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## CONTENTS

### LANGUAGE, CULTURE, COMMUNICATION

<b>Oleksandr Alieksieiev</b>	
EXPERIMENTAL SYSTEM OF VOCATIONAL TRAINING OF PHYSICAL CULTURE TEACHERS FOR ORGANIZATION PUPILS' INDIVIDUAL WORK .....	8
<b>Iryna Biriukova</b>	
CULTURAL AND EDUCATIONAL PROJECTS OF ODESA NATIONAL SCIENTIFIC LIBRARY AS WAYS OF PROMOTION LITERATURE, BOOKS AND READING IN MODERN SOCIETY.....	15
<b>Uliana Danyiuk</b>	
THE KYIV PERIOD OF MIKHAIL MORDKIN'S CREATIVITY (1918-1919).....	25
<b>Viktoriiia Herasymenko</b>	
THE FIGURES OF ODESA MAYORS IN THE SECOND HALF OF THE NINETEENTH AND THE EARLY TWENTIETH CENTURIES IN PRE-REVOLUTIONARY, SOVIET AND CURRENT RESEARCHES.....	32
<b>Olga Lefterova</b>	
PLACE OF LATIN IN CONTEXT OF TRENDS IN MODERN INTERDISCIPLINARY STEM EDUCATION .....	39
<b>Natalia Mrynska</b>	
INTRODUCTION OF THE COEXISTENCE EXPERIENCE INTO AN INCLUSIVE LEARNING ENVIRONMENT: PHILOSOPHICAL-ANTHROPOLOGICAL AND SOCIO-CULTURAL ANALYSIS.....	47
<b>Yaryna Oprisnyk</b>	
MEMORY AND SPACE IN KAZUO ISHIGURO'S NOVEL "THE BURIED GIANT": INTERMEDIAL ASPECT.....	56
<b>Lubov Pecherskyh</b>	
«THE UNSIMPLE» BY T. PROKHASKO: A QUASI-HISTORICAL NOVEL.....	67
<b>Katerina Rumyantseva, Larysa Movchan</b>	
THE RELATIONSHIP BETWEEN PROCRASTINATION AND CREATIVE THINKING.....	74
<b>Oleksandr Shevchenko</b>	
STEAM-APPROACH IN THE CONTENT OF THE HOBBY GROUP WORK TECHNICAL CREATIVITY .....	81
<b>Yulia Tsymbal</b>	
WORD-FORMATING AND SEMANTIC CHARACTERISTICS ENGLISH METHODOLOGICAL VOCABULARY.....	87
<b>Viktoriiia Zhukovska</b>	
REFERENTIAL PROPERTIES OF ENGLISH DETACHED NONFINITE CONSTRUCTIONS WITH AN EXPLICIT SUBJECT: OPERATIONALIZATION AND QUANTIFICATION.....	94

### INNOVATION, WORK, SOCIETY

<b>Vitaliy Kosovych, Bohdanna Kosovych</b>	
FIELDS AND LIMITS OF ECONOMIC HUMANISM.....	103

**Yuliya Levchenko**

WOMEN'S PARTICIPATION IN POLITICS AND GOVERNMENT:  
THE EXPERIENCE OF THE UNITED ARAB EMIRATES AND OF CHINA.....112

**Natalya Orlovska, Yuliia Stepanova**

CORRUPTION PREVENTION SYSTEM IN THE BORDER GUARD AGENCIES  
(STATE BORDER GUARD SERVICE OF UKRAINE AS AN EXAMPLE).....118

**Anastasiia Yefimenko**

THE ESTABLISHMENT OF A BALANCE BETWEEN PRIVATE INTERESTS  
OF THE AUTHORS AND PUBLIC INTERESTS OF THE SOCIETY  
IN THE DIGITAL AGE .....126

**HEALTH, ENVIRONMENT, DEVELOPMENT****Artem Andriiaka, Stanislav Vydyborets**

OPTIMIZATION OF DIAGNOSIS OF SECONDARY METABOLIC  
DISORDERS AND TREATMENT TACTICS IN PATIENTS WITH ANEMIA  
IN NEOPLASTIC DISEASE IN COLORECTAL CANCER .....132

**Inna Chorna**

MOLECULAR MECHANISMS UNDERLYING CANCER  
CELL RADIORESISTANCE .....142

**Mariia Derbak, Iryna Khramtsova**

THE DIAGNOSTIC VALUE OF ANTIBODIES TO NEUTROPHIL  
ELASTASE IN NAFLD AND COPD PATIENTS .....152

**Alona Homola**

THE MODERN VIEW OF PHYSICAL THERAPY ON RECOVERY  
OF PATIENTS AFTER STROKE WITH UPPER LIMB SPASTICITY.....159

**Varvara Hryhorenko**

PROGNOSTIC CLINICAL, MORPHOLOGICAL  
AND IMMUNOHISTOCHEMICAL MARKERS  
OF LOW-GRADE SEROUS OVARIAN CARCINOMAS  
OF WOMEN WITH SEROUS BORDERLINE TUMORS IN ANAMNESIS.....165

**Olesia Liakh, Marianna Tovt-Korshynska**

THE ROLE OF PEPSINOGENS IN THE FORMATION  
OF GERD IN PATIENTS WITH COPD .....173

**Ievgeniia Loshkarova**

CHANGES IN METABOLIC EFFICIENCY  
IN SKILLED ATHLETES DURING INTENSE EXERCISE.....181

**Oksana Muliarchuk, Stanislav Vydyborets**

CHARACTERISTICS OF BLOOD DONORS, ACCORDING TO THE RESULTS  
OF COMPLEX LABORATORY TESTS OF PERIPHERAL BLOOD .....189

**TECHNOLOGY, CREATIVITY, IMPLEMENTATION****Olga Protasenko, Galyna Mygal**

HUMAN FACTORS: THE PROBLEM OF MAN-MACHINE  
INTERACTION UNDER THE DIGITALIZATION CONDITIONS .....198

## INTRODUCTION

**Dear colleagues, authors and readers of the Scientific Journal of Polonia University  
(PNAP – Periodyk Naukowy Akademii Polonijnej)!  
Congratulation on the release of a new PNAP 48 (2021)!**

In this issue we are presenting scientific articles, which deal with urgent problems of language, culture, communication, and education, as well as innovations and sociology, issues on health and environment development, technology, creativity and implementation.

The collected papers and their objectives represent researches in linguistics, intercultural communication, literature and education. Among them: word-formating and semantic characteristics of English methodological vocabulary, referential properties of English detached nonfinite constructions with an explicit subject, memory and space in Kazuo Ishiguro's novel "The buried giant" in the intermedial aspect and genre peculiarities of a quasi-historical novel "The Unsimple" by T. Prokhasko.

The authors in the sphere of education elicit pedagogical aspects of current trends in cultural and educational projects of Odesa national scientific library as ways of promotion literature, books and reading in modern society as well as introduction of the coexistence experience into an inclusive learning environment with the help of philosophical, anthropological and socio-cultural analysis and experimental system of vocational training of physical culture teachers for organization pupils' individual work.

PNAP 48 (2021) also highlights the current problems of modern society, such as fields and limits of economic humanism, women's participation in politics and government: the experience of the united Arab Emirates and in China, corruption prevention system in the border guard agencies.

Health issues are focused on optimization of diagnosis of secondary metabolic disorders and treatment tactics in patients with anemia in neoplastic disease in colorectal cancer, molecular mechanisms underlying cancer cell radioresistance, the diagnostic value of antibodies to neutrophil elastase in nafld and copd patients, as well as prognostic clinical, morphological and immunohistochemical markers of low-grade serous ovarian carcinomas of women with serous borderline tumors in anamnesis. Authors in the sphere of technology, creativity and implementation elicit human factors: the problem of man-machine interaction under the digitalization conditions.

We thank our authors, who have already sent their scientific articles to PNAP. We would also like to express our particular gratitude to all the members of the Editorial Board, to the reviewers, and to those who kindly accepted our proposal to work together and contribute to the creation of PNAP.

**LANGUAGE, CULTURE, COMMUNICATION****EXPERIMENTAL SYSTEM OF VOCATIONAL TRAINING  
OF PHYSICAL CULTURE TEACHERS FOR ORGANIZATION  
PUPILS' INDIVIDUAL WORK****Oleksandr Aliksieiev**

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**Summary**

Article outlines methods of introduction of experimental system of vocational training of future physical culture teachers for organization of individual work with pupils. It has been underlined that introduction of the developed system provided for the reasonable selection, structuring and construction of the content of study material in selected disciplines taking into account a purposeful influence on the formation of each component of readiness of future physical culture teachers for organization of individual work with pupils. In the process of research and experimental work it was taking into account that under the selection and structuring of the content of academic disciplines should be understood: strict definition of structure elements that make up the discipline; applying the procedures of optimization for each of these structural elements; establishing and maintaining in optimal state connections and interrelations between elements of the structure of academic discipline in accordance to the integrative criteria for evaluating the effectiveness of its construction. Methodical peculiarities of introduction of the developed system have been outlined. Realization of experimental system of vocational training of future physical culture teachers for organization of individual work with pupils was carried out on the basis of a number of fundamental postulates – principles. Given the complexity and versatility of the process of vocational training of future physical culture teachers for organization of individual work with pupils, principles of research activities have been systematized into some complex. In particular, it was decided to structure the principles into three blocks, each of them regulates the experimental activity or specifies the logic of selection of the essence of certain elements of the author's pedagogical system.

**Keywords:** future physical culture teachers, students, experimental check, system, components, readiness for organization of individual work with pupils.

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## 1. Introduction

Introduction of experimental system of vocational training of future physical culture teachers for organization of individual work with pupils based on the implementation of experimental methods of such a process. This, at the same time, provided for the implementation in the educational process of certain pedagogical conditions and use of structural-functional model of the developed system. Methods of vocational training of future physical culture teachers for organization of individual work with pupils are reflected in the logic of organization of the third, executive stage of the experimental study, has being lasted for 4 years and observed the following steps:

- the experimental methods of realization of the author's system of vocational training of future physical culture teachers for organization of individual work with pupils have been developed and tested;
- the forming stage of scientific research was carried out, in the process of which an experimental test of the hypothesis, conceptual provisions, the efficacy of pedagogical system, pedagogical conditions and structural-functional model of vocational training of future physical culture teachers for organization of individual work with pupils has been carried out;
- approbation of the author's methods for purposeful formation of students' readiness for organization of individual work with pupils in future professional activity has been carried out;
- possibilities of using means, resources of developing environment of the institutions of higher pedagogical education in vocational training of future physical culture teachers for organization of individual work with pupils during conducting trial experimental and open classes according to innovative methods, have been analyzed;
- on the basis of using methods of observation, interviews, survey, questionnaires, analysis of the efficacy of activities of different structure components of the developed system the prognostic substantiation of its development has been done.

Taking into account the system nature of key provisions of the process of vocational training of future physical culture teachers for organization of individual work with pupils, in the context of the research, the verification has been carried out by empirically verifying its individual components in terms of achieving the ultimate purpose.

## 2. Peculiarities of experimental system implementation

Due to the necessity of ensuring the effectiveness of pedagogical studies, within the framework of scientific intelligence relied on the thesis that the pedagogical experiment should be conducted optimally (*Titova, 2-17; Shapovalova, 2014*), that is, with the minimum necessary time and efforts of the experimenter (*Drahniev, 2013: 138*). In this order the theories of planning pedagogical experiments, in particular, the works of Yu. Tanasiichuk, have been analyzed (*Tanasiichuk, 2021: 109*). The researcher argues that the most appropriate in terms of implementation of innovations in the educational process of higher education is the classification of experimental plans in the presence of control and experimental groups:

- experimental plans, which involve the use of control group;
- experimental plans, where only control groups take part.

In the context of scientific study it seems appropriate to choose the first type of experimental plan to verify the effectiveness of implementation of the author's system, pedagogical conditions and structural-functional model of vocational training of future physical culture teachers for organization of individual work with pupils. For this purpose, students were divided into control (CG) and experimental (EG) groups.

The division of students into EG and CG was carried out taking into account a number of factors, compliance with which provided the most equal conditions for the entry of future physical culture teachers in the pedagogical experiment. Such features are: almost identical quantitative composition of students and digital indicators of formation of all components of readiness of future physical culture teachers for organization of individual work with pupils in both categories of groups.

The entry level of readiness of future physical culture teachers for organization of individual work with pupils was determined by students of control and experimental groups at the stage of input control (further – IC) by using special diagnostic tools (questionnaires, polls, tests in the discipline of «Physical Education», etc.). The expediency of such a division of students into CG and EG was confirmed by the results of the entry level of formation of readiness of future physical culture teachers for organization of individual work with pupils.

### 3. Methodical aspects of implementation of the author's system

It should be noted that the implementation of the developed system provided for the reasonable selection, structuring and construction of the content of study material of the selected disciplines, taking into account the purposeful influence on the formation of each component of readiness of future physical culture teachers for organization of individual work with pupils.

In the process of the research and experimental works it was taken into account that the selection and structuring of the content of academic disciplines should be understood that:

- the first is clear definition of the structural elements that make up the content of the academic discipline;
- the second is applying the optimization procedures to each of these structural elements;
- the third is establishing and maintaining in the optimal state of connections and relations between the elements of the structure of the academic discipline in accordance with the integrative criteria for assessing the effectiveness of its construction.

In determining the procedures for selection and structuring of the content of academic disciplines in the study, we relied on scientific investigations of D. Bermudes (*Bermudes, 2016*), Yu. Drahniev (*Drahniev, 2013*), V. Ishchuk (*Ishchuk, 2014*) and others. Thus, scientists propose within this procedure to carry out:

- the identification of the general goals of activity;
- the concretization of tasks, choice the best content of work by determining the main, essential knowledge;
- the choice of effective forms, methods, means and technics, taking into account the existing material and technical possibilities.

Theoretical analysis of the problem of selection and structuring of the content of academic disciplines gave the opportunity to do transformation of study information concerning anatomical, physiological, physical, anthropometric and methodical features of the organization of individual work with pupils, at three levels:

- a) element by element – clarification of goals for structuring the training course; adequate reflection of goals and tasks in the content of academic discipline; identification of didactic readiness of the subjects of education (that are the physical culture teachers) for implementation of the content of academic discipline in the real educational process; selection and optimal combination of different types of learning and cognitive activities, means and methods of study; use of better organizational forms of studying academic discipline;

б) content-subjective – determination of the compliance of all structural elements of the content of academic discipline and making adjustments to its construction; rational use of temporary and other reserves; analysis and evaluation of the effectiveness of the process of teaching the discipline and the correction on this basis of all elements of the system in order to achieve optimal results;

в) interdisciplinary – establishing interdisciplinary relations and using the capabilities of the last ones in the purposeful formation of readiness of future physical culture teachers for organization of individual work with pupils; formation of integrative courses, which give the possibility of holistic presentation and study of problems of professional activity of physical culture teacher during the differentiation and individualization of pupils' physical education; creation of special didactic materials that reveal the features of the created courses; taking into account practical direction of the content of educational courses.

Such research and experimental work gave the opportunity to clarify the goals in the process of selecting the content of academic disciplines selected for experimental research and to attach the selected goals to the purpose of studying the announced courses. The defined goals were directed to the development of cognitive activity of students; formation of innovative pedagogical thinking; cognition by students the necessity in continuous self-development in the innovatization of means, forms, methods and techniques of organization of individual work with pupils, etc.

At the same time, the outlined goals made it possible to find out that the important element and a necessary condition for optimizing the selection and structuring of the content of academic discipline is the constant updating of educational and methodological support. To this end, in the process of implementing the formative stage of the research there was a systematic improvement of the content of selected academic disciplines by clarifying the normative part, expanding the national-regional (sectoral) component, using reserves of additional and optional part of the content of disciplines.

It should be mentioned that future physical culture teachers, who were the participants of CG, studied the disciplines selected for the experimental research during the executive (formative) stage of our scientific exploration according to traditional methods in accordance with generally accepted curricula. Training of EG students was carried out on the basis of the use of the author's experimental methods of system implementation, pedagogical conditions, structural-functional model of vocational training of future physical culture teachers for organization of individual work with pupils.

#### 4. Principles of experimental system

Implementation of experimental system of vocational training of future physical culture teachers for organization of individual work with pupils was carried out basing on a number of basic postulates – principles. The principle in modern pedagogical science is understood as «initial didactic provisions that reflect the course of objective rules and patterns of the learning process and determine its direction in the development of personality» (Karchenkova, 2006: 69). Rules take a lower place in the hierarchy of pedagogical theory and is a transitional link from theory to practice (Tanasiichuk, 2021: 39).

The given explanations were taken into account within the research. Considering the complexity and versatility of the process of vocational training of future physical culture teachers for organization of individual work with pupils, *principles* of research actions have been systematized into a certain set. In particular, it was decided to structure the principles into *three*

*blocks*, each of which regulates experimental activity or specifies the logic of selection of the content of certain elements of the author's pedagogical system.

The first block contains a set of organizational principles (the principle of humanistic direction in study; the principle of continuity of vocational training of future physical culture teachers for organization of individual work with pupils; the principle of practicality; the principle of unity of educational, developmental and upbringing functions of study in higher education and others). Organizational principles are directed to optimal regulation of lecturers' and student's activities, who were covered by experimental work in the direction of vocational training of future physical culture teachers for organization of individual work with pupils.

The second block – are principles, which reflect general pedagogical postulates of functioning of the educational process in higher education (principles of scientificity, accessibility, clarity, strength of knowledge, skills and abilities, development of students' mental abilities (principle of thoroughness), systematicity, consistency, etc.). Implementation of the complex of mentioned principles ensured the achievement of optimal use of information arrays of disciplines «Theory and Methods of Moving Games and Entertainments», «Theory and Methods of Physical Education», «Human Anatomy with Sports Morphology Foundations », «Therapeutic Physical Training», «Theory and Methods of Teaching Sports Games», «Use of Non-traditional Sports Games in Physical Culture Lessons» and organization of pedagogical communication in educational process.

The third block of instructions transmits a set of specific principles of vocational training of future physical culture teachers for organization of individual work with pupils (the principle of nonlinearity, prevalence of student's autonomy, comprehensive integrativity, etc.). Taking into account the specific principles gives an opportunity to explain the features of organization of students' educational activities of the outlined specialty and to retransmit the author's vision of functioning of the researched process. Let us review the essence of some of them in more details.

*The principle of nonlinearity* was realized in the process of vocational training of future physical culture teachers for organization of individual work with pupils at three levels: 1) sources of information; 2) structure of learning courses; 3) presentation of educational material.

The next specific postulate of research is *the principle of prevalence of student's autonomy*. The project of The Concept of Education Development of Ukraine for the period 2015–2025 notes that the purpose of higher vocational education is to train a qualified specialist, competent in the field of his/her professional activity, competitive on the labor market, capable of effective work at the level of world standards, ready for continuous professional growth, social and professional mobility, continuous self-improvement and self-development throughout life. Therefore, the priority in the context of current trends in the development of higher vocational pedagogical education in Ukraine and the world socio-economic conditions is the development of abilities and skills of student's autonomy. In addition, the formation of autonomy in the process of obtaining vocational education, according to N. Stepanchenko, determines the emergence of independence of future physical culture teachers in making professional decisions regarding the specifics of the organization of physical training and sports activities of pupils (Stepanchenko, 2017: 126).

Besides, the application of the principle of prevalence of student's autonomy was based on ensuring open access of students to information about the content and structure of learning courses; course tasks and requirements on the performing; knowledge control «points» and evaluation criteria for all types of educational activities; opportunities to use additional education (optional courses, elective courses, information sources, etc.).

To realize the announced principle in terms of quarantine restrictions, the design of the content of training courses was carried out on the basis of the use of information and communication technologies and distance learning tools. Such research actions made it possible providing feedback in the systems of relationship «lecturer – student», «student – student», «student – group», etc.

The next postulate of vocational training of future physical culture teachers for organization of individual work with pupils is *the principle of comprehensive integrativity*. Implementation of the announced principle within the research took place in a few directions; intradisciplinary (horizontal), interdisciplinary (vertical), interpersonal and intersystem integrativity.

Intradisciplinary (horizontal) integrativity in the process of vocational training of future physical culture teachers for organization of individual work with pupils was based on a complex and interrelated formation of knowledge, abilities, skills of students for performing different types physical training and pedagogical professional activities, as well as on the proportional combination of educational material disciplines «Theory and Methods of Moving Games and Entertainments», «Theory and Methods of Physical Education», «Human Anatomy with Sports Morphology Foundations », «Therapeutic Physical Training», «Theory and Methods of Teaching Sports Games», «Use of Non-traditional Sports Games in Physical Culture Lessons», that is relevant and important for solving various pedagogical tasks related to strengthening and maintaining the individual health of schoolchildren, popularization of the paradigm of healthy lifestyle and physical activity through effective selection of means and methods of individualization of physical culture of applicants for general secondary education.

Interdisciplinary (vertical) integrativity of vocational training of future physical culture teachers for organization of individual work with pupils was provided in the process of solving conflicting professionally oriented problems by students, where the search for ideas to solve involved the use of professional knowledge on different disciplines. At the same time, the designed author's tasks integrated the information of the courses chosen for experiment and were developed together with practicing physical culture teachers.

The interpersonal integrativity in the plane of our scientific research was considered as cooperation and co-creation of all participants of the educational process, which was achieved on the basis of ensuring comprehensive openness of the space of dialogical and polylogical interaction of lecturers and students. Implementation of interpersonal integrativity contributed to the personal development of future physical culture teachers through students' participation in various types of cognitive activities (guided self-study, self-education, research, educational creativity, cooperation and collaboration with lecturers/students, etc.)

## 5. Conclusions

Summing up, we note that the implementations of author's pedagogical system, pedagogical conditions and model of vocational training of future physical culture teachers for organization of individual work with pupils were directed to the complex formation of singled out components of the studied phenomenon by using developmental potential of the environment of institutions of higher pedagogical education. In order to analyze the results of the executive (formative) stage of the experimental study, the final level of formation of readiness of vocational training of future physical culture teachers for organization of individual work with pupils was determined. We think that there is a necessity to highlight the results of statistical data that demonstrate and confirm the effectiveness of the proposed author's system, pedagogical conditions and structural-functional model of vocational training of future physical culture teachers for organization of individual work with pupils.

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## CULTURAL AND EDUCATIONAL PROJECTS OF ODESA NATIONAL SCIENTIFIC LIBRARY AS WAYS OF PROMOTION LITERATURE, BOOKS AND READING IN MODERN SOCIETY

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### Summary

Libraries play an important role in the system of public institutions that ensure the right of citizens to information, knowledge, education, use of cultural achievements and public access to information resources, popularization of books and reading as a way of learning about the world, education of educated and comprehensively developed individuals with critical, panoramic thinking. The introduction of systematic measures to promote books and reading in modern society remains an extremely important mechanism of cultural, professional and intellectual enrichment, and in general – the development of human capital, its sustainable economic and social progress, increasing the competitiveness of the state in global political, economic, cultural and information space. The work of libraries, which are constantly looking for innovative forms of their activity, is inextricably linked with the process of raising the level of education and culture. The aim of this work is to examine the innovative experience of cultural and educational projects of Odesa National Scientific Library, which made the library an important center for the promotion of literature, reading and books. Currently, there is no single study that would reveal the experience of unique cultural projects of Odesa National Scientific Library. Thus, the systematization and analysis of information about these innovative projects implemented by the library is incredibly relevant.

