the subordinate clauses of which are introduced not by unions, but by union words with interrogative semantics: *who, what, where, when, where, where from*, etc. In complex sentences with union words, the subordinate clause, as a rule, has the meaning of an indirect question : I ask *who this girl is and where she came from*. Such constructions are widely used in both ancient and new Indo-European languages.

**Purpose of the article** – is study of the structural and modal features of indirectly interrogative sentences in the ancient Greek language and the Greek language of the Gospels (Koine) and analyze the options for their interpretation into Russian.

In *ancient* Greek, indirectly interrogative subordinate clauses were introduced "interrogative and indefinite interrogative pronouns, adverbs, as well as particles εἰ *if*, πότερον (εἰ ἄρα)...ἢ *if... or*, εἴτε *or ... or*. If the predicate of the governing sentence is used in the main tense, then in the indirect question the mood is retained, which would be if the question were direct, i.e. indicative or conjunctiva (less often optative); after historical times, there may be an optative. For instance: ἐρωτᾷ, τί ποιῆ *he asks what to do*; ἠρώτα, τί ποιεῖ (ποιούη) *he asked what to do*» [5, p. 73]. In Koine, the grammatical expression of indirectly interrogative constructions does not differ much from the classical ancient Greek sample. "In an indirect question, the same time and mood remains as it would be if it were used as a direct question, that is, an independent interrogative sentence" [4, p. 127].

As for union words that introduce indirectly interrogative subordinate clauses, in the language of the Gospels there is a predominance of *interrogative* pronouns and pronouns over *relative* ones [6, p. 79], many of which are gradually falling out of use. The fact is that in the ancient Greek language, pronouns (interrogative, indefinite, demonstrative and relative) and adverbs derived from them constituted one system of so-called "correlative" pronouns and adverbs. The *correlative* pronouns and adverbs of S.I. Sobolevsky calls words "that are in a mutual relation with each other in meaning (and partly even in form), so that one of them contains a question, and the rest contain pronominal concepts that answer this question. These words, in their grammatical meaning, can be nouns, adjectives and adverbs, and in their logical meaning they can be *interrogative, indefinite, demonstrative* and *relative*. So, for example, to the question: "What kind of bread do you want?" the following answers can be given, expressed

by pronoun adjectives: 1) "any" (indefinite); 2) "this" (indicative); 3a) "(the one) that lies on the table" (relative quotient); 3b) "(all), whatever you give" (relative general)" [6, p. 78]. Thus, according to their grammatical characteristics, relative pronouns and adverbs of the Ancient Greek language can be compared with demonstrative and attributive pronouns in Russian. Interrogative pronouns and pronominal adverbs of the Greek language, as a rule, were correlative pairs with their relative new formations. But if the former could be used both in direct and in indirect questions, the rest could only introduce indirectly interrogative constructions, and were more often used in the complex sentence with intrinsic-attributive clauses [5, p. 118]. Therefore, we believe that in the ancient Greek language at an early stage of the development of hypotaxis, a mixture of some types of attributive and object constructions could occur. However, already in classical ancient Greek, the process of differentiation of these types of subordinate clauses begins. In the Koine, in indirect questions, interrogative forms of pronouns and adverbs are mainly used.

I.V. Bazhenov notes a rather rare use of the relative pronoun ὅστις in the Gospel of John (each, which, who, whoever) [5, p. 79]. Instead of complex ὅστις, ὅτι (union, the main meaning - *what*) [3, p. 153], very often used in the classical language, in the Gospel of John there are τίς (who?), τί (what?) [3, p. 210] when dealing with indirect dependent questions [1, p. 286]. P. Chantrain also speaks of the gradual disappearance of complex forms of relative pronouns from the Greek language. "In the Koine ὅστις almost does not differ in meaning from the simple relative pronoun ὅς (which); its declension dies away, and we find in it only the nominative singular and plural forms" [7, p. 109].

The fate of the pronominal adverb ὅπως (no matter how, how) is interesting [6, p. 80], from which came the subordinate modal union ὅπως, which introduced target constructions and explanatory-object clauses with an unreal modal plan in the ancient Greek language. As we said in paragraph 2 of chapter 1 and in paragraph 1 of this chapter, in koine ὅπως gradually fell out of use. This pronominal adverb very rarely introduced indirectly interrogative clauses, where the preference was mainly given to the interrogative adverb-particle πῶς (how?) [3, p. 185]. Ὅπως in indirectly interrogative clauses it is sometimes found in the Gospel of Matthew, less often in the Gospel of Mark, and the main condition for the use of this union word is the presence in the main part of the complex sentence of a control predicate with semantics *to confer, to have a meeting*. For instance:

ἐξεληθόντες δὲ οἱ Φαρισαῖοι συμβούλιον ἔλαβον κατ' αὐτοῦ, ὅπως αὐτόν·

*ἀπολεσωσιν* [8, p. 29]. (The Pharisees, having gone out, *had a consultation* against Him, *how to destroy* Him [2, p. 13].) (Gospel of Matthew (12, 14).)

οἱ Φαρισαῖοι καὶ ἐξελθόντες εὐθέως μετὰ τῶν Ἡρῳδιανῶν *συμβούλιον ἐποίουν* κατ' αὐτοῦ, ὅπως αὐτὸν *ἀπολέσωσι* [8, p. 78]. (The Pharisees, having gone out, immediately made up a consultation with the Herodians against Him, *how to destroy* Him [2, p. 40].) (The Gospel of Mark (3, 6).)

At the same time, subordinate clauses with similar semantics in the governing verb with the meaning *to seek* (search for information) were introduced by the interrogative *πῶς*. For instance:

καὶ ἤκουσαν οἱ γραμματεῖς καὶ οἱ Φαρισαῖοι καὶ οἱ ἀρχιερεῖς, καὶ *ἐζήτουν πῶς* αὐτὸν *ἀπολεσωσιν* [8, p. 99]. (The scribes, (and the Pharisees), and the chief priests heard this, and *they were looking for how to destroy* Him [2, p. 52].) (The Gospel of Mark (11, 3).) This phenomenon can be explained as follows. The predicate *to have a meeting* on semantics is *final-objective* (there is a shade of purposeful action), therefore the use of the relative pronominal adverb ὅπως after it in the indirectly interrogative constructions of the Gospels can be considered a completely natural phenomenon.

### Conclusions

Based on the results of the analysis, it can be concluded that in both the ancient Greek language and the Greek language of the Gospels, indirectly interrogative subordinate clauses were more often introduced with interrogative and indefinite interrogative pronouns, but in the late Koine many of these allied words are gradually falling out of use. The tendency to the loss of a number of indirectly interrogative union words can be explained by the translated nature of the Gospels (not all texts were originally written in Greek), stylization of the narrative in the "bookish" style (in folk speech, polyfunctional semantic unions and union words are rarely used due to the difficulty of perceiving the meaning statements), as well as the author's lack of a clear differentiation of unions and allied words by meaning (Greek was not a native language).

The gradual replacement of relative polyfunctional pronouns and pronouns with interrogative in indirect interrogative constructions could be carried out only in those languages of the Indo-European family that distinguish between grammatical forms of interrogative and relative pronouns. This tendency to replace allied words at a certain stage of language development is due to the need for semantics differentiation of complex sentences with attributive and object subordinate constructions.



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## FEATURES OF THE STRUCTURE OF SEMI-PREDICATIVE CONSTRUCTIONS FOR EXPRESSING OBJECT RELATIONS IN THE OLD RUSSIAN LANGUAGE

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**Abstract.** *The article examines the structure of semipredicative constructions for expressing object relations in the Old Russian language and considers aspects of their evolution in the General context of the history of the Russian language. As a result, it is possible to establish that semi-predicative constructions with a participle in the accusative case (analogous to the Greek Accusativus cum participio) were actively used in the Old Russian language, especially in the initial period of development of the Russian hypotaxis. Such semi-predicative participial constructions were a detailed version of a complex complement, so they were familiar to the Russian language, in contrast to the infinitive constructions synonymous with them, which are syntactic calques from the Greek language. These constructions, despite all external changes in the participle system, have been preserved in modern Russian, and can now be used along with explanatory object adjectives. In "transition-type" adjuncts and explanatory-object constructions, the modal Union Yes was most often used out of all modal particle unions. It can rightfully be considered a universal subordinate Union that introduces several types of subordinate constructions with an unreal modal meaning.*

**Keywords:** *Old Russian language, object relations, semi-predicative constructions*

The system of participles of the *Old Church Slavonic* and *Old Russian* languages is more reminiscent of the Greek than the Latin system of participles (especially in relation to pledges). In the absence of future participle forms (which in other ancient languages were, as a rule, endowed with some additional modal shades), the participle in the Old Russian (as well as in the Old Church Slavonic [2, p. 95]) had four main forms (present and the past tense of the real and passive voice) and was a rather flexible verb

form in syntactic respect. Thus, the use of semi-predicative constructions with an accusative participle in the Old Russian language (an analogue of *Accusativus cum participio*), especially in the initial period of the development of Russian hypotaxis, was quite common.

**Purpose of this article** – is to investigate the features of the structure of semi-predicative constructions for expressing object relations in the Old Russian language and to consider aspects of their evolution in the general context of the history of the Russian language.

According to the observations of T.P. Lomtev, "constructions with the second accusative participle of the active voice in the meaning of the object with the verbs of thinking and mental perception, feeling and sensory perception were presented in various ancient Russian monuments" [3, p. 540]. Most often, such constructions are found with verbs *видѣти, слышати, зрѣти, чюти, вѣдати, мнѣти, сожалѣти*. (For example, *Изяславъ же слыша Гюргя пришедша* (= that Gyurgiy came) [3, p. 541].) Such semi-predicative participial constructions were not alien to the Russian language (in contrast to their synonymous infinitive constructions, which in translated works are, for the most part, syntactic tracing papers from the Greek language). Therefore, these constructions, with all external changes in the participle system, have been preserved in modern Russian, and at present they can be used along with explanatory-object clauses. (Я слышу поющую в небе птицу. = Я слышу, что в небе поёт птица.) The main difference in this area of the modern Russian language from Old Russian, in our opinion, is the reduction in the semantic series of predicates, in which these participial constructions could be used. In modern Russian, such participial constructions are used, as a rule, with predicates of *sensory perception*, while in Old Russian it was considered the norm to use object participial expressions also in predicates of *thinking and cognition*.

At present, such predicates for the most part require the expression of the characterized object not in the form of participial phrases, but in the form of subordinate constructions. In the Old Russian language, especially at the early stage of hypotaxis development, at first there was no such differentiation of the forms of expression of explanatory-object relations according to the semantics of the governing verb. However, "the constructions with the second accusative participle of the active voice, as well as participial expressions in the verbs of *perception, thinking and feeling*, were elements of the old quality and gradually died out. Subordinate clauses were an element of a new quality in these verbs" [3, p. 542]. Thus, in the Russian language, in the sphere of explanatory-object structures,

the formation of a certain structural type of complex sentence began, which could function as an alternative version of object participial structures and subsequently to a lesser (with predicates of sensory perception) or greater (with verbs of thinking) degree replace object participial phrases.

Before proceeding to illuminating the process of development in the Russian language of explanatory-object union structures, formed on the basis of object participial phrases in the accusative case, it should be remembered that such participial phrases were used in most cases after the predicates of *speech, thinking, cognition, sensory perception*. The predicates of this group, as a rule, are modally neutral and do not express the category of optativity, in contrast to the predicates of *desire* and *will*. Therefore, a judgment (in the form of a participle or in the form of a subordinate clause) after such modally neutral predicates is usually a statement of the real course of events, and not a "possible world" (an imaginary desirable or undesirable situation) of the subject of speech (thought, cognition, sensory perception, etc.). Consequently, the modal meaning of such constructions can be considered real by the semantics of the control predicate. At the same time, a small group of verbs that govern object infinitive constructions, similar to the Accusativus cum infinitivo turnover, were characterized by the semantics of *will*. Thus, the modal meaning of the subordinate structures formed on their basis was surreal.

Along with participial phrases in the accusative case, in the Old Russian language other constructions were also in use, capable of expressing explanatory-object relations. These were the "transitional type" constructions introduced by the modal union-particle *да*. These "subordinate clauses" were used after predicates expressing the category of optativity (predicates of *desire, expression of will, resistance, fear*). (Моляхъ тя да посмотриши свои дѣши.). Thus, the modal plan of such constructions was expressed in their very structure - the analytical form of the imperative mood.

In addition to the "transitional type" constructions, in the Old Russian language there were used subordinate constructions, where the modal union *да* was combined with the subjunctive mood or with the infinitive of the predicate verb. (Моляшеса стѣма да бы ицѣленіе рѹцѣ получила. Моляшеса, да бы ни оушима слышати [4, p. 620].) But, as in the Old Church Slavonic language, in Old Russian such explanatory-object subordinate clauses were less common than target subordinate clauses of a similar structure, and the subsequently formed union *дабы* was found in the explanatory-object subordinate clauses much less frequently [1, p. 337].

In the monuments of the Old Russian language, explanatory-object subordinate constructions with an unreal modal meaning could be introduced by the modal union *абы*. (И по томъ биша чоломъ князю великому Василию Дмитриевичу, *абы помогль* беднымъ псковичемъ в тошна времени [5, p. 310].) The modal union *абы* due to subsequent historical changes (the displacement of modal unions by semantic ones) has not survived in the Russian language. This union did not have much syntactic flexibility, since without a modal particle *бы* was not an independent subordinate union and could not be used in "transitional type" constructions. According to researchers of the history of the Russian language, explanatory-object clauses with the unions *абы*, *дабы* rarely go beyond the book style and in the subsequent development of the language die off [5, p. 310]. Other modal conjunctions-particles, introducing target clauses of the "transitional type", *отъ*, *амь*, were also used quite rarely in explanatory-object constructions.

### Conclusions

Thus, we can conclude that semi-predicative constructions with participles in the accusative case (analogous to the Greek *Accusativus cum participio*) were actively used in the Old Russian language, especially in the initial period of the development of Russian hypotaxis. Such semi-predicative participial constructions were an expanded version of a complex addition, so they were familiar to the Russian language, in contrast to their synonymous infinitive constructions, which are syntactic tracing copies from the Greek language. These constructions, with all the external changes in the participle system, have been preserved in modern Russian, and at present they can be used along with explanatory-object clauses. In the subordinate clauses of the "transitional type" and in the explanatory-object constructions of all *modal* conjunctions-particles, the modal conjunction *да* was most often used. It can rightfully be considered a universal subordinate union, introducing several types of subordinate constructions with an unreal modal meaning.

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**NEW APPROACHES TO DETERMINING THE TACTICS  
FOR THE TREATMENT OF PATIENTS WITH MALIGNANT  
NEOPLASMS**  
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**Abstract**

**Purpose** of this work – is to determine the definition of nutritional extinction and its characteristics in different phases of carcinogenesis, to show the role of consultation by a nutritionist in the choice of programs for personalized metabolic correction. **Materials and methods.** 107 patients with adenocarcinoma of the head of the pancreas (T3 and T4) were under observation. In addition to traditional methods, the nutritional status was assessed according to the parameters of the well-known personalized alimentary-volemic diagnosis and the main general metabolic syndromes (inflammatory, hypermetabolism-hypercatabolism, toxic-anemic, anorexia-cachexia). **Results.** The phases of nutritional extinction have been identified, in accordance with which original metabolic correction schemes have been developed. The effectiveness of the programs used, calculated by the NE degree, turned out to be significantly higher in comparison with standard solutions. The feasibility of using such a tactic was confirmed (in addition to traditional tests) by measuring metabolism in lysosomes (according to the analysis of cathepsin L levels using ELISA in the blood serum of the examined groups of patients). **Conclusions.** 1. When determining the tactics of nutritional treatment of cancer patients, it is advisable to distinguish phases of nutritional extinction, on the basis of which a differentiated metabolic correction should be carried out. 2. The role of nutritional counseling (along with consulting a surgeon and anesthesiologist)

makes it possible to clarify the strategy for treating patients with oncological pathology, and in some cases, to make adjustments in the choice of the nature of the surgical aid.

In the process of treating almost every oncological patient, at one stage or another, the issue of the possibility and feasibility of using a certain personalized tactics (surgical, palliative) is considered. The modern principle of choosing antitumor treatment is its individualization, depending on the pathomorphological and biological (molecular-genetic) characteristics of the tumor, as well as the characteristics of the patient's body. Every year, both new anticancer drugs are introduced into practice, and new technological approaches to the management of patients with malignant neoplasms in various phases of carcinogenesis are tested.

**Purpose** of this work - to determine the definition of nutritional extinction and its characteristics in different phases of carcinogenesis, to show the role of consultation by a nutritionist in the choice of programs for personalized metabolic correction.

**Materials and methods.** 107 patients with adenocarcinoma of the head of the pancreas (T3 and T4) were under observation. In addition to traditional examination methods (described in the "Clinical guidelines" approved by the All-Russian National Union "Association of Oncologists of Russia" in 2019-2020) [1-2,4], the nutritional status was assessed according to the parameters of the well-known personalized AVD (alimentary-volemic diagnosis) and the main common metabolic syndromes (inflammatory, hypermetabolism-hypercatabolism, toxic-anemic, anorexia-cachexia). Statistical processing - according to Statistic-15.

**Results.** Recently, patients who have not very low body weight (including not at all) have often been admitted to hospitals for surgical and chemotherapy, patients with various degrees of cachexia make up only about 10%. At the same time, about 30% of patients with altered parameters of protein-energy, volemic, electrolyte homeostasis need nutritional correction and support (NS). NS – is the process of providing adequate nutrition using methods other than normal food intake, including parenteral nutrition, tube (including enteral, stoma, etc.) nutrition, or a combination of both. But not everyone needs a complete set of NS environments. Thus, in the terminal phase, “patients do not die because they don’t eat, but they don’t eat because they die” (Cecily Saunders, 2005).

To diagnose this condition, a test procedure (rehydration, nutrition) is recommended. In nonterminal patients, in some cases, absorption is preserved to some extent, but intoxication syndrome is expressed, in some



patients - pain syndrome, etc. What are the criteria for choosing the volume of provision of differentiated (personalized) nutritional care for these different groups of patients?

Answering this question, we were able to identify 3 groups of patients with different levels of metabolic disorders, allowing us to determine the phases of gradual degradation of metabolic processes, which we designated as nutritional extinction (NE). The selection of groups, as mentioned above, is based on the criteria based on the well-known AVD and the main metabolic syndromes characteristic of cancer patients (fig. 1 and 2).

As a rule, phase 1 NE consisted of patients after surgical and combined treatment with nutritional deficiencies of 30-31 points on the AVD, phase 2 - patients with nutritional deficiencies of 32-34 points on the AVD with associated severe toxic-anemic syndrome, phase 3 - palliative patients with nutritional deficiencies of 35 or more points, incl. with a significant incidence of pain. Nutritional deficiency in these groups met the criteria shown in fig. 1.

In accordance with the allocated degrees, the treatment tactics are determined. At grade 1 NE, it is advisable to use nutritional support according to needs, as recommended by ESPEN; at grade 2 NE in the structure of nutritional support, it is necessary to use a detoxifying component (in particular, detoxification nutrition with special nutritional compositions, depending on the detoxification phase); at grade 3 - substitutional nutritional support with low-energy low-protein compounds in combination (fig. 3) with analgesic therapy and psychological support, which is consistent with the tactics described by K. Loser et al. [2013].

**Patients who have previously undergone radical surgical and/or complex treatment (grade 1)**

Decrease in VC and breathing reserves below 60% as a predictor of a difficult p/o period, secondary immunodeficiency of varying severity, decrease in heart ejection fraction below 50%, **3-8 points according to APACHE**,  
**Needs about 90 g/day of protein, energy requirement 2500-2600 kcal/day,**  
 Deficiency of circulating protein, unexpressed deficiency of somatic proteins, PIF and LSF are practically not determined by AVD **31-32 points,** etc.

30-31 points

**Patients who received only different chemotherapy regimens (grade 2)**

Intestinal insufficiency syndrome  
 In some cases, the presence of a stoma  
**Molecular markers** (increased lipolysis, increased catabolism of muscle protein with reduced synthesis in muscles), bioimpedansometry (OS and IV are preserved, PA is changed, the prognosis is doubtful)  
**Karnofsky scale** over 50  
**AVD over 33**  
**Endotoxiosis** (can be 1, 2 or 3 degrees, more often 2 degrees)  
**Needs about 3500-4000, protein needs 110-120g/day**  
 Hepatic-renal dysfunction of varying severity  
 Fluid deficiency  
 Decreased somatic protein  
 Decreased decrease in total lipids  
 Deficiency of iron, potassium  
 Severity 9-11 on the APACHE scale  
**INTOXICATION SYNDROME**  
**PATIENTS** with high NRI, hepatic dysfunction, survival up to 3-4 years **(34 points according to AVD criteria)**

32-34 points

**Extremely severe patients receiving palliative care (grade 3)**

Fluid growth in the tissue sector (**OS and IV growth, PA high, low ACM = negative forecast**)  
 Deficiency of circulating potassium, magnesium, zinc  
**REFRACTIVE CACHEXIA**, decrease in total lipid mass, somatic protein, visceral protein  
**Toxic-anemic syndrome**  
 Hepatic renal failure  
**Severity 12 and > according to APACHE**  
**Protein requirements 70-78 g/day**  
**Energy requirements 1200 - 1300 kcal/day**  
 Intestinal insufficiency syndrome (violation of the activity of the intestinal microbiota, suppression of the digestive-transport function, in some cases - the presence of stomas)  
 Karnofsky scale of **40 or less**  
 Molecular markers (MIF: is high when LSF is normal)

36 or more points

**Fig.2 Characteristics of the main general metabolic syndromes in oncology [3].**

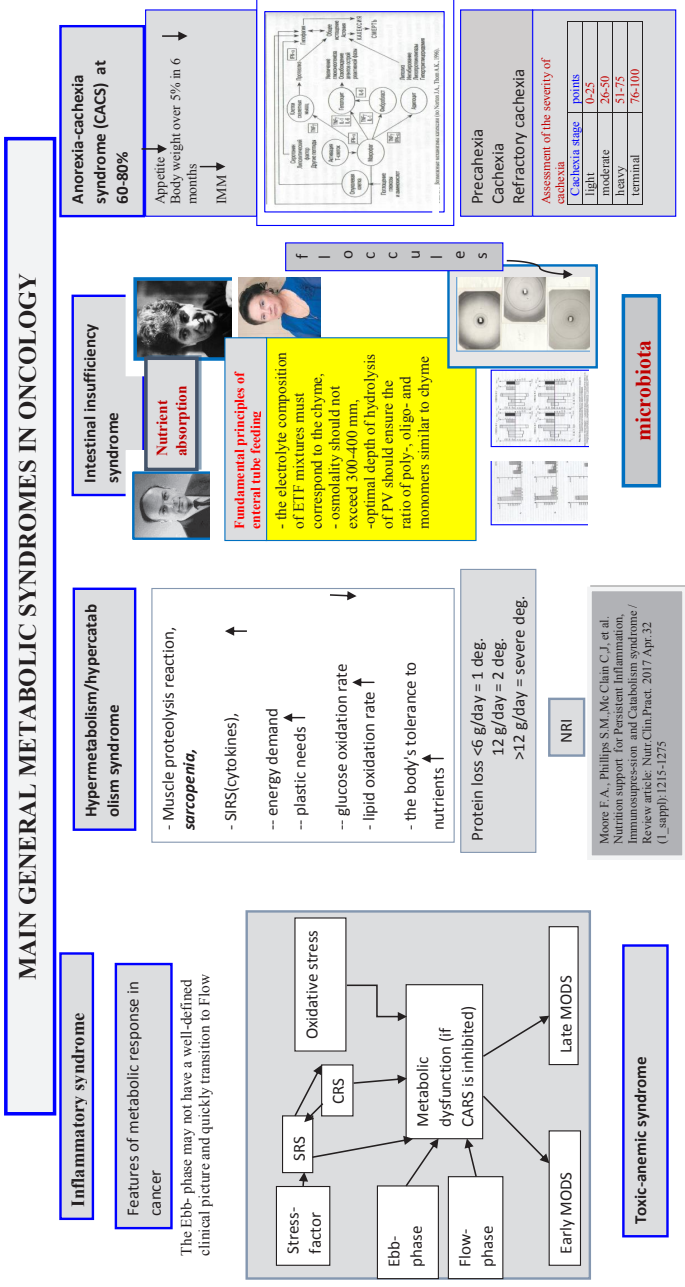
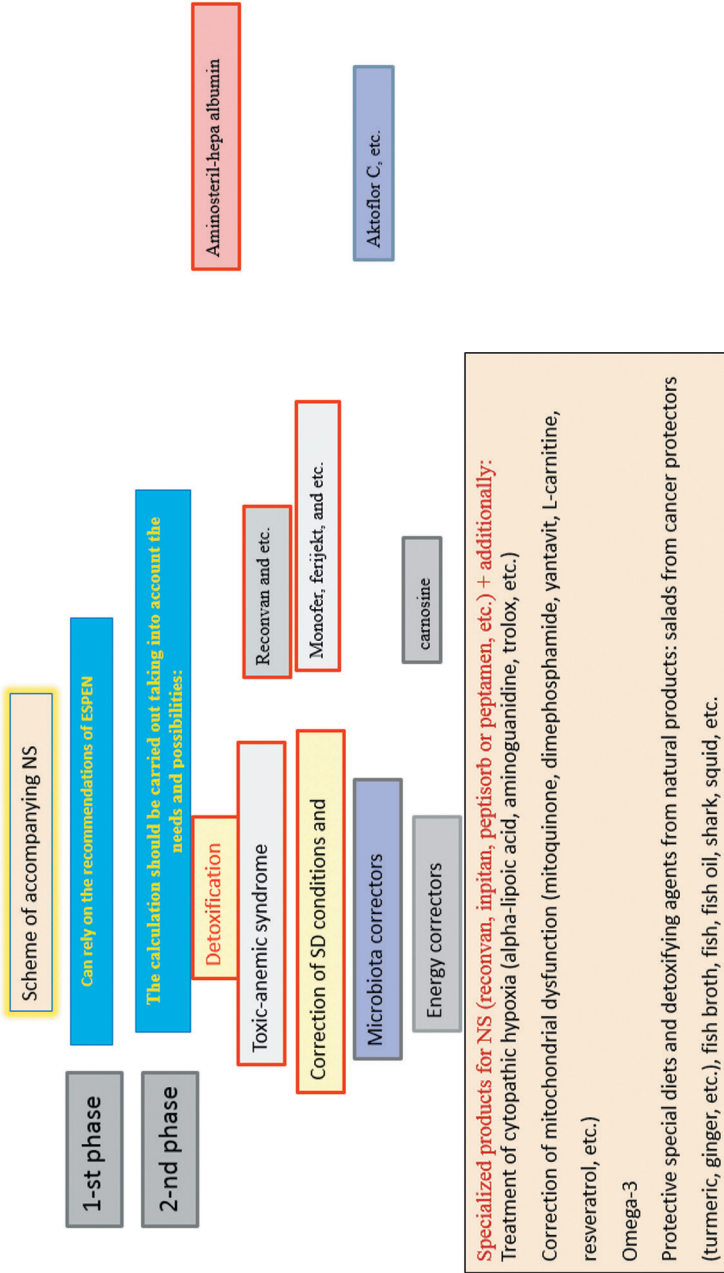


Fig.2 Characteristics of the main general metabolic syndromes in oncology [3].