**Keywords:** library, culture, popularization of reading, book promotion, innovative forms of library activities, Odesa National Scientific Library.

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### 1. Introduction

The intellectual development of society depends on many objective and subjective factors, the most important of which are the development of book publishing, book distribution, book promotion and reading. The introduction of systematic measures to promote books and reading in modern society remains an extremely important mechanism of cultural, professional and intellectual enrichment, and in general – the development of human capital, its sustainable economic and social progress, increasing the competitiveness of the state in global political, economic, cultural and information space.

The Law of Ukraine «On Libraries and Librarianship» defines a library as an information, cultural, educational institution (establishment, organization) or structural unit that has an organized storage of documents, access to other sources of information, the main task of which is to provide information, research, educational, cultural and other needs of library users (*Pro biblioteky...*, 1995). In accordance with Library Development Strategy for the period up to 2025, approved by the Resolution of the Cabinet of Ministers of Ukraine No. 219-p from

March 23, 2016, libraries are «... a basic element of cultural, scientific, educational, information infrastructure of the state. They are important for the development of information and language culture of society, patriotic, legal and environmental education, the formation of lasting interest in the study and understanding of national history and culture. Libraries contribute to the development of reading, thinking and educated nation, able to practically implement the acquired knowledge and experience in the development of independent Ukraine» (*Stratehiia rozvytku ...*, 2019).

Libraries' activities, which are constantly looking for innovations, are inextricably linked with the process of raising the level of education and culture. Thus, for Ukrainian libraries the most urgent task is and remains the promotion of citizens' rights to knowledge, education, use of cultural achievements and free-for-all access to information resources, popularization of reading as a way of world cognition, raising of educated and versatile individuals capable to apply the acquired knowledge and experience for the development of independent Ukraine.

Priorities, directions and content of cultural and educational activities of Odesa National Scientific Library, which is a leading cultural, educational, research and information institution, that performs the functions of research, methodological and coordination center on library science, bibliography, document science, are determined and implemented in accordance with the Library Statute [*Statut ...*, 2020].

Annually, Odesa National Scientific Library (ONSL) implements about 300 socio-cultural projects at the international, national and regional levels, aimed at promoting library resources and services, advocacy of library institutions, attracting new readers, expanding the range of cognitive reading interests, meeting and developing information needs and requests of the population, the formation of meaningful leisure.

Given the challenges of today, Odesa National Scientific Library uses both successful traditional and innovative forms of activities, which, thanks to relevant content, creativity, involvement of a wide range of partners, draw public attention to books and reading, and attract new visitors to the library. Experience of cultural-educational projects of Odesa National Scientific Library have made the library an important center for the promotion of literature, reading and books.

## 2. Digital socio-cultural projects of ONSL

Odesa National Scientific Library is actively introducing innovative cultural and educational projects, which are implemented by use of information and computer technologies. In 2018-2019, major innovative projects were implemented, which gained worldwide recognition.

In 2018, as a part of the project «The Old Engraving – Cultural Heritage of Ukraine», implemented under the egis of the Ministry of Culture of Ukraine with the support of the Ukrainian Cultural Foundation, Odesa National Scientific Library not only digitized more than 600 engravings of XVI–XIX centuries, but also developed a modern web resource that will provide free online access to digital heritage – native and foreign engravings, which are stored in the collection of Odesa National Scientific Library (*The Old Engraving ...*, 2021). For the first time presented the results of many years of hard work of librarians on scientific collection of unique engravings by masters from England, Italy and the Netherlands, Germany, Ukraine, France of XVI–XIX centuries, which are stored in ONSL collection of rarities (*Biriukova*, 2019).

The history of formation, composition and content of this collection deserves careful study and popularization, because the attractiveness of engraving as an art form is that each of



the prints is an independent original work of art. The web portal will provide free access to the mentioned resource to art lovers, researchers of Ukrainian and world culture, art critics, historians, museum workers, restorers, librarians around the world.

As part of the project presentation, an exhibition of original engravings was presented to visitors, the catalog of which was sent to native and foreign partners of Odesa National Scientific Library, and the most interesting 20 showpieces can be presented as a mobile exhibition in Ukraine and abroad (*Starovynna hraviura...*, 2018).

Since 2019, the project «Treasures of Ukraine: Digital Collection of Book Rarities in Odesa National Scientific Library» provides remote access to the most valuable rare books from ONSL collection, which are of exceptional historical and cultural value and subject to inclusion in the State Register of National cultural heritage (*Biriukova*, 2020).

The project «Treasures of Ukraine: Digital Collection of Book Rarities in Odesa National Scientific Library» will serve to create an insurance stock of book rarities, which are subject to entry in the State Register of National Cultural Heritage; providing free remote access to documents from the library; fulfilling the cultural, educational, informational, research and other needs of users; spreading of information about the cultural heritage of Ukraine, the introduction of modern information technologies in the activity of the library. The online resource, which presents a digital library of book rarities in Odesa National Scientific Library, will be available 24/7 (*Treasures of Ukraine...*, 2021). The first stage of the project implementation is to digitize documents of 1801–1922 in Ukrainian, regardless of the territory of their publication, and in any other languages published in modern Ukraine during 1801–1860. After processing the documents according to these criteria, the digital library will be replenished with documents defined by the «Procedure for selection of manuscripts, rare and valuable publications to the State Register of National Cultural Heritage», approved by the Ministry of Culture of Ukraine № 437 from 14.06.2016 (*Pro zatverdzhennia...*, 2016).

These projects effectively promote the development of national culture and art in the state, provide favorable conditions for the development of intellectual and spiritual potential of the individual and society, provide broad access to national cultural heritage, as well as support cultural diversity and integration of Ukrainian culture into the world cultural space.

### **3. All-Ukrainian Exhibition-forum «Ukrainian Book in Odesa Region»**

Since 2019, the Intellect Forum project has been implemented at a high professional level, it combines two powerful streams of events of the All-Ukrainian Exhibition-forum «Ukrainian Book in Odesa Region» (*Vseukrainska vystavka-forum...*, 2021) and OdesaBiblio-Summit (*OdesaBiblioSammit*, 2021) – a program of professional communication for librarians in Ukraine and abroad.

In our opinion, the most significant in terms of the sustainable impact on the development and maintenance of reader demand for new book editions is the nationwide cultural and promotional project of the All-Ukrainian Exhibition-Forum «Ukrainian Book in Odesa Region», which was founded in 1999 and for 22 years in a row provides comprehensive presentation of publishing projects, reading and promotion of book publishing in Ukraine, as well as represents Ukrainian books in the world.

The founder and main organizer of this most important cultural festival of the South of Ukraine is Odesa National Scientific Library (initiator) under the auspices of the Ministry of Culture and Information Policy of Ukraine, with the partnership support of public authorities and local governments, the professional community and civil society institutions (Odesa

Regional State Administration, Odesa Regional Council, Odesa City Council, Book Chamber of Ukraine, Ukrainian Association of Publishers and Booksellers, Ukrainian Book Institute, Ukrainian Library Association, Odesa Regional Writers' Association of Ukraine, National, state, regional, city libraries, etc.).

The main purpose of the exhibition-forum is to preserve and increase the spiritual and cultural heritage of Ukrainian people, to create favorable conditions for the publication and popularization of Ukrainian books, to replenish the libraries of the Southern region with new publications, distribution of books among readers, nurture reading culture and love for books on the best examples of domestic and world literature, support of young writers, poets and artists, guiding of youth. (*Vasylevska, 2019*).

The participants of the exhibition-forum are publishing houses, cultural institutions, literary agencies, public organizations, unions, educational institutions, creative and professional associations, authors, and illustrators of books, etc.

Every year the program of the All-Ukrainian Exhibition-forum «Ukrainian Book in Odesa Region» provides a complex of more than 50 professional and literary events, including a book exhibition-fair in the main reading hall of the library. Presentations of books and publishing projects, personal meetings with writers and historians; literary, poetic and musical evenings, master classes with demonstration of books of the corresponding profile, intellectual games, chess tournaments, autograph sessions, discussions, author's readings, press conferences, various performances which attract attention of the general public, local authorities, mass media, creative circles of Ukraine.

The importance of the forum for Odesa region and the South of Ukraine is evident: within mere 22 years, more than a thousand different events have been held to promote reading; about 300 participants – leading publishing houses of Ukraine presented their newest publications and publishing projects; the events of the exhibition-forum were attended by about 120 thousand people.

The exhibition-forum «Ukrainian Book in Odesa Region» became one of those resonant and cultural events, due to which Odesa in 2019 received the status of «City of Literature of UNESCO», joining the network of creative cities of the world.

Traditionally, the most famous Ukrainian writers take part in the events of the exhibition-form, meetings with famous cultural and scientific persons from Ukraine and other countries of the world take place. Famous and celebrity guests always attract the readers, contribute to improvement of reading culture and love for the printed word on the best examples of Ukrainian literature. It is worth mentioning the high motivation of the authors in meeting with their readers. Personal meetings of authors with their readers is an incredibly special communication, when the author has the opportunity to receive critical comments or positive feedback on their own literary work. Not to mention the aesthetic pleasure of young readers from communicating with the author. Such mutual interest makes the event extremely bright, interesting, and effective in promoting books and reading.

For example, in different years there were: a meeting with Taras Fedyuk, poet, vice-president of the Association of Ukrainian Writers, winner of Taras Shevchenko National Prize, one of the leaders of the contest "Coronation of the Word" (2007, 2012); with well-known journalist Zoya Kazanzhy (2014); meeting with children's writer and screenwriter Irene Rozdobudko (2016, 2020, 2021); a special guest of the exhibition in 2017 was the writer Myroslav Dochynets, winner of the Taras Shevchenko National Prize of Ukraine and the President of Ukraine Prize «Ukrainian Book of the Year»; in 2018 the exhibition was visited by Yevhen

Polozhiy, Ukrainian writer and journalist, editor-in-chief of the newspaper «Panorama» (Sumy) and many other famous people from literary circles, in 2019, 2020 and 2021 a meeting was held with fiction writer Andriy Kokotyukha, winner of the Golden Writer of Ukraine .

In 2019, our international partners joined the forum. National Parliamentary Library of Georgia Director, poet, writer, TV anchor Georgy Kekelidze presented his work in 2018).

Traditionally, a number of events are held to promote children's books, including author's readings and meetings with Volodymyr Rutkivsky, poet and novelist, well-known Ukrainian children's writer, winner of Taras Shevchenko National Prize of Ukraine, Inna Ishchuk, children's writer, winner of the 5th International Competition for the best work for children (*Korniychuk Prize, 2017*) in the category «Poetry for Children» and other contemporary children's writers. Meetings with Serhiy Dmytriyev, Head of Odesa Regional Organization of the National Union of Writers of Ukraine, head of the literary studio for novice writers of the Odesa Region «School of the Young Author», Associate Professor of the Department of General and Slavic Linguistics of Odesa National Mechnikov University. Mykola Senchenko, Director of the Book Chamber of Ukraine, Doctor of Technical Sciences, Professor, Honored Worker of Science and Technology of Ukraine, supports the project with his active participation, speeches, and presentation of newly published books. Soirees, presentations of books, author's readings by Oleksandr Afonin, Honored Worker of Culture of Ukraine, prose writer, poet, President of the Ukrainian Association of Publishers, and Book Distributors are of great interest.

Traditionally, the exhibition is visited by leading specialists in library science, librarians, representatives of central and local authorities, prominent public and religious figures, leaders of public opinion.

The forum takes place in Odesa National Scientific Library, branch libraries, museums, theaters of the city, as well as in the District centers of Odesa Region, which contributes to the development of cultural life in the region.

The obligatory bright component of the forum is the book festival trip to the remote district cities of Odesa region. During the outing of the Book Festival the district centers life is flourishing, a special atmosphere of the holiday is created – the Book Festival and this cultural event becomes one of the most important events in the cultural and book life of the town. «Culture promoting invasion» consisting of librarians, writers, publishers, scientists, artists organizes a book fair, presentations, meetings, autograph sessions, workshops, which allow local citizens to get as close as possible to information, create conditions for receiving new books in remote cities, replenish the collections of district centralized library systems, rural, school libraries, orphanage libraries. About 45,000 books were donated to social institutions during those field trips. And books with autographs and personalized inscriptions of authors during autograph sessions are stored in family libraries as valuable items.

An important point of the project is to determine the winners of the competition «The Best Book of the Exhibition-Forum».

The competition of readers' reviews «Utter a Word about the Book», launched by ONSL in 2011, helps to support the reading activity of young people, attract new readers, promote reading, and capture attention to new books. For the past two years, the competition has been supported by the local branch of the Rotary Club, which has provided cash prizes for the best work. During the competition, participants are invited to write a review of books from the list of publications that have received awards from various domestic book competitions. Library specialists form a relevant book exhibition in the main reading room of the library, drawing readers' attention to new books. The best reviews are published in the catalog of the exhibition-forum «Ukrainian Book in Odesa Region», and from 2019 – on the website of ONSL.

The exhibition-forum also includes conferences, round tables, discussions of experts on ways how to cooperate and coordinate the efforts of libraries and publishers to promote Ukrainian books and reading among young people. The growing relevance of this series of events led to the launch in 2019 of OdesaBiblioSummit project as a program of professional communication for professionals and library partners, which aims to create, develop and implement innovative practices in libraries, popularize books and reading, optimize customer service, discuss current problems of professional activity and exchange of work experience.

According to library experts, promotion of reading should not only be considered as a priority in the cultural and educational policy of the state, which is important for the future of the country, but also to take comprehensive measures, including developing interagency partnerships to promote reading in all institutions related to books by initiating coordinated projects and campaigns in the Ukrainian communication space, such as book festivals, fairs, reading competitions, etc. (*Vylehzhaniina, 2020*). The long-term practice of holding the exhibition-forum «Ukrainian Book in Odesa Region» proved the effectiveness of events that productively contribute to the development of Ukrainian cultural and artistic environment, popularization of books as an intellectual product and attribute of modern lifestyle, reading among various segments and improving the art of book publishing.

#### 4. Project «Night in the Library»

A new initiative that has become a trademark of the library and found a passionate response from the book lovers' community – culture promotional project «Night in the Library. Poetics of Love» (*Velyka Odeska bibliionich..., 2021*). This is a broad-ranging cultural event, which is held for two years in a row on International Book Donation Day and St. Valentine's Day.

The project is aimed primarily at attracting young people to read and intends not only to draw attention to books and reading, but also to demonstrate the capabilities of libraries and prove that visiting the library can be not only for research or educational needs but also the desire to fulfill creativity or just spend quality leisure time.

2019, in total, the events of the project «Great Odesa Library Night» were attended by more than 1.5 thousand guests. During such an action in all corners of the library different activities occur, which are characterized by elements of theatre and game, which always causes activity of participants, whether a book exhibition, literary work, book illustration, book installation, theatrical performance, literary and musical performance, poetry readings, classes from masters of folk art, and the festive atmosphere is created by musical performances by professional musicians and singers. Thus, the increased interest of visitors was caused by originally decorated book exhibition «Book Symphony of Love», an intellectual game «What? Where? When?», an unusual for the library display of hats from the Fashion Houses of Chante and the «RoyalFamilyModels», which was accompanied by a retrospective discourse on the role of the headdress in a woman's life with a thematic exhibition of books and rare fashion magazines about the art of hat design.

People of all ages gladly participated in selfie quests, which gathered about a hundred participants each year. The route of the quest was laid out on the most interesting places of the exquisite library building. A book was hidden in each location, which the quest participant must find and take a photo with. For the results of the quest, all participants received prizes. And for the little ones they arranged a children's space – «KinderLand», where young visitors, future readers of the Library, had fun, interesting and useful time.

The organizers of the project during the preparation of events try to consider the preferences of all segments of the population and different age groups. In 2020, the event was positioned in the media as the Great Odesa Library Night thanks to the involvement of partners from the libraries of the city and region, cultural and artistic centers of Odesa and more. «Night in the Library» brings together patrons with different interests, backgrounds, and levels of activity. Practice has shown that the events were interesting for both young people who seek active action, and older people who enjoyed spending the evening in the intellectual, cultural environment.

In February 2021, despite the challenges and restrictions due to the COVID-19 pandemic, Great Odesa Library Night was a success. Taking into the account quarantine restrictions on the number of visitors who were allowed to stay inside the premises, the number of events had to be reduced. At the same time, we managed to attract 21 partner institutions, thanks to which a broad program of the holiday was created. As part of «Great Odesa Library Night-III» there was a poetic teleconference, which brought together Odesa poets from around the world. The event took place thanks to the creative union of the office «Odessa City of literature UNESCO» and the public organization «Bibliopolis». 21 Odesa poets (19 of them - representatives of the Poets of Odesa City of Literature UNESCO) performed live in the library, and online event was attended by the poet, Professor of Ghent University O. Yudin (Belgium). There was also a literary and musical marathon in the languages of the world «Poetics of Love». Long-term partners and friends of the library presented their native culture: Charitable Foundation «Bavarian House, Odesa», Alliance Française Odesa, a branch of the Greek Cultural Foundation in Odesa, public organization «Odesa A. Mickiewicz branch of the Union of Poles in Ukraine», Odesa regional public organization Georgian Cultural and Educational Center «Iveria», All-Ukrainian Center of Bulgarian Culture, Regional Center of Gagauz Culture, public organizations «Bakhtale-Tavrichane», «United Youth» and others. The marathon program organically included not only poetry, musical compositions, but also fragments from performances. The literary and musical marathon was attended by students of Odesa K. F. Dankevych Professional College of Arts, National University «Odesa Law Academy» and Odesa National Maritime University. The masterful musical greeting was played by the winner of international and national competitions, saxophonist Heorhiy Stremyadin. During the evening, you could immerse yourself in the world of fashion from the international modeling agency «Royal Family Models» to the music of Yevhen Lukashov, Honored Worker of Culture of Ukraine. A tree of friendship was installed in the festive hall, which symbolized the multinational Odesa region. After the performance, the representatives of cultural and artistic institutions and national-cultural societies of Odesa decorated the tree of friendship with colorful ribbons, symbolizing flag colors of the peoples of the world.

The guests of Biblionight willingly visited the salon of the poetic bouts-rimés «My love story» and wrote poems about love with inspiration. An ancient literary game that was very fashionable in France and Italy in the XVII-XVIII centuries is gaining popularity today. During the game, each participant showed his style of writing: both funny quatrains and serious philosophical poetry were composed.

A new poetry collections were exhibited during the game. Participants got acquainted with the publications, read their favorite poetry, looked for inspiration, quoted lines from Ukrainian and world literature. Poetic bouts-rimés encouraged creativity, intellectual communication and left an unforgettable emotional impression and great mood!

The decoration of the event was the presentation of the romantic photo exhibition «Love in my city» by photographer, member of the National Union of Photo Artists of Ukraine Angelina Tarasenko.

The participants of the holiday had a wonderful opportunity to take part in the master class «The Wonderful World of Vytynanka» of Marianna Panasyuk, a folk master of this kind of art, an employee of Odesa Regional Center of Ukrainian Culture. The master class was interesting for both children and adults, they made themselves the «book angel» as a keepsake. Children were able to show their creative potential, develop imagination and figurative thinking. Adults had the opportunity to distract themselves from everyday life, learn the meditative power of creativity and, perhaps, get a new exciting hobby.

All events are broadly announced and promoted in local and regional media, online publications, information portals, social networks, etc. Press conferences are held, TV stories are prepared, etc. In 2019-2021, there were over 400 mentions in the media, which, of course, also contributes to maintaining a positive image of the library as a place of meaningful leisure for the whole family, promotes both libraries and reading culture.

Attending events were free, on the terms of free donation in support of the social project «Litera» – project of equipping the open summer reading area «Litera» in the courtyard of the library as an open public space for residents and guests of the city, where you can read a book and relax in a cozy atmosphere in the fresh air, became an unconditional professional challenge and pleasure for ONSL staff (*Litera...*, 2021). It stimulated the further introduction of innovative forms of popularization of books and reading, attracting the attention of the locals, raising funds for project development through crowdfunding mechanisms.

A charity fair «From Heart to Heart» was also organized, where visitors to the Library had the opportunity to buy a souvenir, book or decoration from the librarians who donated their personal belongings: bakery, sweets, handmade jewelry for every taste, various souvenirs, collectible dolls, all sorts of things for the kitchen, utensils, piggy banks, figurines, woolen socks, a bouquet of dried lavender, beautiful books and coffee set for a cozy winter reading-with-coffee (*Blahodiinyi yarmarok...*, 2020). At the same time in the courtyard of the library was a dancing party, disco under the stars.

To underline a positive effect on the image of the library aesthetically designed advertising and information printed materials are presented: brand walls, billboards, posters, flyers, booklets, bookmarks, postcards, pocket calendars and more, it adds to recognizable identity of the organization, determines the mission of the institution, attracts visitors.

##### 5. Immersive performance-promenade «DIALOGY»

The unusual theatrical project, in the implementation of which ONSL acted as a partner, deserves special attention. In 2018, the Ukrainian company «U!Zahvati» presented the first in the history of the country collaboration of theater and library – an immersive performance-promenade «DIALOGY» (*Premiera spektaklia...*, 2018). Thanks to the support of the Ukrainian Cultural Foundation, a theatrical performance took place in two national libraries (Odesa and Kyiv), thanks to which the audience had the opportunity to gain a new theatrical experience. Being placed into the narrative, everyone could become a co-author of the performance, get acquainted with the immersive form, feel the dialogue with the action and with himself. The idea, drama, script was written specifically for the library space. After the library closing time in the evening, a group of 20 spectators had come to its premises, exchanging their phones for headphones to fully immersed themselves in the plot. Each spectator had his own personal dialogue with the storyline, which was written just for the library by the famous Ukrainian writer Tamriko Sholi.

## 6. Conclusion

Thus, the creation of interesting, meaningful, unusual events, innovative projects that increase the number of library visitors and attract media attention, is one of the most effective elements of encouraging reading among different age groups and segments of the population.

Through the implementation of cultural advancement projects, the library effectively reveals its powerful informational, resource, service, historical and cultural potential, is constantly evolving, overcoming the challenges of time, and moving forward.

New initiatives, cultural promoting projects and socio-cultural programs position the library as a leading information center, and, at the same time, form a positive image of the library, achieve a balanced relationship between the library and the public. In addition, such popular and resonant events attract the attention of sponsors and patrons, which helps to develop partnerships, expand the circle of «friends of the library», to attract additional funding, which is a necessary component in the activities of the library.