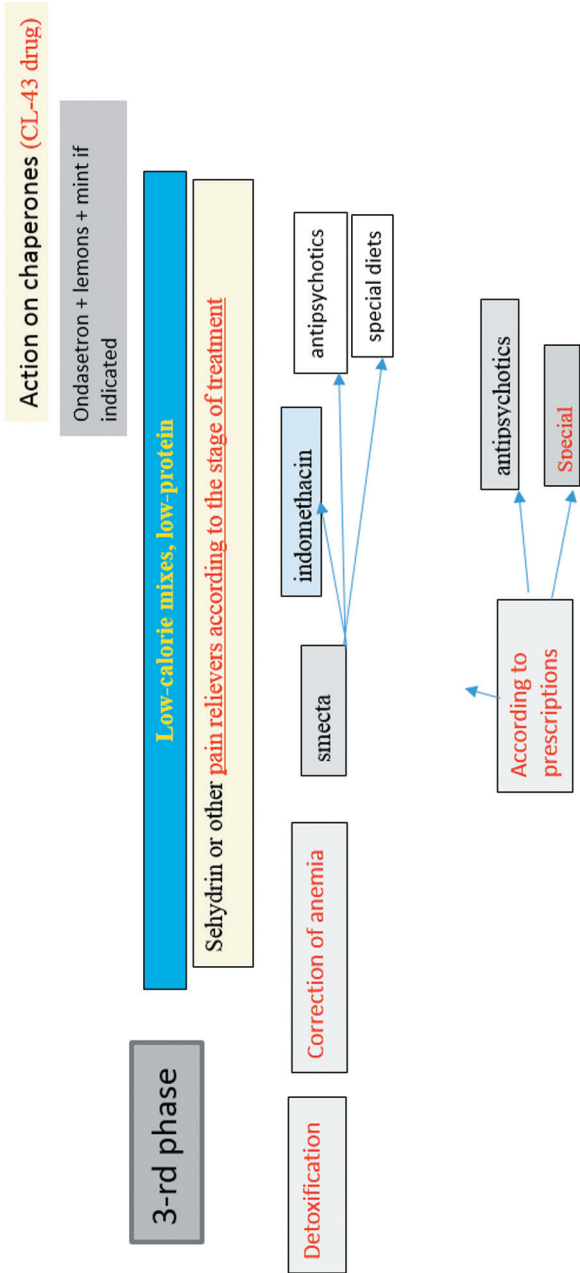


Fig. 3. Approximate NS schemes depending on the phases of the NE.

To ensure such a personalized-group approach, not screening, but complete diagnostics of nutritional status disorders provided by a nutritionist specialist was especially relevant. In this regard, the goal of the second part of the work was: to show the need for metabolic counseling (consultation of a nutritionist) already in the preoperative period, which can limit the choice of the nature of the surgical intervention. Were selected two groups of patients with adenocarcinomas of the head of the pancreas in stages T2N0M0, T2N1M0, T3N1M1, T4N0M1, respectively, made up two groups (who underwent neoadjuvant consultation only by a surgeon and anesthesiologist and who consulted a surgeon and anesthesiologist). Patients of the first group (25 people) underwent preoperative consultation with an anesthesiologist and surgeon. The second group of patients (11 people), in addition to consulting an anesthesiologist and a surgeon, was examined by a nutritionist. The operational, anesthetic and nutritional risks were assessed for all of them according to standard methods and the treatment tactics were determined, taking into account, incl. nutritional risk. It turned out that in the second group the postoperative period proceeded more easily, with fewer surgical and metabolic complications, and 1.5 times less bed-day. At the same time, operational and anesthetic risks did not always correlate with nutritional risk (NR). In this regard, NR in the preoperative period becomes a very significant indicator, and its determination is mandatory. It should be noted that bioimpedance data characterize the state of water sections, PA (phase angle) and active body weight and correlate with the biochemical characteristics of metabolic status and metabolic risk, which makes it possible to quickly verify the program of neoadjuvant nutritional correction, depending on the degree of nutritional extinction, which determines the possibility of choosing the nature of treatment (surgical, combined, palliative).

Consequently, the role of neoadjuvant metabolic counseling for patients with oncopathology is very significant, and neoadjuvant nutritional correction and nutritional counseling are an obligatory component of the treatment of patients with cancer.

The effectiveness of the programs used, calculated by the NE degree, turned out to be significantly higher in comparison with standard solutions. The feasibility of using this tactic is confirmed (in addition to traditional tests) by measuring [5] metabolism in lysosomes (according to the analysis of cathepsin L levels using ELISA in the blood serum of the considered groups of patients). The relationship between cathepsin L (an early marker of lysosomal damage) and the risk of developing nutritional and metabolic changes in colorectal cancer and pancreatic adenocarcinoma turned out to be significant. Changes in the concentration of cathepsin L in the blood

before adjuvant chemotherapy correlated in 86% with liver lesions (hepatomegaly, hepatosis, an increase in ALT and AST, fibrosis, cirrhosis, end-stage hepatic failure), in 87% - with the cardiovascular system (dyslipidemia, increased risk cardiovascular diseases), in 22% - with intestinal damage (malabsorption, decreased activity of intestinal enzymes), in 36% - spleen (splenomegaly, anemia, thrombocytopenia). The NR (nutritional risk) was high. After combined treatment under the cover of nutritional correction in patients in the 1st and 2nd stages of NE, despite a slight decrease in nutritional parameters, NR was moderate or did not change, and cathepsin L in 69% of cases was close even to the target values (in 1 stage NE), tended to decrease in 25% (in patients with stage 2 NE), and remained elevated in 6% (patients in stage 3 NE and partially, in 15%, in stage 2 NE). Changes in the level of cathepsin L under the influence of a combination of surgical and CT treatment also correlated with BIM data (the growth of total and extracellular water is prognostically unfavorable, and the level of cathepsin L is extremely low). This indicates the effect of cathepsin L on the metabolic activity of lysosomes with the subsequent breakdown of nutrient components. Cathepsin L can serve as an early marker of nutritional dysfunction and another marker for determining the management tactics for cancer patients. It also serves as a marker of poor nutritional support (NS) and monitoring the effectiveness of treatment.

**Conclusions.** 1. When determining the tactics of nutritional treatment of cancer patients, it is advisable to distinguish phases of nutritional extinction, on the basis of which a differentiated metabolic correction should be carried out.

2. The role of nutritional counseling (along with consulting a surgeon and anesthesiologist) makes it possible to clarify the strategy for treating patients with oncological pathology, and in some cases, to make adjustments in the choice of the nature of the surgical aid.

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## CIRCADIAN RHYTHM OF BODY TEMPERATURE DURING TOXEMIA OF BURN DISEASE IN ADULTS

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**Abstract.** *The authors revealed the most pronounced burns in area and depth in patients of group 1 at the age of  $27.3 \pm 5.6$  years. The highest IF index in group 1 determined the longest duration of intensive care in ICU. Fluctuations of the mesor of the circadian rhythm of body temperature occurred in waves in a circadian rhythm during the period of toxemia in all patients. In group 1, a tendency towards an increase in the mesor and an increase in the amplitude of daily fluctuations in the circadian rhythm of body temperature indicate an increase in the likelihood of septic complications after 10 days of intensive therapy. An inadequate response with insufficient consistency of compensatory mechanisms to burn stress was revealed in patients of group 3 ( $71.3 \pm 7.0$  years) with a relatively less severe burn injury. A significant difference in the temperature response in the circadian rhythm throughout the entire period of toxemia was found between the first and third age groups.*

**Keywords:** *circadian rhythm of body temperature, toxemia, adult burn disease*

**Relevance.** The period of adulthood is the longest period of a person's life, in which, as a rule, three stages or sub-periods are distinguished. This is the period of early adulthood (20 to 40 years old), middle adulthood (40 to 60 years old) and late adulthood (60 years and older). Each of the above age periods has its own characteristics and specifics. Other authors distinguish between the mature age period I (22-35 years old men, 21-35 years old women). The circadian, bicircadian, weekly, seasonal, and other rhythm of physiological functions is of prime importance. The variability in the rate of development, and then aging, is largely determined by hereditary (genetic) factors, environmental conditions (general ecological, associated with occupational and household hazards), social conditions, and bad habits (smoking, alcoholism, drug addiction). Mature age II period



(36-60 years old men, 36-55 years old women). Maturity itself. Between the ages of 30 and 50, body length remains constant, and then gradually begins to decrease. In this age period, there is a continuation of optimal social activity. Elderly (61-74 years old men, 56-74 years old women) age. Senile (75-90 years old) age. During these periods, there are gradual involutions changes in the body. There is a disintegration of body functions at all levels of the organization. Structural and functional changes in the central nervous system, and at the end of the stage, bright signs of "mental aging" are common. Age-related changes in the adaptive and regulatory mechanisms of the body take place in three stages: maximum stress to maintain the range of adaptive capabilities; decrease in reliability: the adaptive capabilities of the organism decrease while maintaining the level of basic metabolism and functions; decreased basal metabolism and body functions and a sharp limitation of the range of adaptability [1,2].

It is known that burn disease develops in 10% of deep burns, 20% of superficial burns. The period of toxemia begins in a few hours or during the first day after getting a burn. Along with the pain factor during this period, the phenomena of intoxication of the body come to the fore. There is a violation of protein metabolism, which is due to the loss of plasma and the breakdown of protein in various tissues of the body, even at a remote distance from the burn site. The toxic effect is enhanced by the absorption of bacterial toxins and tissue decay products from the burned tissues. The duration of toxemia depends on the severity of the lesion and the general condition of the body. With severe burns, it lasts 10-15 days and can imperceptibly turn into septicotoxemia. Usually, the beginning of the period of toxemia coincides with the onset of fever in the patient, and the end with clinically pronounced suppuration of the burn wound [3].

Due to the lack of information on the differentiated assessment of the severity of the condition, the characteristics of the stress reaction of hemodynamics, the respiratory system and other systems of homeostasis, the determination of the prognosis depending on the characteristics of the organism in different age periods, we considered it necessary to study the data of monitoring the systemic inflammatory response, hemodynamics, to identify the features inherent in age-related groups, including old age, in order to improve the effectiveness of treatment, optimize the prognosis.

**Purpose of the work.** Study the circadian rhythm of body temperature during the period of adult burn disease toxemia.

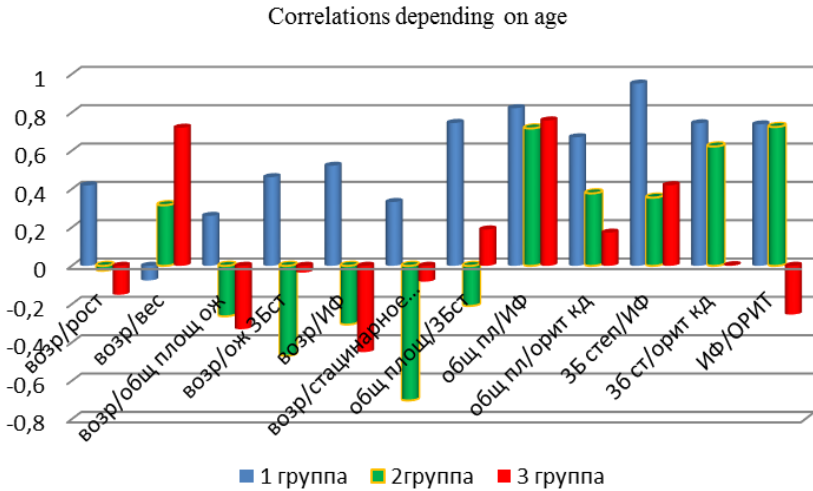
**Material and research methods.** The results of monitoring the temperature index, hemodynamics, infusion therapy of 25 patients admitted to the department of combustiology of the republican scientific center of

emergency medicine due to burn injury were studied. After excretion from the cheek, anti-inflammatory, antibacterial, infusion therapy, correction of protein and water-electrolyte balance disorders, early surgical, delayed necrectomy, additional parenteral nutrition, syndromic, symptomatic therapy were carried out. The systemic inflammatory response was studied by monitoring the hourly continuous recording of body temperature in patients with severe thermal burns in three age groups - group 1 - 12 patients aged 20-40 years, group 2 - 7 patients aged 41-60 years, group 3 - 6 patients - 61 -78 years old. The division into groups was dictated by the well-known features characteristic of each age group, described in detail in the literature.

**Table 1**  
**Patient characteristics (25)**

	<b>Age, years</b>	<b>Height, cm</b>	<b>Weight, kg</b>	<b>Total burn area, %</b>	<b>Burn of 3B grade</b>	<b>IF, units</b>	<b>Days in the ICU</b>
Group 1	27,3 ±5,6	174,9 ±5,7	73,0 ±22,2	59,4 ±13,5	21,3 ±13,3	119,4 ±38,4	22,4 ±14,6
Group 2	50,7 ±7,1	165,8 ±6,3	73,8 ±14,3	54,3 ±16,5	11,9 ±8,9	92,5 ±20,8	13,3 ±2,4
Group 3	71,3 ±7,0	165,3 ±8,4	73,3 ±8,9	40,8 ±5,8	21,7 ±6,7	86,7 ±12,8	18,8 ±9,5

As can be seen from Table 1, the age groups were significantly different and averaged  $27.3 \pm 5.6$  years in group 1,  $50.7 \pm 7.1$  years in the second, and  $71.3 \pm 7.0$  years in the third. The total area and area of deep skin burn lesions did not differ significantly between the groups. The highest IF indicator was revealed in group 1, which determined the longest duration of intensive care in ICU in the youngest group. Thus, the most pronounced burns in terms of area and depth were found in patients in group 1.



**Fig.1**

As shown in fig. 1, in all age groups there was a direct relationship between IF and the total area of the burned surface of the skin, so in group 1 the positive correlation of the IF index and the total area of the burn surface was 0.822, in 2 - (0.717), in 3 - (0.758 ). The revealed reliably significant correlations characterized the direct dependence of the prevalence of more severe burn injury of grade 3 B in group 1 (0.745), the direct relationship between IF and the total area of the burn surface (0.822), the need for long-term monitoring of vital indicators and intensive therapy in ICU conditions (0.743) , direct dependence of IF on the burn area of 3B degree (0.9507). The found inverse relationship between the duration of inpatient treatment and age in group 2 (-0.702), apparently, is due to the severity of burn injury at a relatively young age.

Dynamics of the mesor of the circadian rhythm T during toxemia, depending on age

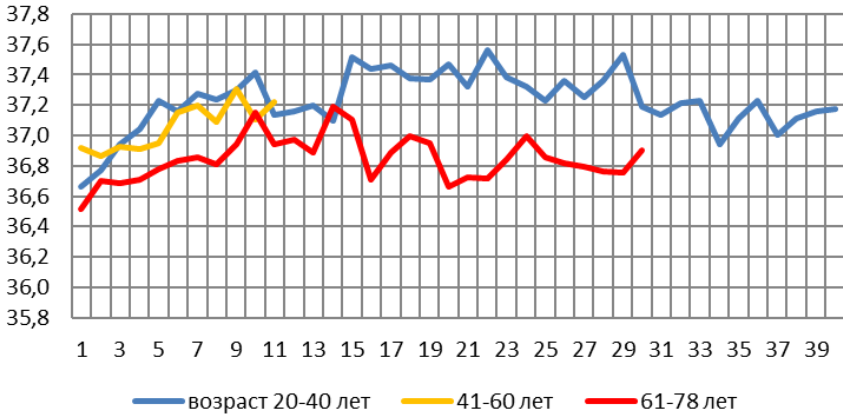


Fig.2

Changes in the mesor of the circadian rhythm of the temperature reaction during the period of toxemia occurred in waves (fig. 2). On day 1 in all patients, normal body temperature increased to maximum values in group 1 on day 10, in the second - on day 9, and in group 3 - on day 10. Near-week periods of fluctuations are traced in all patients.

Average temperature in the circadian rhythm during the period of toxemia depending on age

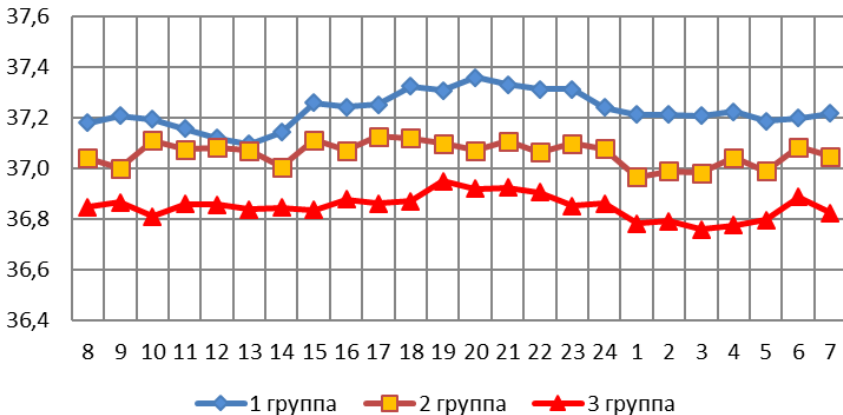
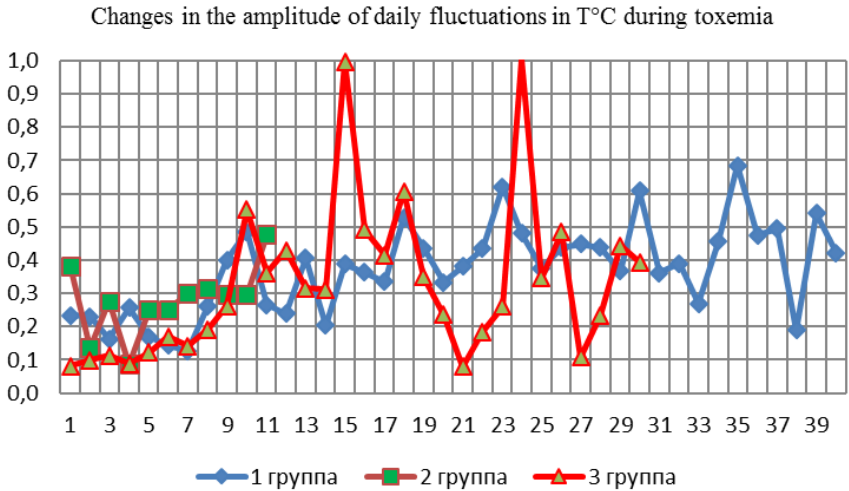


Fig. 3

A reliably significant difference in the temperature response in the circadian rhythm throughout the entire period of toxemia was found between the first and third age groups, which indicates significant differences in adaptive capabilities in burn disease of the age groups under consideration (fig. 3).



**Fig.4**

Fig. 4, the maximum amplitude of the circadian rhythm of the temperature reaction (1 °C) was revealed in patients of group 3 on days 15, 24, which was most likely due to an inadequate response to intoxication of the body due to insufficient consistency of compensatory mechanisms in conditions of depletion of the energy resources of patients 3 groups with a total area of skin burn injury of  $40.8 \pm 5.8\%$ , an area of damage of grade 3B of  $21.7 \pm 6.7\%$  and IF of  $86.7 \pm 12.8$  units (comparatively less pronounced burn injury from all groups under consideration). In group 1, the amplitude of the daily fluctuation of  $0.2^\circ\text{C}$  in the first three days gradually increased to  $0.7^\circ\text{C}$  on the 35th day, expressing a high risk of transition to septicotoxemia. With burns with an area of  $59.4 \pm 13.5\%$ , grade 3B  $21.3 \pm 13.3\%$ , I.F.  $119.4 \pm 38.4$  units in group 1, a tendency towards the increase of the mesor and an increase in the amplitude of daily fluctuations in the circadian rhythm of body temperature indicates an increase in the likelihood of septic complications after 10 days of intensive therapy.

The range of daily changes in T°C depending on age



**Fig. 5**

Changes in daily body temperature occurred almost synchronously in all groups (fig. 5). This revealed a direct strong correlation between the dynamics of the amplitude and the daily range of the circadian rhythm of body temperature in group 1 (0.7868), in group 2 the direct relationship was 0.9188, and in group 3 - 0.9261. The most significant daily fluctuations in body temperature were detected on days 15 and 24, which corresponded to the instability of homeostasis in group 3. Apparently, these periods are critical; they determine the advisability of additional corrective measures at the end of the second and third weeks of the toxemia period in elderly patients.

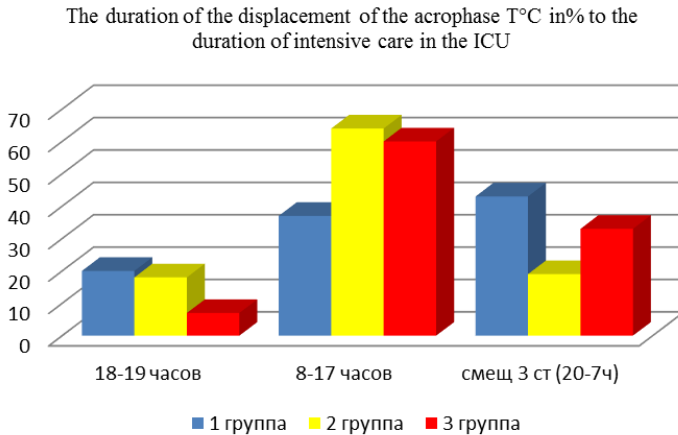


Fig. 6

The ongoing intensive therapy contributed to the maintenance of a moderate shift in the acrophase of the circadian rhythm of body temperature in all age groups (fig. 6) for 37% in group 1, 64% in the second and 60% of the duration of intensive therapy in ICU conditions.

**Conclusions.** The most pronounced burns in terms of area and depth were found in patients of group 1 at the age of  $27.3 \pm 5.6$  years. The highest IF index in group 1 determined the longest duration of intensive care in ICU. Fluctuations of the mesor of the circadian rhythm of body temperature occurred in waves in a circadian rhythm during the period of toxemia in all patients. In group 1, a tendency towards an increase of the mesor and an increase in the amplitude of daily fluctuations in the circadian rhythm of body temperature indicates an increase in the likelihood of septic complications after 10 days of intensive therapy. An inadequate response with insufficient consistency of compensatory mechanisms to burn stress was revealed in patients of group 3 ( $71.3 \pm 7.0$  years) with a relatively less severe burn injury. A significant difference in the temperature response in the circadian rhythm throughout the entire period of toxemia was found between the first and third age groups.

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**THE SEVERITY OF NEUROLOGICAL SYMPTOMS IN PATIENTS WITH THE CIRCLE OF WILLIS PATHOLOGY, DEPENDING ON THE LOCALIZATION OF CIRCULATORY DISORDERS**

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**Goal.** *To assess the severity of neurological symptoms in patients with ischemic stroke in various vascular basins under conditions of the circle of Willis pathology.*

**Materials and methods.** *45 patients were studied, including 21 men and 24 women, the average age was  $66.92 \pm 15.12$  with Willis' circle pathology, confirmed by magnetic resonance angiography in the acute period of ischemic stroke. All patients underwent a neurological study according to the National Institutes of Health Stroke Scale, an assessment of the Rivermead mobility index, and the Rankin disability assessment scale before and after treatment.*

**Results.** *Patients with ischemic stroke in the left middle cerebral artery basin had the highest National Institutes of Health Stroke Scale scores. Patients with pathology in the basin of the right middle cerebral artery showed the greatest changes according to the Rivermead and Rankin scales. After treatment, for pathology in the basin of the left middle cerebral artery, the greatest changes were preserved with positive dynamics according to the National Institutes of Health Stroke Scale. Assessment of indicators on the Rankin scale for pathology in the vertebrobasilar basin had the best results after treatment.*

**Conclusion.** *Patients with ischemic stroke in the basin of the left middle cerebral artery had significant changes in the pathology of the circle of Willis, in patients with pathology in the vertebrobasilar basin, significant changes after treatment according to the National Institutes of Health Stroke Scale, Rivermead and Rankin scales.*



**Keywords:** *acute cerebrovascular accident, magnetic resonance angiography, the circle of Willis pathology.*

**Introduction.** Vascular diseases of the brain are an urgent problem of modern medicine and determine its independent direction - angioneurology. In turn, cerebral strokes occupy the leading place in the structure of cerebrovascular pathology. This is due to the continuing trend towards their constant growth in the world [1]. Disruption of blood supply to the brain can be due to several factors. In situations where the abnormal configuration of the circle of Willis has caused serious blood flow disturbances, the pathology can be expressed by symptoms of a stroke with possible paralysis, paresis, impaired consciousness, fainting and other symptoms characteristic of this disease.