A positive feature of the projects is that they do not only promote library collections, meet the interests of readers, but also reveal the creative potential and abilities of users and patrons, shape their aesthetic tastes, readers' preferences and more. In modern society, the library acts as a distinctive communication cultural platform, intellectual space – a place of self-education and career guidance, a center of historical and national-cultural heritage, educational and scientific center, filled with various means of information interaction.

Thus, the introduction of innovative cultural and educational projects of Odesa National Scientific Library not only provides modernization of forms and methods of socio-cultural activity of Odesa National Scientific Library, which include informational, cognitive, cultural, educational, communicative, organizational, practical, entertaining, aesthetic, creative, relaxing, etc., but also effectively promotes the realization of citizens' rights to knowledge, education, use of cultural achievements and universal access to information resources, development of national and world science and culture.

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## THE KYIV PERIOD OF MIKHAIL MORDKIN'S CREATIVITY (1918-1919)

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### Summary

The purpose of the study is to identify the main directions of Mikhail Mordkin's creativity in Kyiv in 1918-1919. Chronological, comparative, typological and other methods are used in this work. The Kyiv period of M. Mordkin's creativity is associated with his pedagogical, performing and choreographic activities. His productions of the ballets *Flowers of Granada*, *Giselle*, *La Fille mal gardée (The Wayward Daughter)*, as well as dance numbers and divertissements in opera and drama performances became meaningful to the artistic life of the city. M. Mordkin gained valuable experience of the director as a result of cooperation with Ukrainian creative intellectuals (L. Kurbas, M. Bonch-Tomashevsky, A. Petritsky, V. Verkhovynets). The stage production skills of Mordkin as the dancer served as an example for many Ukrainian artists. Mordkin as the teacher managed to significantly increase the size of the ballet troupe of the Kyiv Opera in a short time. It was made thanks students from his own studio, he expanded their professional capabilities through careful and systematic physical training. The research materials can serve as a basis for creating special courses on the history of choreography, can be used in subsequent theoretical studies devoted to the learning of Russian and Ukrainian ballet theaters or in the educational process in academic institutions of the corresponding profile.

**Keywords:** ballet, dance, choreography, Ukrainian ballet theater, choreographic art.

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### 1. Introduction

The history of the Ukrainian ballet theater of the first quarter of the XX century has many famous names of Russian dancers and choreographers, whose stage work significantly influenced the development of ballet art in Ukraine, such as Bronislava Nijinska (of Polish origin), Alexandre Kochetovsky, Leonid Zhukov, Maria Reizen, Kasyan Goleizovsky, Asaf Messerer, Rostislav Zakharov. An honorable place among the listed masters of the Russian ballet scene is also occupied by the creative individuality of Mikhail Mordkin, whose active performing and ballet-master's activities significantly strengthened the artistic processes in the Kyiv theater environment of the 1910-1920s.

It should be noted that the work of M. Mordkin in Ukraine has repeatedly become the subject of research by Russian and Ukrainian leading figures of art history. Among them are Elizaveta Surits (*Surits, 2006*) and Yurii Stanishevskiy (*Stanishevskiy, 2002; Stanishevskiy, 2003*). Based on the chronology of events presented by the named art critics, we managed to supplement the Kyiv period of M. Mordkin's creativity with new historical and art facts (the names of M. Mordkin's Kyiv students, the names of the divertissements he staged, details of pedagogical work with the actors of the Molody Teatr (Young Theater) by L. Kurbas). In particular, the main sources of these facts are the memoir literature of V. Vasyenko (*Vasyenko, 1984*), O. Stalin'skiy (*Stalin'skiy, 1994*) and materials from the theatrical periodicals of 1918-1919 (*Muzykalnyy vestnik, 1919; Teatral, 1919; Visti, 1919*).

The purpose of our research is to identify the main directions of creativity of Mikhail Mordkin in Kyiv in 1918-1919. Chronological, comparative, typological and other methods are used in this work.

## 2. The ballet life of Kyiv of the early XX century

Despite the fact that by the early XX century Kyiv was a large industrial, economic and cultural center of the southwestern part of the empire, classical ballet as an integral theatrical phenomenon did not exist in its artistic life before the mid-1920s. In order to fully present the staging capabilities of the only one ballet troupe in the city of the Kyiv City Theater, we will illustrate several facts that characterize the state of ballet art in the city and the pace of its development in the early XX century.

Thus in 1908, thanks to the significant efforts of the choreographer S. Lenchevsky, the corps de ballet of the theater increased to nine pairs, which allowed the artists and the director to present to the Kyiv audience the expanded choreographic divertissement Primorsky Holiday for the first time. In 1909, choreographers S. Lenchevsky and M. Lange staged one act from Cesare Pugni's ballet *Catarina ou la Fille du bandit*. An important event in the work of the Kyiv ballet troupe was the premiere of one act from the ballet *Robert and Bertram* by G. Ostrembinger and the one-act performance *Les Sylphides* (Chopiniana) staged by choreographer K. Zalevsky in 1910. In the same year, the troupe was able to perform on its own the expanded act *Walpurgis Night* from the opera *Faust* by Charles Gounod, where the original technical equipment was first used for the so-called "flying ballet" (*Stanishevskiy, 2002: 110*).

The show of full-act ballet performances on the stage of the Kyiv Opera Theatre became possible only thanks to the tours of the artists of the Imperial Theaters from Moscow and St. Petersburg. One of the first such performances was a tour of a large group of dancers from the St. Petersburg Imperial Mariinsky Theater led by soloists O. Smirnova and N. Obukhov in 1911. Along with excerpts from famous ballets (*Swan Lake* by P. Tchaikovsky, *Paquita* by L. Minkus), the dancers presented full-scale performances on the Kyiv stage: *Coppélia* by L. Delibes, *The Magic Flute* by R. Drigo, *La Fille mal gardée* (*The Wayward Daughter*) by P. Hertel, *La Halte de cavalerie* by J. Armsheimer.

In the following year, 1912, a group from Petersburg headed by L. Egorova and S. Andriyanov arrived in Kyiv on tour, who showed the local residents *Swan Lake* and *Sleeping Beauty* by P. Tchaikovsky, *The Little Humpbacked Horse* by Cesare Pugni (*Stanishevskiy, 2002: 110-111*).

### 3. The first visits of M. Mordkin to Kyiv

The Moscow ballet premier Mikhail Mordkin began his regular visits to Kyiv in 1913. According to the materials of E. Surits, the artist came with tours to Kyiv at least four times: April 16-21, 1913; April 9-15, 1914; in March 1915; April 11-20, 1916. The researcher suggests that the artist could be connected with the city on the Dnieper not only by close theatrical, but also personal ties (*Surits, 2006: 90*).

Little is known about the first two visits of M. Mordkin to Kyiv: he arrived with his partner A. Balashova to perform on the stage of the City Opera House.

In March 1915, the dancer arrived in Kyiv as a member of a group of artists from the Moscow Bolshoi Theater; they performed the show *Flowers of Granada*, music by M. Moshkovsky (scenography by P. Kuznetsov and V. Dyachkov, libretto by K. Goleizovsky), as well as divertissements: *Norwegian Dances*, *Dance of the Gallic Warrior*, *Blind Happiness* choreographed by M. Mordkin (as a performer distinguished himself as a first-rate mimic actor) (*Surits, 2006: 91-92*).

In the theatrical season 1915-1916 M. Mordkin and A. Balashova together with a group of artists from the Moscow Bolshoi Theater showed the Kyiv citizens the ballets *Giselle* by Adolphe Adam and *La Fille mal gardée* (The Wayward Daughter) by P. Gertel (conductor P. Chimino).

According to E. Surits, the compositional interpretation of Mordkin's *Giselle* was, to some extent, borrowed from the production of A. Gorsky, premiered in 1907 (the artist performed the part of Albrecht in it) (*Suric, 2006: 62*). M. Mordkin's interest in A. Gorsky's edition was not accidental. The thing is, is that the main features of the ballet reform carried out by A. Gorsky at the turn of the XIX and XX centuries were quite confidently observed in *Giselle*. First of all, he brought out stage conventions from A. Adam's ballet, essentially synthesizing dance and pantomime; turned to historical primary sources and created the real national flavor on the stage; rethought and reproduced the consistent logic of the story progress; developed the effectiveness and strengthened the dynamics of separate parts; improved the compositional construction of corps de ballet scenes due to the asymmetric arrangement of artists on the stage, etc. (*Poklad, 2017: 195*).

Following the *Giselle* by A. Gorsky's, M. Mordkin also made the costumes more authentic (customized them for each individual artist), endowed not only the leading performers, but also the corps de ballet participants with their own line of behavior; developed new details for the image of the main character (Albrecht). According to E. Surits, M. Mordkin was the one who rethought the *mise-en-scène* of the beginning of the first act (inherent in many modern editions of *Giselle*), in which the Duke of Silesia made his way to the hut opposite *Giselle's* house to dress as peasant before meeting *Giselle* (*Surits, 2006: 62*).

In *La Fille mal gardée* (The Wayward Daughter) M. Mordkin turned to the work of A. Gorsky again. The Ukrainian researcher O. Bilash suggests that the production by A. Gorsky in 1903 on the stage of the Moscow Bolshoi Theater served as an example to follow (*Bilash, 2019: 76*).

It should be noted that M. Mordkin's performances in Kyiv not only aroused incredible admiration of his talent, but also significantly increased the interest of the Kyiv audience in ballet art. The novice Ukrainian artist Oleg Stalinskyi (later the soloist of the Kyiv State Academic Opera and Ballet Theater named after T. Shevchenko) was among the admirers of M. Mordkin's creativity. Oleg Stalinskyi wrote in his memoirs: "I have finally established myself in my dream [to dance], seeing a couple of years later the artist of Bolshoi Theater Mikhail Mordkin with his partner Balashova, who came on tour to Kyiv. First time I saw a dancing man, and how dancing! He was very successful and became the idol of the public. For the first time I got into the atmosphere of theatrical excitement, for the first time I came under the powerful influence of talent. I was conquered, in love, literally dreamed of Mordkin" (*Stalinskyi, 1994: 338*).

#### **4. Creation of a dance studio and production of ballets by M. Mordkin**

Mikhail Mordkin came to Kyiv again two years later. It should be noted that theatrical life in Kyiv has intensified as much as possible since the mid-1918. "Red banners were fluttering and cold and hunger reigned in Moscow and Petrograd, and Kyiv, which was at that time in the so-called "neutral zone", attracted with warmth and bread, relative prosperity and the still unknown possibilities of bourgeois democracy" (*Chechel, 1993: 23*). In the summer of 1918 the city was filled with scientists, Moscow and Petrograd celebrities, entrepreneurs, artists, painters. The actor, director and playwright Nikolai Evreinov successfully presented his theatrical evenings at the Art Theater of Miniatures, the actress Stanislava Vysotskaya studied

in practice the possibilities of the human body and voice in the field of dramatic art according to the Stanislavsky system.

In addition to the creative intellectuals from Moscow and St. Petersburg, artists from provincial theaters, which were closed as a result of the socio-economic collapse, came to Kyiv for the purpose of job search. The increase of the artistic potential in the city contributed to the creation of the "Trade Union of Stage Figures" in March 1918, which was looking for an engagement for its members. More comfortable living conditions in Kyiv (compared to Moscow) got held up M. Mordkin in the city for more than one year. He arrived here in the summer of 1918, together with him came: his wife – Bronislava Pozhitskaya, stage partner – Margarita Froman and her brother – dancer Max Froman. Almost immediately after arrival, the management of the Kyiv Opera (at the beginning of the 1918-1919 season it was renamed the K. Liebknecht Kyiv State Opera House) signed a contract with M. Mordkin and M. Froman to arrange weekly ballet performances.

Given the lack of ballet stuff in Kyiv, first thing Mordkin attempted to train qualified ballet dancers in his own dance studio, located in the spacious lobby of the Molody Teatr (Young Theater) (17 Proriznaya) – a drama troupe led by avant-garde director Les Kurbas.

M. Mordkin's lessons with the actors of Kurbas were one of the conditions upon which the premises were rented. Vasyl Vasylko, a member of the Molody Teatr (Young Theater), left memories of this unique stage practice. He wrote: "Fate brought us together with Mikhail Mikhailovich Mordkin in a very interesting way. He wanted to organize a ballet studio in Kyiv and was looking for premises for it. Once he came to us, examined the premises and offered to sublet the theater lobby at the time when we were not working, that is, from 8 to 10 in the morning and from 3 to 6 in the afternoon. We all knew Mordkin well from his tour in Kyiv with his former partner ballerina Balashova ... S.K. Bondarchuk conducted negotiations with M.M. Mordkin on behalf of our management. Although we needed money desperately, the interests of creativity were above. Bondarchuk replied to Mordkin that on condition that he personally practice plastic education with us, we would sublet our lobby to him. For such a master, the prospect of plastic education practice with 'ignoramus' is, of course, bondage, but he had no other choice, and he agreed. Thus our classes with Mordkin began three times a week. We were happy, but Mikhail Mikhailovich suffered incredibly with us, especially with those who were slow-paced. Sometimes he despaired. And yet the lessons continued in an atmosphere of complete devotion to the teacher" (*Vasylko, 1984: 144*).

By the early of April 1919 M. Mordkin formed a certain team of young dancers, whose efforts (with the participation of soloists Bronislava Pozhitskaya, Margarita Froman and Max Froman) was organized a choreographic evening on the stage of the Theater of the Ukrainian Soviet Republic named after V. Lenin (former Russian Drama Theater "Solovtsov"). The concert program included dance numbers: Dreams and Waltz by F. Chopin, The Torment of Love and The Joy of Love by F. Kreisler, PUNCHINELLE by S. Rachmaninov, Dying Swan by C. Saint-Saens, as well as the one-act ballet 2nd Rhapsody by Franz Liszt. The orchestra was directed by the conductor M. Steiman (*Teatral, 1919*).

The success of the students involved in the theater's artistic activities had both positive and negative consequences: on the one hand, M. Mordkin's school was at the peak of popularity, on the other hand, the artist received an additional pedagogical load, for which he was not ready: in the summer of 1919, the Section of Stage Education of the Kyiv City Council obliged Mordkin to work in a free choreographic school for proletarians for 100 people (*Visti, 1919*).

In the theatrical season 1918-1919 M. Mordkin directed on the stage of the K. Liebknecht Kyiv State Opera House ballets Giselle by A. Adam and La Fille mal gardée (The Wayward

Daughter) by P. Gertel by the efforts of his studio students (*Vasylo, 1984: 150*). Thanks to the announcements of theatrical premieres published in the Musical Bulletin No. 1–3 (information for June – July) 1919, we can find out the full cast of the participants in the performance, whom we conditionally call M. Mordkin's studio students. There are Alena, Abramova, Balashova, Bankovskaya, Barbo, Bycheva, Bronskaya, Buchinsky, Virskaya, Vozdvizhenskaya, Volova, Volfovich, Desnitskaya, Zhabchinskaya, Zalevskaya, Zimin, Kamorna, Karitsky, Karnetskiy, Krivtsova, Kudina, Lange, Levenberg, Lugovskaya, Lyadova, Moisen, Muravin, Nelidova, Petrakevich, Polesskaya, Preobrazhenskaya, Ratina, Sabina, Savchenko, Sanovskaya, Svatkovskaya, Svengaevsky, Tarasova, Timan, Fedorova, Flor, Chumicheva, Yakovleva I, Yakovleva II, Yansen among them (*Muzykalnyj vestnik, 1919*).

Giselle was decorated by A. Petritsky (costumes by artist Grechanin), conducted by M. Steiman and N. Bakaleinikov. The main parts were performed by: M. Froman (Giselle), M. Mordkin (Albrecht), Bankovskaya (mother of Giselle), I. Chistyakov (servant of Albrecht), M. Froman (Elder Duke), B. Pozhitskaya (Bathilde), Ustinsky (Forester) (*Dejch, 1988: 7*). E. Surits rightly pointed out that the Kyiv production of *Giselle* in 1918 strongly resembled the performance of 1915, not only in the choreographic, but also in the scenographic key, since A. Petritsky significantly relied on the artistic developments of K. Korovin (at the same time, in contrast to the last one, he chose the concept of excessive historical authenticity) (*Surits, 2006: 113*). Researcher V. Poklad emphasized that, taking into account the compositional concepts of A. Gorsky, M. Mordkin, at the same time, brought in the performance several his own choreographic decisions: he made separate choreographic cuts (abandoned the variation of the soloists in the second act), strengthened the acting of the main parts performers, increased the number of stage props, implemented a new lighting plan for the performance (*Poklad, 2017: 196*).

### 5. M. Mordkin's creativity in music and drama theaters

It should be noted that in addition to working at the K. Liebknecht Kyiv State Opera House, M. Mordkin took part in the work of the State Ukrainian Musical Drama, created in June 1919 at the initiative of the directors L. Kurbas and M. Bonch-Tomashevsky. The creative team also included conductor M. Bagrinovsky, singer M. Litvinenko-Volgemut, scenographer A. Bondarchuk, director S. Bondarchuk.

Y. Stanishevsky noted that the ballet troupe, headed by M. Mordkin, numbered forty people (*Stanishevskiy, 2003: 39*). The first performances of the collective were M. Lysenko's opera Drowned, the ballet (rather, a synthetic performance) *Asiada* to the music by L. Burgo-Ducudre and I. Gutel, as well as a number of divertissements: Dance with a bow and arrow from the ballet *Salamambo* by A. Arensky; *Bacchanalia* by O. Glazunov; *Mazurka* from the opera *Ivan Susanin* by M. Glinka; *Dreams* to music by F. Chopin (*Stanishevskiy, 2003: 41*).

The *Asiada* (another title is *Arabian Nights*) premiered on August 19, 1919. It is known about the ballet that it was first staged by M. Mordkin under the influence of M. Fokine in 1910 for the second American tour with A. Pavlova. This time the choreographer significantly updated the choreographic and musical editions enlisting the support of conductor M. Bagrinovsky, artist A. Petritsky, actor and director L. Kurbas, who played the role (with text) of Sheikh (*Bondarchuk, 1969: 93–94*).

Subsequently, the same creative team prepared the operas *Pebbles* by S. Monyushko and *Taras Bulba* by M. Lysenko (with the participation of L. Sobinov). Moreover, in *Pebbles* L. Kurbas was to a certain extent artificially Ukrainianized the plot, which told about the events

from the life of the girl-hutsulka. With the support of V. Verkhovynets, M. Mordkin managed to create original dance pictures on the Hutsul theme, the center of which was the male dance "Arkan". Unfortunately, the premiere of the opera (and with it the show of choreography) did not take place, because on the appointed day (August 30, 1919) the troops of A. Denikin and S. Petlyura entered Kyiv at the same time. Under the shelling, the scenery and musical material of the performance were completely destroyed.

It is important to note that the search of original stage solutions by M. Mordkin did not pass without leaving a trace for the Kyiv creative intellectuals: for example, L. Kurbas in subsequent years widely used the method of working with plastic material developed by M. Mordkin in theater practice. In particular, the theater critic A. Deich, in his memoirs about L. Kurbas's production of Oedipus the King, left the following remark: the chorus was "pantomimic, something like a new ballet in the style of Mordkin ..." (*Dejch, 1988: 182*).

We will emphasize that in addition to opera and ballet performances M. Mordkin was busy preparing dramatic premieres during his work in Kyiv. So, on May 1, 1919, the production of Fuente ovejuna (Sheep source) based on the work of F. Lope de Vega, consonant with the then revolutionary events, took place on the stage of the Theater of the Ukrainian Soviet Republic named after V. Lenin. The director of the performance was K. Mardzhanov who is known as the commissioner of the theaters of Kyiv. Following the dramatic decision of the last one, M. Mordkin staged the choreographic picture Dance with Cloaks, which, according to E. Surits, became one of the most emotional scenes of the performance. The art critic wrote: "It arose when the rebellious people rejoiced after the victory over the enemy who had fled from the battlefield. In the context of the performance, it was not just a folk dance, but a dance of the winners" (*Surits, 2006: 115*). The researcher was convinced that thanks to the work on the play of M. Mordkin it became one of the most important artistic events of cultural and political life of the city of that time.

It must be said that the intensification of the political conflict in Ukraine, as well as a significant deterioration of socio-economic conditions of life in Kyiv prompted M. Mordkin to leave the city in October 1919 and go to the Crimea.

## 6. Conclusions

The Kyiv period of M. Mordkin's creativity was closely connected with his activities in the field of ballet pedagogy, choreographer and performance practice. His productions of the ballets Giselle, La Fille mal gardée (The Wayward Daughter), Asiada, as well as dance numbers and divertissements in opera and drama performances became significant for the artistic life of the city. M. Mordkin gained valuable director experience from the cooperation with representatives of the Ukrainian creative intellectuals (L. Kurbas, M Bonch-Tomashevsky, A. Petritsky, V. Verkhovynets). The stage skills of Mordkin as the dancer served as an example for inheritance for many Ukrainian ballet dancers. Mordkin as the teacher managed to significantly increase the size of the ballet troupe of the Kyiv Opera in a short time. It was made thanks students from his own studio, he expanded their professional capabilities through careful and systematic physical training.

We consider that the study of the creative biographies of the artists of the M. Mordkin's dance studio, a detailed understanding of the influence of M. Mordkin on the creative plastic method of L. Kurbas, the restoration of the main milestones of M. Mordkin's activity in the Crimea after leaving Kyiv, etc. are prospective and possible directions for further research.

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## THE FIGURES OF ODESA MAYORS IN THE SECOND HALF OF THE NINETEENTH AND THE EARLY TWENTIETH CENTURIES IN PRE-REVOLUTIONARY, SOVIET AND CURRENT RESEARCHES

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### Summary

The given article deals with the historical period: from the second part of the nineteenth to the beginning of the twentieth centuries when there was the “silver era” of Odesa city development. The article provides the initial analysis and classification of major historical publications that are basic for the creation of prosopographic portrait and related to the life and work of nine Odesa mayors such as: Semen Vorontsov, Mykola Novoselsky, Grigory Marazli, Valeryan Ligin, Petro Kryzhanovsky, Pavlo Zelenyi, Vasyl Protopopov, Mykola Moiseyev and Borys Pelikan who held the self-government office from the beginning of the City Regulations of 1863 until the turning points in the first half of the twentieth century – World War I. The material for the investigation was singled out from the works of mayors’ contemporaries, Soviet researchers, modern Ukrainian and foreign historians. 45 published papers were analyzed. In the research, the following methods were used: the methods of synthesis and analysis and the method of critical thinking. Also the biographies and activities of Odesa city mayors were presented in the reviewed works. The findings have suggested that the history of city self-government and the role of city leaders in this process should be the subject of a special systematic and comprehensive study.

**Keywords:** Odesa city council, leader of self-government, prosopographic portrait, scientific works.

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### 1. Introduction

Nowadays a very young scientific discipline – prosopography caused a new look at the study of life and activity of historical figures, the need for their concretization and reflection in a set of life circumstances, family and non-family societies. The main tools of prosopography help to rediscover personalities in the context of their major periods of life.