The compensatory capacity of the circle of Willis, which is the main intracranial collateral circulation pathway, depends on the presence of its constituent vessels [4,5] and the size of the vessels [6,7]. The classic version of the arterial circle is closed, has a symmetrical shape, which is formed by the following arteries: anterior cerebral, posterior cerebral, anterior connective, posterior connective, internal carotid (supra-wedge-shaped part). There are many options for the development of the circle of Willis. This can be tripling (trifurcation), aplasia, hypoplasia, complete absence of any arterial elements.

The influence of the circle of Willis, which is the primary collateral circulation, on ischemic stroke has attracted considerable attention [3]. The presence of an anomaly in the circle of Willis is a prerequisite for the development of hemodynamic ischemic stroke, especially in the presence of other concomitant factors (eg, stenosis or occlusion of the precerebral arteries) [2]. The severity of cerebral infarction correlates significantly with collateral circulation of cerebral arteries. Good collateral circulation allows timely reperfusion of blood flow to ischemic penumbra, which reduces cerebral infarction volume, minimizes neurological impairment, and improves prognosis.

**Materials and methods.** The aim of our study was to assess the severity of neurological symptoms in patients with Willis' circle pathology, depending on the localization of circulatory disorders in the acute period of ischemic stroke. We conducted a neurological status study according to the National Institutes of Health Stroke Scale (NIHSS) of 45 patients with acute cerebrovascular accident with Willis' circle pathology confirmed by MRA of the brain. The study involved 45 patients, the average age was  $66.92 \pm 15.12$ , of which 21 were men, 24 were women.

All patients underwent an assessment of the neurological status according to the NIHSS, assessment of the Rivermead mobility index, and the Rankin scale of disability assessment. The study group of patients on admission underwent MRI of the brain, MRA of the brain. Analysis of the stroke subtype revealed in 30 atherothrombotic stroke subtype, 4 cardioembolic, lacunar 6 patients, 5 were diagnosed with transient ischemic attack

All patients from the study group had pathology of the circle of Willis: absence of one PCA (31.2%) and both PCA (48.9%), absence of all connecting arteries (4.4%), anterior (4,4% ) and posterior trifurcation (11.1%).

Against the background of the treatment in dynamics, after 10 days, the neurological status was assessed according to the NIHSS, as well as a study in the dynamics of the data of the Rivermead mobility index and the Rankin scale.

Statistical processing was carried out using a two-way analysis of variance with repeated measurements (complex between-within ANOVA design) to assess the dynamics of each of the measured parameters in the sample as a whole and to assess the homogeneity of the dynamics of each of the measured parameters in the studied subgroups. To assess the dynamics of indicators within each of the studied subgroups, as well as for pairwise comparisons of the studied subgroups for each of the measured indicators separately before and separately after treatment, the Fisher LSD test was used. For contrast comparisons for each of the measured parameters, the Scheffe linear contrast analysis was used.

**Results.** The study group of patients in the course of the study was divided into three subgroups depending on the location of the violation of the blood supply to the brain, the data are presented in table 1.

**Table 1. Study group depending on the pool with impaired blood supply**

Name of the blood supply	Number of patients	
	Absolute amount	%
Posterior circulation	20	44,4
Right middle cerebral artery	11	24,4
Left middle cerebral artery	14	31,2

The number of patients in the vertebrobasilar basin constituted the largest subgroup in the amount of 20.

The data of the study group, depending on the results of the NIHSS, are presented in Table 2.

**Table 2. Contrast comparison of each NIHSS pool before treatment**

Name of the blood supply		NIHSS before				p-level
		Comparison group		Contrast group		
ID	Name	Average	Standart deviation	Average	Standart deviation	
{A}	Posterior circulation	4,900	4,327	7,840	5,352	<b>0,066</b>
{B}	Right middle cerebral artery	5,818	3,219	6,765	5,582	0,424
{C}	Left middle cerebral artery	9,429	6,223	5,226	3,939	<b>0,013</b>

The data in the table show that the greatest severity of the lesion was in patients with circulatory disorders in the left MCA basin ( $9.429 \pm 6.223$ ).

Rivermead mobility index was assessed in the studied subgroups, the data are presented in Table 3.

**Table 3. Pairwise comparison of Rivermead pools before treatment**

Name of the blood supply		Number of patients	Rivermead after		p-level		
ID	Name		Average	St deviation	{A}	{B}	{C}
{A}	Posterior circulation	20	5,300	4,181		0,819	0,886
{B}	Right MCA	11	4,909	4,182	0,819		0,930
{C}	Left MCA	14	5,071	4,827	0,886	0,930	

The Rivermead mobility index has significant changes in patients with circulatory disorders in the right MCA basin ( $4.909 \pm 4.182$ ).

The degree of disability according to the Rankin scale in various subgroups is presented in Table 4.

**Table 4. Pairwise comparison of the Rankin pools before treatment**

Name of the blood supply		Number of patients	Рэнкин до		p-level		
ID	Name		Average	St deviation	{A}	{B}	{C}
{A}	Posterior circulation	20	3,600	0,883		0,109	0,854
{B}	Right MCA	11	4,545	3,236	0,109		<b>0,099</b>
{C}	Left MCA	14	3,500	1,286	0,854	<b>0,099</b>	

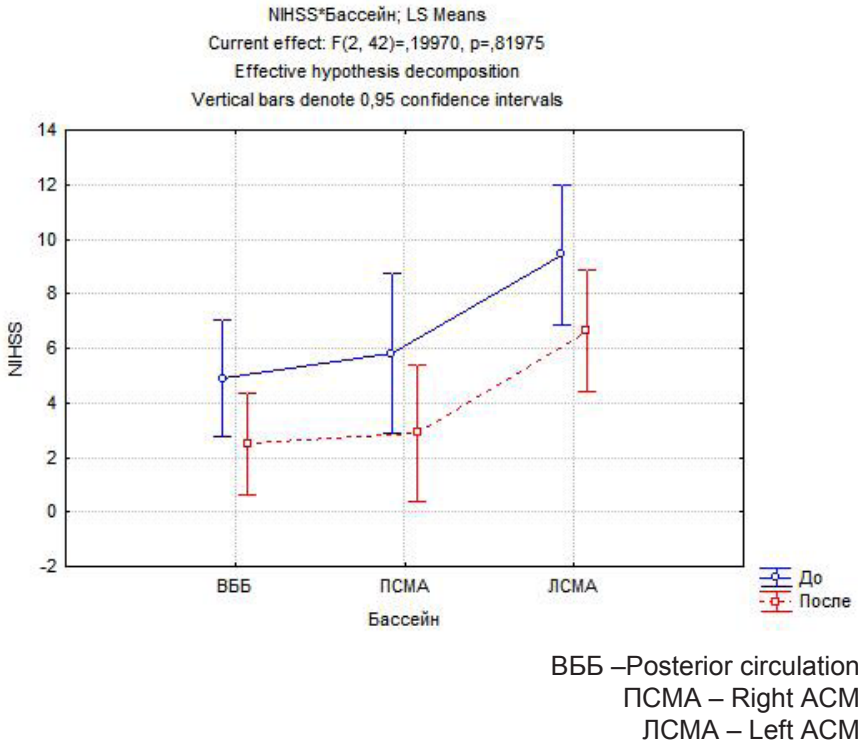
The degree of disability according to the Rankin scale is clearly shown in patients with dysfunction in the right MCA basin ( $4.545 \pm 3.236$ ).

In the dynamics against the background of the treatment, the neurological status was assessed according to the NIHSS data, the NIHSS data indicators are presented in the table

**Table 5. Dynamics of NIHSS at different localization of circulatory disorders**

Name of the blood supply		Number of patients	NIHSS				p-level
			Before		After		
ID	Name		Average	St deviation	Average	St. deviation	
{A}	Posterior circulation	20	4,900	4,327	2,500	3,364	<b>0,000049</b>
{B}	Right MCA	11	5,818	3,219	2,909	2,427	<b>0,000074</b>
{C}	Left MCA	14	9,429	6,223	6,643	5,773	<b>0,000203</b>
Sample as whole		45	6,533	5,088	3,889	4,427	<b>0,000000038</b>

The dynamics of neurological symptoms according to NIHSS in this study is shown for the entire study group: before treatment  $6,533 \pm 5,088$ , after treatment  $3,889 \pm 4,427$ ,  $p = 0.000000038$  with the preservation of significant changes in patients in the subgroup with impaired blood supply in the left MCA basin ( $6,643 \pm 5,773$ ).



**Fig. 1 Dynamics of NIHSS in different localization of circulatory disorders.**

In the study group of patients, positive dynamics was revealed in all subgroups. In the subgroup with impaired blood supply in the left ACM, in the presence of positive dynamics, significant changes in the NIHSS remained: before treatment  $9.429 \pm 6.223$ , after treatment  $6.643 \pm 5.773$ .

The assessment in the dynamics of the Rivermead mobility index was carried out in the studied subgroups, the data are presented in the table

**Table 6. Dynamics of Rivermid at different localization of circulatory disorders**

ID		Name	Number of patients	Rivermead				p-level
				Before		After		
				Average	St.deviation	Average	St.deviation	
{A}	Posterior circulation	20	5,300	4,181	11,900	4,038	<b>0,000000021</b>	
{B}	Right ACM	11	4,909	4,182	10,091	4,369	<b>0,00024</b>	
{C}	Left ACM	14	5,071	4,827	9,286	5,690	<b>0,00066</b>	
Sample as whole		45	5,133	4,294	10,644	4,725	<b>0,000000000402</b>	

Patients with impaired blood supply in the right MCA basin had good dynamics after treatment:  $10.091 \pm 4.369$ ,  $p = 0.00024$ .

Patients of the studied subgroups had the following indicators on the Rankin scale in dynamics (table 7)

**Table 7. Rankin dynamics at different localization of circulatory disorders**

ID		Name	Number of patients	Rankin				p-level
				Before		After		
				Average	St.deviation	Average	St.deviation	
{A}	Posterior circulation	20	3,600	0,883	1,700	1,031	<b>0,000087</b>	
{B}	Right ACM	11	4,545	3,236	2,273	1,104	<b>0,000395</b>	
{C}	Left ACM	14	3,500	1,286	2,429	1,505	<b>0,047</b>	
Sample as whole		45	3,800	1,841	2,067	1,232	<b>0,00000073</b>	

Patients in the subgroup with impaired blood supply in posterior circulation had the best results: before treatment  $3,600 \pm 0.883$ , after treatment  $1,700 \pm 1.031$ ,  $p = 0.000087$ .

**Discussion.** Patients in the acute period of ischemic stroke with Willis' circle pathology on admission had the highest number of points on the

NIHSS scale ( $9.429 \pm 6.223$ ) in the subgroup with impaired blood supply in the left MCA basin,  $p = 0.013$ . Assessment of the mobility index on the Rivermead scale revealed the greatest changes in patients with impaired blood supply in the right MCA basin ( $4.909 \pm 4.182$ ). The severity of the degree of disability (according to the Rankin scale) prevails in this study in patients with pathology in the right MCA basin ( $4.545 \pm 3.236$ ).

After treatment, after assessing the dynamics according to the NIHSS, positive results were revealed for all groups of patients,  $p = 0.0000000038$ . In the subgroup with impaired blood supply in the left ACM, with the greatest changes according to NIHSS, in the presence of positive dynamics, the greatest changes remained: before treatment  $9.429 \pm 6.223$ , after treatment  $6.643 \pm 5.773$ ,  $p = 0.0002$ .

In this study, patients with the maximum changes in mobility assessment on the Rivermead scale (before treatment  $4.909 \pm 4.182$ ) in the subgroup with impaired blood supply in the right ACM basin had good dynamics after treatment:  $10.091 \pm 4.369$ ,  $p = 0.00024$ .

Assessment of the indicators of the degree of disability (according to the Rankin scale) showed significant positive results for the entire study group: before treatment  $3,800 \pm 1,841$ , after treatment  $2,067 \pm 1,232$ ,  $p = 0.00000073$ . Patients in the subgroup with impaired blood supply in the posterior circulation had the best results: before treatment  $3,600 \pm 0.883$ , after treatment  $1,700 \pm 1.031$ ,  $p = 0.000087$ .

### **Conclusion.**

1. Patients with pathology of the circle of Willis have the greatest severity of neurological symptoms in vascular catastrophe in the basin of the left middle cerebral artery.
2. Patients with impaired blood supply in the vertebrobasilar basin have the best results after treatment (according to the NIHSS).
3. Patients with impaired blood supply in the vertebro-basilar basin in the presence of Willis circle pathology have the best results after treatment according to the Rivermead mobility index and the degree of disability according to the Rankin scale.

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## ANTIOXIDANT ACTIVITY OF ADAPTOGENS FOR CORRECTION OF ENVIRONMENTALLY RELATED HEALTH RISKS

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**Abstract.** *The research approach is based on the concept of oxidative stress as the root cause of various pathologies. To maintain and strengthen human health, it is necessary to enrich the diet with the help of high-tech food adaptogens, which combine antioxidants of various mechanisms of action. In this case, the functional potential of adaptogens must be reliably established. Currently, most food adaptogens are imported products. The consumer is forced to trust the manufacturers' declarations on the functional ability of the product. However, the effectiveness of these drugs is often low or nonexistent. The aim of the work was to screen the functional activity of biologically active micronutrients. The assessment parameter was the antioxidant activity of nutrients. Screening was performed using inhibitory chemiluminescence assay. Only 8 of 72 test objects were effective. The paper concludes that it is necessary to assess the adaptogenic properties of micronutrients using the Fenton reaction medium. The results of using a biogenic model using microvolumes of whole blood as sources of free radicals in vitro are discussed. The rate of change in the rate of formation of free radicals under the influence of adaptogenic nutrients reflects their effectiveness in preventing oxidative stress. Natural and artificial ecosystems are sources of raw materials for food adaptogens. The reserves and variety of plant materials in Siberia are quite large. Adaptogenic nutrients created during import substitution are proposed to be tested using chemiluminescence inhibitory assay.*

**Keywords:** *oxidative stress, adaptogens, nutrients, inhibitory analysis, chemiluminescence, antioxidants.*

Adaptogens are a chemically heterogeneous group of nutritional factors of natural or artificial origin. They are united by a functional feature,

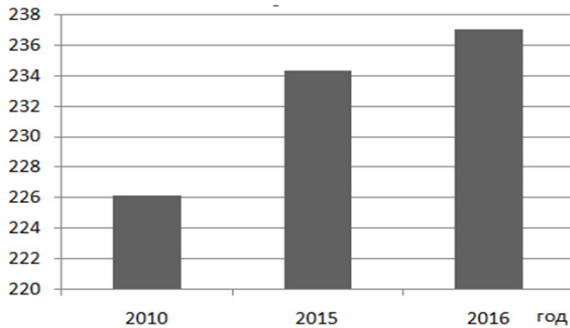
namely the ability to increase the body's nonspecific resistance to a wide range of harmful effects of physical, chemical and biological nature [1]. This effect is due to the ability of these compounds to inactivate exogenous and endogenous free radicals involved in the mechanisms of pathogenesis. Thus, adaptogens must exhibit antioxidant properties.

According to the FAO/WHO definition, health as an integral function is determined by a number of factors with different equity contributions. Lifestyle accounts for at least 50%. At least 20% is the contribution of physical, chemical and biological environmental factors. The rest of the contribution is provided genetically (20%) and socially (10% - the quality of medical care and support) [2]. Thus, the state of human health is mainly (70%) determined by the ecology and lifestyle.

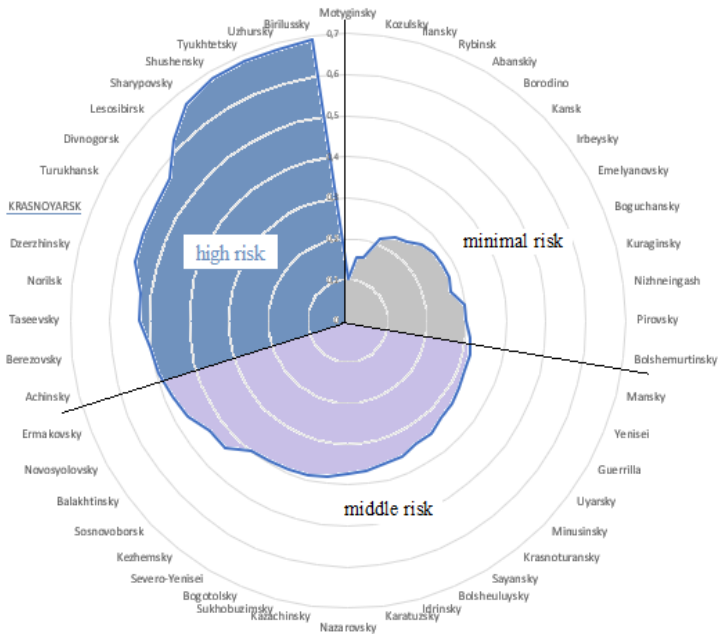
The center of the Krasnoyarsk Krai - Krasnoyarsk (population 1 million people) - is among the leaders in the anti-rating of cities with a high level of air pollution [3]. More than 90% of all air emissions are the result of the production activities of industrial giant enterprises. If at least "RUSAL", one of the industrial flagships, is excluded from this list, the rest of the enterprises will produce 70% of harmful pollutants [3] participating in the formation of pathogenetic syndromes. The factors that worsen the health of the Krai population include pulsating migration and redistribution of the population of rural and urban areas, uneven distribution of residential areas, increased emissions from the growing traffic flow, squeezing out natural landscapes with not always viable artificial plantations. The processes are taking place against the background of the increasing instability of weather and climatic conditions. As a result, a socio-economic background is formed, which reduces the quality of life of people [4]. This is confirmed by the analysis of statistical data of the territorial body of the Federal State Statistics Service for the Krasnoyarsk Krai [6]. Despite the implementation of departmental state and municipal health programs, the incidence rate of the population of the city of Krasnoyarsk is steadily increasing (fig. 1).

Compared to rural areas, the metropolitan area has a significantly higher prevalence of many diseases, including non-communicable ones. In an urban environment, dysadaptive syndromes are more acute and more severe. stressful diseases, fatigue and professional burnout [9]. Evolutionarily determined mechanisms of adaptation to environmental parameters turn out to be untenable under conditions of acute and chronic stress. As follows from the current analytical data of the Office of the Federal Service for Supervision of Consumer Rights Protection and Human Welfare in the Krasnoyarsk Krai (the Office of Rospotrebnadzor for the Krasnoyarsk Territory), of the 48 territories of the Krasnoyarsk Krai, 29% are characterized

by a minimal risk of general morbidity, 44% - moderate degree, and 27% - a high risk of morbidity (fig. 2).



**Fig. 1. Integral morbidity of the population for all major classes, groups and individual diseases; the ordinate axis is a thousand people (according to [7])**



**Fig. 2. Territories of Krasnoyarsk Krai with a significant excess of the indicator of the initially identified environmental-caused morbidity of the population (according to [8])**

The regional center, on the territory of which half of the entire population of Krasnoyarsk Krai is concentrated, belongs to the latter group [9].

Analysis of the contribution of various pathologies to the structure of the general morbidity of the population allows us to conclude that respiratory diseases are numerically dominant. This is consistent with the data of the environmental audit department of the Krasnoyarsk branch of the Federal State Unitary Enterprise State Center "Nature" on the increase in the integrated air pollution index (API) from 11.7 (2006) to 21.2 (2010) [10].

The functioning of any living systems is based on the processes of oxygen exchange. In the course of oxygen-dependent oxidation, chemically aggressive free radical metabolites are inevitably formed. Under the influence of air pollutants, chain processes are activated, endogenous antioxidant defenses are weakened, and as a result, the formation of free radicals is enhanced. This is a trigger for oxidative stress, which in turn triggers pathogenic mechanisms. Consequently, external influences aimed at inhibiting the production of free radicals, or reactive oxygen species (ROS), in the internal environment of the body, will increase the resistance of the human body to oxidative stress [11]. The most physiological approach to the implementation of such an external influence is functional nutrition. A characteristic property of functional nutrients is the ability to inactivate ROS and/or prevent the initiation of primary free radical reactions. The physiological consequence is an increase in the body's adaptability to the action of stress factors. Consequently, nutrients that contain antioxidants are adaptogens. The enrichment of the diet with adaptogens is a condition for functional nutrition.

Two decades ago, this problem was considered in Russia only in the aspect of the production of dietary and/or therapeutic and prophylactic food products. The concept of functional food products has spread in Russia along with the traditions of a healthy lifestyle, the theory and practice of healthy eating. Interest in biologically active food components and adaptogenic food supplements grew rapidly in the 90s and has not disappeared until now. In the foreign trade turnover of Russia, in the category of functional food products, imports traditionally dominate exports both in value and in kind [12].

However, the problem also has a downside. The share of functional products based on local raw materials remains unreasonably low, and the principles of import substitution in this area are often declarative in nature. This is largely due to economic reasons. It is difficult for startup initiators to compete with advanced high-tech industries.

At the same time, the contingent of consumers of these products is expanding independently of the real state of health, and sometimes contrary

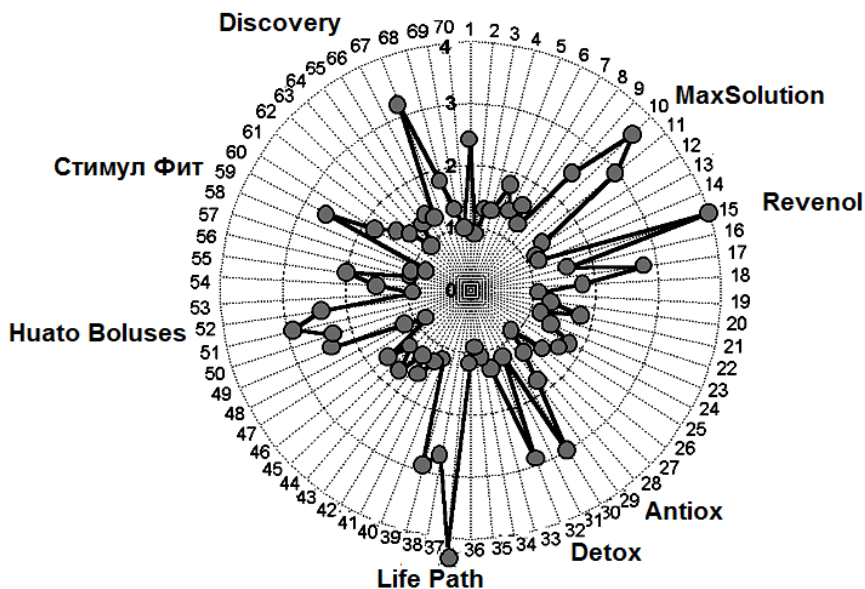
to common sense. This occurs in the absence of reliable statistics on the effectiveness of commercial drugs. Data is accumulating about the insufficiently high, and often completely absent, effectiveness of food additives, the properties of which are declared by manufacturers as adaptogens. At the same time, the preparations fully meet the requirements of sanitary and hygienic regulations, technical conditions and GOSTs, therefore it is almost impossible to substantiate consumer claims.

Therefore, the urgent task is the following. To assess the effectiveness of food adaptogens, it is necessary to use a fundamentally new methodology. The purpose of such an assessment should be not traditional static indicators of the quality and safety of a nutrient, but its ability to influence the kinetics of key metabolic reactions, primarily oxygen metabolism. Within the framework of the concept that defines the adaptogenic properties of a food object as its ability to prevent oxidative stress, antioxidant activity becomes one of the most informative indicators of the functional properties of a food component.

The aim of this work was to evaluate the antioxidant properties of a number of commercially available alimentary adaptogens using chemiluminescence analysis of the rate of free radical processes in a model where phagocytes of whole (undivided) human blood were a biogenic source of free radicals.

We used chemiluminescence analysis, which allows observing and measuring the parameters of the kinetics of ROS production by latex-stimulated phagocytes in human blood. The measurements were carried out on an automated complex "Biochemiluminometer 3606", the analysis method is described in detail [8]. This technology allows simultaneous in vitro testing of samples under uniform conditions, which ensures high reproducibility and accuracy of analysis. The measurement time was 90 minutes. The comparison parameters were the peak height ( $I$ , counts/s) and the time to reach it ( $T$ , s), as well as the light sum over the observation period ( $S$ , million counts).

Fig. 3 shows the results of inhibitory chemiluminescence analysis of 70 biologically active micronutrients, of which eight drugs had the ability to reliably reduce the amount of biogenic free radicals, of which only two samples are produced in Russia, and most are imported. The most active inhibitors of stimulated chemiluminescence of human blood were foreign drugs "*Antiox*", "*Detox*" ("*Vision*" USA), "*Revenol*" ("*Neways*" USA), "*Life Path*" ("*Enrich*", USA), "*Boluses Huato*" ("*Qixing*", Guangzhou, China) as well as Russian-made products "*Stimul Fit*" (CJSC Evalar, Biysk) and "*MaxSolution*" (OJSC "Siberian Health", Novosibirsk).



**Fig. 3. Multiplicity of reduction of activated blood chemiluminescence under the influence of high-tech commercial adaptogens**

These products are sold through a sales network. The analysis of information on the component set and the chemical composition of these nutrients was carried out using materials available in the public domain. It was found that despite the variety of brands, all biocompositions have the same chemical composition. Therefore, the manufacturers' claims about "originality" and "uniqueness of the formula" are more a marketing tool than a real characteristic. The active principle of all drugs was a complex of bioflavonoids with various trade and/or pharmaceutical names (pycno-enol, resveratrol, etc.) [2].

A rich and practically inexhaustible source of bioflavonoids has traditionally been the plants of the forest, forest-steppe and taiga zones of Siberia. Therefore, the results obtained in the work can be used to develop projects for the production of adaptogenic nutrients from local plant materials, which will give an undoubted economic, environmental and social benefit. A condition for the successful implementation of such areas is a mandatory assessment of the real adaptogenic effectiveness of the products obtained.

### Conclusions and suggestions

1. One of the physiological, affordable and economical ways to compensate and level the effect of oxidative stress initiators is the use of high-tech food adaptogens.
2. The source of phytoadaptogens can be the regional flora of natural ecosystems and agrocenoses, the plant potential of which is not fully and effectively used.
3. The urgent problem of assessing the adaptogenic activity of nutrients can be solved using inhibitory luminescence analysis, which provides rapid, informative and objective control of the antioxidant capacity of high-tech drugs.
4. The economic niches of biologically active products, which are currently being vacated due to the crisis and sanctions processes, can be filled with popular adaptogens from local raw materials, which are necessary to improve the health of the population as an important component of improving the quality of life in general.

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## **SURFACE CONTAMINATION WITH ANTIBIOTIC RESISTANT BACTERIA**

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**Abstract.** *The aim of this study is to assess the total microbial contamination of the most exploited surfaces. The objects of the study were public toilets, doorknobs, study tables in schools and universities, keyboards in computer labs, mobile phones of schoolchildren and students, and headphones. Among the isolated and identified microorganisms, Staphylococcus aureus, Escherichia coli, Enterococcus faecalis, Pseudomonas aeruginosa, as well as spore-forming bacilli (Bacillus spp.) were most prevalent. The largest number of microorganisms was found on keyboards, doorknobs, toilets and cell phones. The isolated bacteria have been tested for antibiotic susceptibility by disc diffusion, contributing to the development of an ongoing understanding of antimicrobial resistance in microorganisms. The isolated microorganisms, to one degree or another, had multiresistance to the studied antibiotics.*

**Keywords:** *surfaces, washes, microorganisms, quantification, antibiotics, resistance*

### **Introduction**

The microflora of surfaces is formed by air and contact microflora. Many surfaces, primarily modern glass and plastic materials, contaminate dust particles and aerosols due to accumulated static electricity. For example,

on the screen of computer monitors, keyboards and mice, telephones, faxes, copiers and folders, the total number of microorganisms can be higher than in public toilets. Among these microorganisms, there are pathogens of intestinal, skin, pulmonary, ophthalmic and other infections [1, 2].

Contaminated surfaces are an important factor in the contact spread of microorganisms. A biological film is very often formed on surfaces, which is an ecological niche of bacteria. The multicellular nature of the bacterial communities of biofilms protects microorganisms from various unfavorable environmental factors, and also forms bacterial resistance to antibiotics [3, 4]. Biofilms provide compatible conditions for horizontal gene transfer, such as high cell density, increased genetic competence, accumulation of genetic elements or uptake of resistance genes [5].

Antibiotic-resistant bacteria are a growing health and economic challenge as well as an economic one. For example, in Europe, health care losses amount to more than nine billion euros per year. In the United States, direct health care costs associated with antibiotic resistance exceed \$ 20 billion. Estimated costs of treating one patient with an antibiotic-resistant infection range from 18588 US dollars to 29069 US dollars [6, 7]. This determines the relevance and direction of this study.

### Research method

The objects of the study were public toilets, doorknobs, study tables in schools and universities, keyboards in computer labs, mobile phones of schoolchildren and students, and headphones. The quantitative registration of microorganisms (colony forming units - CFU) on the surfaces was carried out by the method of washes followed by sowing on solid nutrient media.

Determination of the sensitivity of bacteria to antibiotics was carried out by the diffusion method using discs with antibiotics (table 1).

**Table 1**  
**List of antibiotics used**

<b>№</b>	<b>Name</b>	<b>Designation</b>	<b>№</b>	<b>Name</b>	<b>Designation</b>
1	Ofloxacin	OF	8	Doxycycline	TLZ
2	Clarithromycin	KTM	9	Levofloxacin	DOC
3	Benzylpenicillin	PEN	10	Phosfomycin	LFC
4	Ciprofloxacin	CIP	11	Tobramycin	FOS
5	Cefoperazone	CPR	12	Optokhin	TOB
6	Novobiocin	NB	13	Tetracycline	OP
7	Tylosin	TLZ	14	Ampicillin	TETR

Statistical processing of the research results was carried out using classical methods of mathematical statistics and a Microsoft Excel spreadsheet.

**Research results**

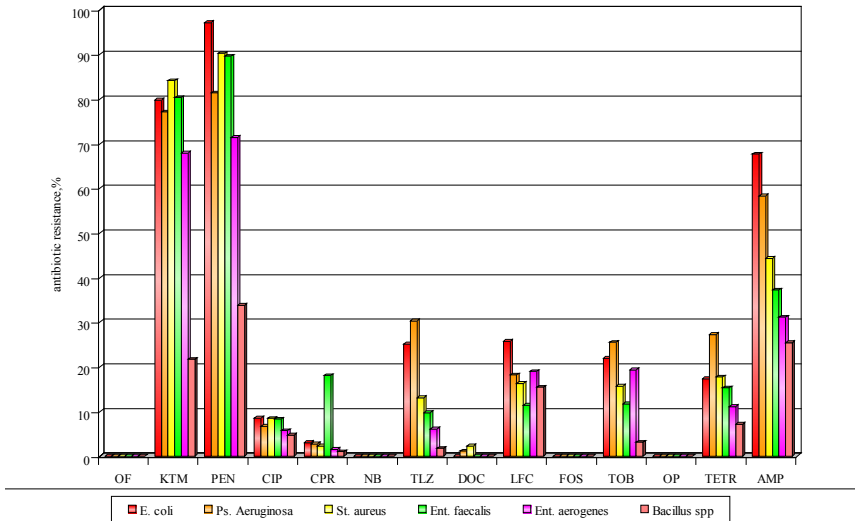
The largest number of microorganisms (138 CFU/cm<sup>2</sup>) was present on the surface of the keyboard of the computer classes. 122 CFU/cm<sup>2</sup>, 79 CFU/cm<sup>2</sup> and 95 CFU/cm<sup>2</sup> were seeded from the surfaces of door handles, toilets in schools and universities, and cell phones, respectively. The smallest number of microorganisms was on the surface of headphones and school desks (table 1).

**Table 1**  
**Bacterial contamination levels of various surfaces (CFU/cm<sup>2</sup>)**

Microorganisms	Toilet seats	Keyboards	Cell phones	Door-knobs	Headphones	School desks
E. coli	19,3±5,1	21,1±9,3	15,3±6,2	17,1±8,08	5,1±0,6	0
Ps. aeruginosa	17,1±3,4	19,2±8,6	9,7±4,6	11,2±5,9	0	0
St. aureus	7,7±2,5	35,4±3,7	23,2±8,3	19,9±6,1	7,5±1,8	5,0±2,3
Ent. faecalis	22,7±3,3	15,8±9,9	7,9±2,08	13,7±4,4	3,4±2,2	0
Ent. aerogenes	9,4±1,6	12,0±6,1	11,4±3,4	25,5±7,3	1,7±1,1	0
Bacillus spp	3,31±0,9	34,4±13,4	27,6±11,9	34,3±12,3	6,6±4,2	4,1±1,4

The microorganisms were most resistant to clarithromycin (21.7-84.1%), benzylpenicillin (33.8-97.1%) and ampicillin (up to 31.1-67.7%). They are followed by tylosin (1.7-30.3%), levofloxacin (11.4-25.7%), tobramycin (3.1-25.5%), tetracycline (7.1-27.2%) and ciprofloxacin (4.7-8.5%). Isolates of bacteria of the intestinal group (E. Coli, Ps. Aeruginosa, Ent. Faecalis, Ent. Aerogenes) and St. aureus showed the highest antibiotic resistance. (fig. 1).

The most effective antibiotics were ofloxacin, novobiocin, fosfomycin, and optoquin.



**Fig. 2. The level of resistance of microorganisms to antibiotics.**

**Conclusions**

1. Bacterial contamination of surfaces ranged from 9.1 to 138 CFU/cm<sup>2</sup>. The largest number of microorganisms (138 CFU/cm<sup>2</sup>) was sown from the keyboard surface of the computer classes. 122 CFU/cm<sup>2</sup>, 79 CFU/cm<sup>2</sup> and 95 CFU/cm<sup>2</sup> were seeded from the surfaces of door handles, toilets in schools and universities, and cell phones, respectively.
2. The predominance of representatives of the intestinal microflora on the studied surfaces indicates their fecal contamination.
3. Constant use of doorknobs, cell phones, keyboards contributes to the accumulation of microorganisms on their surface. These objects are the priority carriers of various microbes from person to person.
4. The isolated microorganisms, to one degree or another, had multiresistance to the studied antibiotics. Antibiotic resistance rates ranged from 1.1% to 97.1% for all isolates.
5. The microorganisms were most resistant to clarithromycin (21.7-84.1%), benzylpenicillin (33.8-97.1%) and ampicillin (31.1-67.7%). They are followed by tylosin (1.7-30.3%), levofloxacin (11.4-25.7%), tobramycin (3.1-25.5%), tetracycline (7.1-27.2%) and ciprofloxacin (4.7-8.5%). Isolates of bacteria of the intestinal group (E. Coli, Ps. Aeruginosa, Ent. Faecalis, Ent. Aerogenes) and St. aureus showed the highest antibiotic resistance.

6. Determining the number of antibiotic-resistant bacteria can provide insight into the ongoing development of antimicrobial resistance and improve hygiene behavior in school and college students.

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## EFFECT OF ECHINOCOCCOSIS ANTIGEN ON MORPHOMETRIC PARAMETERS OF THE LIVER IN WHITE MICE

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**Abstract.** *When studying the liver of white mice, which were injected with echinococcal antigen, significant changes in the morphological picture were noted: violation of the tract structure, diapedesis of erythrocytes, necrosis of hepatocytes, tissue edema, single accumulations of lymphoid cells. Based on the foregoing, we can conclude that the development of a preventive vaccine against echinococcosis is associated with certain difficulties (toxic effect on the liver).*

**Keywords:** *echinococcosis, antigen, tracts, hepatocytes*

### Relevance

The metabolic activity of echinococcus contributes to a fairly persistent pathological transformation of the host's target organs and numerous shifts in the immune-neuro-endokine system and the physicochemical properties of its biomedica. This, in turn, indicates the presence of rigidly defined changes in the body, which can be provided due to the presence of metabolic products of the parasite. Considering the above, we studied the effect of the echinococcus antigen on the parenchyma and blood circulation of the liver.

### Introduction

Echinococcosis (Echinococcosis) - helminthiasis from the group of cestodoses, characterized by the formation of parasitic cysts in the liver, lungs or other organs and tissues. Single-chamber echinococcosis caused by *Echinococcus granulosus* is less aggressive than multi-chamber (alveococcosis). The developmental cycle of both species takes place with a change of hosts - the sexually mature stage is localized in the intestines of canines, the larval stage in the parenchymal organs of numerous intermediate hosts of various species and humans. Parasitosis is widespread in nature everywhere, in the world the highest incidence of echinococcosis is noted in Australia, New Zealand, North Africa. Endemic foci of trichinosis are also observed in Kazakhstan, Ukraine, in the Central regions of the European part of the country of Russia, in the North Caucasus and the Arctic coasts. Due to the planned implementation of preventive medical and sanitary-veterinary measures in the Russian Federation, the incidence of echinococcosis is decreasing. However, there are endemic foci in the wild in all climatic zones. As a rule, hunting contributes to the infection with improper processing and skinning of killed animals and the collection of mushrooms and berries without a sanitary and veterinary examination. The disease is difficult to diagnose, and its treatment (surgical and therapeutic) is laborious and costly. As a result, the question of developing a vaccination scheme for echinococcosis is acute. However, there are no studies on the action of the echinococcus antigen on parenchymal organs. In connection with the above, the aim of the work was to study the effect of the antigen from protoscolexes of echinococci on the microstructure of the liver of laboratory animals [3-5].

### Materials and methods

For the experiment, female white outbred mice weighing 16-19 grams were used, which were formed into groups: control and experimental, 5 mice in each group. The mice of the experimental group were injected with the cellular antigen of echinococcus twice at a dose of 60 mg of protein in saline.

After the end of the experiment (on day 90) of the mice for histological studies after slaughter, liver pieces were taken from 5 mice of the experimental and 5 mice of the control group, which were fixed in 10% neutral formalin. The preparation of paraffin histological sections with a thickness of 5-7  $\mu\text{m}$  was carried out on an MS-2 sled microtome according to the classical method (Merkulov G.A.) [5]. Sections were stained with Mayer's hematoxylin and eosin. The morphometry of the area and perimeter of the central and sublobular veins, the area and perimeter of the sinusoidal space were performed. The arithmetic mean (M) was calculated: the area and perimeter of the central and sublobular veins. Statistical analysis of the obtained digital data was carried out using Microsoft Office Excel 2015. Then, the significance of differences between the control and experimental groups was calculated at  $p=0.05$  and  $p=0.01$ , Student's t-test is aimed at assessing the differences in the mean values of the two samples, which are distributed over normal law. Photos and morphometric measurements were made using the Vision Bio system (Epi 2014) with automatic signal processing and display. The work was carried out in compliance with the international principles of the Helsinki Declaration on the humane treatment of animals, the principles of humanity set forth in the directive of the European Community (86/609/EC), "Rules for conducting work with the use of experimental animals" [2, 6].

### Research results

In a morphometric study of the liver, it was found that the area of the central vein in the experiment was 2 times ( $P \geq 0.01$ ) larger than in the control, and compared with the sublobular vein by 9 times ( $P \geq 0.01$ ). The area of the sublobular vein in the experimental group was reduced by 1.5 times compared with the control. The area of the sinusoidal space remains equal. (table 1). In the morphological picture, a violation of the tract structure, diapedesis of erythrocytes, necrosis of hepatocytes, tissue edema, and single accumulations of lymphoid cells were noted (fig. 1-4). The above changes, especially hepatocyte necrosis, indicate the toxic effect of the antigen on the liver.

**Table 1**

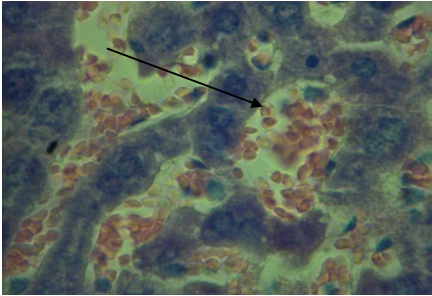
**Morphometric parameters in the liver of white mice upon infection with nematodes**

Indicators	Control group	Experimental group (nematodes)
Sublobular vein, S ( $\mu\text{m}^2$ )	4696,17 $\pm$ 234,80	3917,38 $\pm$ 579,03
Central vein, S ( $\mu\text{m}^2$ )	754,28 $\pm$ 37,71	7289,67 $\pm$ 1373,85***

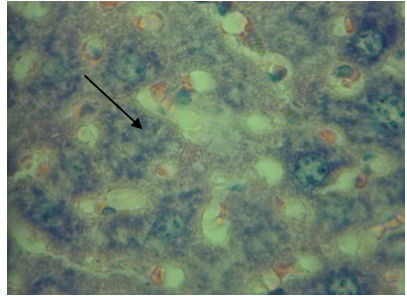


Sublobular vein, P ( $\mu\text{m}$ )	401,17 $\pm$ 20,12	265,59 $\pm$ 22,62
Central vein, P ( $\mu\text{m}$ )	120,98 $\pm$ 7,13	451,69 $\pm$ 54,91
Sinusoidal space, S ( $\mu\text{m}^2$ )	276,08 $\pm$ 13,80	275,84 $\pm$ 21,76
Sinusoidal space, P ( $\mu\text{m}$ )	116,39 $\pm$ 6,51	101,05 $\pm$ 6,59

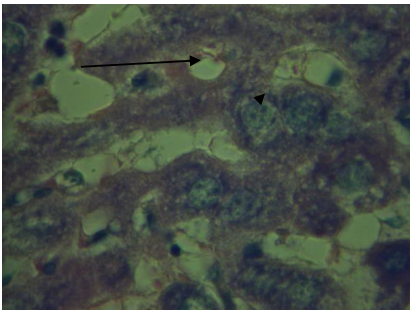
Statistical significance:  $P \geq 0,05^{**}$  and  $P \geq 0,01^{***}$



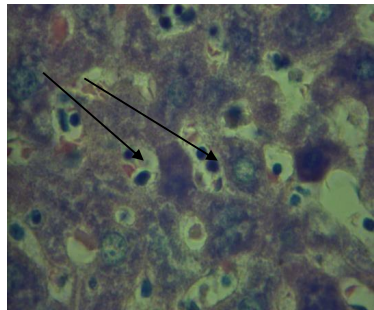
**Figure 1. Erythrocyte diapedesis and hemolysis. Azur + eosin stain. Objective magnification x100**



**Figure 2. Hepatocyte necrosis and fatty hepatosis. Azur-eosin staining. Objective magnification x100**



**Figure 3. Interlobular and intertract edema. Azur-eosin staining. Objective magnification x100**



**Figure 4 Accumulation of lymphoid cells between hepatocytes and hepatic tracts. Azur-eosin staining. Objective magnification x100**

Thus, it is necessary to recommend the correction of measures to combat echinococcosis, taking into account the characteristics of the epizootic process, the introduction of an antigen against the background of a

number of immunomodulators is effective. However, experiments carried out on laboratory animals have shown the toxic effect of echinococcosis antigen on the liver, which calls into question the effectiveness of the administration of this antigen. Based on the foregoing, it can be concluded that the development of a preventive vaccine against echinococcosis is possible, but fraught with certain difficulties.

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**INTERNATIONAL COOPERATION ON ENVIRONMENTAL ISSUES  
IN NIGERIA**

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**Abstract.** *The paper discusses the issue of international cooperation on environmental issues in Nigeria: the role of international agreements in the field of environmental ecology; basic principles of international cooperation in the field of environmental protection; environmental education in Nigeria; principles of environmental project management; and several measures aimed at reducing atmospheric pollution.*

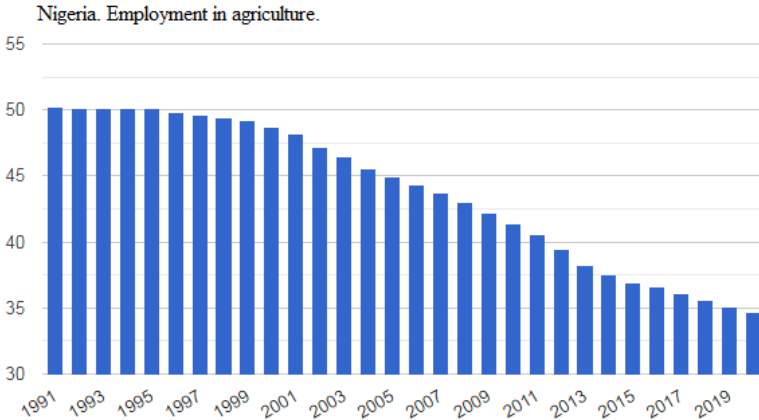
*The issues of coordination both between the state and between international organizations dealing with similar problems, as well as issues of mutually beneficial cooperation in the field of environmental ecology are considered in the Research paper.*

**Keywords:** *Ecology of the environment, International cooperation, Environmental education, International agreements, Principles of environmental protection.*

**Introduction**

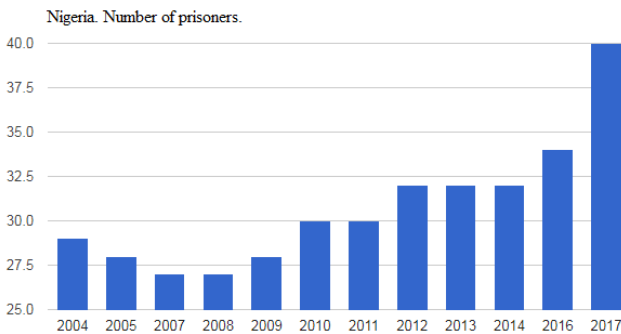
The protection of environmentally clean natural resources such as water, air, soil and food is one of the main problems of international cooperation. This is because the energy crisis and global warming, has regional and often global implications, and can be addressed only through the joint efforts of the international community. Such cooperation is possible if several countries concerned meet together and, having reached an agree-

ment, arrive at some framework agreements on goals, objectives, methods of problem-solving and results, preparing further documentation and generally implementing projects, and presenting international standards in the field of environmental protection developed through cooperation.



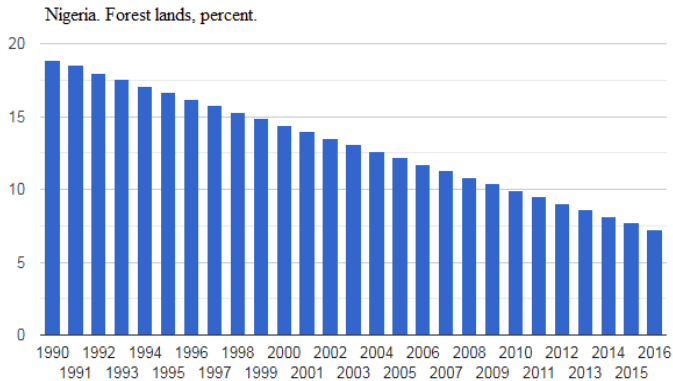
**Fig. 1. The diagram of employment of the local population in agriculture [5]**

On the other hand, as long as environmental pollution persists, the most successful way out of this situation is to join forces at the international level, as communication between countries provides a platform for the generation and dissemination of expertise and the sharing of related resources. For example, to address the problems associated with large-scale logging in the Amazon basin during logging, several South American



**Figure: 2. Chart of growth in crime in Nigeria [5]**

countries meet regularly to exchange knowledge and experience among the various economic organizations in the region, logging authorities and organizations [1]. During such cooperation, it is easy to obtain real resources, including information, financial support, and experts. It should be noted that increasing levels of economic activity in developed countries and, on the contrary, a significant deterioration in the financial situation of the local population (Aboriginals) have led to a reduction in the agricultural population in developing countries (see fig. 1), the rapid urbanization of the population and the consequent increase in social (crime, see. fig. 2) and environmental problems, in particular the destruction of tropical forests (fig. 3), increased unhygienic conditions, etc. [2-4]. Indeed, the impoverishment of the local smallholder population necessitates the sale of their smallholdings, as they cannot withstand the competition from large landowners.



**Figure: 3. Diagram of deforestation in Nigeria [5]**

In this case, they go to the city, increasing the urban population, but due to lack of education they cannot find work, and therefore cannot rent decent housing and settle in urban slums (favelas in Brazil, Makoko in Nigeria)<sup>1</sup> increasing the unemployment and social and environmental pressure on the city (see Fig. 4 and 5). Besides, environmental problems in developing countries, particularly the environmental damage caused by uncontrolled industrialization on the one hand, and the uncontrolled exploitation of natural resources on the other, make the livelihoods of the indigenous

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<sup>1</sup>**Favelas** are slums in Brazilian cities where people live without water, central heating and electricity. There are no schools, hospitals or other institutions necessary for normal life in these areas. On the streets, slums are ruled by crime and drugs. [BrazilLife.ru>favela-v-brazilii](http://BrazilLife.ru/favela-v-brazilii).

**Makoko** is a floating slum in Nigeria that sits in the lagoon of the Atlantic Ocean, right against the backdrop of high-rise modern buildings in the Nigerian city of Lagos. [grimmir74.livejournal.com>2839436.html](http://grimmir74.livejournal.com/2839436.html)

peoples of these regions threatened. Such «development» of regions of some developing countries requires urgent action within the framework of global cooperation, as it can lead not only to environmental problems in the said regions but also to negative social consequences. International cooperation in the field of environmental protection is based on several accepted norms of international law, which focus on the protection of the global environment.



**Figure: 4. Favelas in Brazil**



**Figure: 5. Makoko in Nigeria. Makoko about a century ago was a fishing village, which was founded by people from neighbouring Benin. The slum population is now populated by migrant workers from across West Africa**

During the 1990s, economic development issues related to environmental actions were discussed at the international level as a global issue. As a result, the United Nations Conference on Environment and Development (UNCED) was held in Brazil in June 1992 and adopted a plan of action, "Agenda 21", based on the concept of sustainable development. Subsequently, the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention on Biological Diversity (UNCBD) and the Declaration of Forest Principles were also adopted. Subsequently, as international cooperation developed, several other global frameworks were adopted to address global environmental issues. These programmes include the UN Convention to Combat Desertification (UNCCD), the Kyoto Protocol and the Cartagena Protocol on Biosafety (Colombia) [7].

In a world of competing jurisdictions and multi-tiered governments, environmental problems are not unique to a single State or region. For example, pollution causes damage in a region, which eventually also affects neighbouring areas. Besides, environmental problems are common to several countries. This applies to most issues even if they are local and within national boundaries. Environmental problems are found all over the world, and this is the reason for the widespread interest of policymakers, which they demonstrate in the world [8]. Several problems can, in some cases, be addressed by national authorities and, at first glance, there may not be an urgent need for international cooperation. However, the fact that many regions and countries face the same problems is a major reason for cooperation. Benchmarking helps to identify the main causes and problems and can facilitate the dissemination of policies, technologies and the sharing of best practices [9]. Besides, depending on the extent to which a problem requires substantial scientific and technological funding, international cooperation can facilitate the acquisition and sharing of knowledge, as well as reducing costs and improving overall efficiency. Thus, the most valuable contribution of international cooperation can be said to be the acquisition of intellectual capital, financing, information and technology, which facilitates the economic integration of all countries of cooperation.

The goal of international cooperation in the field of environmental protection is to preserve the environment as a platform for the natural habitation of humankind. It is therefore essential that all countries, including Nigeria, that share a common environment establish and strengthen environmental management mechanisms. Moreover, since the development of any country depends on a healthy environment, and sustainable development requires the preservation of the local environment, including air,



water and soil, and since environmental protection at the local level is a prerequisite for progress in basic services, developing countries such as Nigeria will ultimately need to address not only their local environmental problems but also the global challenges facing the entire world's population. Thus, cooperation for the preservation of the natural ecology of our planet has become an agreement between countries, providing the necessary mechanism for their implementation, while sustainable policies have also been singled out within each country as a policy instrument supporting these agreements. Only in this way will we be able to provide an optimal and effective solution to the environmental problems of the world as a whole.