The main focus in prosopographic studies concentrates on source base. However, information about many clarifying details about personal data, family ties, immediate environment, career growth, participation or role in historical events – can already be recorded in the works of scientists and contemporaries of Odesa mayors in the second half of the nineteenth century and early twentieth century.

The study of the history of hometowns is one of the most pressing issues of our time. Local historians are in constant search of discovering more new facts about the past of their native land. The history of city self-government and the role of individual historical figures in it still need thorough consideration.

The purpose of the article is to identify and analyze works of the past and current researches made by historians, politicians, cultural figures which are devoted to the activity of



Odesa city mayors. These materials will help restore the picture of the history of urban self-government through the personalities of the leaders of Odesa for creation a prosopographic portrait. In accordance with the purpose, the use of the method of analysis and synthesis allowed analyzing the general state of scientific development of the topic in Ukrainian and foreign historiography, to group historiography by issues. The method of critical thinking was introduced in order to search, analyze, classify and select information by level of significance.

## 2. The mayors' personalities and the research of them

The City Regulations were introduced in Odesa city in 1863 (earlier than the national city reform of the 1870s) and gave more authority to the city leaders to innovate and implement progressive ideas. From the activation of the above-mentioned document until the beginning of the World War I, the position of the mayor of Odesa was held by the following personalities: Semen Vorontsov (1863-1867), Mykola Novoselsky (1867-1878), Grigory Marazli (1878-1895), Valeryan Ligin (1895-1897), Petro Kryzhanovsky (1897, 1905), Pavlo Zelenyi (1898-1905), Vasyi Protopopov (1906-1908), Mykola Moiseyev (1908-1913) and Borys Pelikan (1913-1917). For modern Odesa citizens such names as: S. Vorontsov, M. Novoselsky, G. Marazli are well-known, but they can tell not much about the activities of these people. The names of the other city mayors remain a mystery even for scientists.

It should be stressed that the study of the main figures of Odesa municipality has not been highlighted in detail too. There are scarce publications about the state of the city under the leadership of a certain mayor, biographical information about the mayors, or monographs devoted to the anniversaries of Odesa, which include the period after the enactment of the City Regulations in 1863 and before World War I.

For the more thorough analysis of the existing publications we have divided the whole historiographical process of the research into three periods: pre-revolutionary (XIX – early XX century), soviet (1921-1991) and present-day. The latter began with the proclamation of Ukrainian independence. Each of above-mentioned periods of the research of Odesa mayors' activity is marked by various socio-political reasons, the possibility of access to various sources and the implementation of scientific publications taking into account ideological principles.

## 3. The pre-revolutionary historiography

Contemporaries of Odesa mayors, such as stockbroker S. Bernstein and censor S. Plaksin, mostly described the general state and events in the city, mentioning only some sentences about the current mayors after 1863 City Reform (*Bernstein, 1881; Plaksin, 1901*). The similar trend can be traced in the special jubilee works – to the so-called 100th anniversary of Odesa foundation (1894) (*Kirpichnikov, 1894; Odessa, 1894; Synchronisticheskoe izobrazhenie, 1897: 5,7,9-10,13; Stoletiyе Odessy, 1894*).

A bright and fundamental example of the description of the mayor's activity is a brochure (extract from the “Novorossiysky Telegraph” newspaper of 1880) with an overview of the activities of such mayor as M. Novoselsky (*Obzor deyatelnosti, 1880*). The work less saturated with information is the reference from the biographical dictionary of Poltava province about V. Protopopov and the obituary about M. Novoselsky from the “Notes” of Odesa Society of History and Antiquities (*Pavlovskij, 1914; Markevich, 1900*).

Also an important issue is the availability of materials from the local press, namely, separate articles of the Duma, sketches written by journalists, newspaper editors and anonymous

people. Quite revealing examples are biographical references with the portraits of Odesa mayors at election, essays on the celebration of holidays and professional anniversaries, feuilletons with assessments of activities, scandals, inter-election disputes, photos from illustrated newspaper supplements and obituaries, memoirs of the above-mentioned personalities.

Moreover, it should be noted that in the majority of the pre-revolutionary works, the assessments of mayors were positive; much emphasis was placed on the activities of G. Marazli and M. Novoselsky. The newspapers could have had more conflicting views, especially if the city government's decision did not meet to the demands of the local community.

#### 4. The Soviet period of research

During the Soviet period, the study of the people of noble origin was unacceptable, and the events and phenomena of the post-reform era were deliberately silenced. In 1928, the anniversary collection on the existence of the newspaper "Odesa Herald" provided a brief review of the activities of one of the mayors – P. Zelenyi as the editor of the "Odesa Herald" newspaper for 1878-1884 (*Berman, 1928*).

Emphasizing on the working class of the population, a jubilee essay devoted to the 150th anniversary of Odesa as a hero city, mentioned one of the mayors. G. Marazli was mentioned as one of the constant leaders, "fathers" of the city, and in general the author of the section gave a positive assessment to the heads of self-government of Odesa in 1860-1890 (*Dobrolyubskij, 1947: 85*).

In 1960 a generalized popular science essay on the history of Odesa region and Odesa city appeared. In this book the period of active development of industry in the second half of the nineteenth century was mentioned. In particular, V. Zagoruyko specially mentioned several personalities, such as: M. Novoselsky, G. Marazli and P. Zelenyi who were Odesa mayors. M. Novoselsky was praised both for his economic views and initiatives, and for his important work to improve the city's infrastructure and communications. His successor, G. Marazli, appeared with a sharply opposite character, due to belonging to the largest business families of the time, who "made their millions on the wheat trade" and "for greater popularity – returned the crumbs of the acquired wealth to the public with great noise". The last mayor of the list, P. Zelenyi was mentioned as the editor of the "Odesa Herald" newspaper and the mayor. The author described P. Zelenyi neutrally, as a territorial liberal with progressive views, who maintained broad ties with the Ukrainian intelligentsia, foreign cultural figures and publishing houses (*Zagorujko, 1960: 38-41*).

During the Soviet period, the American researcher P. Herlihy came to Odesa and worked with the archival documents. After her visit the book "Odessa. A History, 1794 – 1914" was published in Harvard University (*Herlihy, 1987*).

In the text of the book the names of several mayors – S. Vorontsov, M. Novoselsky, G. Marazli and P. Zelenyi were mentioned. There were some details about their life and the period of activity as the heads of the city with interspersed memories of the contemporaries about their behavior and character.

#### 5. Contemporary Ukrainian and foreign historiography

The transformation of this problem into an object of study took place only after Ukraine gained independence. General essays on the history of Odesa, written by present-day researchers, have references to the mayors of Odesa, their administrative, public and charitable activities (*Stanko, 2002; Malahov, 2004; Grebcova, 2009; Libin, 2009: 229-232, 276-278; Demin, 2011*).

The publication of the monograph aimed at describing the activity of one of Odesa mayors, who devoted almost a quarter of his life to the service of Odesa – G. Marazli, became a positive shift to the profound investigation of the topic under analysis. Since 1990s, the publications written by different researchers, local historians and employees of educational and cultural institutions on the life and various spheres of G. Marazli's activities have appeared regularly (*Terenteva, 1994; G. G. Marazli, 1995; Kulyk, 1997; Izuvita, 1999; Chopp, 2000; Doncova, 2001; Hryhorii Marazli, 2006; Terentieva, 2006; Reshetov, 2007; Reshetov, 2012*). Grigory Marazli is the most outspoken person among the cohort of mayors of the post-reform era.

Later M. Novoselsky, P. Zelenyi, and B. Pelikan – the mayors, who also received attention from modern scholars studying regional history, became the popular figures too (*Krasyuk, 1993; Zlenko, 1994; Zlenko, 1997; Fajtelberg-Blank, 2008; Goncharuk, 2012*). In particular, the figures of M. Novoselsky and B. Pelican in historians' investigations were highlighted by the same authors, namely, S. Reshetov and L. Izhik who wrote about G. Marazli (*Reshetov, 2013; Izhik, 2014*).

S. Vorontsov and V. Ligin were mentioned in single publications devoted to some episodes of Odesa life – activities in the Society of Fine Arts and the Imperial Novorossiia University (*Savelieva, 2005; Abramov, 2009*). The figures of P. Kryzhanovsky, V. Protopopov and M. Moiseyev have not been the subjects of definite investigations, articles, references yet, except for the works of the author (*Palamarchuk 2017; Herasymenko, 2018; Herasymenko, 2021*).

Foreign historiography also made contribution into the investigation of the activity of Odesa mayors. P. Herlihy continued her work on the study of historical events and figures of Odesa (*Herlihy, 2018*). The pages of Jewish history of Ukraine presented by O. Solzhenitsyn also described Odesa city, in particular the tragic events of 1905, where mayors played their significant role (*Solzhenitsyn, 2001*).

The attention of Polish and German researchers was paid to V. Ligin, his family, and overseas activities of the government (*Górak, 2016; Rolf, 2020*). The modern reprint of the Court Calendar of 1915 finally shed light on the activity of one of the less-known mayors, M. Moiseyev (*Krylov-Tolstikovich, 2015: 437*).

## 6. Conclusions

The foregoing in this article allows us to conclude the following. In the first, pre-revolutionary, period, the general picture of the development of Odesa was covered in essays and works dedicated to the 100th anniversary. The names of the city mayors were mentioned scarcely in the sections of the above-mentioned works. Brief biographical information could be found only in obituaries. Their positions and public activities could be found on the pages of multi-volume reference books.

During the Soviet period, under the pressure of the so-called “class approach”, political situation, communist ideology and lack of information, scientists failed to conduct a thorough study of Odesa city governmental leaders.

After gaining the state independence the significant changes took place in Ukraine. One of them was connected with history direction. The various researches (articles or monographs) on the history of the city began to be published. These papers included the descriptions of the mayors' biographies or highlighting some famous city personalities or covering the direction of government officials. The most studied public figure is G. Marazli, followed by M. Novoselsky, P. Zelenyi, B. Pelican. There is still a very limited amount of information about

S. Vorontsov, V. Ligin, P. Kryzhanovsky, V. Protopopov and M. Moiseyev. Foreign researchers also write about the personalities of Odessa mayors, but only in connection with their family ties or foreign activities.

Thus, despite a great number of publications, the history of urban self-government and the role of city leaders have not yet been the subject of special systematic and comprehensive research. Due to prosopography and its tools, a significant shift in terms of studying the group of historical personalities of the city government of Odessa can take place.

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## PLACE OF LATIN IN CONTEXT OF TRENDS IN MODERN INTERDISCIPLINARY STEM EDUCATION

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### Summary

The article attempts to rethink the meaning of modern education in the context of combining two opposing trends, to determine the status of Latin in the context of trends regarding modern education, which covers different fields of knowledge and combines interdisciplinary approaches. The solution to this issue is seen in the creation of a highly professional philosophy of education, where one of the leading places will be occupied by a combination of humanities, natural sciences and exact sciences. A special role in this process is taken by Latin as a fundamental discipline in the process of language training of future specialists in the field of modern technologies. The prestige of Latin as a subject is that Latin for many centuries has played a significant role in the education system, in particular in specialized one, because this language is provided with vocabulary to explain certain abstractions. The article concludes that it is necessary to motivate future specialists to study Latin, which not only forms the fundamentals of the terminological base, but is a means of raising the level of scientific culture of future mathematicians, physicists, and IT specialists. Studying Latin at the departments of exact disciplines will help students not only to have a deeper understanding of terminology in their native language, but also to master the language competence required in research work.

**Keywords:** The Latin language, exact disciplines, terminological base, mathematical sciences.

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### 1. Introduction

Acquisition of modern professions requires comprehensive training and knowledge in various educational fields of natural sciences, engineering, technology, programming, etc. The development of innovative technologies and new areas of science needs a creative approach not only in solving issues of research, but also in the implementation of practical tasks. Therefore, in the process of training highly qualified personnel, along with the formation of purely professional skills, it is necessary to develop the creative potential of the individual. Without studying the humanities, which should take place along with the study of professional disciplines, training of modern level specialists turns into a challenge. The topicality of this paper is determined by the need to rethink the meaning of modern education in the context of combining two opposing trends: training of personal, individual Mind and Intellect, and development of sophisticated techniques and skills to extract other people's information and use other people's Intellect / mind. The solution of this issue is seen in the creation of highly professional philosophy of education, where one of the leading places will be occupied by the combination of humanities and natural sciences. A special role in this process is taken by Latin as a basic discipline in the process of language training of future specialists in the field of modern technologies.

The purpose of this research is to identify the place of Latin in the context of developing trends in STEM education and to prove the effectiveness of the study of the ancient language in the structure of a multidisciplinary approach to training in the exact sciences.

## 2. Research analysis

STEM is a term used to combine disciplines that cover the natural and exact sciences, as well as engineering and programming. STEM (S – science, T – technology, E – engineering, M – mathematics). (*Hlosarii terminiv STEM-osvity, 2021*).

Theoretical aspects of the issue of STEM education are considered in the works of many modern researchers. In particular, in the works of Wolins, Inez S. “Interdisciplinary Teaching: Branches, Ties, and New Connections (*Wolins, Inez S., 1992*)”, Elizabeth A. Berman, Jodee L. Kuden “Interdisciplinary Approach” (*Berman, Kuden, 2017*), Holland Lorna “How to teach children woodworking through S.T.E.A.M fields” (*Holland, 2017*), Radul S. “Professional Self-Actualization of a Specialist in Context of Computer Tendencies of Current STEM Education: Foreign Experience” (*Radul, 2018*), Romanko I. “Technology “Science-Practice-Culture” in STEAM Education” (*Roman'ko, 2018*), Zaskalieta S. “Application of Interdisciplinary Relations Principles in Higher Education: Foreign Experience” (*Zaskalyeta, 2020*). Deron Cameron, Former UPES Principal – US's 1st STEAM Certified School, Current TCSS Curriculum Coordinator notes that “STEAM represents a paradigm shift from traditional education philosophy, based on standardized test scores, to a modern ideal which focuses on valuing the learning process as much as the results (*Holland, 2017*).

The introduction of a new educational paradigm involves the intertwining of different, from the point of view of the traditional paradigm, educational disciplines. Technology and technical creativity in modern society are actively used in the humanities, while the achievements of the humanities are implemented in innovative technologies and fields of science that are related to the exact and natural sciences. For example, people in creative professions (musicians, writers, designers, etc.) are taught not only the art, but also the skills of writing computer programs. In turn, artificial intelligence systems are developed on the basis of the creation of symbolic systems that mimic high-level mental processes: reasoning, thinking, emotions, language, creativity, etc., which are part of humanitarian disciplines. Thus, it can be argued that nowadays the process of globalization has covered not only the economic, market and social spheres, but also affected education. Globalization not just changes the system of subjects studied, it requires the improvement of teaching the exact sciences, including physics and mathematics with focusing on the current day specifics. Physics, mathematics, cybernetics, while being studied, should be perceived not just as scientific facts and formulas, but as a mechanism for purposeful formation of scientific thought in students undergoing the process of cognition the world around (*Kuz'menko, Dembits'ka, 2017*). Knowledge, education, information are becoming new raw materials in international commerce, sources of power, important components of individual and corporate wealth. New technologies and the formation of labor in such societies are going to play a dominant role. Education is a workforce whose consciousness is already prepared for innovations and practical work with these new technologies (*Pedagogika i psikhologiya inklyuzivnogo obrazovaniya: uchebnoye posobiye, 2013*). Under such conditions, in the structure of training high-level specialists, especially in the format of higher education, there is a need to rethink the essence of the humanitarian approach to education, which is based on European civilization as a unique world civilization, and rethink the educational processes that formed the basis of the latest man-made society. Therefore, the creation of modern tools



and the development of skills for their application is inextricably linked with the use and interpretation of the basic principles based on culture worldview. The study of Latin will not only form fundamentals of the terminological base, but also will be a means of raising the level of scientific culture of future mathematicians, physicists, and IT specialists.

### 3. Latin in the context of mathematical sciences

Latin has always been important for exact disciplines. M. Copernicus (1473–1543), F. Kepler (1571–1630), P. Fermat (1601–1665), I. Newton (1642–1727), and L. Euler (1707–1783), K.F. Gauss (1777–1855) wrote their scientific works in Latin, while G. Galileo (1564–1642), R. Descartes (1596–1650), B. Pascal (1623–1662) used it partly. The treatise “On Proportions” (*De proportionibus*) by the mathematician and mechanic Albert of Saxony, “*Summa de arithmetica, geometria, proportioni et proportionalita*”, “Algebra” by Christopher Clavius, “*Mathematicae collections*” by Papius of Alexandria, etc. were published in Latin. Friedrich Nietzsche noted that Latin cannot be perceived passively, understood inattentively – it is a language with excellent conciseness – “this is the minimum of the sum and number of signs and this is the maximum achieved by the energy of signs” (*De Larminat*, 2016). Therefore, it is natural that the Latin language for centuries remains the main source of scientific terminology. “Science is international in nature, and for it the presence of a single language alongside the national languages, which serves the purposes of international communication, is a positive factor. The Latin language retained its significance even when the national languages of Europe, borrowing Latin and Latinized Greek vocabulary, became an effective tool of scientific creativity” (*Borovskiy*, 1991).

Each language is multifunctional, it classifies, systematizes, conceptualizes the world around it in its own way, in accordance with the accumulated practical experience, consistent with the traditions and principles created during centuries of its existence. Latin is one of those languages that are still active in the field of writing and publishing books. Latin is studied in many educational institutions and at the same time not always solely at philological direction. The reason is that the Latins after leaving the live communication retains the ability to develop. Its high cultural significance has a significant / great influence on the living languages in which it operates. However, we can mention the many artificial languages that were created to facilitate communication between speakers of different languages, sometimes distant from each other, to become the basis for the formation of international scientific nomenclature. The most successful attempt was the creation of Esperanto, though it was not so successful as to displace Latin. We should also keep in mind that Esperanto, like most artificial languages, is still based on Latin. The prestige of Latin as a subject is that Latin for many centuries has played a significant role in the education system, in particular in specialized one, because this language is provided with vocabulary to explain certain abstractions.

The well-known modern mathematician Laurent Schwartz, who made a notable contribution to the development of functional analysis and a Fields Prize winner, noted that the study of mathematics and the study of Latin have many features in common (*Schwartz*, 1997; 42-43). Both in the study of Latin and in the study of mathematics, as Laurent Schwartz points out, consistency and imitation are very important. Mathematics and Latin are combined due to specificity of cases in the application of complex rules: whether grammatical rules used in translation, or in the application of theorems in mathematical exercises, “... the same desire to leave nothing behind is not only practical, it brings great pleasure from dominance over the subject” (*Schwartz*, 1997; 42-43). Knowing Latin and ancient Greek well, he could not fail in mathematics, as his contemporaries point out.

The great geometer Lagrange advised Augustine-Louis Cauchy, a famous French mathematician, to master classical languages before taking mathematics seriously. Latin and Greek not only did not detract from Cauchy's brilliant mathematical career, but undoubtedly served it. Henri Poincaré, another great mathematician, noted that scholars who have had the opportunity to study Latin have always noted its high cost, thanks to the harmony and logic of language structure (*De Larminat, 2016*). Therefore, today the question of the need to study classical languages along with mastering the exact disciplines is the subject of active discussion in the European media.

According to research conducted by R. V. Milenkova, the teaching of Latin in US schools is based on methodological standards that have been developed taking into account modern requirements for the quality of higher education, and allow basic knowledge of Latin to focus on professional terminology. (*Paradigmy kul'turnoy pamyati i konstanty natsional'noy identichnosti, 2020*). Unfortunately, our students who master technical specialties do not have a basic knowledge of Latin, which to some extent complicates the understanding of the basics of special terminology. However, back in 2001, Lviv University introduced the teaching of Latin in all specialties, which prompted specialists to create specialized textbooks, which have not been available in Ukraine or abroad. The first such textbook was "Latin" by N. Revak and V. Sulyma. In 2015, a textbook of Latin for mathematics and physics students was created. The authors of the textbook note: "The study of Latin for a mathematician or physicist should be a way to a deeper and broader understanding of his own profession, to understanding of culture in general" (*Nazarenko, 2012:305*).

#### 4. Latin as the basis for creating modern terminology

Studying Latin at the departments of exact disciplines will help students to have a deeper understanding of terminology in their native language and in mastering the language competence required in research work. Knowledge of Latin will contribute to the successful acquisition of foreign languages, as a number of Latin abbreviations do not require translation from any European languages: 1) sq; sqq = sequens; sequentia; 2) sc.; scil. = scilicet; 3) viz. l = videlicet; 4) v; q.v. = vide; quod vide; 5) v.s. = vide supra; 6) v.i., v.inf. = vide infra; 7) v.v. = vice versa. Special expressions that also do not require any additional translations or additional explanations: Terminus ad quem; Terminus a quo; Terminus ante quem; Terminus post quem; Technical terms, etc.

One can also note the words of Latin origin, accordant with the words of the Ukrainian language, so their English equivalents are remembered faster. For example, canon, substance, hypothesis, bonus, theory, manipulation, formula, excursion, veto, campus, energy. The associative perception of such terms affects the facilitated assimilation of such words by students, therefore, forms not only logical thinking, but also linguistic (speech) conjecture. In addition, the study of Latin also develops a prediction mechanism, which is an integral aspect of the student's linguistic activity. Some English terms of Latin origin, for example, discreteness; ex-pōno, ěre, – eksponenta – exponential curve, exponential; extremism, a, um-extremum; factor, ōris m- factorial; figure, ae f- figure; formula, ae f- formula; functio, fnis f- function; inter-polatio, ōnis- interpolation; degree, us m- degree; inter-vallum, and n-interval interval; linea, ae f; locus, and m; modŭlus, i.; maxĭmus, a, um; minus., numeration help to build associations that lead to their recognition in the native language.

A number of mathematical terms of Latin origin such as discriminant (<discrimans: active adjective from discrimĭno, āre, āvi, ātum – to divide, distinguish); coefficient (<co

(indicates the commonality of action) + *efficiens* active adjective from *efficio*, *ēre*, *fēci*, *fec-tum* – to produce, condition), “*longitūdo coëfficiens*” – “auxiliary length” factor in the term of the equation, which added to it the required number of measurements for homogeneity), etc., should also be noted, as they will remain relevant in scientific discourse due to their ability to outline in “one word a concept that requires several words”. Understanding the semantics of Latin origin terminology will form the basis of the future professionals’ scientific worldview, and give better understanding of the processes in the field of new technologies that actively use new information and communication services, systems and environments, as well as semantic networks, the correctness and effectiveness of which depends on the amount of training (a large amount of data and its quality). For example, the term *ordinate* comes from the Latin expression *ordināte ductae*, “orderly” drawn lines. Here is an explanation of this term given in a Latin textbook for mathematicians: “If the points on a parabola or other curve are connected by parallel chords so that the diameter of the parabola, crossing these chords, divides them in half, then half segments of parallel chords will be exactly what Apollonius called “orderly drawn” lines. Therefore, from each point A of the parabola one of the orderly lowered segments AB can be lowered to the diameter... In Latin, this expression was transmitted as “*ex diametro abscissa ad verticem*”. Hence the term *abscissa*. If a parabola (or other conical section) is inscribed in a Cartesian coordinate system so that its diameter (axis) is the x-axis, the vertex is the origin, and the tangent to the vertex is the y-axis, then the coordinates of the curve points will be given by Apollonius “orderly” and “drawn” lines, i.e. – ordinates and abscissas. To apply the coordinate method in stereometry, we had to add another axis. It was called “added” (*applicāta*). The spatial Cartesian coordinate system was introduced by the French mathematician F. Lagire (1679). He was the first to use the term “beginning” of coordinates. In Latin origin is *origo*. Hence the tradition of marking the origin of coordinates with the letter O (or from the French *origine*). The notation *x*, *y*, *z* for the coordinates was adopted at the beginning of XVIII century, due to the fact that in general the tradition of denoting unknown quantities by the last letters of the Latin alphabet (*x*, *y*, *z*), and known ones with the first (*a*, *b*, *c*) was started by R. Descartes”. Such knowledge not only lays the foundations of the terminological basis, but also forms scientific literacy in future professionals (*Dombrovs'kyj*, 2015:154).