### **1.1 The role of international agreements in the field of environmental ecology**

The negotiation of international agreements in the environmental field is one of the main ways in which the world community can emerge from the environmental crisis. It is generally recognized that an exit strategy can be achieved only through the unity of action of all States in the field of environmental protection. Today, no country can solve its environmental problems alone or cooperate with a small group of countries. Clear coordinated efforts by all States are needed, as a form of coordination among them on a strict international legal basis. The environment can be considered as part of the common heritage of mankind, as some cycles and mechanisms of nature operate beyond national boundaries [10]. Actions in one country often have a direct impact on another as seen in several instances. International treaties and conventions help to ensure the sustainable use of shared resources as well as the overall and effective management of environmental problems, including global warming and the conservation of biodiversity. Nigeria is a party to several regional and international agreements.

Cooperation among States, within regions and at the international level is essential for the protection of environmental resources and the peaceful use of such resources in a sustainable manner. For example, the River Niger originates in Guinea (see fig. 6) and extends over a distance of 4,180 km through Mali, the Republic of Niger and Nigeria. Since the Niger River basin is shared by 10 countries, water management is internationally coordinated by the Niger Basin Authority (NBA).

A major NBA initiative has been the adoption and implementation of the Sustainable Development

Action Plan [11], which most notably includes the management of several hydroelectric and agricultural dams built along the river. When one



country wants to construct a dam, it must develop plans for NBA decision, as the representatives of each Niger River Basin country are part of the NBA, each country has the opportunity to comment on water development plans. The NBA supports a strong legal framework for cooperation in water resources management and encourages cooperation on potential investments between countries with river borders. The NBA has its responsibilities in ensuring that water use in the Niger River makes sense for the entire basin and is in the interest of local communities.



**Figure: 6. Illustration to the question of the formation of the Niger River Basin in Nigeria and other neighbouring countries**

The NBA has made progress in many joint projects, such as the Niger Hycos of Niger, which collect and collate data from NBA member countries. There is also a riverbank protection project. Furthermore, bilateral joint initiatives are being implemented between the countries of the basin. For example, a joint project between Mali and Guinea in the upper Niger basin [12] was initiated in response to a pollution incident in upper Guinea that affected the supply of drinking water in Bamako, the capital of Mali. Accordingly, Mali, Niger and Nigeria have taken steps at the national level to implement adaptation planning for climate change. Mali and Niger developed National Adaptation Programmes of Action (NAPA) with support from the United Nations Development Programme (UNDP) and the Global

Environment Facility (GEF). This is a requirement for the least developed countries that are signatories to the United Nations Framework Convention on Climate Change (UNFCCC). Nigeria, which is not the least developed country, was not obliged to prepare a NAPA. However, with the support of UNDP and the Canadian International Development Agency (CIDA), Nigeria prepared a similar document in 2010 as her National Adaptation Strategy and Action Plan (NASPA) [12]. Regional and international cooperation allows for the sharing of knowledge, responsibilities, experience and technical know-how on environmental issues, and lack of cooperation between countries can lead to resource conflicts, regional instability, and the unsustainable use of environmental resources. For example, the earlier existence of dams on the River Niger, combined with climate variability, in the past has led to misunderstandings between countries sharing the river. The Seling Dam project in 1982 coincided with a drought period, and downstream countries believed that Mali had conserved water, resulting in lower river flows. Such incidents can now be dealt with by the NBA as data are collected and transmitted between countries [12].

As a rule, nature knows no State borders, it is universal and unified. Therefore, disruptions in one country's ecosystem will inevitably trigger reactions in neighbouring countries. If, for example, Nigerian industries or other countries emit flue gases into the atmosphere with an unacceptably high proportion of harmful contaminants, these emissions will not adversely affect only the environmental health of these countries, but also causes considerable damage to the flora and fauna of neighbouring countries. All other components of the natural environment (river flow, marine waters, migratory species of animals, etc.) do not recognize State boundaries. As seen, the high priority of the environmental factor in international relations is constantly increasing due to the progressive deterioration of the biosphere.

### **1.2 Basic principles of international cooperation in the field of environmental protection**

International cooperation in the field of environmental protection is governed by international environmental law, which is based on universally recognized principles and norms. The most important contributions to the development of these principles were made by the UN Stockholm Conference on the Human Environment (1972), the World Charter for Nature approved by the General Assembly (1982) and the UN International Conference on Environment and Development (Rio de Janeiro, 1992). Accordingly, in the development history of the basic environmental principles of international cooperation, three stages (periods) are usually distinguished [10].

1. The United Nations Stockholm Conference on the Environment (1972) marked the beginning of a decisive phase in the environmental policies of States and international communities. The conference resulted in the adoption of a Declaration defining the strategic goals and directions of activity of the world community in the field of environmental protection. The Conference established the United Nations Environment Agency (UNEP) with its headquarters in Nairobi (Kenya). The UNEP programme organizes and plans environmental activities in three functional areas: 1) environmental assessment - global observing system; 2) environmental management; and 3) supporting measures (environmental education and training). UNEP also coordinates the activities of other international organizations in the use, reproduction and protection of environmental components - land, water, atmosphere, flora and fauna, etc.

2. The World Charter for Nature was adopted by the United Nations General Assembly on 28 October 1982. Like the Stockholm Declaration, the World Charter for Nature defined the priorities of the international community in the field of the environment for that period, which greatly influenced the further development of the State environmental policy. According to many scientists and experts, the World Charter for Nature, compared to the Stockholm Conference (1972), has moved forward in "consolidating international legal principles of environmental protection and natural resource management". Among the basic principles enshrined in the Charter are the following: humanity is aware that it is an integral part of nature. Therefore, nature must be respected and human beings must not violate its basic principles, i.e. the genetic basis of life on Earth must not be threatened. It is necessary to preserve the population of each life form, wild or domesticated, and to preserve the habitats necessary for this purpose; all areas of the Earth, both land and sea, must be protected under these requirements, special protection should be accorded to unique areas –representative of all types of ecosystems and habitats of rare or endangered species; natural resources should not be wasted but used sparingly, as required by the principles set out in this Charter; biological resources shall be used only to the extent that they are naturally recoverable; and reused resources, including water, shall be reused or recycled [10].

3. United Nations Conference on Environment and Development (Rio de Janeiro, 3-14 June 1992).

The assembly of 114 heads of State and representatives of 1,600 non-governmental organizations was held in Rio de Janeiro. This was undoubtedly the most impressive environmental forum of the twentieth century. The Conference adopted five key documents: the Rio Declaration on Envi-

ronment and Development, Agenda 21, the Statement of Principles on the Management, Conservation and Sustainable Development of All Types of Forests, the Framework Convention on Climate Change, Convention on Biological Diversity. The most important achievement of the United Nations Conference was the recognition of the following facts: "The problems of environment and economic development cannot be considered separately" (principle 4), "States shall cooperate in a spirit of comprehensive partnership to preserve, protect and restore the health and integrity of the Earth's ecosystem" (principle 7), "Peace, development and environmental protection are interrelated and inseparable" (principle 25). It was recommended that an environmental strategy be developed taking into account the state of the world community [10, 13]. The conference stressed that there is no viable alternative to sustainable development, which means that economic development and the environment can be addressed simultaneously.

**1.3. Nigeria's Participation and Development in International Environmental Cooperation.**

To promote environmental sustainability under international agreements, Nigeria has developed the 1999 National Environmental Policy, a key policy document for sustainable development. In this document, policies and programs for broad environmental categories relate to forestry, biodiversity, pollution control, land degradation, water management, climate change, marine and coastal environment, clean energy, and environmental crime.

Nigeria has participated in various environmental conferences and has signed several environmental treaties and conventions [6] as shown in table 1 below. These treaties and conventions signed by Nigeria and other countries, are aimed at regulating several activities ranging from intercontinental movements of hazardous wastes to problems related to deforestation, global warming, prohibition and cessation of trade in endangered species of birds, animals and insects and protection of wetlands [13-16].

**Table: 1**

<b>Nigeria's Treaties and Conventions on the Environment. [14], [15]</b>		
<b>Title of treaty or convention</b>	<b>Year of signing</b>	<b>Year of enforcement</b>
African Convention on the conservation of nature and natural resources.	1968	1974
Convention concerning the protection of the world cultural and natural heritage.	1972	1975

Convention on international trade in endangered species of wild fauna and flora (CITES).	1973	1987
Vienna Convention for the protection of the Ozone layer and the Montreal protocol on substances that deplete the ozone layer.	1985	1988
Basel Convention on the control of the transboundary movement of hazardous wastes and their disposal.	1990	1992
Convention on the conservation of migratory species of wild animals.	1979	1983
United Nations Framework Convention on climate change.	1992	1994
Convention on Biological Diversity (Rio Conference).	1992	1993
International convention to combat desertification in those countries experiencing serious drought and/or desertification, particularly in Africa.	1994	1996
Convention on wetlands of international importance especially as waterfowl habitat.	1971	1975
The Kyoto Protocol to the UN convention on climate change.	1997	1997

These agreements, according to Cunningham et al. [15], theoretically cover almost all aspects of human impact on the environment. The Government of Nigeria also takes pollution and degradation of the environment seriously. Various national and regional initiatives have been undertaken at all levels of government with efforts to promote environmental sustainability in the context of national sustainable development [16, 17]. The Government has successfully put in place some institutional arrangements for environmental governance. The Federal Ministry of Environment is mandated to ensure a quality environment favourable to the health and well-being of fauna and flora; to promote the sustainable use of natural resources, and to restore and maintain the ecosystem, raising public awareness and promoting understanding of, inter alia, the interlinkages between the environments.

Besides, specialized agencies have been established to focus more on some specific environmental issues. These include the National Oil Spill Detection and Response Agency (NOSDRA) and the National Environmental Standards and Regulations Enforcement Agency (NESREA), which were established in 2006 and 2007 respectively [17]. NOSDRA has the mandate to implement the national oil spill contingency plan, and NESREA is responsible for ensuring compliance with all environmental laws, guidelines, policies, standards and regulations in Nigeria, and ensure compliance with all international environmental agreements, protocols,

conventions and treaties which Nigeria signed [17]. To address climate change, Nigeria has put in place institutional structures and policies for national implementation of the UNFCCC, the Kyoto Protocol and other instruments. The Government is also concerned with environmental protection and sustainable development of the Niger Delta, which is the country's crude oil base.

Since 1992, when UNCED was held, the commitment of the Government of Nigeria to international cooperation in the field of environmental protection and sustainable development has increased tremendously. Besides, the country has adopted three main strategies - collaboration, part-nership, and networking with international communities [17]. Nigeria is more proactive in strengthening its cooperation with countries of both the North and the South. Closer cooperation is being established with multi-lateral organizations, such as the United Nations and its specialized agencies, as well as with the New Partnership for Africa's Development, ECO-WAS and bilateral organizations to assist in the implementation of friendly programmes and projects.

Since Rio, Nigeria has made significant efforts to address the major environmental and sustainable development issues identified and agreed at the United Nations Conference on Environment and Development (UNCED). Nigeria has made progress in establishing the necessary institutional framework for sustainable development. For example, in 1992, the Federal Environmental Protection Agency (FEPA) was given a broader mandate for the conservation of natural resources and its functions were expanded under its status as a public authority [16]. Some important milestones made in Nigeria in the field of the environment formed the basis of the new agenda in the field of environmental protection and conservation of natural resource in the country. National environmental policies and related legislation, guidelines and standards for environmental impact assessment are being progressively reviewed and strengthened in line with the objectives of Agenda 21. Moreover, with the awareness that the climate is slowly and steadily changing as a result of human activity, the Government is systematically monitoring through relevant agencies and departments to determine the rate of change (in quantitative terms). Such information is essential for early warning of natural disasters, such as floods, erosion and drought. Besides, some greenhouse gases are monitored to determine the level of air pollution in the country.

The Government also plans and administers land resources in the country through the relevant agencies. Various programmes, including soil surveys, land assessment, fertilizer testing, fertility management and soil

conservation, are being implemented with due consideration for their environmental effects. One of the main concerns of the Federal Government of Nigeria is the steady decline in national forests and efforts to implement sustainable forest management. To this end, actions and programmes aimed at forest conservation are being implemented through the development of appropriate strategies and an action plan. The serious environmental and socio-economic impact of desertification and drought in Nigeria had also prompted the Government to take some measures to mitigate the problems, which had led to the establishment of an environmental fund. Besides, watershed irrigation projects are being implemented nationwide, demonstrating the Government's commitment to promoting sustainable agriculture and rural development.

There is also a policy objective of the Federal Government concerning biological diversity which takes into account the relevant provision of the Convention on Biological diversity. It has focused on the conservation of these vital resources, the sustainable use of its components, and the equitable sharing of benefits derived therein. To achieve this goal, priority programmes to expand the network of national parks and reserves and to collect data on Nigeria's flora and fauna are being implemented in addition to the development of the National Biodiversity Strategy and Biodiversity Action Plan. Furthermore, to ensure the sustainable use of our coastal waters and adjacent lands, the Government has developed an action plan to combat water pollution and conserve biodiversity in the Niger Delta region of the country. At the international level, joint efforts are being made with the West African sub-region within the framework of the Gulf of Guinea Large Marine Ecosystem (GOGLME). The project aims to monitor coastal waters from the point of view of pollution and biodiversity conservation. Besides, relevant agencies are conducting measurements of certain meteorological parameters over the Atlantic Ocean bordering the country.

Nigeria has also prioritized its freshwater resources in response to growing concerns about the increasing pressure on water systems caused by poor water use, which affects both the quality and quantity of water. In this regard, the Government, through the Ministry of Water and Rural Development, is implementing programmes to protect the quality and supply of fresh water in the country. Some of these include the preparation of the National Water Master Plan (1995-2020), the assessment of water resources and the adoption of a decree, for the rehabilitation of dams and soil erosion sites and the establishment of water-quality laboratories. Other measures include the development of a national water policy, the development of a national rural water supply strategy and action plan, the de-



velopment of the sanitation sector and the strengthening of national water quality monitoring networks.

After Rio de Janeiro, Nigeria also launched a programme for the disposal of hazardous chemicals and toxic waste and established the FEPA / University of Ibadan Liaison Center to conduct research and training in the management of industrial, household and hazardous waste. State initiatives in the field of international cooperation in the field of environmental protection have a long history. Nigeria has also adopted (through ratification, acceptance, approval or accession) various environmental treaties in the field of pollution control. All these international agreements regulate various aspects of oil pollution damage by prohibiting certain actions, establishing liability, establishing compensation systems, controlling pollution and establishing reporting and response systems [18].

The Government of Nigeria has also developed approaches to protect and manage the environmental and health impacts of oil and natural gas exploration and production in the Niger Delta. In recent years, the Federal Government of Nigeria has enacted laws and regulations to ensure that the exploration and exploitation of oil resources, both on land and at sea, can be controlled by legal systems, to minimize environmental and health risks [19]. As part of its strategy to keep abreast of international developments in environmental law, the Federal Government has organized an international seminar on environmental policy, which culminated in the adoption of a national environmental policy in 1989. The National Environmental Policy 1989 was revised in 1999. Under the revised 1999 National Policy, the ultimate goal is to achieve sustainable development in Nigeria and, *inter alia*, to ensure that all Nigerians enjoy a quality environment conducive to their health and well-being [16].

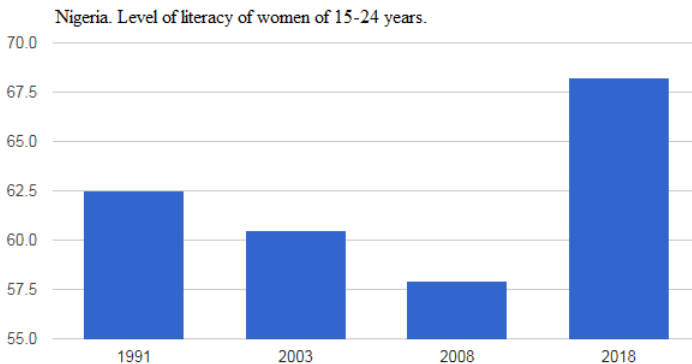
The international community, as well as the Government of Nigeria, have recognized that desertification is a global economic, social and environmental problem for many countries in all regions of the world and cannot be tackled alone without the involvement of other States [20]. To this end, the Government of Nigeria facilitated the involvement of other actors, including the Private sector, Non-governmental organizations NGOs, Community-based organizations and Donors. Many NGOs are now actively involved in the implementation of the Convention to Combat Desertification in Nigeria and some of them are very active in the negotiation process. Prominent national and International NGOs that actively participate in the Global NGO Network on Desertification in Nigeria are the Nigerian Environmental Study/Action Team (NEST), the Nigerian Conservation Fund (NCF), Forest Association of Nigeria (FAN) and the International



Union for the Conservation of Nature (IUCN). At the international level, Nigeria has actively participated in the meetings and activities of the Convention to Combat Desertification (United Nations). Nigeria is involved in many bilateral and multilateral relations that are directly or indirectly related to the fight against desertification. These include the Lake Chad Basin Commission (LCBC); Nigeria – Niger Joint Commission for Co-operation (NNJCC); The African Ministerial Conference on the Environment (AMCEN); The Permanent Inter-State Committee on Drought Control in the Sahel; Economic Community of West African States (ECOWAS), United States Agency for International Development (USAID), United Nations Educational, Scientific and Cultural Organization (UNESCO), Japanese International Cooperation Agency (JICA), Canadian International Development Agency (CIDA), TerrAfrika, etc.

### 1.4. Environmental Education in Nigeria

Environmental education (EE) plays an important role in creating knowledge and positive attitudes and behaviour towards the environment among members of society [21]. It helps to educate people and better understand their nature and the consequences of their actions. According to Thathong [22], since education can help find new ways to cultivate positive attitudes and attributes to overcome environmentally destructive behaviour, it can lead to individual desire and willingness to take action for the environment. The need for EE is essential and compulsory for the education system

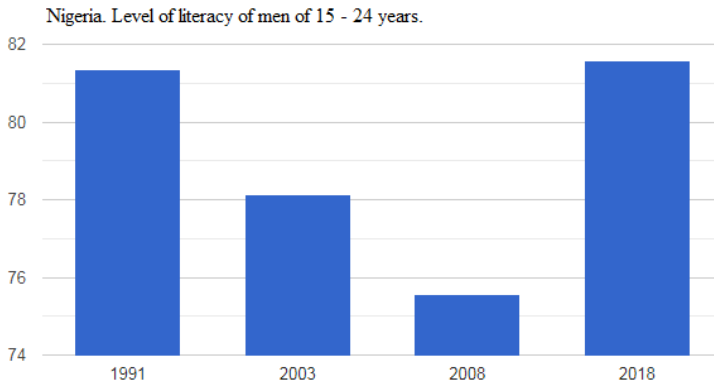


**Figure: 7. Chart of literacy rate among women of age 15 - 24 years old [5]**

in Nigeria. The need or demand for EE is the result of discrimination of the negative human actions on the environment, which causes environmental

injustice, land degradation, and pollution, which ultimately leads to ecological collapse - agricultural land degradation, pollution of the river and coastal marine basins, and the degradation of fish stocks, with a negative impact on the population. This is because many Nigerians lack environmental knowledge (see fig. 7, 8) due to lack of education, and therefore do not understand the value of nature and the problem between humans and the environment [21].

Environmental protection in Nigeria has long been enshrined in Nigerian legislation and in a formal institutional framework to address the various environmental challenges facing the society. According to Jackson O.R [23], Nigeria's environmental efforts have been undertaken since the British colonial rule in the 1900s through regulations. Besides, during this period, some elements of environmental protection were introduced in the educational sector (schools) through the inclusion of an environmental component in several disciplines taught at schools. According to Ahoje [24], it was



**Figure: 8. Chart of literacy rate among men of age 15 - 24 years old [5]**

only in the 1950s that the West African Examination Council developed a curriculum that was used to teach biology in schools containing environmental elements such as soil conservation. Since then, in the 1960s, ecology was taught in schools in the form of studying several natural subjects containing basic environmental concepts, terms and basic laws, since environmental protection has been a major topic in international forums. This has led Nigeria to start a robust EE programme as early as the 1970s in response to the proposals of the World Environmental Summits. Similarly, the 1972 Stockholm Conference, the 1975 Belgrade Conference and the

1977 Tbilisi Conference, combined with the 1992 Earth Summit in Rio de Janeiro, encourage Nigeria to make its citizens have the awareness of the environmental problems facing the country in particular and the world in general [21]. The Koko incident in 1988, when toxic waste was dumped in the Koko Port, Delta State, by foreign nationals, revealed a low level of environmental awareness among the population. This scenario led to concerted efforts by the NCF in 1988 to encourage the Federal Government to lead the Nigerian Educational Research and Development Council (NERDC) (currently Nigerian Educational Research Council (NERC)) to include environmental education elements in the agenda of the Review Conference on Civic Education [25]. Subsequently, UNESCO sponsored a national workshop on the integration of EE elements into the national school curriculum. Accordingly, following the efforts of the NCF to ensure EE in Nigeria curriculum, a National Strategy for Environmental Education was developed and adopted by the Federal Government [21].

Universities and colleges in Nigeria began to contribute to the establishment of Environmental institutes to produce scientists that would ensure the effective achievement of the objectives of environmental education, among which is the «Environmental Education Programme» in the University of Benin, presented in 2007 under the auspices of the Department of Health, Environmental Education and Human Kinetics. This department is now called the Department of Safety and Environmental Education. Besides, the Centre for Environmental and Scientific Education of Lagos State University, all with the focus on issues related to environmental management and education [24]. These institutions of higher education offered hope for the preservation of the environment in the country, especially since they helped to train environmental scientists and teachers with bachelor's, master's and doctorate degrees in various environmental disciplines, having the needed Environmental education, which has contributed to raising the level of EE in the country.

It should be noted that the presence of bachelors, masters and doctors of ecology in the country does not guarantee that the idea of environmental protection will be accepted by the population. These professionals can communicate information to the public if the Federal Government in general and the State and Local Governments, in particular, facilitate the dissemination of this information with adequate funding for environmental programmes. However, it was necessary to reach out to the population not only through information programmes but also by forcing them to participate directly in those programmes, using tax systems, fines and other fiscal methods. Unfortunately, despite the efforts of NERDC to develop EE

curricula, the situation analysis that was devoted to this issue in the work of our reference in [21], showed that such efforts had not yet materialized in any specific form in the country. The curriculum has not yet been fully implemented in schools, thus preventing generations of Nigerians from relying on EE. Consequently, in higher educational institutions, EE is taught as a separate or specialized programme in some Nigerian universities and colleges. Although the courses at most of these institutions are in their infancy, thanks to the tenacity and enthusiasm of some of these universities, particularly in the field of scientific research, there is also a positive side to the dark cloud of Nigerian environmental education. Providing sustainable environmental education in Nigeria would enable the general public to have the skills, knowledge, motivation and attitude to deal with various environmental issues and problems or to work to improve the environmental situation, thereby engaging them in environmental actions, such as persuasion involving educating and lobbying members of the public; ensuring that consumer habits change towards a better understanding of the environment and its place in nature, with the implementation of actions that will influence political decisions and participation in the restoration of natural resources, in particular.

### **1.5. Environmental governance**

The government of Nigerian is committed to environmental degradation by undertaken various national efforts at all levels of government to promote environmental sustainability in the context of national sustainable development. The Government recognizes that good environmental governance is critical for sustainable development hence the National Environmental Policy 1989 was revised in 1999 [17]. The revised policy aims to achieve sustainable development in Nigeria and, in particular, to provide all Nigerians with a quality environment that is conducive to their health and well-being, the conservation and use of the environment and natural resources for the benefit of the present and future generations, the restoration, maintenance and strengthening of ecosystems and ecological processes necessary for the functioning of the biosphere and the conservation of biological diversity, and the adoption of the principle of optimal sustainable use of living natural resources and ecosystems; raising public awareness and promoting understanding of the main links between the environment and ecosystem development in general, encouraging the participation of individuals and communities in efforts to improve the state of the environment; cooperation in good faith with other countries, international organizations and institutions in order to ensure the optimal use of trans-boundary natural resources and to effectively prevent or combat trans-

boundary environmental pollution. Besides, some specific strategies and action plans have been developed [17]. These include National Policy to Combat Drought and Desertification; Drought Preparedness Plan; National Policy to Combat Erosion, Floods and Coastal Zone Management; National Environmental Sanitation Policy; National Environmental Sanitation Action Plan; National Forestry Policy; National Biodiversity Strategy and Action Plan; National Healthcare Waste Management Policy/Action Plan and Guidelines; State of the Environment Report 2008, amongst others.

### **1.6. Pollution Control**

To ensure the reduction of air pollution, the federal government adopted the 2011 National Environmental Regulations [17]. The purpose of these regulations is to control vehicle pollutant emissions, purify the air space in Nigeria, and restore, maintain and improve air quality. It also aims to ensure regular emission control and maintenance for vehicles operating at high speeds; protection of citizens' right of access to clean air; and improving the health conditions of Nigerians, especially in urban areas with high levels of air pollution as a result of increased vehicle numbers. Besides, the government procured a mobile air quality monitoring station in the Federal Capital Territory (FCT) as one of the genuine components of the government's air quality monitoring program. This state-of-the-art equipment is designed for on-site monitoring and assessment of any environmental focus requiring urgent attention. Monitoring stations are supplemented with sets of mobile portable equipment for monitoring air quality for such main pollutants as ozone - O<sub>3</sub>, nitrogen oxides - NO<sub>x</sub> (nitrogen oxide NO, nitrogen dioxide NO<sub>2</sub>, nitrous oxide N<sub>2</sub>O, nitrate-nitrogen radical NO<sub>3</sub>), carbon monoxide - CO, solid particles, noise, etc. [17]. Nigeria participated in the International Civil Aviation Organization (ICAO) environmental activities that aim to improve the efficiency of the fleet around the world to reduce global emissions. Nigeria was recently admitted as a third African member to the ICAO Committee on Aviation Environmental Protection (CAEP). Under the chairmanship of Nigeria, the 37<sup>th</sup> Assembly of the International Civil Aviation Organization (ICAO) adopted the first global sectoral resolution on greenhouse gas (GHG) emissions from the international air transport sector.

To reduce oil spillage, the Government has also developed measures, including the implementation of integrity control techniques for pipeline systems; a real-time pipeline system monitoring project, aimed at detecting, containment and quantifying the leakage of transportable media through pipelines under real conditions; involving production communities in pipeline surveillance activities and the implementation of the amnesty

programmes in the Niger Delta areas [17]. Besides, strategies have been developed to eliminate gas flaring in the short and long term. Short-term strategies include increasing the flaring penalty per 1,000 cubic feet of gas and shutting down wells that produce a high gas-oil ratio. Long-term strategies include the accelerated implementation of the gas industry development programme and the implementation of a master plan for its development that provides the necessary infrastructure and fiscal incentives [17].

### **1.7. Benefits of International Cooperation in Nigeria**

The obvious fact is that regional and international cooperation facilitates the exchange of knowledge, responsibilities, experience and technical know-how on environmental issues, and Nigeria can and does benefit from such cooperation. The Urban Basic Services Programme (UBS) [26] is being implemented in the country to promote the integration of environmental infrastructure, water, sanitation, drainage and solid waste management. The project involves the identification of key areas in some Nigerian cities and the development of a package of programmes for the advancement of women and children. Besides, the project is funded by a UNICEF grant of \$ 3 million from the United Nations Children's Fund. Concerning background air pollution monitoring, the Federal Government of Nigeria was able to establish a regional environmental monitoring station in Oshogbo in 1993 under the auspices of the Global Atmospheric Watch (GAW) programme of the World Meteorological Organization (WMO). The station monitors background air pollution.

Under the requirements of the Montreal Protocol and the provisions of the global Agenda, 21 for the phase-out of ozone-depleting substances, ODS, the phase-out of ozone-depleting substances in Nigeria requires that priority be given to programmes in line with our reference in [26], being implemented by the Federal Environmental Protection Agency. Ongoing activities include: institutional strengthening for the phase-out of ODS in Nigeria with a grant of \$3 million from the United Nations Industrial Development Organization Trust Fund, and the establishment of an institutional mechanism to coordinate national efforts to protect the ozone layer. The Geographic Information System (GIS) programme is being implemented through bilateral cooperation with the World Bank through the Bank-assisted Environmental Management Project in Nigeria [26]. GIS enhances the ability to monitor environmental components. As a result of this programme, soil erosion monitoring points (SEMP) have been set up in six ecological zones of the country, headquartered in Kaduna, in the Savannah zone. These efforts also include local and foreign training of technical and managerial manpower requirements. Besides, several ongoing pro-

grammes and projects have been launched to address the problem of deforestation [26]. The main funding agencies are the African Development Bank (ADB) and the World Bank. The forestry project initiated in 1987 with the assistance of ADB continues to operate with a \$100 million loan. In the past, external sources of financing under various international environmental conventions for specific projects, including projects of bilateral or multilateral partners and regional development banks, constitute an important source of funding for activities, related to combating desertification in Nigeria [20]. It is expected that such permanent possibilities will allow rendering significant assistance in the implementation of the projects of the Strategic Action Plan for the «Great Green Wall». The available external financing mechanisms can be considered in the following categories: Global Mechanism; International organizations such as Food and Agriculture Organization FAO, United Nations System Development Program UNDP, United Nations Environment Program UNEP, International Fund for Agricultural Development IFAD, World Meteorological Organization WMO, etc. who can be involved in specific projects/programs identified in the context of combating desertification under the UNCCD; bilateral assistance; multilateral assistance: World Bank, European Union, African Development Bank, World Bank; and assistance from the Global Environment Facility GEF.

### **Conclusion**

The global environment is clearly facing many environmental challenges. These problems include population explosion; loss of biodiversity; climate change; ozone depletion; air and water pollution, etc. [7]. Nigeria also had its share in this global issue with notable contributions to addressing these global challenges. Since these problems are of a transboundary nature and transcend the national borders of different States, the states in the international system began to engage in serious international cooperation in the bid to find solutions to these disturbing environmental challenges. Therefore, over the years, within the framework of international conferences, various efforts have been made to develop common platforms based on which acceptable conditions of solving these problems could be obtained. Through these conferences, the international community has been able to enact and enforce a plethora of international environmental laws that govern the use of natural resources in an environmentally sound manner. Obviously, regional and international cooperation facilitates the exchange of knowledge, responsibilities, experience and technical know-how in solving environmental problems, and Nigeria, it should be noted, has benefited from this cooperation, which allows her to receive appropriate bonuses from this cooperation in the future. It is also believed that

lack of cooperation between countries can lead to conflicts over the use of resources, regional instability and, ultimately, the degradation of the industries that use those resources.

Improved coordination among multilateral environmental organizations, especially in the area of human development, more efficient use of financial resources would avoid unnecessary duplication of different organizations dealing with the same problems. This will enhance the optimal use of available human resources in government, scientific and academic community, helping to ensure the effective use of limited opportunities and access to the most skilled workforce. More efficient use of available human resources in government, and in academia, contributes to the best use of a country's limited capacity and access to the most skilled labour force.

The Government of Nigeria is also taking pollution and environmental degradation seriously, establishing a governance system at all levels to promote environmental sustainability as part of its national sustainable development agenda. At the same time, the government has successfully put in place some institutional mechanisms and trained human resources to deal optimally with environmental problems. However, despite the progress made, further development and intensification of international cooperation, both bilateral and multilateral, including organizations of the United Nations system, are required to address the environmental crisis in Nigeria.

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## NATURAL MERCURY CONTENT IN THE BAIKAL SEAL AND ITS PARASITES

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**Abstract.** Present data (2020) on the content of mercury in the tissues of the organs of the Baikal seal (*Phoca sibirica*), in its ectoparasite - louse *Echinophthirius horridus baicalensis* and endoparasite nematode *Contracaecum osculatum baicalensis* at the fourth larval stage (L4) are presented. It was found that most of all mercury is concentrated in the liver and scalp of seals, in lice and nematodes; in minimal quantities - in the fat of seals.

**Keywords:** Baikal, seal, tissues of seal organs, parasites, mercury.

### **Introduction**

Mercury is a toxic element that enters the organisms of animals and humans with food (through the gastrointestinal tract), the respiratory tract and the integument of the body. Aquatic mammals are currently being studied in detail for the presence of heavy metals, including mercury (Graewska et al., 2020, etc.). Parasites are also being explored as potential indicators of environmental health (Sures et al., 1999).

Baikal seal *Phoca sibirica* Gmel. - endemic to Baikal, which is located at the top of the trophic pyramid of the pelagic hydrobiocenosis (Kozhov, 1972).

The aim of this work was to study the content of natural mercury in the organs and tissues of the Baikal seal, as well as in its ecto- and endoparasites.

### **Material and research methods**

The materials were collected in April 2020 on the eastern coast of South Baikal, near the village of Mishikha. Nine specimens of adult Baikal seals

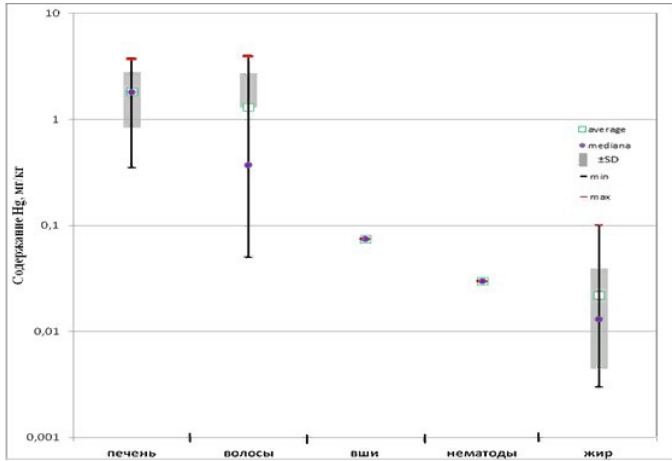
were examined. They were taken from hunters licensed to hunt animals. Among them there were 7 adult females and 2 males. Tissue samples and parasites were placed in sterile tubes with stoppers, provided with numbers and labels, and then stored in refrigerators at  $-20^{\circ}\text{C}$ . We used samples of ectoparasites - the louse *Echinophthirius horridus baicalensis* and endoparasites from the seal intestines - the nematode *Contraecaecum osculatum baicalensis* at the fourth larval stage (L4).

A total of 29 samples were analyzed (table 1). Parasitic nematodes were observed in 5 animals in this sample, the total infection was 55.6%, the average intensity of invasion was 4.45 parasite specimens per examined individual, the minimum number of parasites was 4, and the maximum number was 17 specimens. Lice were collected from 9 animals. Their infestation with insects was 100%, the intensity of the invasion was 12, 9 instances, the minimum number was 3, and the maximum number was 52 instances.

The mercury content in the biotic components of Lake Baikal was determined by the atomic absorption method with flameless determination of reduced atomic mercury vapors using a RA-915+ device with an RP-91 prefix during computer registration. The measurement accuracy of the device was monitored by annual testing and adjustment of the device by the manufacturer (LUMEX, St. Petersburg). Chemical analysis was carried out on the equipment accredited by the Center for Collective Use "Isotope-Geochemical Research" of the Institute of Geochemistry, SB RAS (analyst O.S. Ryazantseva). The correctness of the results was confirmed by the analysis of standard samples of the Baikal biota.

### **Results and discussion**

As a result of processing our materials, it was found that the maximum amounts of mercury were found in the liver, hair, lice and nematodes (fig. 1, table 1). In fat, this element was found in lower concentrations.



**Fig. 1.** Content of mercury in samples of seal organs (liver, fat, hair) and its parasites (lice *Echinophtirius horridus baicalensis* and nematode *Contraeaecum osculatum baicalensis* L4).

**Table 1**  
Mercury content in samples of the Baikal seal *Phoca sibirica* (April 2020).

№	№ of seals, gender	Age of animals	Body part	Mass fraction of total mercury in the sample, mg/kg ± accuracy indicator, mg/kg
1	1 ♀	6+	liver	1,81 ± 0,45
2	2 ♀	10+		0,43 ± 0,11
3	3 ♀	6+		3,16 ± 0,79
4	4 ♀	10+		1,93 ± 0,48
5	5 ♀	4+		2,95 ± 0,74
6	6 ♂	7+		0,68 ± 0,17
7	7 ♀	5+		0,35 ± 0,09
8	8 ♂	5+		1,40 ± 0,35
9	9 ♀	6+		3,73 ± 0,93
10	1 ♀	6+	fat	0,012 ± 0,005
11	2 ♀	10+		0,014 ± 0,006
12	3 ♀	6+		0,010 ± 0,004
13	4 ♀	10+		0,012 ± 0,005
14	5 ♀	4+		0,013 ± 0,006
15	6 ♂	7+		0,017 ± 0,008

16	7 ♀	5+	fat	0,003 ± 0,001
17	8 ♂	5+		0,101 ± 0,025
18	9 ♀	6+		0,016 ± 0,007
15	1 ♀	6+	hairline	0,37 ± 0,09
16	2 ♀	10+		0,23 ± 0,06
13	3 ♀	6+		0,05 ± 0,02
14	4 ♀	10+		0,19 ± 0,04
15	5 ♀	4+		0,10 ± 0,03
16	6 ♂	7+		2,90 ± 0,72
17	7 ♀	5+		0,47 ± 0,12
18	8 ♂	5+		3,50 ± 0,87
19	9 ♀	6+		3,96 ± 0,99
20	Joint sample from seals №№ 1, 2, 4, 5		nematodes	0,03 ± 0,01
21	Joint sample from seals from № 1 to № 9		lice	0,075 ± 0,035

Lice are known to be blood-sucking insects. The endemic Baikal seal is parasitized by the endemic subspecies of lice - *Echinophthirius horridus baicalensis* (Anoplura: Echinophthiriidae). It was first discovered by L. Freud (Freund, 1928) and described by M.Ya. Assom (1935). In the Baikal seal, parasites are concentrated on the head, back and at the base of the flippers.

The parasitic nematode *Contraecaecum osculatum baicalensis* (Anisakidae) is also an endemic subspecies, the final host of this parasite is the Baikal seal. In Baikal fish (the second intermediate hosts), the parasite (L3) is localized in the body cavity. In the seal, it completes its development (Rusinek, 2007) and feeds on the host's blood.

It is known that the main natural sources of mercury are deposits of this element and gas emissions from the bowels of the earth. Mercury is a rare element, since its average content in the earth's crust is 0.45 mg/kg (Kuzubova et al., 2000).

Baikal is located in the Baikal rift zone, where earthquakes are constantly recorded. An increase in the content of mercury in water is an indicator of nearby earthquakes (Koval et al., 2003). Mercury is an element that accumulates in the tissues and organs of living organisms, including humans.

Earlier it was found that this element accumulates in the liver of the Baikal seal at maximum concentrations, and also that the low level of mercury in the organs of seals is determined by its low content in the Baikal water. Initially, it was believed that mercury in the water of Lake Baikal is of natural origin (Pastukhov et al., 2011). However, in recent years, it has been shown that during earthquakes, its content significantly increases in the water of Lake Baikal and its content depends on the intensity of earthquakes in the Baikal rift zone (Grebenshchikova et al., 2018, 2019, 2019a, 2020). Accordingly, mercury can enter fish and seals, turning into methylmercury, an organic toxicant that causes them to be poisoned.

It is known that the highest bioconcentration of mercury in the pelagic zone of Lake Baikal occurs in the upper trophic chains (pelagic fish → seal) (Pastukhov, 2012).

We conducted a comparative analysis of our and literature data. It was found that at present mercury in the organs and tissues of the seal is found in significantly smaller amounts than in other authors (table 2), which, in our opinion, is explained by the absence of intense geodynamic movements and earthquakes in Lake Baikal during the sampling of seals.

**Table 2**  
**The content of mercury in the organs and tissues of seals**  
**(according to different authors).**

<b>Organs and tissues</b>	<b>M.V. Pastukhov and others., 2011</b>	<b>T.S. Ershova, V.F. Zaitsev, 2016</b>	<b>Our data</b>
Liver	♂ 4,08± 1,23 ♀ 6,65±4,30	1-7 years: 3,64±0,44 7-12 years 4,19±0,87	♂ 1,04±0,26 ♀ 2,08±0,52
Fat	no data available	1-7 years: 0,22 ±0,04 7-12 years: 0,14±0,2	0,022 ± 0,010
Hair cover (adult animals)	2,44±1,008	no data available	1,30±0,32

Thus, the data obtained allow us to conclude that both the seal and the parasites of seals, as well as their owners, accumulate mercury in their organisms. Lice accumulate mercury to a greater extent, since they do not leave the host, and nematodes live in the seal until maturation (less than six months), which is probably why they contain a small amount of mercury.

It is necessary in the future to continue the monitoring biogeochemical study of the components of the Baikal water ecosystem as indicators of changes in the chemical and ecological state of Lake Baikal.

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## ALGORITHMS FOR THE SIGNALS IDENTIFICATION OF A DEFECTIVE AXLE BOX BY BEARING ACOUSTIC MONITOR

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**Abstract.** *In the Russian Federation and the area of the 1520 gage systems working with thermal sensors are used for a search of heating axle box or wagon wheelset. It is notorious that thermal sensors fundamentally do not allow controlling nascent axle box defects of freight wagons and the trends of their development are included in the failures diagnosis only at the last stage of defects development. In the case of the system application, the principles of which will be described later, the authors see that it can act as a duplicate of a multifunctional complex of technical means (CTMM), which will significantly improve safe railway operation, as well as significantly reduce the current two thousand stops of trains according to unconfirmed indications of CTMM. This is directly related to the economy of the transportation process, where the infrastructure component of the tariff includes money for the creation and maintenance of diagnostic systems. In addition, the capabilities of the system based on acceleration sensors make it possible to more accurately calculate trends in the technical condition change of the bearing, and thus increase the reliability of the forecast for the safe mileage of the car. The system's capabilities can be extended in the future with additional important functions, such as wheel tread monitoring and bogie prowling control.*

**Keywords:** *train-based rolling stock fault detecting systems, bearing acoustic monitor, algorithm for production defective axle box, rolling element shape defect.*

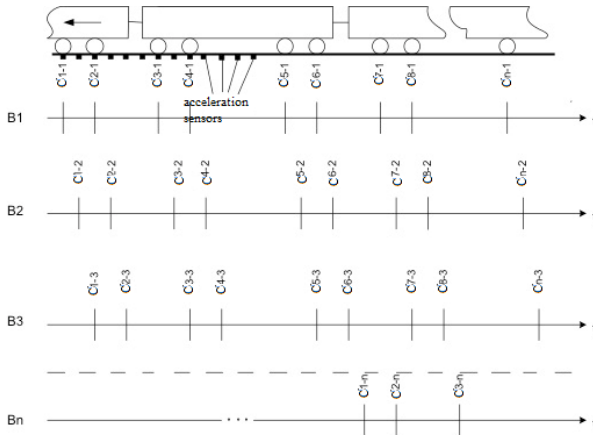
Algorithm for receiving the vibration signal of the bearing during measurements on the rail track.

Assume that the measuring section includes rail track with uniformly installed acceleration sensors B1 – Bn and multichannel measurement system. Assume that the measuring section includes a rail track with uniformly installed acceleration sensors B1 - Bn and a multi-channel measurement system. Train with bearings C1 – Cn passes through the measuring section.

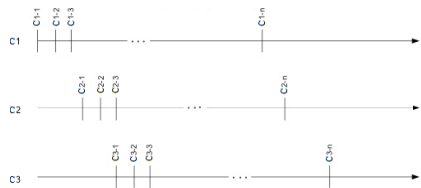
Figure 1.1 shows the assumed time charts of direct multichannel acceleration measurements on the rail by B1- Bn sensors, and figure 1.2 depict the converted into continuous acceleration implementations for each bearing. The number of implementations corresponds to the number of the passing train bearings. Since each wheelset passes the same section of rail track, the resulting acceleration implementations must be correlated with a time shift corresponding to the distance between the sensors. This follows from the assumption that the places where the sensors are installed during the passage of wheelsets have approximately the same reactions, and the difference part will contain the diagnostic information of interest. In practice, these reactions may differ significantly for various reasons. The main ones should be considered the condition of wheelsets, condition of bogie with elements of dry friction, type and loading of the car affecting the dynamics of the bogie, influence of external factors such as acoustic noise etc.

Based on the above, if it is possible to identify the passing train from the measurements of the dispatch service or other sources up to the bearings on constructive, technological, dynamic parameters and external factors, the result of which would be the union of temporary implementation accelerations to the group, then after conducting cross correlational analysis it is possible to select correlated components of the spectrum from the implementations depict on Fig 1.2, and for the remaining part of the signal, make diagnostic of bearing units.

Obviously, that the more complete the identification of the passing train and external influencing factors will be provided, the more accurate the diagnostic of axle boxes will be ensured. To select acceleration samples from the result measurement corresponding to the passage of a given wheelset, the signals of pedal sensors that are triggered during the wheel passage are used. This information also helps to identify the type of bogie, the type of car and the speed. Installation of a force sensor under the rail allow estimating the load on the bearing from the weight of the car.



**Fig. 1.1 Time diagrams of expected acceleration measurements on the rail**



**Fig. 1.2 Compiled diagrams of accelerations on bearings**

Suppose a bogie car with 4 bearings moves at an unknown speed  $V$ , where the diameter of the wheelsets rim  $D$  (mm), the distance between the axles of wheelsets  $\ell$  (mm), number of rolling elements ( $N_{re}$ , ratio of the middle bearing diameter to the diameter of the rolling element  $D_c/D_{re}$ , rotation frequency of the wheelset  $F_1$  (Hz)

Rotation frequency of the wheelset is found according to the formula:

$$F_1 = \frac{\ell}{\pi D \cdot \tau} \quad [1.1]$$

where,  $\tau$  - the time corresponding to the lag in the passage of two bogie wheelsets is determined by the results of spectral analysis of the registered implementation of the process by one of the sensors during the passage of the train. Cepstrum is the energy spectrum in which the abscissa is the axis of time. Obviously, the first harmonic of the spectrum with maximum amplitude will correspond to the time of interest  $\tau$ , because bogies with two wheelsets form the rolling stock in the overwhelming case. The resolution

of spectral analysis (duration of implementation) and constant movement speed define the accuracy of determination  $\tau$ . Certainly, the longer the passing train, the more accurate the determination of  $\tau$ .

The main frequencies on which bearing defects can appear are found by known formulas. [1]

Ball Pass Frequency Inner Race (BPF1)

$$F_B = \frac{N_{re}}{2} \cdot F_1 \left( 1 + \frac{D_{re}}{D_C} \right) \quad [1.2]$$

Fundamental Train Frequency (FTF)

$$F_C = \frac{F_1}{2} \left( 1 - \frac{D_{re}}{D_C} \right) \quad [1.3]$$

Ball Spin Frequency (BSF)

$$F_{TK} = \frac{F_1}{2} \cdot \frac{D_C}{D_{re}} \left[ 1 - \left( \frac{D_{re}}{D_C} \right)^2 \right] \quad [1.4]$$

Frequency of excitation in case of a defect in the shape of rolling elements (FFB)

$$F_{FB} = 2 \cdot F_1 \left( \frac{D_C^2}{D_{re}^2} \right) \quad [1.5]$$

Frequency of excitation when changing the shape of the internal track (FFI)

$$F_{FI} = \frac{F_1 \cdot N_{re}}{2} \left( 1 - \frac{D_{re}}{D_C} \right) \quad [1.6]$$

According to the task, it is necessary to determine the optimal number of piezo accelerometers installed on the rail track and the distance between them. It is necessarily to meet following requirements:

Accelerations generated by the wheelset when passing the location of sensors installation, should be arranged as much as possible from the accelerations generated by the next or previous wheel pair.

The number of transducers (sensors) installed on rail should allow the duration of the arranged time implementation for each bearing to provide the required high resolution of spectral analysis which would highlight the diagnosed bearing frequencies and at the same time provide statistical reliability of the assessment.

The first requirement is met by applying weighting window in the time domain. The resolution of spectral analysis is provided by the overlapping degree of the weighted samples of the process. The nature of samples weighing and overlapping is reflected in the next section on Figure 1.2.

The maximum duration of a single process sample is determined by the distance between the wheelsets axles and the movement speed of the bogie and should be no more  $\tau$ , and spectrum resolution

$$B_e = \frac{1 \cdot K_B}{\tau \cdot n_q} \quad [1.7]$$

where,  $n_q$  - number of installed sensors,

$K_B$  - number of sensors (Average value).

Analyzing the list of diagnosed frequencies, it is possible to arrange them in ascending order starting with the lowest. In the following order :  $F_C$  (FTF),  $F_1$ ,  $F_{TK}$  (BSF),  $F_{F1}$  (FFI),  $F_B$  (BPFI) and  $F_{FB}$  (FFB).

In spectral analysis of the implementation of the form (Figure 2) get a linear spectrum with zero components at frequencies

$$F_{ON} = \frac{1}{t_b} N \quad N = 1, 2, \dots, N \quad [1.8]$$

Obviously, when  $N = 1$  and  $t_b = \tau$   $F_{01} = F_1$ , that the amplitude of the main frequency of the wheelset's rotation turns into zero. In order to prevent the diagnosed frequencies from falling into zero nodes, it is necessary that all the diagnosed frequencies are in the frequency range  $0 - F_{01}$ . Otherwise speaking  $t_b < \tau$ .

By setting the attenuation frequency  $F_o$ , it is possible to define the duration of one recording section by the indications of one sensor

$$t_b \leq \frac{1}{F_o} \quad [1.9]$$

let,  $F_o = K \cdot F_B$  (BPFI) – highest frequency of the first harmonica from the list of diagnosed frequencies, where  $K$  – number of smashes (unaveraged). Exclude the  $F_{FB}$  frequency from consideration, since it is an order of magnitude higher than  $F_B$  (BPFI).

The distance between the sensors should be such that the wheelset runs over their locations with new contact points, i.e. the contact of the wheel with the location of the next sensor is the angle of the sector corresponding to the inequality

$$\frac{360}{\phi} \neq N \quad [1.10]$$

where,  $N$  - integer,  $\phi$  – arc angle of the sector.

The number of sensors is determined based on the lowest diagnostic frequency (in our case Fundamental Train Frequency  $F_C$ ), thus at least one frequency period is covered  $F_C$ . On the other hand, the number of sensors determines the duration of implementation, which is related with the statistical reliability of the spectrum [1.7].

Based on these provisions, will calculate the minimum required number of installed sensors and the distance between them.

From the expression [1.3] the minimum duration of the process

$$T_p = \frac{1}{F_c} = \frac{1}{F_1 \left(1 - \frac{D_{re}}{D_c}\right)} \quad [1.11]$$

Assuming that individual process samples have the same duration  $t_\ell$  can get

$$T_p = t_\ell \cdot n_q \cdot \frac{1}{K_B} \quad [1.12]$$

where,  $n_q$  – number of sensors.