Mathematical terminology of Latin origin can be expressed not only by words, but also by signs, namely the sign of the paragraph § (abbreviation of the Latin expression *signum sectionis* (§<ss) – “section sign”. (*What does the symbol mean*; 2021)

Paragraph sign ¶. It is assumed that the sign ¶ comes from the Latin letter C, as the Latin word *capitulum* means “chapter”. The paragraph sign is used in computer typesetting programs and text editors to indicate the presence of an unprinted special translation code at the end of the paragraph. (*Dombrovs'kyj*, 2015:155))

Non-verbal terms are interpreted by means of verbal language” plus (+), minus (-), multiplication sign ( $\times$  or  $\cdot$ ) etc., or graphs and formulas containing letters of the Latin alphabet *S* = *ab*. Since *verbum est signum*, according to Aurelius Augustine in mathematical language symbols are used:  $\alpha$ ,  $\beta$ ,  $\gamma$  ..., or *A*, *B*, *C* ..., or  $\Delta$ ,  $\delta$ , *E*,  $\epsilon$ , *Z*,  $\eta$ , which express concepts that are not related to real things and can be used “to indicate the headings of different classification systems” (*Zaryts'kyj*, 2004;72).

An important section in the study of Latin terminology is the analysis of borrowed Latin roots. Such an analysis is meaningful and constructive for understanding and perceiving not only purely English vocabulary to which it tends. One Latin root can form up to twenty or more derivatives in English or in other Romance languages expressed by different parts of speech (verbs, adverbs, nouns and adjectives). For example, the Latin root *dict* was used to obtain

such derivative forms as contradict, dictate, dictation, dictator, dictatorship, dictatorater, dictatori-ally, dictatorial, edict, predict, dictionary, dictaphone, dictabelt. The root *fōrm-* / *fōrma-* (form in English) is word-forming for almost forty derivatives: conformance, conformant, conformity, counterreformation, deform, deformable, deformation, deformity, disinformation, formable, formal, informal, formally, informally, formality, formant, format, formation, formative, formula, formulary, formulation, inform, informal, informality, informant, information, informative, irreformable, malformation, nonconformance, per-formance, preform, preformat, reformable, reformat, reformation, reformatory, transform, transformable, transformation, transformational, transformative, triform, triformity, uniform, uniformity. Move, mot (*movere*, *motus* / move, mo-tion) formed such words as mobile, immobile, mobility, motor, momentum, move, mover, to move, movable, immovable, motionless, movement.

Word-forming elements can be not only Latin roots, but also Latin prefixes, such as sub- (submarine, subconscious, subsoil, subway, subhuman, substandard, subjacent); inter- (international, interfaith, intertwine, intercellular, interject, intergovernmental, intergenic, interface); de- (deactivate, debone, defrost, decompress, deodorize, deplane, dehydrate); pre- (preconceive, preexist, premeditate, predispose, prepossess, prepay, prelaunch, predate). Analysis of Latin stems, which form a series of English words, allows students to “decode” the meaning of many words. Such decoding can be both an interesting game and an opportunity for a deeper understanding of professional text material.

Here is an excerpt from the professional literature text:

Newton was the first person to figure out the tangent-line definition of velocity for cases where the  $x-t$  graph is nonlinear. Before Newton, nobody had conceptualized the description of motion in terms of  $x-t$  and  $v-t$  graphs. In addition to the graphical techniques discussed in this chapter, Newton also invented a set of symbolic techniques called calculus. If you have an equation for  $x$  in terms of  $t$ , calculus allows you, for instance, to find an equation for  $v$  in terms of  $t$ . In calculus terms, we say that the function  $v(t)$  is the derivative of the function  $x(t)$ . In other words, the derivative of a function is a new function that tells how rapidly the original function was changing.

## 5. Conclusions and suggestions

Determining the place of the Latin language in the process of implementing the principle of integrative education of highly qualified specialists, the formation of their scientific literacy and professional terminological competence is timely. As the analysis shows the percentage of words of Latin origin in the professional literature is extremely high. Latin as a language that is able to actively develop a figurative system of thinking and logic, should take a worthy place in the structure of STEM education, which is actively implemented in many countries around the world. Understanding the semantics of Latin origin terminology will form the basis of the future professionals’ scientific worldview, thus they will better understand the processes in the field of new technologies that actively use new information and communication services, systems and environments, as well as semantic networks, the correctness and effectiveness of which depends on the amount of training, large amount of data and its quality.

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# INTRODUCTION OF THE COEXISTENCE EXPERIENCE INTO AN INCLUSIVE LEARNING ENVIRONMENT: PHILOSOPHICAL-ANTHROPOLOGICAL AND SOCIO-CULTURAL ANALYSIS

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## Summary

The article aims to improve the interaction between society and persons with disabilities. The author has found the interrelation between a person with a disability and Paul Tillich's "the courage to be". The research attempts to convince the public of the need to involve persons with disabilities, as representatives who are aware of a disability, in inclusive education. As a result of the re-use of L. Wittgenstein's method and "pedagogy of experience" by V. Bederkhanova and I. Shustova, a mutually beneficial synthesis between experience and practice in the dimension of coexistence has been established. The objective necessity of simultaneous use of performance and performativity in pedagogical practice has been analyzed and described. The definition of "bilateral" or "double" inclusion has been formulated. The use of "bilateral inclusion" will expand the social boundaries for persons with disabilities and provide the necessary experience in the pedagogical realm for both children with disabilities and healthy children. The analysis and conclusions prove the effectiveness of involving persons who have faced a disability in an inclusive environment.

**Keywords:** inclusion, double inclusion, pedagogy, experience, practice, man, disability, teacher, teacher with disability, inclusive environment, representation.

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## 1. Introduction

Inclusion is a term that has come into use in the 21<sup>st</sup> century. The term has stepped out of the shadow of theory and has been primarily oriented to educational processes. Plenty of articles related to inclusion have been published in domestic and foreign scientific journals. They have covered the cases when a teacher with a disability is involved in the "healthy environment of students".

At first glance, the topic deals with social philosophy and requires it to be considered as – following the definition of inclusion itself – "involvement", "attraction", where involvement means a social environment. However, this article emphasizes the philosophical-anthropological aspect. Thus, the research task is to study the importance and significance of such inclusion to a person with a disability and the value of involving persons with disabilities in teaching activities to the community.

According to state acts, inclusive education means the inclusion of children with special needs in a mutual learning process that allows "healthy" children to see "untypical" children in their society and contributes to forming a shared communicative environment. However, there is no communicative model between "healthy" children and an adult with a disability.

Consequently, “healthy children” do not obtain the relevant experience of communication and cannot decide for themselves what type of behavior or “emotional anchor” to use in communication with the relevant persons. This significantly narrows the child’s worldview, especially in modern Ukraine, which is undergoing military conflict and where the number of persons with disabilities is growing.

*The purpose of the article* is to elucidate the issue of “reverse” or “double inclusion”, which is inextricably linked with the perception of a person with a disability and is subject to rules far removed from the experience and coexistence.

In the context of the abovementioned purpose, the author sets a range of tasks, which go hand in hand with pedagogy and philosophical anthropology. First, it is essential to clarify the mechanism for the impact of experience and practice on an inclusive environment. The author analyzes this issue by relying on the philosophy of L. Wittgenstein. Second, there is a need to analyze how a teacher with a disability can create a coexistent union with a student. The author deals with this task based on V. Bederkhanov’s pedagogical philosophy and her article “Co-existence in education as a method of pedagogy of “experience””.

*Methods* used in the article refer to L. Wittgenstein’s philosophy and “pedagogy of experience” by V. Bederkhanova & I. Shustova.

*Scientific novelty.* L. Wittgenstein’s philosophy is used for the first time as part of the study of a disability and inclusion; the pedagogical method of “experience” becomes an analysis of “double inclusion” based on coexistence.

*Conclusions.* The research has found a direct interrelation between experience and a rule. The term borrowed from L. Wittgenstein’s philosophy – “representation” – is applied. The gap between the influence of “rules” on the subjective feelings of an individual is analyzed. The mutually beneficial interaction between performance and performativity is determined, and the values of both concepts to inclusive education are proved. The article establishes a pattern of coexistence in terms of an inclusive environment. “Bilateral” and “double inclusion” is defined. Based on research findings, the author proposes holding a course for the development and expansion of the environment of “double inclusion”.

*Research results.* The level of study of the issue of concern has allowed using the contributions of philosophers, educators, and sociologists. L. Wittgenstein’s theory is currently considered in the context of social sciences, in which the concept of rules determines behavior (Rodina, 2020). The phenomenology realm by E. Husserl covers humanitarian issues (Sanzhenakov, 2020). Pedagogical aspects have also been elucidated in L. Wittgenstein’s philosophy, which N. Medvedev thoroughly studies (2019). Pedagogy in the perspective of delving into the learning environment and in direct contact with philosophy opens new opportunities found in research by the following pedagogues and philosophers: V. Bederkhanova, I. Shustova, (2020), S. Alekhina, M. Alekseeva, E. Agafonova (2011). This allows expanding the boundaries, from theoretical philosophical anthropology to practical projects.

## 2. The courage to be atypical in society

Paul Tillich writes about “the courage to be” a part of a society of democratic conformism, pointing out that “Originally the democratic-conformist type of the courage to be a part was in an outspoken way tied up with the idea of progress. The courage to be as a part in the progress of the group to which one belongs, of this nation, of all mankind, is expressed in all typically American philosophies: pragmatism, process philosophy, the ethics of growth, progressive education, crusading democracy” (Tillich, 1995: 79).



According to Winzer M., inclusion has had a detrimental effect on society (Winzer, 2009:81). The scientist notes that formally edited positions and ideas became widely used for marketing and PR than for blurring the lines between “atypicality” and “typicality” of an individual. The desire to root out segregation and discrimination in the West through the asymmetric actions of the authorities resulted in a counter-movement of a conservative society. At the same time, there was an exaggeration of mercy. Some sociologists highlight this fact: “Even those persons with disabilities who live an ordinary life (about a third of them) suppress the feeling of pariah due to a sense of patronage of healthy individuals” (Stubbins, 1988:2).

The article was written in 1988, but it is still highly cited. It is not surprising because most works devoted to inclusion deal with the rights of a person with a disability, protect him, take care of him, guard him forgetting that the first objective and desire of a person with a disability is to be socialized. The Constitution of Ukraine guarantees the equality of human rights and responsibilities, but persons with disabilities are often accused of the benefits of their condition – the state cares about them, they are mentioned in the media, ones seek to improve their living conditions, they are provided with aid. However, despite the care of the state, the inadequacy of measures, or rather not entirely right vector of measures, primarily affects the fact that a person with a disability is out of touch with society – one is not socialized.

### 3. Wittgenstein’s theory

Researchers analyzing L. Wittgenstein’s philosophy highlight the core construction used in his contributions – following a rule to delineate the boundaries of language and the world. The conceptual influence of Wittgenstein’s philosophy shaped some research patterns which have rules but, at the same time, don’t have. To be more precise, rules can’t be understood without practice. (Wittgenstein, 1994:199, 496, etc.). The rule is based on the synergy of experience and practice, but practice obeys the rule, and experience subsequently creates additional rules, or even different from the original ones. “A clearly identified core of such concepts is always followed by a tail of peripheral features to which it is often impossible to decide whether to incorporate them in the content of the defined concept” (Rodin, 2020:36).

Thus, according to L. Wittgenstein, language has creative power and concurrently obeys the backward patterns of perception. However, the modern world destroys the relevant concept. The meaning of the action was determined by the actor. Now, this meaning is given by the context which escapes from the uninitiated interpreter. This causes the impossibility of applying rules and rules-consistent actions as such because the former and latter presuppose some universality, while contextuality makes the action unique (Sanzhenakov, 2020: 42).

### 4. Performance and performativity

A. Moiseeva, in her article “Wittgenstein and performative turn”, argues that instead of it (a rule), it is possible to pay attention to how the factor of inclusion (i.e., the action of the rule) “works” in the studied practices, i.e., to examine the processes of generation and transformation of rules by participants of rule-consistent activity” (Moiseeva, 2020: 46). The scholar develops her idea that the performative concept of language can create new notions in the humanities. At the same time, she divides performance and performativity, saying that performance is internal and is generated from within the person, and performativity – external and seems to set the rules of the game of the external world.

Thus, there is the performative concept of language without the simultaneous combination of performance and performativity – modern living language cannot exist apart of it. As a result, if this does not happen, the relations between I always remain at the level of IT and will never be able to transit to the communication of I and YOU. The relations “I” and “You” mean that one person treats another person as his equal. An individual recognizes in another individual the same personality as he is, tries to understand the inner world of his interlocutor, and does not impose his “opinion”, as well as feelings (the author’s), on him (*Burkhanov, 2013: 17*).

## 5. Bilateral inclusion

If one considers the above provisions regarding inclusion, then one faces a paradox – there are rules, and the rule itself is meaningless because there is no experience of its application. In other words, communication is always at the level of I and IT. In order to get out of such communication and move into the relations of I and WE, purposeful conscious actions are needed.

L. Wittgenstein states that it is impossible to understand the world without experience; he often refers to comparisons or examples, specifies that successful communication primarily requires defining concepts and frameworks of their perception, i.e., rules. In the philosopher’s opinion, “master” must define conceptual system, and the direct duty of the “slave” is to clarify and produce semantic definitions.

Wittgenstein never touched upon pedagogy directly, but his colleagues did it for him by referring to his philosophy and the technique of grammatical research. J. Medina, M. Peters, and J. Stickney, gave pride of place to L. Wittgenstein’s philosophical methodology into their contributions and applied to fundamentally different areas of philosophy. “Fittingly, Wittgenstein’s way of self-improvement and working on personal viewpoint can be called pedagogical” writes J. Stickney (*Stickney, 2005: 301*). Moreover, we, as philosophers, understand that the construction of dialogue may collapse if we do not introduce conceptual clarity while studying the issue. “A philosopher can help a pedagogue get rid of conceptual ambiguity that hinders fruitful communication: he can teach one to be relieved from the obsessive philosophical images”, wrote PhD N. Medvedev in his work (*Medvedev, 2020: 87*). The outline of L. Wittgenstein’s rhetoric also becomes clear if one analyzes his fragmentary examples of the perception of various concepts. Medvedev writes that if we focus on his examples of life situations, the context of thinking turns to be multifaceted and goes way beyond language. Immersion in these examples and situations reveals complex philosophical truths that are far from grammar.

By referring to the contributions by L. Wittgenstein, the author finds out a lot of problems named “grammatical misunderstanding”. The discovery of the sensory world of ordinary and, at first sight, comprehensible definitions is found quite ambiguous during a thorough examination. Ludwig Wittgenstein writes: “We are so much accustomed to communication through language, in conversation, that it looks to us as if the whole point of communication lay in this: someone else grasps the sense of my words — which is something mental: he as it were takes it into his own mind” (*Wittgenstein, 2018: 176*).

When analyzing this quote as part of the explanations of one person to another (when both have no experience of disability) what a disability is, one faces a paradox – neither of the interlocutors can be honest and immersed, and therefore, cannot cover the concept in detail. “If someone says that “the word of “pain” to take on meaning, it is necessary to recognize pain as such when it occurs”; one can answer, “It is no more necessary than acknowledging the absence of pain” (*Wittgenstein, 2018: 199*).

Speaking of experience, Ludwig Wittgenstein insists that any experience not experienced personally is the “experience of the slave” (*Wittgenstein, 2018: 114*). In the same way, people perceive the experience of others somewhat remotely until this experience directly affects them. Further, L. Wittgenstein notes that no description can satisfy a person without direct impact and calls this “experience of influence” (*Wittgenstein, 2018: 116*). Consequently, the philosopher implies that a person who experiences other’s feelings or follows other’s explanations is guided until he acquires the “experience of influence”, thus separating “phenomenon” and “experience”. According to the philosopher, “phenomenon” is a detached sample, but “experience” gives a causal connection. Only in this case, a person gains experience empirically as if living it himself. He specifies that language cannot convey experience as feelings, moods for personal use, and therefore, the other will not be able to understand this language, that is, to understand my experience (*Wittgenstein, 2018: 140*). The researcher writes: “Individual experience is essential not because each individual has personal experience but because nobody knows whether others have the same experience or something similar” (*Wittgenstein, 2018: 149*).

A. Sanzhenkov (2020) in his article, referring to the phenomenology of Edmund Husserl, concludes that if the meaning of action used to be given by the actor, now (apparently implying the processes of expansion of society) it is filled with the meaning of an uninitiated interpreter (p. 42). But if according to E. Husserl, sciences carry out their constructions on the self-evident ground of the lifeworld”, where the lifeworld is the world of “original evidence”, then the obvious confuses the very construction of inclusive education in which the production of concepts belongs to the interpreter (*Husserl, 2004: 172*).

Developing our thought, we conclude that performance becomes performativity by separating experience from the rule, and, accordingly, cannot denote a phenomenal experience and cause “representation” as such (*Wittgenstein, 2018: 184*).

Hence, any perception of a disability remains beyond the comprehension of people, who are learning to be in the world of a person with a disability and develop skills given these definitions and rules.

The rule destroys the rule itself – inclusion becomes impossible, and a person faces a misunderstanding in the world of relatively healthy people. This will continue until we replace compassion and care with understanding and form our personal opinion about disability through “representation”, which is not regulated by rules but created by imagination during the direct communication of I with another.

L. Wittgenstein writes: “We do not learn to make empirical judgments by studying rules; we are taught to reason and make connections. Thus, a set of arguments becomes conceivable for us” (*Wittgenstein, 2018: 156*). Accordingly, communication with a person with a disability creates a simultaneous “bilateral” or “double” inclusion. Therefore, a person with a disability learns to live in the environment of healthy people, and a healthy person obtains experience from a person with a disability. Consequently, “double inclusion” is a mutual involvement in the being of the “other” who enriches another’s being with his experience and creates coexistence.

## 6. Coexistence in pedagogy as an experience of “double inclusion”

“Pedagogy of experience” by V. Bederkhanova interprets coexistence as the interrelation of human I and WE (*Bederkhanova, 2020: 33*). At the same time, a person isolates himself in conscious engagement through “representation”.

Martin Heidegger discussed co-being and coexistence as the possibility to be natural and concurrently share being with others and repeatedly linked the notions of presence with the

co-being “Based on the common being-in-the-world, the world is always the one that I share with others. The world of presence is a shared world. Being-in is co-being with others. Intra-world-being in is co-presence” (*Heidegger, 1997: 118*). Hence, the interrelation of co-existence and co-being ensure the integrity of semantic interaction affirming the position of a person in reality. Defragmentation of modern society based on firm views and positions triggers problematic situations in coexistence with a disability and destroys the reflexive stimulator of perception.

In other words, until two people meet, they cannot empathize with each other. Their positions differ, and they cannot model their subjective reality towards other people’s requests. However, co-being triggers co-existence, that is, participation in other’s life with the reflection of self-centered positions. Interaction within co-existence makes it possible to correct the usual notions, and the effect of action in co-existence acquires a double meaning, which is reflected in the subjective existence of the two.

In a broad sense of these processes, two parties are involved: “the world of a person with a disability” and “the world of a healthy person”, but according to reflections, the contact of these worlds is useful to both. In the case of the perception of a person with a disability, one acts as an agent, a person who brings his imperfection to the world. In the case of the perception of a healthy person, he acts as a falsifier of participation, an accomplice. The world expands the boundaries of cognition from the level of rule to the level of possibility; as a result, possibilities create conditions for interaction.

The humanization of educational processes has always meant giving up the authority of the teacher. The teacher becomes a friend, mentor, guide, person who assists in learning without deflecting the process from the basic foundations of life. Thus, following personal principles, the teacher creates a comfortable environment for in-depth study of the subject based on his knowledge, experience and allows including valuable semantic features of an individual. The academic training of social educators and teachers with disabilities expands the boundaries of students’ perceptions.

## 7. The value of “double inclusion”

After analyzing several articles devoted to training an educator for activities in inclusive space written by the authors of the collection “Inclusive education: theory and practice” presented at the second International scientific-practical conference, the author has identified the necessary features teachers should have to work in the relevant environment, as follows:

- respect for what that is missing in their personal experience;
- understanding that a disability does not always affect mental abilities and does not depend on the physical condition;
- recognition of equal opportunities for all students;
- following true pedagogical goals, priorities, and values;
- teamwork skills.

However, virtually all researchers agree that the experience of a disability should be regarded and respected as a particular system of personal values. This suggests that we must first accept that such an experience is valuable that is incomprehensible to a healthy person, but it should be respected. According to the value system of the axiological approach, personality dominates over form, but a different form is worth accepting and respecting. What if you imagine that a teacher has such an experience (experience of a disability), then the first rule – respect, understanding and value – is already innated in the experience. A teacher with a disability can not only to share his experience but also easily accept the values of other person, a priori.

Professional training in an inclusive environment automatically creates co-existence: psychological, emotional, and existential. Thus, the article by C. Alekhina et al. "Readiness of teachers as the main factor of success of the inclusive process in education" reveals unwillingness of a teacher to work with children with disabilities due to fear (Alekhina et al., 2011: 84). Fear, in turn, gives feedback from other children and gives rise to their fear. However, considering the fact that fear is caused by the lack of experience, experience is crucially important – it can be obtained through "representation".

S. Petrova states that "personality is not a passive recipient of the social environment, it actively influences it, selectively responds to external stimuli, and anticipated behavioral norms" (Petrova, 2016: 69). A teacher with a disability directly interacts with a person who has endured a "limit situation" and has been able to overcome it, outdo oneself thanks to one's spirit.

In a learning environment, where the goal involves not only acquiring knowledge but also the multilevel education of the individual, people who have experienced a disability can show a value of spirit and courage. Due to the fact that such people have experienced and coped with disability, they can influence the formation of the student's character and provide morally, socially and emotionally healthy and favorable conditions for personality formation. The old reference links of a disability with weakness are cut.