From the [1.8] and [1.9] for  $N = 1$

$$t_\ell = \frac{1}{K \cdot F_\ell} \quad [1.13]$$

Then

$$n_q = \frac{T_p}{t_\ell} = T_p \cdot K \cdot F_\ell \cdot K_B$$

Substitute into this expression [1.11] and [1.2] get

$$n_q = K \cdot \frac{1}{F_1 \left(1 - \frac{D_{re}}{D_c}\right)} \cdot \left(\frac{1}{2} F_1 \left(1 + \frac{D_{re}}{D_c}\right) \cdot N_{TK}\right) \cdot K_B = K \cdot \frac{D_c + D_{re}}{D_c - D_{re}} \cdot \frac{N_{re}}{2} \cdot K_B$$

[1.14]

Example. Diagnostic object parameters (bogie 18-100 CNII - KHZO):

distance between wheelsets axles of the bogie	$\ell = 1850$ mm
wheelset rim diameter	D = 950
measured lag time of signal passing	
at the movement speed $V = 90$ км/час	$\tau_3 = 0.0768$
number of rolling elements in the bearing	$N_{rs} = 14$
ratio of the average bearing diameter	
to the rolling element diameter	$D_c / D_{rs} = 5.94$

Determine:

diagnostic frequencies

required number of sensors

distance between sensors

Spectral analysis resolution

According to the formula [1.1] find the rotation frequency of the wheelset (the main frequency for the bearing)

$$F_1 = \frac{l}{\pi D \tau} = \frac{1850}{3.14 \cdot 950 \cdot 0.0768} = 8.07$$

According to the formulas [1.2 - 1.6] find the diagnosed frequencies.

$$F_C = \frac{F_1}{2} \left(1 - \frac{D_{re}}{D_C}\right) = \frac{8.07}{2} \left(1 - \frac{32}{190}\right) = 3.36 \text{ Hz}$$

$$F_B = \frac{F_1}{2} \left(1 + \frac{D_{re}}{D_C}\right) \cdot N_{re} = \frac{8.07}{2} \cdot \left(1 + \frac{32}{190}\right) \cdot 14 = 66.0 \text{ Hz}$$

$$F_{TK} = \frac{F_1}{2} \cdot \frac{D_C}{D_{re}} \left[1 - \left(\frac{D_{re}}{D_C}\right)^2\right] = \frac{8.07}{2} \cdot \frac{190}{32} \left[1 - \left(\frac{32}{190}\right)^2\right] = 23.28 \text{ Hz}$$

$$F_{FI} = \frac{F_1}{2} \cdot N_{re} \left(1 - \frac{D_{re}}{D_C}\right) = \frac{8.07}{2} \cdot 14 \cdot \left(1 - \frac{32}{190}\right) = 46.98 \text{ Hz}$$

$$F_{FB} = 2 \cdot F_1 \left(\frac{D_C^2}{D_{re}^2} - 1\right) = 2 \cdot 8.07 \left(\frac{190^2}{32^2} - 1\right) = 533.1 \text{ Hz}$$

Find the minimum number of sensors according to the formula [1.14].

Set  $K = 1.2$  and  $K_B = 3$

$$n_q = K \cdot \frac{D_C + D_{re}}{D_C - D_{re}} \cdot \frac{N_{TK}}{2} \cdot K_B = 1.2 \left(\frac{190 + 32}{190 - 32}\right) \cdot \frac{14}{2} \cdot 3 = 35.4$$

Calculate the frequency of the spectrum envelope moving to zero

$$F_o = 1.2 F_B = 1.2 \cdot 66.0 = 79.2 \text{ Hz}$$

Based on the capabilities of the measurement system (maximum number of channels is 64), accept the number of sensors installed on one rail

$$n_q = 32$$

Resolution of the spectrum will be

$$Be = \frac{1}{t_{\xi} \cdot n_q} = \frac{F_o}{n_q} = \frac{79.2}{32} = 2.475 \text{ Hz}$$

Take the value  $Be = 2.5 \text{ Hz}$ , get  $F_o = 80 \text{ Hz}$ .

Duration of one sample

$$t_{\xi} = 0.0125 \text{ s}$$

Duration of the process implementation

$$T_p = 0.4 \text{ s}$$

Find the distance between the sensors

$$l_q$$



$$\ell_q = \frac{l \cdot t_k}{\tau_3} = \frac{1850 \cdot 0.0125}{0.0768} = 301.1 \text{ mm}$$

Based on the distance between the sleepers  $\ell_{sl} = 600 \text{ mm}$  take the value

$$\ell_q = 300 \text{ mm}$$

Verify the condition [1.10]

$$\frac{\pi D}{\ell_q} \neq N$$

$$\frac{3 \cdot 14 \cdot 950}{300} = 9.94$$

Length of measuring section should be about 10 meters.

$$\ell_R = \ell_q \cdot (n_q - 1) = 300 \cdot (32 - 1) = 9300 \text{ mm}$$

From the calculation of the diagnosed frequencies of the rolling bearing, it is clear that the frequency group  $F_C, F_{TK}, F_{FI}, F_B$  is in the lower end of the spectrum of the spectrum, while the frequency  $F_{FB}$  (frequency of excitation in case of a defect in the shape of rolling elements)  $\sim 10$  times higher than  $F_{FI}$ . In the statistical diagnostic model above, this parameter may not be defined because it is higher than the frequency  $F_o$  and during the process may plot on the frequency  $F_{FB} = N \cdot F_o$  or close to it. From the diagnostic point of view the  $F_{FB}$  frequency is an important criterion for evaluating the bearing condition and requires control.

Therefore, along with the statistical diagnostic model will consider the resonant model, which primarily determines the  $F_{FB}$  frequency. The method consists in measuring the acceleration on the rail near the joint at the time when the wheelset passes this place. Sensors must be positioned on the left or right of the joint. The frequency  $F_{FB}$  and its multiple components are found in the signal spectrum and their amplitude is estimated

Taking into account that the  $k \cdot F_{FB}$  frequencies are in the range of sound frequencies, it is advisable to carry out diagnostics using acoustic pressure sensors installed near the joint of the rail track. The action of bearing control monitor [8] bases this principle. A single measurement may not provide detection of a rolling element defect, because there may be no conditions for forcing of the defective rolling element in the moment of passing the joint.

In principle the number of measurements should correspond to the

number of  $N_{TK}$  rolling elements, and the joints are located at a distance determined by the frequency of the  $F_c$  separator and the number of rolling elements.

$$\ell_j = M \cdot \frac{\pi D F_1}{F_c(N_{re} - K)} \quad [1.15]$$

where,  $K, M$  - integer, withal  $0 < K \leq (N_{TK} - 1)$  and  $M > 0$

Example. From the previous example, known

$$D = 950 \text{ mm} \quad F_1 = 8.38 \text{ Hz} \quad F_c = 3.35 \text{ Hz} \quad N_{TK} = 14$$

Identify possible variations of distances between joints

Minimum distance at  $M = 1, K = 1$ .

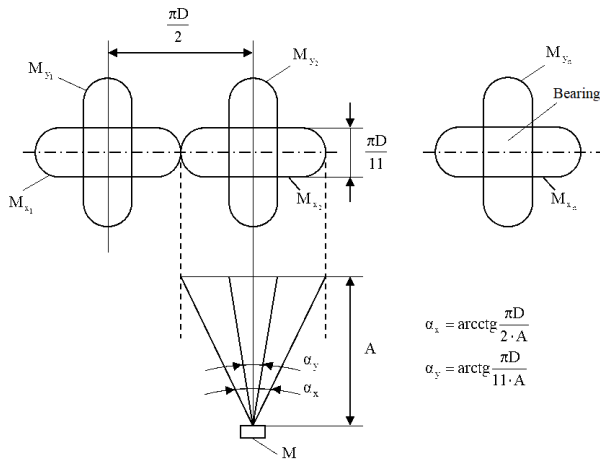
$$\ell_{j.min} = M \frac{\pi D F_1}{F_c(N_{re} - K)} = \frac{3.14 \cdot 950 \cdot 8.38}{3.35(14 - 1)} = 574 \text{ mm}$$

Distance at  $M = 1$  and  $K = 11$ .

$$\ell_{jK=11}^{M=1} = \frac{3.14 \cdot 950 \cdot 8.38}{3.35(14 - 11)} = 7462 \text{ mm}$$

Identification algorithm of the acoustic signal of defective bearings

The «Bearing control monitor» system (similar RailBAM) is widely used on the Russian railways, which allows to identify axle box defects at an early stage of their by measuring and analyzing acoustic noises emitted by vibrations of defective axle box bearings, passing through the BCM station. The system functions as an independent installation connected to the railway computer network and allows data exchange with other monitoring systems [6]. This system is based on Trackage Acoustic Detection System (TADS), [3] in which acoustic measurements are based on the principle of a linear array consisting of 2 microphones at each control point, oriented in the vertical and horizontal directions (figure 1.3). Since the selection of an object's acoustical signal is based on correlation analysis, the accuracy of which is provided by the largest amount of averaging samples, the number of observation points (array nodes) is selected mainly based on the cost of the equipment used. In particular, the system (BCM) has 6 points on each side of the track with a total number of 24 microphones. The distance between the measurement points is chosen so that the control object is constantly in the microphone's field of view, and the vertical view should cover only the object of control, in our case it is a bearing. In the BCM system, the contact zone of the wheelset with the rail track was the object of control.



**Fig. 1.3 Scheme of the roadside acoustic tracking BCM system**

Strobe obtained from the contact of the wheel with the pedal installed opposite the microphone record the connection of the axle box with the microphone array node.

Below is an example of calculating the angles of a microphone shroud . The length and parameters of the attachment should provide a resonant frequency as low as possible. The highest mode should not exceed 1 kHz. The shrouds must be manufactured with high precision so that the deviations in the transmission characteristics of the measuring channels will be the lowest.

$M_x, M_y$  – vertical and horizontal acoustic array microphones;

$D$  – wheelset rim diameter;

$A$  – minimum distance from microphone to bearing;

$\alpha_x, \alpha_y$  – angles for the microphones shrouds.

Calculation example.

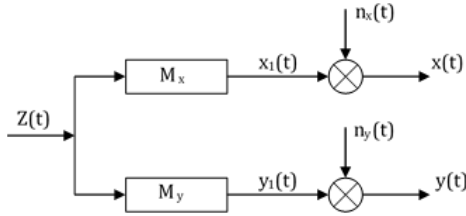
Take the values for the bogie 18-100  $D=957$  mm,  $A=1500$  mm. Then angles of the microphones shrouds

$$\alpha_x = \arctg \frac{\pi \cdot 957}{2 \cdot 1500} = \arctg(0.994) \quad \alpha_x = 45.7^\circ$$

$$\alpha_y = \arctg \frac{\pi \cdot 950}{11 \cdot 1500} = \arctg(0.181) \quad \alpha_y = 10^\circ 10'$$

Take the value  $\alpha_x=45^\circ$ ,  $\alpha_y = 10^\circ$ .

Consider the model of acoustic signals passage measured at single point by microphones  $M_x$  and  $M_y$  on Fig. 1.4.



**Fig. 1.4 Model with one input and two outputs**

Let acoustic noise  $Z(t)$  emitted by the passing train come to the inputs of the  $M_x$  and  $M_y$  microphones. Signals  $x(t)$  and  $y(t)$  – noise measured by microphones. Unobservable signals  $x_1(t)$  and  $y_1(t)$  – noise emitted by the bearing when the train is moving distorted by the transfer characteristics of microphones and their amplifiers. Noises  $n_x(t)$  and  $n_y(t)$  – uninformative noises of the passing train that should not fall into the microphone array node – they are not correlated with each other and with signals  $x_1(t)$  and  $y_1(t)$ .

It is required to determine the spectra of bearing signals.

Taking into account that the measuring path is calibrated and configured so that the transfer characteristics of the  $M_x$  and  $M_y$  are the same and stable

$$x_1(t) = y_1(t) = v(t) \tag{1.16}$$

Then

$$x(t) = v(t) + n_x(t)$$

$$y(t) = v(t) + n_y(t)$$

Moving to the frequency domain we have the power spectral densities

$$G_x(f) = G_v(f) + G_{n_x}(f)$$

$$G_y(f) = G_v(f) + G_{n_y}(f)$$

In a known expression of coherence function

$$\gamma_{xy}^2(f) = \frac{|G_{xy}(f)|^2}{G_x(f) \cdot G_y(f)}$$

the condition [1.16] implies that

$$|G_{xy}(f)|^2 = G_v(f) \cdot G_v(f)$$

Then

$$\gamma_{xy}^2(f) = \frac{G_v^2(f)}{G_x(f) \cdot G_y(f)}$$

and therefore the spectrum of bearing noise

$$G_v(f) = \gamma_{xy}(f) \cdot \sqrt{G_x(f) \cdot G_y(f)} \quad [1.17]$$

According to the received spectrum, it is possible to get an assessment of the rolling element form defect of the bearing unit.

### Conclusion

From the considered options for the construction of the operational diagnostic system of wheelsets axle box during the passage of the train at the time of measurements on the rail, it follows that the station control service must have two measuring sections of the rail track, one of which must have joints. At the stationary measuring section, diagnostics of bearing units is performed at the  $F_C$ ,  $F_{TK}$ ,  $F_{FI}$ ,  $F_B$  frequencies using acceleration sensors installed on the rail track. Industrial operation of five bearing control monitors (st. Izhory Oktiabrskaya railway, st. Losta Severnaya railway, st. Miass Luzhno-Uralskaya railway, st. Inskaya Zapadno-Sibirskaya railway, st. Bataisk Severo-Kavkazskaya railway) based on the algorithms described in the article, showed a 98% confirmation of indications sorting of the axle boxes.

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## ANALYSIS OF EXISTING SOLUTIONS FOR AUTOMATING THE STANDARD CONTROL OF STUDENTS DEGREES WORKS

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**Abstract.** *This article is devoted to the problem of primary verification of electronic documents, namely, the analysis of existing software solutions for automated verification of the compliance of final qualification papers with the requirements of GOST and USDD in the environment of a higher educational institution.*

**Keywords:** *automated standard control; verification of final qualifying works; processing word documents; web application; situation-oriented databases.*

One of the stages of control of admission of final qualifying work (hereinafter - FQW) of students of technical specialties to defense is to check the compliance of the FQW design with the above standards. Currently, there are requirements for the design of technical documentation in accordance with the standards of the Unified system for design documentation GOST 2.104 (hereinafter USDD), GOST 7.32-2001 "System of standards for information, library and publishing. Research report. Structure and design rules"<sup>1</sup>, GOST 2.105, GOST 7.32-2001, OS FSBEI HE "Ufa State Aviation Technical University" (hereinafter - USATU) 016-2007<sup>2</sup>.

Let's consider this process on the example of the Department of Automated Control Systems of USATU. At the moment, the task of collecting, checking and indicating errors is performed by the appointed responsible employees of the department (hereinafter referred to as the Heads). Students submit paper copies of FQW to the Principal. Verification by the

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<sup>1</sup>Statement on the requirements for the content, volume and structure of FQW.

URL: [https://www.ugatu.su/media/eduInfo/Polozh\\_o\\_trebovaniyah\\_VKR\\_SPO.pdf](https://www.ugatu.su/media/eduInfo/Polozh_o_trebovaniyah_VKR_SPO.pdf)

<sup>2</sup>Template for creating reports in accordance with GOST [Electronic resource]

URL: <http://www.fad.ugatu.ac.ru/attachments/article/297/Требования%20к%20оформлению%20ВКР.pdf>

Supervisor is carried out visually, at the same time, the identified errors are marked, comments for correction and the work is returned to the student, or, if there are no errors, the Supervisor and the Norm controller sign in FQW about the compliance of the work with the requirements. The student, in turn, eliminates the identified errors, and the verification cycle begins again. At the same time, the activities of the staff of the department during the graduation project are not limited only to the initial verification of those provided by FQW, which affects the workload. Most of the time, Reviewers do the routine work of looking for common mistakes such as alignments, paragraphs, headings, fonts, indents, borders, etc. Taking into account the human factor, the irresponsible approach of students, lack of knowledge of the standards for document processing, ignoring comments on the correction, as well as tight deadlines, stressful situations, etc., there is an increase in the number of iterations of the verification cycle, queues arise, the quality of verification decreases, and some errors may not be found in time. It is important that students submit the FQW for verification on paper. Accordingly, to correct errors, it is necessary (albeit mostly in part) to reprint the pages of the work, which carries both additional financial costs for the student and the excessive use of paper for printing.

There is a need to automate the process described above, which will save the Checkers at least from working with typical design errors. For this, a software solution (application) should be developed, which, based on the available sample templates, could check the FQW loaded into it (in docx format) and display a list and location of errors found in the text, as well as comments for their correction. The application can have a knowledge base of the standards used, which, in turn, must be changeable, augmentable and modifiable. That is, it should be possible to introduce a completely new format for the standard, since, depending on the faculty or department, FQW may include unique elements that already exist or will appear.

An alternative solution to the problem is to use ready-made templates with built-in styles, forms and a ready-made structure. With a ready-made template, the student will spend less time writing and filling out the document. Styles will allow him to avoid formatting errors in most cases, and a ready-made structure will avoid confusion in presentation. Consequently, the number of obvious errors will tend to zero, and the number of check cycles will decrease. But the examiner will still have to spend time on visual inspection, and the very obligation to use the template and the guarantee of the correctness of such use lies entirely on the student's shoulders. In addition, if the template or standard changes, there is a chance that the student will use the old template by mistake. Based on this, the use of



ready-made templates can be called a partial solution.

Using the suggested application will change the existing process. Now the student will first "pass" his FQW for verification to the application. After correcting all errors, the student can print the FQW and submit it to the Inspector for visual control. It is obvious that the transition to an electronic initial check will be an advantage that saves both time (no queues, reduced check cycles, reduced workload on employees) and financial resources (the need to reprint FQW, the ability to process documents remotely). Of course, the Verifier will still have to deal with verification, but in this case we will only talk about errors that cannot be formalized for automatic verification using sample templates, which will significantly reduce the number of iterations of the verification cycle.

Consider the existing software solutions to the above problem.

**Software Normcontroll SGA**<sup>3</sup>. This program is designed to check the correctness of the design of creative works in accordance with the template and the requirements of regulatory control. The requirements for each type of creative work are different. The "Normcontroll" program is installed on the student's personal computer and is used to check the design of creative works and to detect errors made in the design.

This program checks the following types of work:

- Course work;
- Methodological manual for course design;
- Report on Master's Practice;
- Practice report;
- Creative work, TV essay;
- Report on R&D master;
- Electronic FQW pre-protection.

After executing this program, the user receives 3 documents:

- Initial document with the display of recorded errors;
- Document with comments on the errors found;
- Document with a table showing compliance with all requirements.

Disadvantages of the existing solution:

- The program is not updated (the last update was released in 2014);
- You need to customize your work to a certain template;
- The program requires installation on a PC.

**Android application "Electronic normcontroller"**<sup>4</sup>. Allows you to check the correctness (norm control) of coursework, diploma and practical

<sup>3</sup>Normcontroll SGA software with detailed manual.

URL: [https://sga.ucoz.com/news/normokontrol\\_sga/2015-01-08-4](https://sga.ucoz.com/news/normokontrol_sga/2015-01-08-4)

<sup>4</sup>Electronic normcontroller

URL: <https://play.google.com/store/apps/details?id=com.vildanov.normativecontroller>

works created in MS Word 2007 and higher .docx format, for compliance with GOST (7.32-2001). After executing this program, the "Check Result" tab will display the errors found and how to fix them.

After executing this program, the "Check Result" tab will display the errors found and how to fix them.

Disadvantages of this solution:

- There is only an Android version of the application;
- FQW is checked for compliance with only one GOST;
- It is required to download and install this program.

**"Electronic Normcontrol" Program**<sup>5</sup>. It is intended for checking the design documentation, developed in electronic form, for compliance with the specified standards (in accordance with the specified rules).

Functionality of the program

- file name check (performed by the file name check module);
- checking AutoCAD (dwg) files for compliance with the specified standards (performed by the module for checking AutoCAD drawings in dwg format);
- identification of objects that caused violation of standards;
- the ability to correct errors;
- an open interface for developing new verification rules.

The system initially contains a number of preset processing rules. The settings are open, i.e. the user can develop (configure) the rules required for a particular enterprise. Some of the rules can be configured without programming, using the system administration module. Deeper customization and creation of new rules is done by programming using AutoLISP, NET (for example, C#, VB) for AutoCAD, Arx. Accordingly, any types of checks that have an algorithmic solution can be implemented.

The main disadvantage of this solution is the need to download and install this program.

Summing up, it is worth noting that the main disadvantages of the above programs are: the need to download and install, often the inability to customize the verification rules in accordance with the requirements of the Normcontroller. Processing rules are set as exceptions, which also complicates system configuration. We propose to consider the implementation of such functionality in the form of a web application, and specifying the rules by entering a template file. The proposed approach has the following advantages:

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<sup>5</sup>Electronic normcontrol

URL: <https://rusapr.ru/pages/shortcode/bentley-systems/23-software/97-elektronnyj-normkontrol>

- Remote access of students to the site and the ability to check FQW online;
- Ability for the Normcontroller to centrally influence the rules for processing FQW - just upload a new template to the site.
- Ability to deploy and configure a similar application to other universities and organizations to check the compliance of documents with the rules of the organization.

As a backbone technology, the Situation-Oriented Database (SODB) model [1-3] can be used, which provides specifications and new elements for creating ready-made electronic documents based on sample files. The concept is based on the technology of dynamic DOM objects associated with the states of the dynamic SODB model, while the creation of documents in the course of interpretation and loading with specified processing are carried out automatically taking into account the specified conditions. The final document is sent to the user through the browser [4]. The web application will be able to accept the reference file, store it and process it. For this, an analysis of the structure should be carried out, based on the results of which a list of available components (headings, indents, table and page parameters) is formed. The variability of the components and the hierarchy of location must be considered. According to these rules, it is supposed to analyze the check file to find errors in its design. Accordingly, the algorithm must rely on some kind of schema or data model so that it does not refer to the reference file every time.

Further studies are planned to be devoted to a more detailed study of the implementation of such a web application, both in line with the latest trends in the development of SODB [5-7], and other approaches.

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## ANTHRACITE-BASED ACTIVATED CARBON FOR DRINKING WATER TREATMENT

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**Abstract.** *The problems of removing organic and inorganic contaminants from natural and waste water using activated carbons (AC) in order to obtain drinking water are considered. It is shown that anthracites are a valuable raw material for the production of water-purifying activated carbons. A technology for producing activated carbon of the DAS grade based on anthracite has been developed and its high efficiency in water treatment processes has been shown.*

**Keywords:** *drinking water, waste water, activated carbon, purification efficiency, phenol, formaldehyde, heavy metals.*

Filtration of water through a layer of granular carbon or the introduction of powdered activated carbon into the water are the most versatile methods for removing dissolved organic substances of natural and non-natural origin from water.

Since the content of organic substances of natural origin in drinking water is normalized only indirectly (in terms of color, odors and tastes of water), and the color of water is usually sufficiently reduced by coagulation and chlorination, activated carbon, which is an expensive material, is mainly used to remove substances that cause odors and tastes of water, as well as for removing organic pollutants of unnatural origin from water - various detergents, pesticides, oil products and other toxic substances that enter open water bodies with wastewater from cities and industrial enterprises.

When removing from the water substances that give it odors and tastes, their concentration must be reduced to very low values, at which the smell and taste are no longer felt.

The concentrations of various substances at which they smell or taste in water are not the same. Hydrogen sulfide is felt at a concentration of more than 0.2-0.3 mg/l in water, chlorine - at a concentration of more than 0.3 mg/l, chlorophenol - at a concentration of more than 0.02 mg/l, the waste products of actinomycetes, imparting an earthy smell to water, are felt at a concentration of more than  $1 \times 10^{-8}$  mg/l. Naturally, at such low residual concentrations of the removed substance, the degree of utilization of the sorption capacity of activated carbon when it is introduced into water in the form of a powder will be small. The constant use of powdered activated carbon (PAC) for water treatment is usually not profitable due to the impossibility of its regeneration and losses during dosing.

Filtration of water through a sorbent bed is preferred for the purification of large volumes of water. At waterworks at the final stages of treatment, granular activated carbons (GAC) are used, which can be regenerated, which reduces the cost of water treatment. Filtration through GAC gives water of better and more constant quality in comparison with carbonation, i.e. the introduction of PAC into water [1,2].

For the manufacture of granular sorbents, it is advisable to consider the use of natural raw materials. Anthracite is widely represented in various regions of Russia as a fossil coal raw material.

The potential reserves and volumes of this type of coal raw materials are 35 billion tons. The anthracites of the Donetsk Basin, Kuznetsk Basin and Magadan Oblast are of the greatest interest. To organize new production of activated carbons on their basis, no more than 0.02% of their stock will be consumed [3]. It is especially important to note the low content of volatile substances (less than 5%), which allows such material to be directly activated without carbonization and de-volatilization operations. Also, this material is distinguished by low ash content. As a result, the anthracite-based activated carbon manufacturing process includes only 4 technological steps, while the production of AC on the AG-3 coal-base requires 11 steps.

Currently, "ENPO Neorganika" JSC (Elektrostal, Moscow Region) has fully completed the development of a technology for producing DAS activated carbon based on anthracite. Anthracite from the Eastern Donbass of the Obukhovskaya mine (Rostov Oblast) was taken as a raw material. After crushing pieces of anthracite, the required fraction of 1-3 mm was sown, which was subjected to activation in a laboratory rotating electric furnace in an environment of carbon dioxide and water vapor (in a ratio of 1:3) at a temperature of 870 °C, activation was carried out to a value of 15% burnout [4-5].

Table 1 shows the technical characteristics of DAS activated carbons based on anthracite and industrial coals AG-3 (Russia) based on CC coal) and GCN 830 (Netherlands, "Norit", based on coconut shells).

**Table 1 - Technical characteristics of activated carbons**

Indicators	AG-3	DAS	Coconut based GSN 830
Bulk density, g/dm <sup>3</sup>	400-500	780	550
Abrasion strength,%	70-75	75,2	92,0
Ash content,%	12-15	2,2	2,4
Micropore volume, V <sub>z</sub>			
- cm <sup>3</sup> /g	0,20-0,22	0,22	0,34
- cm <sup>3</sup> /cm <sup>3</sup>	0,09	0,17	0,19
Iodine adsorption activity,			
- mg/g	650-670	600	800
- mg/cm <sup>3</sup>	297	468	400
Dynamic activity for benzene, g/dm <sup>3</sup>	40-42	53	72

It is obvious that the adsorption properties of DAS per unit volume are on average 1.5 times higher than that of AG-3, which is due to its high volume of micropores per unit volume (cm<sup>3</sup>/cm<sup>3</sup>). At the same time, in terms of its quality (with the exception of strength), DAS is at the level of the best world analogue of GCN 830.