When a child in the period of personality formation has a role model of transformation and a rewarding experience of interaction with a person who has one "atypical" peculiarity – "disability", then a detailed understanding of the concept of moral courage will prevail. P. Tillich writes "How is the courage to be possible if all the ways to create it are barred by the experience of their ultimate insufficiency?" (Tillich, 1995: 121). He continues "Courage participates in the self-affirmation of being-itself, it participates in the power of being which prevails against non-being" (Tillich, 1995: 126).

The training of teachers with disabilities at the initial stage of inclusion in children's institutions addresses the issue of readiness of both "unhealthy" and "conditionally healthy" children for co-existence. Theoretically, the idea involves shaping a contributing, creative space where experience is not compiled but lived through.

## 8. Conclusions

The analyzed interrelation between experience and practice is inextricably linked with the concept of representation. It determines the interaction between a person at the level of I and WE and reveals the potential for fruitful inclusion. This connection provides the necessary experience and expands the boundaries of communication. Spirituality and courage create a reasoned value of human life and raise the spirit. The value of such a connection expands the boundaries of experience and creates the essential incentive for inclusion as a goal for a humanistic society: equal interaction for all members.

The revealed gap between the "rule" and "experience" has formed an understanding of the need to engage in society not only children with disabilities but also adults with disabilities. This will significantly contribute to the child's perception of the world, shape the necessary potential to fulfil their moral and spiritual qualities. The value of the union between performativity and performance is identified: an adult person with a disability acts as an agent. This interaction is also defined as mutually beneficial in an inclusive environment: a person with a disability can act as an influencer in the socialization of children with disabilities.

The regularity of coexistence as the value of penetration into the other's world is established. The author has defined "bilateral" and "double inclusion" which are designated as

“mutual inclusion in the other’s being”. All the conclusions confirm the evident benefit from attracting teachers with disabilities to work in an inclusive environment. It is the interaction of a “healthy” child and a teacher with a disability that can create a strong connection between coexistence and expand the boundaries of perception of the individual both at the stage of adulthood and at the stage of adult life. Coexistence eliminates negative responses associated with misunderstanding or inconsistency of rules and experience and, at the same time, destroys the stereotype of lameness of a person with a disability. It also creates direct contact with the “courage to be” despite bodily imperfection and makes one a full member of society.

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## MEMORY AND SPACE IN KAZUO ISHIGURO'S NOVEL "THE BURIED GIANT": INTERMEDIAL ASPECT

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### Summary

The aim of the article is to investigate the phenomenon of intermediality in 2015 novel *The Buried Giant* by the British writer Kazuo Ishiguro. Particular attention is paid to the notion of "literary cinematographicness" (also known as *cinematic* or *filmic mode*), which is defined as the use of cinematic techniques and effects in literature, thus creating the effect of multimodality, with a dramatic-intensive flow of events in the text. Analyzing examples from Ishiguro's novel, the article focuses on such elements of literary cinematographicness as the prevalent audio-visual modality, with an in-depth semantics of sensory images and characters' non-verbal language; the abundance of audial and visual special effects; as well as incorporating different shots sizes, perspectives, and angles that produce the effect of multidimensional space in the recipient's mind. Furthermore, the novel's central motif of memory and recollections determines its non-linear chronotope, with such cinematic techniques as montage, dynamic frame shots, and flashbacks becoming instrumental in depicting the complex spatio-temporal relations between the scattered scenes and images.

**Keywords:** intermediality, literary cinematographicness, audio-visuality, shot, frame, montage, flashbacks, Kazuo Ishiguro.

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### 1. Introduction

Contemporary literature demonstrates a growing tendency of actively borrowing artistic effects and strategies of other art forms, a phenomenon known as intermediality, which is based on Marshall McLuhan's concept of the interaction of different "media", i.e., different channels of human communication. Swedish researcher Sara T. Linkis (*Linkis, 2019*) asserts that writers are increasingly using intermedial strategies to emphasize visual and material aspects of literature; accordingly, the concept of intermedial literature implies the meeting, confrontation, or convergence of literature – or traditional literary media – with other types of media. The intermediality of literature essentially implies its multimodality, that is, an attempt to convey information that is typically transmitted by other media, such as images, sounds, and spatio-temporal dynamics of certain phenomena. "Texts are always multimodal in the broadest, semiotic meaning of the term", as Marco Bellardi claims; thereby, he defines modes as "modalities whereby their medi-ality comes to be expressed and experienced: the material modality, the sensorial modality, the spatiotemporal modality and the semiotic modality", which are the cornerstones of all media and can be either material or mental (*Bellardi, 2018: 38*).

To a large extent, the foundations of the modern theory of intermediality were laid in the works of Mikhail Bakhtin, who pointed out that human language encodes information about the world around us and the society in which it operates; that is, language carries the



collective experience of people, the whole “multitude of bounded verbal-ideological and social belief systems”. Thereby, each word contains “various semantic and axiological content” (Bakhtin, 2010: 288) that indicates one’s occupational sphere, features of a particular group, or worldview, which is actualized in a dialogue, i.e., any exchange of information or ideas between people. In this regard, various seemingly simple phenomena often have additional dimensions of abstract, socially, and culturally conditioned meanings, where “the dialectics of the object are interwoven with the social dialogue surrounding it” (Bakhtin, 2010: 278). Therefore, each word used in oral or written discourse (particularly in literature) appeals to the collective experience of people, this “common space” between the sender and the addressee, actualizing this dimension in the mind of the latter.

Probably, the most multifaceted example of intermediality in literature is *literary cinematographicness* (also termed as *cinematic* or *filmic mode*), whereby authors of fiction imitate the techniques and effects of cinema to dynamize the narrative, employing the reader’s natural ability of visualizing the described sensory images with subsequent reconstruction of their invisible semantics. Since by its very nature cinema incorporates the elements of other forms of art (such as painting, sculpture, architecture, music, and theatre), one can argue that literary cinematographicness enables the maximal multimodality of the text. Most often, the cinematographicness of fiction presupposes the integration of cinematic aesthetics, terminology, plot-constructing techniques, and special artistic effects, which evoke in the reader a subconscious feeling of watching a film. In other words, literary cinematographicness is an example of intermedial transcoding, that is, according to Bakhtin (Bakhtin, 2010: 358), “the ability of language to represent another language”, which in this case means the language of cinema as represented by means of a written word.

The works of the contemporary British writer of Japanese origin Kazuo Ishiguro are vivid examples of cinematic literature, whereby such principles of cinematographicness as audio-visuality, shots of different sizes, montage, and flexibility of the chronotope produce the effect of multidimensional and multisensory literary text.

**The purpose of the article:** to explore the techniques of literary cinematographicness in Kazuo Ishiguro's novel *The Buried Giant*.

**Tasks:**

1. To define the phenomenon of literary cinematographicness as an example of intermediality in the contemporary literature.
2. To investigate the cinematic artistic techniques that can be incorporated in a literary narrative.
3. To trace the system of cinematic effects and techniques in Kazuo Ishiguro's novel *The Buried Giant*.

**Methodology:** the purpose of the study led to the choice of the following methods and approaches: intermedial approach, dialogism, narratology, receptive aesthetics, hermeneutics, and close reading.

## 2. The notion of literary cinematographicness and its constituents

Due to the visual and montage-like nature of human thinking, and that of literature as a form of human thought, it can be argued that literary cinematographicness is to some extent inherent in all works of literature, even those written before the advent of cinema. Comparing the processes of reading books and watching movies, Marshall McLuhan (McLuhan, 1994: 144)

claims they have much in common, noting that the task of the reader is to “follow the black and white sequences of stills that is typography, providing his own sound track. He tries to follow the contours of the author’s mind, at varying speeds and with various illusions of understanding”; in view of this, the connection between the printed text and the film is indisputable and mainly lies in their unique ability to instigate the imagination of the reader or viewer

Nevertheless, more and more scholars (like G. Deleuze, H. M. Puchner, S. G. Kellman, F. Ivaldi, V. Fesenko, A. Pokulevska, N. Dotsenko, I. Martianova, T. Luk'yanets) differentiate the literary works with a visibly high level of “cinematographicness”, where the authors seem to intentionally imitate the aesthetics and techniques of cinema, thus prompting the reader to unconsciously perceive these literary texts as if through the cinematographic lens. Particularly, as noted by Steven Kellman (*Kellman, 1987: 473*), one might consider cinematic a novel “organized as if separate chapters, paragraphs, or sentences were written and then edited into nonlinear patterns.” In addition, cinematic prose aspires to imitate the visual presence of the film, in an attempt “to abandon concepts for percepts, telling for showing” (*Kellman, 1987: 474*). The reasons why writers resort to the techniques of cinematography can be different – from trying to make their work more dynamic and close to the modern reader, and to a conscious desire to convey the atmosphere of cinema. The appearance of cinematic techniques in a literary text can be explained by “the author’s need to dynamize the observed image, to collide, to break its fragments in a paradoxical montage, their desire to control the perception of the reader-viewer” (*Martianova, 2002: 9*). Accordingly, literary cinematographicness is a feature of a text with the “mainly montage-like technique of composition, in which various, but above all compositional means depict a dynamic situation of observation” (*Martianova, 2017: 138*), hence significantly transforming the reader’s receptive mechanisms, motivating the cinema-like multimodality of a literary text.

### **2.1. Audio-visuality and special effects**

Among the major elements of literary cinematographicness one can distinguish the emphasized audio-visual nature of a literary text. Ukrainian scholar Valentyna Fesenko (*Fesenko, 2014*) notes that many contemporary novels demonstrate a pronounced photographic nature of the described visual images, their separateness and spontaneity. In such writings, one can observe a lack of emotional lexemes, thus imitating a “cinematic technique of a cold, impersonal view of the camera lens, which captures the phenomenological presence of things in the world” (*Fesenko, 2014: 382*). This means that a cinematic literary text is often purposefully devoid of the detailed descriptions of what cannot be directly seen or heard, with the inner world of the characters revealed not through descriptions of their thoughts and feelings, but indirectly, through actions, non-verbal language, dialogues, as well as the descriptions of environmental phenomena (such as images of nature and sounds) endowed with a culturally established symbolic and psychological meaning. Additionally, there are certain special audio-visual effects that further enhance the artistic, aesthetic, and emotional effect on the recipient. These include visual effects like blurring, playing with light and colors, contrast of light and darkness, blurry background, the effect of camera focus, as well as the sound effects like echo, contrast of silence and sound, background sounds, rhythm, and music (*Bellardi, 2018*). As a result, such arrangement of a literary narrative automatically reprograms the recipient onto the audio-visual code of perception, prompting them to not only visualize these images, but also independently reconstruct their metaphorical meaning as based on one’s emotional intelligence and socio-cultural experience of the same.

## 2.2. Shots sizes and perspectives

Another element of literary cinematographicness is the use of different shot sizes, angles, and perspectives. According to Yuriy Lotman (*Lotman, 1973: 296*), in a literary work, one can talk about the different shot sizes, “if successive segments of the text are filled with content that vividly contrasts in quantitative terms: different number of characters, whole and parts, descriptions of large and small objects; if one chapter in a novel describes the events of one day, and another – decades”. Researcher Tetyana Luk'yanets (*Luk'yanets, 2017a: 113*) explains this technique in the cinema as “variation of the distance between the point of shooting and the object(s) in focus that is due to the phenomenon of analogy, or semantic and/or structural correlation depicted in successive frames”. Accordingly, in a cinematographic writing, the world is arranged in visible shot sizes and perspectives, which manifest through such elements as detailed, metaphorically-imbued depictions of characters' appearance and non-verbal language (close-up and medium shots), their place of interaction (full and wide shots), the location of the action at the head of a scene (establishing shot), or descriptions of landscapes and distant objects (long shot) (*Lannom, 2020*). Furthermore, according to Luk'yanets (*Luk'yanets, 2017b: 36*), techniques of varying perspectives and angles (also termed as spatio-temporal focalization, verbal holographic modeling of artistic space, verbalization of geometric perspective of the image) “actualize the optical mode of perception through the reflection of shape, size, location of the object in the flow of a literary text, indicating the direction from which this object is observed by another character or an imaginary reader of the text”, hence making the reader to reconstruct and visualize the whole system of spatial connections between the depicted objects just as described in a text.

## 2.3. Montage and flexible chronotope

In cinema, montage is a basic plot-constructing technique that makes the viewer perceive the separate frames as a holistic world, where the order of the combined fragments is dictated by a certain narrative and aesthetic idea. In literature, the term “montage” denotes such way of constructing a narrative that is dominated by the discontinuity of what is depicted in the text, namely, its fragmentary and elliptical nature. Moreover, as Fesenko (*Fesenko, 2014: 387*) appropriately notes, the use of montage technique in a literary work makes it more dynamic, helping to “fixate the spatial intensity of an image”.

The montage in literature is closely intertwined with the chronotope flexibility, manifested through special narrative techniques of temporality construction – with elliptical transitions peculiar to cinema, sudden shifts of spatio-temporal coordinates, vivid time distortions, flashbacks, accelerated or slow-motion pace, etc. Due to these techniques, the literary text becomes “deprived of a linear chronology, which is replaced by a dramatic-intensive order of organizing events in time, creating a psychologically-motivated visual reality” (*Luk'yanets, 2017a: 112*). According to Lotman (*Lotman, 1973: 65*), such “propensity (of cinema) for unevenness, deliberate compression and stretching, is a prerequisite for the emergence of artistic time”, which “is felt by the viewer as artistic energy, tension and semantic saturation”. Therefore, just like a film director, the author of a cinematic literary text deliberately edits and shuffles various scenes and timelines, speeds up or slows down the course of events so as to achieve the desired artistic effect and draw the reader's attention to what is most important at this point in a story (*Lotman, 1973*).

### 3. Literary cinematographicness in Ishiguro's novel *The Buried Giant*

Kazuo Ishiguro's writings are exemplars of contemporary postmodern literature that is characterized by hybridity, particularly on multicultural, multi-genre, and intermedial levels. The multicultural aspect in Ishiguro's works is based on a combination of Western ideas and forms with Eastern aesthetics, aimed at contemplation and in-depth symbolism of sensory images. Simultaneously, this principle determines the literary cinematographicness of Ishiguro's works, where the audio-visual orientation and montage-like segmentation of the narrative produce the effect of presence that is inherent to cinema. Furthermore, the elliptical nature of the writer's prose is determined by his "gap" strategy, with the true story and feelings of the characters hidden behind the scattered scenes and images in the text, while the whole picture is revealed to the reader only in the end of each novel. In addition, a motif of human memory and recollections is recurrent in all Ishiguro's novels, "reflecting the subtle malleability of memory and identity, and the simmering tension between the two, featuring a cast of characters scanning their past for clues to their identity, loss and abandonment" (*Anjum*, 2017: n.p.); notably, this theme requires a flexible combination of different timelines, whereby the technique of flashbacks becomes instrumental, enabling the author to spontaneously penetrate into the characters' memories.

Ishiguro's seventh novel *The Buried Giant* (2015) is a vivid example of the writer's artistic method, which can be considered postmodern in many ways: rethinking the mythopoetic genres of a legend, fairy tale, and fantasy through the prism of the modern worldview, allegorism, the motif of individual and collective unconscious, intertextuality, lack of clear moral criteria, subtle psychologism, the interweaving of several timelines, the open ending, and the appearance of the author in the text. Ishiguro himself noted about the connection between *The Buried Giant* and his earlier works: "I find that my themes remain very similar, but I like to change the periods in which they are set, and the genre" (*Whitmore*, 2017). In this case, the writer experiments with the genre of historical fantasy, representing "artistic rethinking of history", whereby "memory as the author's artistic concept finds expression at all levels of the work and is considered in numerous projections, interconnected with each other, creating a system of varieties" (*Mihejkina*, 2020: 1).

The events in *The Buried Giant* take place in the semi-legendary Britain of King Arthur's times, where an elderly couple, Axl and Beatrice, embark on a journey to find their son. On their way, the characters are constantly accompanied by a strange mist, which does not disappear on these lands for many years. Later it is revealed that this mist is the breath of a dragon, which deprives people of almost all the memories of their past ("*the past <...> had somehow faded into a mist as dense as that which hung over the marshes*" (*Ishiguro*, 2015: 11)). Accordingly, the ubiquitous image of mist in the novel is a symbolic veil that covers the past, which the characters strive to uncover in order to answer the unspoken question that unconsciously haunts them, hence revealing their true identity. Notably, the image of mist is one of the common motifs of Japanese art, symbolizing the vagueness, uncertainty, and the illusory nature of the visible world. In cinematic terminology, this is represented by special visual effects like blurring, fades, and black-and-white picture. Another example of a visual metaphor in the novel is an episode where the contrast between the two banks of the river, light and dark, symbolizes the approaching of the characters to self-awareness as opposed to oblivion: "*though the opposite bank was often bathed in morning light, their side of the river remained shaded and cold*" (*Ishiguro*, 2015: 121)). What defines the novel's plot structure is the motif of quest in its three

interrelated manifestations: “characters travel on the way to their goals, while certain features of semantically significant landscape awaken their recollection, returning chaotic memories that become clear only at the end of the journey” (Borowska-Szerszun, 2016: 32). This plot structure is largely motivated by the “gap” strategy, where the true story is implied through the scattered memories, dreams, dialogues, and images, while the whole picture is revealed to the reader only in the end of the novel, when the characters come to final self-awareness.

The literary cinematographicness of *The Buried Giant* is represented by a set of narrative techniques and artistic effects that direct the reader’s perception onto the polysensory, multi-modal plane, where the described images are transformed into the visual stream of the montage-arranged scenes (much like a motion picture or the “stream-of-consciousness” technique). The predominant audio-visual modality of the text is embodied in the novel through the detailed descriptions of landscapes, natural phenomena and objects, a variety of open and closed spaces, as well as the abundance of remarks depicting characters’ appearance and non-verbal language, indirectly expressing their emotions and thoughts. Furthermore, the visual richness of the novel is marked by a constant play with different shots sizes, perspectives, angles, light effects, and colors, which serve as the primary expression of the metaphorical and psycho-emotional meaning. The examples of the mentioned visual strategies in the novel are as follows:

*“There were instead miles of desolate, uncultivated land; here and there rough-hewn paths over craggy hills or bleak moorland”* (Ishiguro, 2015: 9) – this opening description resembles a “bird’s eye view” landscape, analogous to the establishing long shot that demonstrates the general setting of the novel to the reader.

*“Beatrice appeared confused again. She looked into his face, then all around her, at the pleasant sunshine, their neighbours once more giving attention to their activities”* (Ishiguro, 2015: 19) – this fragment, starting with a close-up focus on characters’ facial expressions (*‘Beatrice appeared confused again’, ‘looked into his face’*), shifts towards full and wide shots, imitating the movement of the camera lens that alternately focuses on different objects (*‘looked into his face, then all around her, at the pleasant sunshine, their neighbours’*). *“A row of standing stones on the far horizon, a turn of a stream, the particular rise and fall of a valley”* (Ishiguro, 2015: 21) – in the given quote, the character’s gaze, just like the moving camera lens, highlights the details and outlines of the horizon, which is typical for a long shot in cinema, thus creating the panorama effect;

*“After an initial descent it climbed steadily, till they found themselves walking along a high ridge, moorland on either side of them. The wind was fierce, but if anything a welcome antidote to the noon sun. The ground everywhere was covered in heather and gorse, never more than knee high, and only occasionally did a tree come into view — some solitary, crone-like specimen, bowed by endless gales. Then a valley appeared to their right.”* (Ishiguro, 2015: 23) – this passage is a colorful example of the spatial plasticity in the novel, with a number of lexemes denoting natural phenomena (*‘wind’, ‘noon sun’, ‘ground...covered in heather and gorse’*), sizes and shapes (*‘high ridge’, ‘never more than knee high’, ‘crone-like’, ‘bowed’*), directions (*‘descent’, ‘climbed’*), as well as objects’ position and distance relative to each other (*‘moorland on either side of them’, ‘occasionally did a tree come into view’, ‘a valley appeared to their right’*). Consequently, such scrupulous detailing of spatial relations between objects automatically constructs a three-dimensional picture in the reader’s imagination with a pronounced effect of presence.

*“Axl was puzzled that a village which from a distance looked to be two orderly rings of houses could turn out to be such a chaotic labyrinth now they were walking through its narrow lanes”* (Ishiguro, 2015: 32) – here, we might observe the effect of a long shot (*‘from a distance*

looked to be two orderly rings of houses') being replaced by a wide shot ('a chaotic labyrinth now...walking through its narrow lanes'), which demonstrates the immediate environment of the character.

"From their low vantage point, the boat loomed large, and Axl could see in fine detail the damaged, coarsened wood, and the underside of the gunwale, where a row of tiny icicles hung like candlewax" (Ishiguro, 2015: 123); "The goat was clearly visible from where they now sat. The two large rocks, leaning one towards the other like an old married couple, had been visible from some way down" (Ishiguro, 2015: 132) – these passages also exemplify the attention to spatial positioning of different objects, utilizing a wide variety of space-defining lexemes ('low vantage point', 'clearly visible from where they now sat', 'leaning one towards the other', 'visible from some way down') as well as close-up focus ('could see in fine detail the damaged, coarsened wood... a row of tiny icicles hung').

"There was a bonfire blazing at its centre, and all around it, illuminated by its light, a large crowd. There were Saxons of all ages, even tiny children in their parents' arms, and Axl's first thought was that they had stumbled upon a pagan ceremony» (Ishiguro, 2015: 33) – here, the effects of focus on a particular object ('a bonfire blazing at its centre') and playing with light effects ('a bonfire blazing', 'illuminated by its light') are evident, as well as a wide shot effect due to the relatively small scale of the described scene;

"...they were in some sort of mausoleum, surrounded by walls bearing traces of murals and Roman letters. Before them a pair of substantial pillars formed a gateway into a further chamber of comparable proportions, and falling across this threshold was an intense pool of moonlight" (Ishiguro, 2015: 93) - the given fragment is a sample of interior description, with peculiar detail with regards to perspective and spatial relations inside the building ('surrounded by walls', 'before them a pair of substantial pillars', 'chamber of comparable proportions');

"Yet as they went forward they found there was a feeble light, so that at times they could even make out each other's outline" (Ishiguro, 2015: 90) - this scene is characterized by the effects of near complete darkness ('a feeble light') and silhouettes ('each other's outline').

"The candle in his hand illuminated his face and upper torso with wobbling shadows, and he was breathing heavily" (Ishiguro, 2015: 90) - in this quote, the image of the torso and face of the character suggest the medium shot, with the additional effect of the contrast of light and shadows ('illuminated', 'with wobbling shadows');

"...the grey-haired man had started to raise his arm, his fingers almost in a pointing gesture, a reprimand all but escaping his lips" (Ishiguro, 2015: 76) – this fragment exemplifies the detailing of the character's appearance, gestures, and facial expressions, which is analogous to a close-up technique in a movie;

"The monastery buildings were now dark shapes against the setting sky. As they drew closer, the monk paused, moved his forefinger over his lips, then continued at a more cautious pace" (Ishiguro, 2015: 82) – in this case, we observe the effects of contrast and twilight, as well as the transition from the long shot ('dark shapes against the setting sky') to close-up ('moved his forefinger over his lips').

In addition, the space described in the novel is further enriched with a multitude of sounds that vary in their intensity and source, overlap and mix with one another, or contrast with silence, setting the audial background and emotional tone of the narrative. For instance:

"...the stars had all but gone, a glow was spreading on the horizon, and the first notes of birdsong were emerging from the dimness" (Ishiguro, 2015: 10) – in this fragment, the described landscape of dawn is supplemented with the background sounds of 'birdsong ... emerging from the dimness'; "He could hear noises outside, but unlike those that had woken them in the night, these were of people going about their business of an ordinary morning"

(Ishiguro, 2015: 42) – here, the background noise is characterized as that of ‘people going about their business of an ordinary morning’, making the reader imagine such sounds as based on their own experience of the same;

“...the sounds, even now echoing across the monastery grounds, of Wistan chopping firewood” (Ishiguro, 2015:72) – this quote exemplifies the audial effect of a peculiar sound (‘chopping firewood’) that produces the effect of echo, spreading ‘across the monastery grounds’.

“...amidst the pleasant birdsong, there had been some strange hissings and murmurs” (Ishiguro, 2015: 100) – in this case, we might observe different sources of sounds that mix with one another (‘the pleasant birdsong’, ‘strange hissings and murmurs’);

“The noise followed a pattern: an intense burst of rustling, as of a struggle, then silence. Then soon, more rustling” (Ishiguro, 2015: 102) – the given quote is an example of the contrast between sound and silence (‘intense burst of rustling... silence... more rustling’).

“It was hard to determine how distant or near it had been, but the sound was unmistakably the cry of a beast; it had resembled the howl of a wolf, though there had also been something of the deeper roar of a bear» (Ishiguro, 2015: 59) – this passage emphasizes the impossibility of determining the distance to the source of a sound that is similar to a howl of an animal;

“And when he began to address the crowd, his voice, though loud enough for all to hear, somehow gave the impression he was speaking in a low, intimate tone appropriate to solemn subject matter. <...> A tone of entreaty had entered his voice. It was almost as if he was making an accusation, and Axl could feel the mood of the crowd changing <...> there was confusion, even fear in the rumble of voices swelling around him» (Ishiguro, 2015: 40-41) – this fragment describes the intonation of the character's speech, while its content is not heard from the point where the protagonist stands; at the same time, the effect of the speech on the audience is notable (‘the mood of the crowd changing’), as well as how the sounds surround the protagonist from all sides (‘voices swelling around him’).

“Edwin, back in the shadows, had started to sing; faintly at first so that Axl had thought the boy was simply soothing his nerves, but then his voice had become steadily more conspicuous. His song seemed to be a slow lullaby, and he was rendering it with his face to the wall, his body rocking gently” (Ishiguro, 2015: 94) – the given quote describes the manner in which the character sings, while also expressing his evident change of mood (‘faintly at first... simply soothing his nerves’, ‘his voice had become steadily more conspicuous’).

Another modality clearly expressed in the novel is that of dynamics and action, which further enhances the effect of cinematographicness. Foremost, among the vivid examples of this strategy are various battle scenes in the novel, as in the following case:

At first both men held their swords pointing downwards, so as not to exhaust their arms. From his vantage point, Axl could see their positions clearly: at most five strides apart, Wistan's body angled slightly to the left. <...> he was taken aback by the suddenness with which Gawain and Wistan met. It was as if they had responded to a signal: the space between them vanished <...> As they did so, they rotated a little, like dancers, and Axl could then see that their two blades, perhaps because of the huge impact of their coming together, had become melded as one. (Ishiguro, 2015: 155-156)

In the given fragment, we observe the scrupulous detail with regards to the spatial positions and movements, firstly indicating the ‘vantage point’ of the spectator, much like the positioning of the camera lens in a film. Furthermore, in the scene, subdivision into a range of successive frames is evident through different movements of both fighters (‘held their swords pointing downwards’, ‘Wistan's body angled slightly to the left’, ‘Gawain and Wistan met’,

'they rotated a little') and alternating shot sizes, starting with full shot depicting both characters at full height, to close-up focusing on peculiar detail ('their two blades...had become melded as one'). The dynamics of movements ('the suddenness with which Gawain and Wistan met', 'they rotated a little'), the emphasis on distances and angles ('pointing downwards', 'at most five strides apart', 'the space between them vanished') are also notable in this passage, which in combination create the effect of a highly tense and dynamic scene in an action movie.

In *The Buried Giant*, Ishiguro also employs montage, which is the result of a sudden change in spatio-temporal coordinates in the adjacent fragments of text. In addition to the various chapters that begin with a new scene (mostly through the panoramic establishing shot), the text of the novel is often split into smaller, less visible fragments, such as the transition to a new scene over a relatively short period of time, thus speeding-up the course of events, as, for example, in the following passage:

But Beatrice had already turned and was climbing the path back to the thorn tree and the figure in the flapping cloak.

A little later, having completed his errand, Axl was returning to the fields, and at the risk of testing the patience of his colleagues, deviated from his route to go past the old thorn again. (Ishiguro, 2015:15)

In the given fragment, we observe a sudden shift from one scene, where Beatrice 'had already turned and was climbing the path back to the thorn tree' to another, which probably occurred a few hours later, with the phrase 'a little later' marking the beginning of a new scene, where Axl 'was returning to the fields' and 'deviated from his route to go past the old thorn again'. In this case, the spatial coordinates do not change since in both scenes, the characters are near a certain thorn tree, but the temporal coordinates are different.

Furthermore, the defining feature of Ishiguro's novel is the interweaving of different timelines – the main one, which describes the scenes from the journey of the protagonists, and fragmented flashback memories from their distant and recent past. For instance:

...ever since Arthur's name had first been mentioned – a nagging, uneasy feeling had been troubling Axl. Now at last, as he listened to Wistan and the old knight talk, a fragment of memory came to him. It was not much, but it nevertheless brought him relief to have something to hold and examine. He remembered standing inside a tent, a large one of the sort an army will erect near a battlefield. It was night, and there was a heavy candle flickering, and the wind outside making the tent's walls suck and billow. There were others in the tent with him." (Ishiguro, 2015: 63)

In this fragment, certain associations of the protagonist ('ever since Arthur's name had first been mentioned') cause a spontaneous transition from the main timeline to the memory ('a fragment of memory came to him'), followed by a description of the scene of the distant past ('he remembered standing inside a tent'). For the reader, this means an immediate and complete replacement of the "frame" in their inner movie, automatically redecorating the new mise-en-scène with the necessary details and images that appear one by one as "instructed" by the text: 'a tent', 'a large one', 'a battlefield', 'night', 'a heavy candle flickering', 'the wind outside', 'others in the tent'.

Overall, the actual as well as symbolic journey of the characters through their memories leads them to a number of important discoveries about their past, including the fact that Beatrice has once betrayed Axl, and that as a revenge, albeit unconsciously, he did not allow her to visit the grave of their son, who had died of plague long time ago. In the end, restoring these memories enables the couple to comprehend their true feelings, hence finding ultimate understanding and peace.



#### 4. Conclusions

Kazuo Ishiguro's novel *The Buried Giant* is an example of contemporary postmodernist literature that utilizes intermedial strategies for a more profound interaction with the recipient's consciousness, primarily through the involvement of cinematic techniques and effects in the narrative.

In the novel, the predominant audio-visuality through the abundance of sensory images and special effects motivates the pronounced multimodality of the text, with a multitude of images and sounds becoming the primary expressions of nonverbalized psychological and symbolic meaning. Thereby, the artistic effect on the reader consists in the need to constantly visualize the described images and interpret their complex multilevel semantics as based on the person's emotional intelligence and socio-cultural experience of such phenomena. In addition, the novel incorporates the effects of different shots sizes (from long shot to close-up), perspectives, and angles, emphasizing the spatial connections between the depicted images, which prompts the reader to construct a multidimensional picture in their imagination, full of colors and sounds, creating the effect of immediate presence that is peculiar to cinema.

Moreover, the emphasis on the dynamics of events through the fragmented narrative, reminiscent of frames sequences and montage technique in cinema, further produces a film-like effect in the novel, allowing the writer to deliberately shift among different scenes and vary the pace of events. Last but not least, the essential feature of the narrative structure in *The Buried Giant* is the use of numerous spontaneous flashbacks into the memories of the characters, whereby the true idea of the novel resides. Consequently, such non-linear timeline requires the reader's ability to independently reconstruct all the spatio-temporal relations in the novel, forming a holistic story with both what is described in the text and what is untold, yet implied.

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**«THE UNSIMPLE» BY T. PROKHASKO: A QUASI-HISTORICAL NOVEL****Lubov Pecherskyh**

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**Summary**

A historical novel is a work that is based on a historical plot, built on the reproduction in the artistic form of a certain historical epoch, a certain period of the people's or the country's past. In view of this, in a historical novel, historical truth must be combined with artistic truth, historical facts with artistic fiction, real historical figures with fictional characters. The post-modern ideology of the multiplicity of meanings, the hesitation in determining the differences between the false and the true, justify today's increase in interest in history and the historical novel as a modern textual reflection of the past.

The study considers the artistic interpretation of the genre of quasi-historical postmodern novel on the material of the text "The UnSimple" by T. Prokhasko. The genre features of the text are determined, in particular inscribing a variant of an event to a certain historical epoch, defining national features with the help of a pseudo-historical plot, creating a geographical utopia and avoiding linearity, rooting a person in a new geographical landscape as a strategy of historical discourse reconstruction.

**Keywords:** genre, historical discourse, quasi-historical novel, postmodernism, topos.

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**1. Introduction**

The formation of the historical novel was marked by temporal dimensions from antiquity to the present. The Middle Ages, Renaissance, Baroque, Romanticism, Realism, and Modernism contributed to the development of the historical novel genre.

The development of the genre of historical novel directly influenced the formation of modifications and transformations of its species. Models of genre differentiations arose due to the need of artistic development of the past in various art forms, the creation of which was prompted by the expansion of the ideological and artistic range of historical themes.

The historian depends entirely on archival documents and sources, so it is not always possible to give a thorough answer to the questions posed by the challenges of time. A writer, unlike a historian, can defend his position basing not only on facts, but on creative fiction, intuitive discoveries. This is especially noticeable in the postmodern historical novel, where the documentary takes the form not of a historical fact, but of a fact of the era.

**2. Theoretical framework**

According to L. Hutcheon (*Hutcheon, 1988: 122*), the postmodern historical novel being in the cross point of literature and history is transformed into a kind of historiographical metaliterature, in particular into a quasi-historical novel, which has its roots in parody pseudo-historical texts of the Baroque period.

The term “pseudo-historical” or “quasi-historical” novel was firstly defined by M. Lypovetsky (*Lypovetsky, 1997*), aspects of understanding history in the postmodern novel are voiced in the works by V. Kurytsyn (*Kurytsyn, 2000*), I. Skoropanova (*Skoropanova, 2007*), M. Epstein (*Epshtein, 2000*).

The postmodern quasi-historical novel in a less degree uses a factual narrative – a narrative as close as possible to reality, to an increasing degree – a fictional narrative – a narrative of fictional events. The problem of interaction of factual and fictional planes occupies a central place in the quasi-historical novel, the specificity of which lies in the author's transformation of real events into fictional ones. Such transformational skill of the author deprives the reader of the opportunity to independently distinguish between factual and fictional events in the work.

The poetics of postmodern quasi-historical novels is structured by neomythologisms, the logic of a nonlinear novel in the construction of their plots, compositions, focusing on the deconstruction of ideas of traditional transculturalism, common Christian roots, “fraternal” unity of Slavs, a myths about the search for a new messiah, the salvation of society by the historically significant role of woman, the privation of the exile nation.

A striking example of Ukrainian quasi-historical novelism is the work of one of the most significant figures in the modern literary process, Ivano-Frankivsk poet, writer, essayist Taras Prokhasko, whose original style influenced the work of many younger prose writers.

As R. Kharchuk points out, in the novel “The UnSimple” T. Prokhasko, for whom the place that is mastered by the genus and forms the genus is of special importance, recombines the plot of tribal history, traditional for European literature, which reflects the history of the people. T. Prokhasko appeals to the strategy of identifying tribal histories with the history of ethnographic territory (*Kharchuk, 2011: 171*).

T. Gundorova (*Hundorova, 2005: 102*) talks about the mythologizing of the Western European myth of Galicia in the author's novel. I. Bondar-Tereshchenko sees metaphysical local lore in the novel, expressed within the historical narrative (*Bondar-Tereshchenko, 2003: 58*).

The writer names the authors to whom the threads of his characters, plot and stylistic lead. These are M. Mamardashvili (phenomenon of consciousness), G. G. Marquez, K. Ransmayr, J. Le Goff, H. L. Borges, S. Dovlatov, B. Grabal, D. Kish, the texts “The name of the rose” by U. Eco, J. Hayzinga's “Homo ludens”, P. Reeker's “Story and Time” (according to I. Bondar-Tereshchenko (*Bondar-Tereshchenko, 2003: 59*)), “Apocrypha of the Ancient Christians”, V. Shukhevych's investigation “The Hutsul land”, “Logico-philosophical treatise” by L. Wittgenstein (as noted by T. Prokhasko (*Teren, 2020: 274–276; Pidgora-Gvyazdovskiy, 2008*)).

Without claiming to create a masterpiece in the context of well-known perfect texts, T. Prokhasko points out: “...I allow myself to add my, roughly speaking, notes in the margins of what has already been done and written before me” (*Teren, 2020: 225*).

In the prose by T. Prokhasko the aesthetics of existence and household hermeneutics have special weight. T. Prokhasko contrasts details and circumstances with the civilization excess and oversaturation. It is attention to the detail, the ability to notice the smallest circumstances, for example, in facial expressions, gestures, intonations that gives T. Prokhasko's prose a special emotional and semantic halo (*Kharchuk, 2011: 169*). According to the researcher, the source of the mysticism of T. Prokhasko's prose is the mystical philosophy of St. Augustine and Neoplatonism (*Ibid.:178*).

The writer notes: “I am interested in small manifestations of life. I am interested in details when everything is in something small” (*Slavinska, 2011*). As the main innovative “trend” of the novel O. Zabuzhko sees the search for an answer to the question of whether it is possible to live in geography contrary to history, at the center of which is a “little man”, and whether a

person can be happy in such conditions (*Zabuzhko, 2015: 9*). The question of accepting history arises as one that requires an answer to continue the further movement of the culture.

O. Zabuzhko points out that in Prohasko's myth a priority of geography over history (place – over time) is absolute (*Ibid.: 11*). The writer himself is also aware of this instruction, he is deeply rooted in the family topos, which gives him not only shelter in the course of life, but also ideal conditions for creativity. The house “<...> for most people <...> is the basis of biography and a clear result of existence. And there the memory rests, because it is the easiest for her to cope with the objects” (*Prokhasko, 2015: 42*). The house as a center of memory and beauty acquires a sacred significance in the novel. “To be accessible, beauty must be able to be worded. And therefore – to be grinded. The house gives that small space in which it is possible to have time to make beauty by own forces ” (*Ibid.: 43*).

Understanding the meaning of an artistic detail, the “small space” of which T. Prokhasko speaks, corresponds to the phenomenological way out of anthropological impasse through the model of self-disclosure of the mind (*Vatorpyn, Olkhovykov, 2002: 138*).

### 3. Methodology

To implement the tasks of the investigation, the traditional general scientific methods were used^ such as: deconstruction, metatextuality and intertextuality.

### 4. Results and Discussion

The heroes of the novel “The UnSimple” feel and accept the call of a related topos and adjust their lives according to it: “...saw the place where felt on the spot – related and happy. In a year Francisk returned there and began to build a town” (*Prokhasko, 2015: 19*). The feeling of accepting a person by a topos is also articulated in the novel (*Ibid.: 85*). Yalivets's topos also serves as a shelter from external information (*Ibid.: 24*).

The topos in the novel acquires a sacred meaning, playing the role of a “place of germination”: Franz found a place that made travel optional <...> my place will always be at the center of European history, because on these lands history in various forms itself comes to our outdoors” (*Ibid.: 37*).

Despite his deep personal roots in the topos and perception of the world exclusively through himself, otherwise there is no world — the writer feels as a part of the flow of hundreds of generations and many different processes, both historical and natural, “I am a small fragment in this great stream,” he points out (*Pleasure to contact, 2015: 199*). Among the “surrogates of pastime” that indicate the transition from significant things beyond the sphere of human influence to less significant <...>, which a person is able to manage, a modern sociologist, researcher of modern society Z. Bauman calls the work on dismantling, reorganization, formation of one's own identity, which requires time and effort (*Bauman, 2005: 120*).

T. Prohasko arranges his world with the help of fixing historical relics. Referring to his brother Y. Prokhasko (Ukrainian literary critic, essayist, publicist, translator, with whom close friendship is being maintained and who is the most important among the author's authorities), T. Prokhasko notes: “...it seemed that we were the last bearers of certain knowledge, relics and heritage <...> it seemed that if I did not do it, it would all be lost” (*Terem, 2020: 93*).

Following the biologist K. Lorentz, T. Prohasko identifies the main source of self-identification the image recorded in the first minutes of life, which is the basic or primary landscape: “Thought is constructed from the landscape, which is primary <...>. Thinking about something,

we have to place the thought on a certain surface. We need the known planes. We need the locality” (*Prokhasko, 2006: 41*).

The landscape that accepted the protagonist and was accepted by the protagonist (“You must truly love places so that they love you” (*Prokhasko, 201: 139*)) in the author's novel is a means of transcendence of man beyond his borders: “<...> between Petros and Sheshul, Franz thought he was traveling to the heavenly islands. Only a few of the highest peaks peeked over the clouds. The western sun shone only for them <...> Franz ceased to belong to himself, joined some cosmic movements <...>» (*Ibid.:37*).

Defining the peculiarities of the modern literary process, T. Prohasko points to the lack of good fiction, which would be a comprehension of the past, in general, the historical genre, “about people's lives in the history, as those historical events still live in us <...>. We have a lot of problems due to the fact that there is an unspoken past: the UPA veterans, lustrations, former enkadvedists, the Ukrainian-Polish conflict, trips to the West and deportations to the East. All this is not comprehended at all” (*Prokhasko, 2019*).

The protagonist of the novel “The UnSimple” expresses a vision of the role of describing human history as a therapy: “If we knew more human destinies, said Sebastian. This is often the main therapy of the speech” (*Prokhasko, 2015: 121*). Because “the basis of each private epic is a list of ideas about the places where family history took place ...” (*Ibid.: 115*), and a huge number of people in the twentieth century contrary to the genetic habit of recording the history of the genus, were forcibly deprived of family memory as a result of repression, resettlement, silence, the desire to preserve the genus, so T. Prokhasko in his novel actually formulates a recipe for survival of the genus and preservation of original identity by means of the affection to the topos.

The writer points out that it is not alternative mythology that is important to him, but the history of the Carpathians, as opposed to the perception of the region as a unique closed land, which stems from the works by Shukhevych, Hnatiuk, Franko, Paul, Soviet ethnography. The author claims that he tried to show in the novel the Carpathians as a territory open to migration (*Teren, 2020: 281*).

Thus, with the regard to the novel "UnSimple", according to the author, “... the landscape can be the main theme, and the story – the leading idea” (*Ibid.: 284*).

Genre features of the postmodern pseudo-historical novel are systematized in some works, for example, the study by I. Ashcheulova (*Ashcheulova, 2007*). Among them there is “the perception of history as an incomplete text, which allows you to create your own version of a historical event or to inscribe an event to a certain era” (*Ibid.: 16*).

The creation of the text in this case is accompanied by serious work with the sources, the documents of the era. Important works on Western Ukrainian ethnography (for example, N. Hobzey's ethno-linguistic dictionary (*Hobzey, 2002*), anthologies of fairy tales, legends, etc.) are easy of access to the writer who has a reputation as an intellectual familiar with world literature. The story of Anna and Sebastian's family, “inscribed into a specific historical epoch” (*Ashcheulova, 2007: 17*), is unfinished, “the plots cannot end”, according to T. Prokhasko.

The novel defines the features of the national character (which is actualized in the novel regional Western Ukrainian folk life, and in general the people's regional worldview and type of thinking) with the help of a pseudo-historical plot (*Ibid.: 17*).

According to T. Gundorova, initiated in the 1980s by Eastern European intellectuals with the idea of “own” Europe, “the project of modernization due to the historical and topographical redistribution of the geopolitical map and romanticization of past history was adopted in the

1990s by Ukrainian postmodernists” (*Hundorova, 2005: 137*). The protagonist of the novel by T. Prokhasko creates a kind of geographical utopia: “Sebastian imagined how nice it might have been with that small Carpathia, which he, using the universal chaos, can defend by himself. He was inventing a beautiful country around Yalivets, where there would be no garbage, everyone would know each other's languages, and the highest institution would be a script bureau, where everyone could submit something really interesting, and the government would be guided by these stories. Everything spoils 'would'” (*Prokhasko, 2015: 140*).

Despite the important position of the topos in the novel's universe, the minor characters are intended, according to the author, “...to hint to the reader that their place, their utopia can be created anywhere, considering the closeness with those who are close; that utopia is always not so much geographical as interpersonal. What is important for utopia is not the place where everything is going so well, but the right people” (*Teren, 2020: 282*). Accordingly, the novel gives rise to the idea of the “comparative geography”, which connects people with the help of stories about unfamiliar places: “Sebastian said that it was most interesting for him to listen to someone telling stories about places he did not know. <...> Great shifts confuse people, and the basis of speech and way of thinking is the comparative geography” (*Prokhasko, 2015: 123*).

The strategy of avoiding the linearity of the plot is chosen by T. Prokhasko consciously. The strategy of “text in the text”, the method of editing fragments “should show that each <...> hero <...> also affects the course of this story”, the author points out that the novel is “unfinished, underdone, torn and chaotic”, which, in the writer's opinion, turned to be necessary and understandable at the time of writing” (*Teren, 2020: 285*).

The theme of human rooting in the new geographical landscape as a strategy for the reconstruction of historical discourse sounds quite clear in the novel by T. Prokhasko. There is a parallel with life, as the writer says, as his father's fate in adolescence was transformed by episodes of resettlement to Siberia and return home (*Prokhasko, 2016: 64–66*). The man has twice gone through a rather painful process of finding roots in a new geographical reality.

Note that the novel by T. Prohasko, according to the author, still retains many unread places, in particular the appearance of Sebastian in Yalivets can be interpreted as a parallel to the quasi-historical novel-saga by A. and S. Golon about adventures in France in the seventeenth century. The description of the novel's “UnSimple” hero's life is reminiscent of the placed into the plot of the saga life story of Vsevolod Golubinov (the real name of S. Golon), husband and co-author of journalist and writer Simona Shangio, known under the pseudonym Anne Golon, who after escape from the revolution of 1917 in Russia was forced to build his own life in France.