Especially important was the fact that activated carbons with identical physicochemical and adsorption properties are obtained from anthracites from different deposits. Table 2 shows the qualitative characteristics of activated carbons based on anthracites of the three main coal basins of Russia: Eastern Donbass, Kuznetsk basin and Omsukchan basin (Magadan region) [4].

**Table 2 - Qualitative characteristics of DAS based on anthracite from various deposits**

Quality indicators	DAS Omsukchan	DAS Donbass	DAS Kuzbass
Bulk density, g/dm <sup>3</sup>	720	780	798
Abrasion strength, %	80,0	75,2	75,8
Ash content, % wt.	3,1	2,2	3,8
Micropore volume:			
- cm <sup>3</sup> /g	0,23	0,22	0,21
- cm <sup>3</sup> /cm <sup>3</sup>	0,16	0,17	0,17
Dynamic activity for benzene, min			
Iodine adsorption activity:	54	53	51
- mg/g			
- mg/cm <sup>3</sup>	600	600	570
	432	468	455

As can be seen from the data given in Table 2, the parameters of the porous structure, as well as the strength and adsorption characteristics of the obtained activated carbons, are practically the same within the measurement error.

It was expedient to consider the possibility of using this type of activated carbons for water purification from organic substances dissolved in water.

Table 3 shows the test results of DAS grade activated carbon based on anthracite, Russian industrial AG-3 and Belgian TL-830 on the efficiency of formaldehyde removal under static conditions. Studies have shown that anthracite-based DAS activated carbon can compete with AG-3 and TL-830 in terms of extracting formaldehyde from water.

**Table 3 - Efficiency of carbons in relation to formaldehyde**

Carbon brands	Initial concentration of formaldehyde, mg/l		
	0,11	0,1	0,06
AG-3	0,032	0,040	0,016
TL-830	0,042	0,040	0,022
DAS	0,033	0,038	0,019

Also, studies were carried out under static conditions on the efficiency of removing phenol from water. The results, shown in Table 4, showed that DAS is not inferior to industrial activated carbons of Russian and foreign production.



**Table 4 - Efficiency of carbons in relation to phenol**

Indicators	Carbon brands		
	AG-3	TL-830	DAS
Initial phenol concentration, mg/l	0,01	0,01	0,01
Equilibrium concentration, mg/l	0,0083	0,0077	0,0091
Initial phenol concentration, mg/l	0,02	0,02	0,02
Equilibrium concentration, mg/l	0,017	0,014	0,0182
Initial phenol concentration, mg/l	0,06	0,06	0,06
Equilibrium concentration, mg/l	0,051	0,043	0,053

Note – Experimental conditions: 1 g of carbon per 1 liter of water, contact time 0.5 h

Similar studies on the efficiency of extraction of difficultly sorbed phenol, as the most widespread anthropogenic pollutant, both in waste and natural waters, were carried out under dynamic conditions for the DAS sorbent and industrial activated carbon of the KAD-I brand (Russia). The results of these tests are shown in Table 5.

**Table 5 - Efficiency of purification of drinking water from phenol with activated carbons under dynamic conditions**

Indicator	Activated carbon brands		Excess, times
	DAS	KAD-I	
1. Sorption capacity before breakthrough (ml/g)			
- with a layer height of 120 mm	9,40	2,15	3,8
- with a layer height of 520 mm	33,98	8,84	
2. Sorption capacity to saturation (ml/g)			
- with a layer height of 120 mm	72,20	29,85	2,5
- with a layer height of 520 mm	94,00	38,16	

Note - Test conditions: sorbate concentration 50 mg/dm<sup>3</sup>, filtration rate 4 m/h.

In this experiment, drinking water was filtered through columns with activated carbon and the effect of the DAS advantage in a high volume of micropores per unit volume ( $V_{mi}$ , cm<sup>3</sup>/cm<sup>3</sup>) was fully manifested.

Thus, it can be stated that the sorption capacity for phenol of the DAS sorbent exceeds the sorption capacity of the industrially manufactured KAD-I sorbent based on coal semicoke ~ 2.5–3.5 times. The DAS sorbent can be effectively used for the purification of phenol-containing wastewater as a load in sorption filters.

Evaluation of the effectiveness of DAS activated carbon in the treatment of waste water from heavy metals was shown at the water purification of the gold recovery plant of the Polymetal company in the Magadan Oblast through a layer of carbon of class 1-3 mm and a filtration rate of 0.5 m/h; layer height 150 mm. The results of the study of waste water filtration through the DAS sorbent bed are shown in Table 6.

**Table 6 - Efficiency of purification of waste waters from metal**

Extracted metal	Unit of measurement	MPC	Source water	Purified water
Iron total	mg/dm <sup>3</sup>	0,10	5,6	4,8
Manganese total	mg/dm <sup>3</sup>	0,01	2,3	< 0,1
Zinc total	mg/dm <sup>3</sup>	0,01	51	< 0,04
Lead total	mg/dm <sup>3</sup>	0,01	< 0,2	< 0,2
Copper total	mg/dm <sup>3</sup>	0,00	48	< 0,1
Cadmium total	mg/dm <sup>3</sup>	0,01	0,12	< 0,05
Magnesium total	mg/dm <sup>3</sup>	40,0	51	40
Nickel total	mg/dm <sup>3</sup>	0,01	0,32	< 0,2

As can be seen from the data presented in the table, the DAS sorbent has a very high efficiency in the extraction of heavy metals from water. Moreover, for all metals, except for iron, it was lower than the MPC, and for such metals as manganese, zinc, copper, cadmium, nickel, the concentration in the treated waste water decreased tens and even hundreds of times.

Based on the above studies, it can be concluded that a simple replacement of the sorption load in the existing water supply systems with the DAS sorbent will increase their resource at least twice. In addition, the bulk density of the DAS sorbent is comparable to the bulk density of quartz sand, so it will not be washed out during backwashing of the filtration unit. In this case, both the filtration of mechanical impurities and the sorption of molecular toxicants will be carried out. This will provide high quality, clean and healthy water without significant capital costs.

Thus, the high adsorption capacity of DAS activated carbon with respect to both organic and inorganic pollutants during water treatment allows predicting its high efficiency in drinking water supply systems.

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## BRIDGE RESOURCE MANAGEMENT IS AN ESSENTIAL PART OF PILOT TRAINING

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**Abstract.** *The paper introduces an analysis of the pilot's role in good communication, coordination and cooperation with the Master/Bridge Team in order to ensure the safety of a ship being piloted to the berth. The Bridge Resource Management training for pilots is considered as a way of preventing accidents involving ships under pilotage.*

**Keywords:** *Bridge resource management (BRM), pilotage, Bridge Team, berth-to-berth passage planning, Master/Pilot information exchange (MPX).*

In the International maritime legislation there is no instrument regulating the responsibility of pilots, although accidents as a result of a pilot's error or omission which has not been revealed in proper time by the Bridge Team of a ship being under pilotage due to poor cooperation between the pilot and the Bridge Team become more frequent. The International Maritime Organization, Port Authorities, etc. take measures by adopting and implementing the appropriate documents to improve the professional level of both pilots and navigators. It is important because that can contribute to a safe navigation and prevention of accidents at sea. In this respect good communications and co-operation between the Pilot and the Captain/Bridge Team has an important role to play. Guidance with respect to the master/pilot relationship is contained in, inter alia, IMO Resolution A.960, the International Chamber of Shipping's (ICS) Bridge Procedures Guide (BPG), and 'International Best Practices for Maritime Pilotage' jointly published by the ICS, Intertanko and OCIMF. The law has traditionally considered a marine pilot on board a ship 'conducting' its navigation as the employee of the ship owner.

IMO Resolution A.960 – Annex 2, Section 2 – Duties of master, bridge officers and pilot – stipulates that the pilot's presence on board does not relieve the master or officer in charge of the navigational watch from their

duties and obligations for the safety of the ship. On boarding the ship and before pilotage commences, the pilot, master and bridge personnel shall be aware of their respective roles. The master, bridge officers and pilot share a responsibility for good communications and understanding of each other's role for the safe passage of the vessels in pilotage waters. Masters and bridge officers have a duty to support the pilot and to ensure that his activity is monitored at all times.

Chapter 5 of the ICS's BPG lists the roles and responsibilities of the ship's bridge team and the pilot when a pilot is on board. It underlines that the master has ultimate responsibility for the safety of the ship and prevention of pollution. The Bridge Team is not relieved of its responsibility for safe navigation after embarkation of the Pilot... The Pilot should effectively communicate expert local knowledge, information and advice to the Bridge Team in English or a working language that is understood by the Master, Pilot and Bridge Team. The Master and other members of the Bridge Team shall be able not only to operate navigation equipment but to provide assistance and advice to the Pilot as necessary, monitor the actions of the Pilot, monitor ship progress against the pilotage plan, identify misunderstandings and ensuring that clarifications are sought immediately if in any doubt...

Although the above documents provide actions for good communications between the pilot and the Bridge Team they are not sufficient to ensure it. The following Table is given to demonstrate only a few of the accidents happened when a vessel being piloted.

Sea Empress	<p>On 15 February 1995, the motor tanker <i>Sea Empress</i>, loaded with a cargo of 130,018 tonnes of Forties light crude oil, grounded off the Middle Channel Rocks in the approaches to Milford Haven. A pilot was on board and the ship was entering the Haven via the West Channel. Although the main engine was stopped, put astern and both anchors dropped, the ship continued to run ahead and came to rest aground, approximately 5 cables north-east of the initial grounding position. The weather was fine and clear with a west-north-westerly force 4/5 wind.</p> <p>As a result of the investigation it was found: The master omitted to discuss the prepared ship's approach plan with the pilot and finalise it with him. This should have been done before the pilot took the con and need only have taken a few minutes.</p>
Skagern/ Samskip Courier	<p>On 7 June 2006, the general cargo ship <i>Skagern</i> and the container ship <i>Samskip Courier</i> collided in the Humber estuary in dense fog. Both ships had experienced pilots on board at the time of the accident.</p> <p>As a result of the investigation it was found: An omission to apply long established collision avoidance methods by the masters and pilots. Poor pilot/master relationships. Masters' reliance on the pilots and poor interaction and communications among the bridge teams.</p>

## Process Management and Scientific Developments

Sea Mithril	<p>On 18 February 2008, the UK registered cargo ship <i>Sea Mithril</i> grounded in the River Trent on three occasions. A river pilot was embarked and dense fog had reduced visibility to about 20m.</p> <p>As a result of the investigation it was found: The master was unable to maintain a command overview of the ship's passage. The master relied totally on the pilot for the safe navigation of his ship. Communication and co-ordination between the master and pilot prior to the groundings were poor. The pilot was not supported by the bridge team, which became dysfunctional after restricted visibility was encountered. Flaws in the bridge organization and available support were not identified by the master or the pilot.</p>
Vallermosa	<p>On 25 February 2009, the oil product and chemical tanker <i>Vallermosa</i>, loaded with a full cargo of 35,000t of jet fuel and bound for the BP Hamble Terminal in Southampton Water, made contact with two oil tankers that were discharging alongside at Fawley Marine Terminal. The accident caused structural damage to all three ships, minor damage to the jetty and minor pollution.</p> <p>As a result of the investigation it was found: <i>Vallermosa's</i> approach was unnecessarily aborted for administrative reasons. The pilot's effectiveness was reduced due to his heightened workload, frustration and increasing stress. The master and bridge team were not monitoring the pilot's actions sufficiently, despite their obligation to ensure the ship's safety.</p>
CMA CGM Vasco de Gama	<p>On 22 August 2016, the 399m long ultra-large container ship CMA CGM Vasco de Gama grounded on the western side of Thorn Channel when approaching the Port of Southampton. The ship was the largest UK-flagged vessel at the time and had two of the port's specialist container ship pilots on board.</p> <p>As a result of the investigation it was found: The ship's bridge team and the port's pilots had the experience, knowledge and resources available to plan and execute the passage effectively. However, a detailed plan had not been produced; the lead pilot had not briefed his plan for the turn round Bramble Bank; the bridge team's roles and responsibilities were unclear. There was an absence of a shared understanding of the pilot's intentions for passing other vessels, or for making the critical turns during the passage.</p>

At 1137 on 4 May 2017, the UK registered container ship *CMA CGM Centaurus* made heavy contact with the quay and two shore cranes while executing a turn under pilotage during its arrival at Jebel Ali, United Arab Emirates. The accident resulted in the collapse of a shore crane and 10 injuries, including one serious injury, to shore personnel.

The *CMA CGM Centaurus* was going too fast for the intended manoeuvre when the pilot started the turn. The pilot was aware that the ship might have been travelling a little faster than he would have liked when he initiated the turn, but was content that the ship would be able to complete it.

The ship's bridge team was uncertain of the maximum speed required to complete the turn safely. There was no agreed plan for the intended manoeuvre, and therefore no shared mental model between the bridge team and the pilot. Consequently, the pilot was operating in isolation without the support of the bridge team, allowing the pilot's decision-making to become a single system point of failure.

The pilot's decision to turn at high speed was not effectively challenged because the ship's bridge team lacked the necessary knowledge and experience to be able to confidently intervene and correct the pilot's action.

The increasing size of vessels within restricted waterways, is leading to reduced margins of operational safety, and therefore the importance of proper planning and monitoring of the passage cannot be over-emphasised.

Prior to proceeding to sea, masters are required to ensure that the intended voyage has been planned using appropriate nautical charts and nautical publications for the area concerned, taking into account the guidelines and recommendations developed by the IMO. The IMO's guidelines and recommendations were set out in its Resolution A.893(21) – Guidelines for Voyage Planning. Appraisal and planning of a berth to berth passage plan should include the completion and approval by the Master of a pilotage plan. The pilotage plan may not be complete until after the Master/Pilot information exchange (MPX) has taken place.

Key considerations for the pilotage plan include: planned track with true course; safety depths and safety contours; safe water; decision points for critical manoeuvres; contingency plans; wheel over positions and turn radius for each course alteration.

SOLAS Regulation 34, as amplified by the guidance contained in IMO Resolution A.893(21), requires to have a comprehensive navigation plan for the safe conduct of the ship from berth to berth.

The MPX carried out on *CMA CGM Centaurus* lacked structure and detail. There was no formal exchange of information except for confirmation of the berth, ropes required and number of tugs to be used. The pilot did not explain the detail of the passage plan, how he intended to conduct it, or the speed profile. For his part, the master did not ask for any of this detail, nor did he brief the pilot on the vessel's propulsion, steering and manoeuvring characteristics. Consequently, the ship's bridge team were unable to monitor progress against the pilot's intended plan and were always reacting to events, instead of being able to anticipate difficulties and take action to assist or intervene.

In this respect Bridge resource management (BRM) is the effective management and use of all available resources, both human and electronic, by the bridge team to ensure the safe navigation of a ship. The essence of BRM is a safety culture and management approach that facilitates communication, co-operation, and co-ordination among the individuals involved in a ship's navigation. BRM incorporates concepts such as workload management, problem-solving, decision-making, communication and teamwork.

The ICS BPG provides detailed guidance on effective bridge organisation and BRM, and states that an effective Bridge Team will manage efficiently all the resources that are available and promote good communication and teamwork.

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) requires all officers in charge of a navigational watch on ships of 500 gross tonnage or more to be competent in BRM. The competence is to be demonstrated through examination and assessment of evidence obtained from one or more of approved training, approved in-service experience or approved simulator training. This requirement became mandatory in 2012. A further STCW requirement that became mandatory in 2012 is for masters and chief mates on ships of 500 gross tonnage or more to be competent in the use of leadership and managerial skill.

The size of ships has grown at a rapid pace, yet ports remain largely the same. Margins for error are therefore decreasing. It is imperative that pilots and ships' bridge teams work together and implement the best practices of Bridge Resource Management to ensure the safety of both ships and ports.

For evaluating the above competence with specific reference to pilotage, STCW requires that responsibility for the safety of navigation is to be clearly defined at all times including periods when the master is on the bridge and while under pilotage.

In order to work effectively with the bridge team, the pilot should be trained in the principles of both Bridge Team Management - the focus being internal and external relationships and operational tasks of the Bridge Team- and Marine Resource Management - the focus being cultural issues and the role of the pilot.

Based on the data provided by the Marine Accident Investigation Branch (MAIB) that was obtained by their inspectors as a result of their discussions with pilots on topics including manoeuvring large container ships, use of tugs, pilots' expectations on boarding, berth-to-berth passage planning, MPX and bridge resource management training for pilots,



the following was identified: 1) pilots boarding large container ships are routinely not provided with a pilotage passage plan prepared by the ship's bridge team; 2) pilots are generally very comfortable in their role and, while recognising that the ship's team has a duty to support the pilot, that support is often neither forthcoming nor requested by the pilot; 3) pilots have very little time to assess the competence of the ship's bridge team after boarding a ship, and, in their experience, the competence of ships' bridge teams varies significantly; 4) they also confirm that it is normal practice after boarding for the pilot to take conduct of a large container ship, and to retain conduct of the ship for berthing and unberthing operations; 5) pilots who have received BRM-P training see value in having done so.

IMO Resolution A.960 Annex 1 - Section 5.3 states that every pilot should be trained in bridge resource management with an emphasis on the exchange of information that is essential to a safe transit. This training should include a requirement for the pilot to assess particular situations and to conduct an exchange of information with the master and/or officer in charge of navigational watch. Maintaining an effective working relationship between the pilot and the bridge team in both routine and emergency conditions should be covered in training. Section 5.5 and sub-section 5.5.4 state that competent pilotage authorities should be encouraged to provide updating and refresher training conducted for certified or licensed pilots to ensure the continuation of their proficiency and updating of their knowledge.

It is very important to have refresher or renewal courses in bridge resource management for pilots to facilitate communication and information exchange between the pilot and the master and to increase efficiency on the bridge. In recognition of the above-said various institutions and training providers, including some pilotage organisations, provide their own resource management training aimed specifically at the needs of pilots, often called 'BRM-P'. This BRM-P training is to become obligatory for the pilots throughout the world in order to ensure communication, co-operation, and co-ordination among the individuals involved in a ship's navigation.

Despite extensive industry guidance and the numerous recommendations of MAIB and those of other established accident investigation bodies, many masters still find it difficult to actively engage in the act of pilotage. Moreover, many pilots appear content to keep the interaction between themselves and the bridge team to a minimum. More effort clearly needs to be made to break down the cultural divide to ensure that mutual cooperation and respect between the bridge team and pilot becomes the norm. A requirement for port operators to insist that pilots attend the BRM-P course and actively apply its principles during all acts of pilotage, would help in this respect.

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**CORRECTION OF THE TRAINING PROCESS IN A PANDEMIC:  
IMPLEMENTATIONS AND PROSPECTS**

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**Abstract.** *The material examines the impact of the new coronavirus infection COVID-19 on the field of physical education and sports activities, which was recorded at the end of 2019 and subsequently spread incredibly quickly around the world.*

*The article presents various courses of events in sports under the influence of the pandemic: the consequences of abrupt cessation of classes, changes in the sports calendar of events, restrictive measures, the use and development of the modern trend - the Internet and digital technologies.*

*The topic under consideration will be of interest to specialists in the field of physical education and sports.*

**Keywords:** *pandemic, coronavirus, COVID-19, self-isolation, athlete, physical education, sports, at home.*

**Introduction**

The pandemic of the new coronavirus infection today is the most acute problem and the most important topic for discussion and restructuring of many spheres of society, including the sphere of physical education and sports. State leaders urge fellow citizens, if possible, not to leave their homes; many businesses and organizations are shutting down or switching to remote operation to reduce the risk of the virus spreading. Unfortunately, however, the pandemic continues to gain momentum, and the projected timing of its end is pushed further and further. This entails the

aggravation of the difficulties of remote work and an even greater minimization of leisure activities, including educational and training.

Sport is an integral part of the lives of people in many countries, as evidenced, in particular, by the final act of the Conference on Security and Cooperation in Europe [1]. But in the current circumstances, the International Sports Calendar is completely revised towards the suspension, postponement, change of conditions for holding or cancellation of sports events. So, some of them are:

- postponed indefinitely;
- moved to other countries with a more favorable epidemic situation;
- carried out in compliance with the regulations of restrictive measures (absence of spectators; reduction in the number of participants; mandatory monitoring of the health of athletes; maintaining a social distance of at least one and a half meters; measuring body temperature; wearing masks by coaches, employees, spectators and athletes outside the training area; use of antiseptics, etc. etc.);
- carried out online in order to improve the morale, psychological state, and ensure the leisure of athletes (for elite sports - in real time, for mass sports - in the form of sending video recordings of participants' performances to the organizers before the start of refereeing online).

At the same time, the most high-profile event in the sports world since the beginning of the pandemic was the postponement of the 2020 Olympic Games in Tokyo (Japan) to the next year. This happened for the first time in the 124-year history of the modern Games (as you know, earlier they were completely canceled in 1916, 1940, 1944). The head of the IOC, Thomas Bach, has reached an agreement on the postponement of the Olympic Games with Japanese Prime Minister Shinzo Abe and Chairman of the Organizing Committee of the Olympic Games Yoshiro Mori. It became clear that in a pandemic, in the shortest possible time before the Olympics, athletes and the world community would not be able to adapt to restrictive measures and recover.

Since the beginning of the pandemic, Russian athletes have not been able to participate in 248 international competitions, of which 31 starts had to take place on the territory of the Russian Federation [1, 3].

At the same time, despite the difficult epidemic situation in the world, for all athletes and coaches, the issue of preserving and maintaining sports shape at a sufficiently high level remains extremely relevant (perhaps more relevant than ever).

### **Main part**

The new virus has wreaked havoc around the world, caused enormous social disruption and economic loss, and, unfortunately, the forecasts for recovery are extremely unfavorable. By the number of people infected in the world, it becomes clear that the pandemic will stretch for a longer time - we are not talking about weeks or months, but about years. As a result of developments, this virus is likely to become one of the largest in modern history.

The sphere of physical education and sports activity includes work with all age groups of the population and implements numerous functions, among which not only the achievement of the highest sports results, but also socially and personally significant for each person (leisure, disease prevention, recreation and rehabilitation, education of the younger generation).

Of course, the presence of restrictive measures in connection with the COVID-19 pandemic, affecting the everyday rhythm of life of athletes, requires coaches, instructors, teachers to rethink the structure and content of the training process. In order to avoid a colossal decrease in the fitness of athletes (physical, technical, psychological) - and this is a problem that the sports sector has already faced in all regions of the world - it is necessary to consider ways to solve it, look for new approaches, methods, technologies. Moreover, on the way to solving the problem, it is important to take into account that a sharp cessation of training leads to serious negative consequences for health, which is especially dangerous in a pandemic. In particular, sudden hypokinesia may result in:

- loss of neuromuscular adaptation (loss of muscle strength - decrease in strength indicators);
- decrease in endurance and volume of muscle mass (in parallel, the ability of muscles to absorb oxygen decreases);
- an increase in the volume of adipose tissue (a slowdown in metabolism, muscles to some extent lose the ability to burn fat);
- increased blood pressure (a sedentary lifestyle affects the blood vessels, which narrow and adapt to slowed blood circulation, as a result of which cardiovascular diseases may appear);
- increased blood sugar (which contributes to the development of cardiovascular disease and diabetes);
- depression, irritability, apathy (according to the results of research in the journal *Psychosomatic Medicine*) [2]. Athletes who were preparing for important starts in their sports career are primarily susceptible to psychological and motivational shock. They had to take an abrupt break

and revise the preparation process. For this, the psychology of the athlete was not ready, they are experiencing uncertainty very acutely.

At the same time, the accelerated digitalization of the training process, including the one based on online technologies, has become a good help in responding to many of the pandemic's challenges. As you know, computer technologies in physical education and sports were actively developed earlier, which was manifested in the emergence of a huge number of technical developments related to the accounting, counting, demonstration, statistical analysis of various parameters of human movements, implemented in all areas of physical education and sports activity. However, in the current circumstances, Internet technologies have also entered this sphere of people's life actively and practically without any alternative, allowing to carry out the training process remotely. This situation, of course, requires comprehension, streamlining of approaches, justification of new methodological developments. It has disadvantages, but there are also advantages, one of which is the ability to positively influence the physical activity of the population.

And this trend is currently developing rapidly. It manifests itself in the emergence of opportunities not to stop the training process, realizing it online; save training broadcasts in video format (this allows coaches and athletes to analyze the work done, which was previously available only to the national teams of the country); to pay sufficient attention to the improvement of such details of the skills of athletes for which, as a rule, there is not enough time in the traditional training regime (especially with a tight competition calendar).

In tandem, a teacher, a physical education researcher (theorist) and a trainer (practitioner), online conferences have become more regular and in demand separately for coaches, judges, athletes and even parents. Often, sports psychologists and sports doctors are involved in this process. Together, this provides a unique opportunity to delve deeper into the professional process, generalize theoretical and practical experience, process information, deliver high-quality material to the required circle of people who can ask questions in real time.

In other words, the current situation of the pandemic, despite all its negative manifestations and consequences, has created, in fact, uncontested conditions for the development and implementation of innovations in the training process and in the entire sphere of physical education and sports activity. So, mobile applications are being actively developed to help in organizing the correct daily routine, in controlling loads, anthropometric data, physical development, in implementing proper nutrition with calorie count-

ing, etc. The young generation, possessing "digital thinking", quite quickly and smartly takes on new devices and uses them for self-development. However, many age specialists are forced to master information technologies. Moreover, it is obvious that their knowledge and experience will be invaluable in future revisions of programs, reassessment of priorities, and revision of teaching materials in the long term.

### **Conclusion**

In general, it should be noted that, of course, it is impossible to replace traditional forms of physical education and sports activity with remote ones, since the main thing in training, educational, competitive and other processes is the direct interaction of their participants. However, these forms can be supplemented in the future. In this sense, representatives of the scientific sports community have to do a lot of work to understand the possibilities of combining traditional and electronic methods of organizing physical education and sports activities. At the current moment in time, the opportunities that have appeared unambiguously create conditions for a safe and anticipatory (from the standpoint of physical and psychological traumatism) return of athletes to a full-fledged training process.

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