There are not only coincidences of events, but also coincidences of the name of Anna with the pseudonym of S. Shangio, a big age difference of the heroes, a sound coincidence of the name Sebastian (from the Greek “sebastos” (“sacred”) or from the Latin “Sebastianus” – “Sebastian, the one who comes from Sebastia”, Sebastia – a city in the historic region of Samaria (Shomron), Israel, or an ancient city in the central part of Asia Minor, modern Sivas) with the colloquial form Seva of the name Vsevolod (by the way, “Seva” is a Sanskrit word meaning “service”), the birth of V. Golubinov in Bukhara in 1903 – the birth of Sebastian in 1893 on Borzhava, stay in Africa during the war and way home through the Black Sea and mountains (*Holubinoff, 2005*).

## 5. Conclusions

Thus, most of the mentioned features of the quasi-historical (pseudo-historical) novel are presented in the text by T. Prokhasko, the writer was consciously searching for “a technique that would help to convey the feeling of the timeless, the transnational, the extracontinental” (Teren, 2020: 279), which he brilliantly succeeded in genre coordinates of the quasi-historical novel.

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## THE RELATIONSHIP BETWEEN PROCRASTINATION AND CREATIVE THINKING

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### Summary

The article considers the issue of the relationship between the phenomenon of procrastination and creative thinking. One of the most common factors that hinder personal and professional effectiveness is procrastination. There is a hypothesis that people with high levels of procrastination have correspondingly well-developed creative thinking, which endows them with the ability to solve problems outside the box and quickly adapt to situations. We consider procrastination as a psychological pattern of behavior characterized by person's delaying planned actions or decision-making followed by negative emotional experiences. Literature analysis has shown that procrastination influences creative activity, which leads to the assumption that people with higher levels of procrastination have a higher level of creativity.

Upon conducting our research, we uncovered the following pattern: students with a high level of procrastination are more inclined to such factors as risk-taking and fantasy; students with a low level are more likely to present curiosity and task complexity; and students with an average level of procrastination are equally likely to present both factors.

**Keywords:** procrastination, creative thinking, creative activity, creativity.

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For a modern person living in a rapidly changing world, issues of personal effectiveness, success and well-being are of particular importance. But often, despite an increasingly wide range of opportunities and individual freedom, a person faces barriers to his success. One of the most common factors that hinder personal and professional effectiveness is procrastination. The relevance of this problem and the tendency to spread it have attracted the attention of modern scientists in the field of psychology, however, many issues related to the phenomenon of procrastination are now debatable and require in-depth study and detailed analysis of this phenomenon. In life, there emerge circumstances and changes that need to be overcome, and a person with creative, unconventional thinking is ready for this. This person does not only adapt to something new, but also takes part in planning and changing the surrounding reality. There is a hypothesis that people with high levels of procrastination have correspondingly well-developed creative thinking, which endows them with the ability to solve problems outside the box and quickly adapt to situations.

Now the number of procrastinating young people is growing. According to the data, between 80 and 95% students of higher educational establishments procrastinate from time to time, and approximately 75% of them consider themselves "chronic procrastinators" and almost 50% of students postpone important things systematically. There is a stereotypical view

of procrastination as a negative phenomenon, which is reflected in the study of the relationship between creative thinking and procrastination. The connection of these manifestations is a poorly studied area and is regarded mainly by foreign authors as the influence of procrastination on creativity. The available theoretical data reflect the ambiguous attitude of scientists to the problem of the influence of procrastination on creative thinking.

The aim of our research is to analyze and empirically study the psychological features of the influence of procrastination levels on students' creative thinking. The hypothesis is based on the assumption that a person's level of procrastination affects the level of creative thinking.

Theoretical and methodological basis of research is made up by the works of such researchers as V. Barabanshchikova, Ya. Varvarycheva, N. Vishnyakova, E. Ilyin, K. Lay, N. Milham, M. Spada, P. Steel, K. Taylor, E. Tunik, E. Thorens, B. Fernie, M. Kholodna and others.

The relationship between creative thinking and procrastination has been studied by different researchers using different approaches.

Some of them believe that procrastination can negatively affect creativity for two reasons. First, research consistently shows that procrastination has a negative impact on academic performance. At the same time, academic performance is positively associated with creativity, it is believed that procrastination harms creative activity. Secondly, the anxiety caused by procrastination impairs creativity. In particular, studies have shown that procrastination is positively correlated with anxiety, anxious people tend to have low scores in divergent thinking, the index of which is widely used in creative research. So, let's assume that procrastination is indirectly harmful to creativity due to anxiety (*Motruk, 2014*).

Other researchers have found that procrastination is positively associated with creativity, as it helps people have more time to brood ideas. Postponing tasks for some time contributes to the remote unification of ideas, therefore, people are more likely to generate new answers (*Varvaricheva, 2008*).

In addition, Diaz-Morales and colleagues have shown that the beneficial effects of procrastination on creativity may be associated with a preference for visual thinking. They examined the effects of a person's motivational, cognitive, and behavioral styles on task postponement. People feel that they do not have enough competence to complete a task, so they postpone it "for later". An analysis of 1,027 adult self-reports showed that procrastinators with high procrastination rates had higher grades.

British psychologists B. Fernie and M. Spada concluded that procrastination stimulates the creativity of the individual, that is, a person is able to create a more original idea, postponing sorting out a problem situation for later.

B. Fernie and M. Spada conducted a study and found that procrastinators often resort to using positive and negative attitudes to overcome stress. Creative procrastinators resort to positive attitudes. Fernie and Spada believe that difficult decisions should be made slowly (*Motruk, 2014*). This increases not only the quality of solving a problem situation, but also the speed of making the right decision. If all the possible aspects of the situations are considered, a person does not need to return to the process of decision making. A procrastinator, like any other person, postpones only those activities that can be postponed. In an extreme situation, even chronic procrastinators will be very agile and show fairly high speed in the decision-making process (*Varvaricheva, 2010*).

There are many examples in history when famous creative people were distinguished by pronounced procrastination. Contemporaries noted their tendency to laziness and relaxation, but their highly productive creative activity can hardly be combined with a lack of strong-willed efforts. They probably reacted with procrastination to situations that little depended on the speed

of solving in their creative life. Those aspects of life that seemed unimportant and optional did not motivate them to create. Therefore, they postponed solving problems. Another reason for the connection between procrastination and creativity is the desire to bring the creative product to the standard. The standard is most often a variable internal standard, and therefore a person is forced to postpone the final completion of a creative product, because the idea of an ideal result in the course of creative work is constantly changing. Therefore, many famous works of art were created longer than it had been intended. Many of them remained unfinished. A creative and a non-creative persons procrastinate for different purposes, thus using their procrastination in a different way. The creative person sees procrastination as a potential for development, and a non-creative person as an obstacle to self-improvement. Procrastination can interfere with a creative personality if a creative identity is not developed yet, which enables to integrate all personal resources for creative activity. It is creative identity that forms a positive attitude to procrastination as a strategy for creative solution of a problem situation (*Motrak, 2014*).

For creative people, in our opinion, procrastination is not just a delay in completing a task. We believe that during the procrastination period, the creative person has already started performing a task that is latent, although in behavioral terms, the person can be busy with things that are only indirectly related to the task while the work is already being done. This is a kind of creative procrastination – hidden performance of work with external abstraction from the task and pronounced procrastination behavior. Creativity in this case is a way of procrastinating without negative experiences and feelings of anxiety. For example, a student was given a task to prepare a report with a presentation on a given topic, but he began to devote time to templates, presentation design, font selection, etc., thus, creating a feeling of activity, but without moving on to the final result for a long time. Perhaps we should highlight a new type of procrastination - "creative procrastination" - a situation in which creative procrastination can be traced, under the guise of creative activity.

Given all mentioned above, we think it is important to emphasize that there is a link between procrastination and creative thinking. Various authors consider this connection as the influence of procrastination on creativity. It should also be noted that authors' opinions on the effect of procrastination on creativity split between positive and negative.

Negative factors include: 1) academic performance, while academic performance is positively associated with creativity; 2) procrastination harms creative activity; 3) anxiety as a result of procrastination worsens creative potential.

In a positive impact, the following aspects can be considered: 1) procrastination enables to have more time for contemplation, therefore, people are more likely to generate new ideas; 2) positive connection is reflected in the preference for imaginative thinking style; 3) preference in choosing positive attitudes to deal with stress.

We consider procrastination as a psychological pattern of behavior characterized by person's delaying planned actions or decision-making followed by negative emotional experiences.

Procrastination, like creativity, does not have a clear definition, so it was considered from the point of view of various concepts that come down to the following: firstly, procrastination is associated with unresolved internal conflicts, traumas; secondly, with emotional states, irrational approach and infantilism. These factors correlate well with the concept of creativity, because all creative people are full of contradictions.

Literature analysis has shown that procrastination influences creative activity, which leads to the assumption that people with higher levels of procrastination have a higher level of creativity.

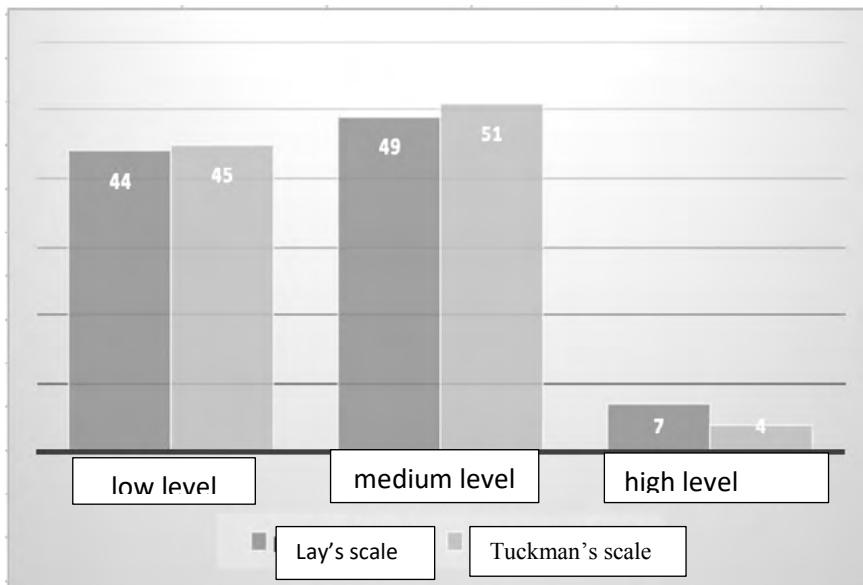
After studying the theoretical data of procrastination, creative thinking and their connection, we formed a sample of 68 people, conducted an empirical study, selected diagnostic material in order to define the level of procrastination and creative thinking in students, as well as to find out what influence is exerted on the level of creative thinking depending on the level of procrastination of the individual. We used the following methods: the scale of total procrastination by K. Lay, Tuckman procrastination scale, self-assessment questionnaire for creative personality characteristics by E. Tunik, the test of creative (divergent) thinking by F. Williams.

We also used descriptive statistics of results using the methods "scale of total procrastination by K. Lay" and "Tuckman's procrastination scale", the results are presented in Table 1.

Table 1

**Descriptive statistics of results according to the methods "Scale of total procrastination by K. Lay" and "Tuckman's procrastination scale"**

Parameter	Value	
	Scale by K. Lay	Tuckman Scale
Minimum	30	29
Maximum	73	60
Arithmetic mean	49	43
Median	46.5	43
Statistic mode	44	44
Standard deviation	10.8	8.38
Variance	120.27	71.41
Asymmetry	-0.25	-0.25
Excess	0.76	0.36



**Fig. 1. Distribution of students by procrastination rate (as a percentage)**

Based on this, the minimum value of procrastination according to the method "Scale of total procrastination by K. Lay" was 30, the maximum - 73. The average indicator is 49 with a deviation of 10.8. By Tuckman procrastination scale, the minimum is 29, the maximum is 60, the arithmetic mean is 43, and the standard deviation is 8.38. The most common value is by the K scale. Lay (mode) 44; median - 46.5, on the Tuckman scale 44 and 43, respectively. Indicators of asymmetry and excess were below the significance level, which indicates the normality of the distribution and the possibility of using parametric criteria in data analysis.

Next, we set procrastination levels according to K. Lay total procrastination scale and "Tuckman procrastination scale" The study of the overall level of procrastination showed a prevailing average level of total procrastination in students. The analysis of the results is shown in Figure 1.

According to the interpretation of the results on the K. Lay's scale, the group with a low level of procrastination can include 30 persons - the results are less than 45 points. The average level includes 33 persons - the results of which are within the range from 46 to 65 points, and the high level includes 5 persons. The results in the figure are presented as a percentage. On the Tuckman scale, low levels of procrastination were found in 31 people, medium levels in 35 people, and high levels in 2 people.

Using the analysis of variance data and the linear correlation coefficient of the obtained data according to the methods "K. Lays' total procrastination scale" and "The test of creative (divergent) thinking by F. Williams", we defined how the level of procrastination affects the level of creative thinking.

Namely, based on the data obtained by the least squares method, we will determine the parameters  $a_1$  and  $a_0$ :

$$a_1 = \frac{\sum(Y_i - \bar{Y})(X_i - \bar{X})}{\sum(X_i - \bar{X})^2}$$

$$a_0 = \bar{Y} - a_1\bar{X}$$

$$a_1 = 0,14$$

$$a_0 = 60,8$$

Thus, the model of the relationship between the level of procrastination and creative thinking will be like that:

$$y = 0.14x + 60.8$$

Let's calculate the tightness of the relationship between the level of procrastination and creative thinking. For this we will use the correlation coefficient:

$$r = \frac{\frac{1}{n} \sum(Y_i - \bar{Y})(X_i - \bar{X})}{\sqrt{\frac{1}{n} \sum(X_i - \bar{X})^2 \frac{1}{n} \sum(Y_i - \bar{Y})^2}} = \frac{\frac{1}{68} 1173.764}{\sqrt{\frac{1}{68} 8058.2353 \frac{1}{68} 11481.659}} = 0.122$$

The correlation coefficient shows that there is a direct ( $r > 0$ ) weak relationship between the level of procrastination and creative thinking.

Let's check the model for adequacy to real reality using the coefficient of determination:

$$R^2 = r^2 = 0,14.$$

So, the model of relation of the level of procrastination to creative thinking is adequate.

Using the Fisher linear correlation criterion with reliability  $p=0.95$ , we evaluate the adequacy of the accepted model to experimental data with freedom degrees 1 and 11 and a

significance level of 0.05 critical value  $F_{kr} = 4,84$ . Since  $F_{(1,11)} > F_{kr}$  then the model is adequate to the experimental data. So, the level of personality procrastination affects the level of creative thinking, which confirms our hypothesis.

The analysis of the results of the study suggests that the level of creative thinking is directly influenced by the phenomenon of procrastination, so accordingly, people with a higher level of procrastination are more likely to be creative and having a creative approach to solving questions or completing tasks.

After identifying the dependence of the influence of the level of procrastination on the level of creative thinking, we compared the data of the "self-assessment questionnaire of creative characteristics of the individual by E. Tunik" and the level of students' general procrastination. The questionnaire contains 4 factors: curiosity, imagination, complexity, and risk-taking. So, for example, a subject with pronounced curiosity is constantly looking for new ways (ways) of thinking, looking for various ways to solve problems, pays attention to search and research activities in order to learn as much information as possible. A person with a developed imagination devotes a lot of time to fantasies about the ways of problem solving, wasting time on direct solutions. The person is focused on the knowledge of complex phenomena, shows interest in complex problems and ideas, and offers too complex ways to solve the problem than it seems necessary. Risk-taking is manifested in the fact that the person's performance will be better with the presence of a direct threat, which is the point of activated potential for action. The results of the study of factors are presented in Table 2.

Table 2

**Results of the "Questionnaire of self-assessment of creative characteristics of the individual by E. Tunik" and the level of students' general procrastination**

Factor	Low procrastination rate	Average procrastination rate	High level of procrastination
Curiosity	81%	53%	40%
Imagination	15%	59%	80%
Complexity	76%	39%	20%
Inclination to risk-taking	10%	69%	100%
Frequency of factor occurrence			

As a result of analyzing the data obtained, it can be noted that students with a low level of procrastination are characterized by curiosity and ability to solve complex tasks. In other words, such individuals usually choose tasks of increased complexity, study the issue in detail from all sides, and try to complete the task on time and with the highest productivity coefficient. So, at the same time, they are not subject to risk and fantasy, they perform tasks clearly according to the rules and plan.

Students who are part of a group with an average level of procrastination are almost equally likely to possess these characteristics. The table shows that risk-taking and fantasy have a greater advantage than curiosity and task complexity, which may indicate that the first two characteristics play a distracting and time-wasting role. Students in this group are more likely to avoid difficult tasks and tend to fall behind with tasks completion.

The data obtained from groups with a high level of procrastination indicate that students spend a significant part of their time on such a factor as imagination or fantasy, respectively, they are prone to risk-taking because of lack of time. Usually, such individuals specifically

provoke a situation of lack of time to complete a task, because only with a sense of tension do they mobilize the ability and desire to perform the postponed work. Also, such a factor as fantasizing is often used for figurative modeling of problem solving, that is, planning without practical actions. A characteristic of students with a high level of procrastination is that they do not choose very difficult tasks.

Upon conducting our research, we found the following pattern: students with a high level of procrastination are more inclined to such factors as risk-taking and fantasy; students with a low level are more likely to present curiosity and task complexity; and students with an average level of procrastination are equally likely to present both factors.

Naturally, the research carried out does not fully highlight all the aspects of this problem. Its results enable us to determine some areas of further research:

- to study and classify specific operational criteria for procrastination and their empirical substantiation;
- to develop algorithms for preventing the phenomenon of procrastination.

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## STEAM-APPROACH IN THE CONTENT OF THE HOBBY GROUP WORK TECHNICAL CREATIVITY

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### Summary

STEAM is actively implemented in the modern educational space of Ukraine. This is due to the fact that one of the important tasks of education is the comprehensive development of the growing generation, their acquisition of the necessary competencies and successful realization in the future. Therefore, the required condition is the formation of an integral (coherent) approach to the content of education and the formation of the educational environment.

Analysis of theory and practice shows that the STEAM-approach contributes to the improvement of the learning process in the educational institutions, including after-school education, based on the use of five components: Science, Technology, Engineering, Arts, Mathematics

It has been established that steam aims to expand opportunities and areas of work, promoting not only the development of the subject competencies in the field of natural sciences, technologies, engineering, art and mathematics, but also the key competencies that are set to ensure effective child socialization and actively interact with each other.

At the heart of large-scale multi-year research, such scientists as N. Balyk, G. Shmyger, Ya. Bykovskiy, N. Polihun, J. Bilyk, V. Zhukova, V. Pikalova, A. David, etc., came to the unanimous conclusion that these components are of great importance in the development of science and society in the future. They are also called disciplines of the 21st century. In the future, they may become the basis for such professions as: chemical engineers, software developers, petroleum engineers, computer systems analysts, mechanical engineers, civil engineers, robotics mechanics, nuclear medicine engineers, architects of underwater structures and aerospace engineers.

Special attention in the article is focused on the question of STEAM -approach in the content of the hobby group work on technical creativity.

**Keywords:** STEAM-approach; technical creativity; hobby group work; after-school education; educational process.

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### 1. Introduction

Scientific and pedagogical researches show that the urgent need in education is to shift the emphasis on the performance of routine mechanical tasks, that are typical for traditional programs on technical creativity for junior pupils, to the formation of skills of the 21st century: effective cooperation in the team, creative solution of tasks, determination and achievement of goals, making important decisions, managing project activity, self-education and development of their talents. In this context, STEM-education is one of the progressive pedagogical innovations of the 21st century beginning.

## 2. Presentation of the main material

The ideas of the STEM-approach in the field of children's education are being developed in many educational systems around the world, including Ukraine. The reform of general secondary education called the "New Ukrainian School" includes nine components, which are among the targets of the STEM-approach to learning. According to the Concept of the new Ukrainian school, the graduate student must be an integral person, a patriot and an innovator, that means, to be able to positively change the surrounding world, develop the economy of the country, compete on the labour market and gain knowledge during life.

N.Polihun points out that STEM-education is based on solving the real problem or the complex issue for which the necessary knowledge of several disciplines is needed. On the one hand, this approach results in improvement of efficiency and quality of natural and scientific education in conditions of formal education (preschool and school), and on the other – STEM-education provokes to go out of standard school education, including establishment and development of partnership relations between staff school teachers, tutors of the hobby groups, researchers and specialists in the sphere of production for realization of joint projects (*Polichun, 2019: 80*).

N. Balyk and G. Shmiger, considering the educational value of STEM-approach to development of content and methods of education of children and youth, summed up its main advantages and promising opportunities, among them:

- possibility of scientific and technical knowledge application in practice – in the process of implementation of STEM-project students apply scientific and technical knowledge in real life;
- development of critical, flexible thinking and skills of problem solving – children, working on creation of different products, face the need to solve problems which they face by their own efforts, reaching the specified;
- active communication in the team – at the stage of discussion for children free atmosphere is formed, which works towards discussion and expression of the team members opinions;
- increasing the recognition interest in technical disciplines – classes that are realized within STEM-approach are exciting and dynamic, it provides active cognitive activity of pupils (*Balyk, Shmyger, 2017: 26-30*).

The main goal of STEM-education is to improve the learning process in educational institutions on the basis of research and engineering activity, and the object is to develop the intellectual-cognitive and creative abilities of the child, the level of which gives a competitive ability during further educational activity and employment according to the requirements of the 21<sup>st</sup> century (*Bilyk, Postova, 2017: 22–25*).

Integration as a key principle of STEM-education will allow to realize the methodological basis and content modernization of the elementary-technical profile hobby groups educational activity, ensuring quality improvement of natural-mathematical training of the elementary school pupils and forming:

- skills of complex practical tasks solving;
- ability to evaluate the problems and make decisions;
- skills of practical and creative application of acquired knowledge;
- critical and divergent thinking, creative qualities, organizational and communication abilities;
- readiness for conscious choice and education;

- financial literacy;
- comprehensive scientific worldview, values, cultural, mathematical, technological, communicative and social competence;
- skills of mastering by means of cognitive, research and practical activity (*Polichun, Slipuhyna, Chernetsky, 2017: 5-9*).

Modern approach to the content and methods of the elementary-technical profile of after-school education, based on STEM-approach, is proposed on this particular challenges and public needs.

In 2010, the active transformation of STEM into STEAM began. Leading educational institutions of Europe and the United States started to defend the need to incorporate art and design into the STEM system to create an integral educational model that could prepare a growing generation to the conditions for the development of an innovative economy in the future. Since then, STEAM has been actively developing around the world and has been widely used by educational institutions and leading corporations in their activities to enhance the value of art and humanities (*Sousa, 2013: 280*).

Thus, taking into account modern scientific researches, it is necessary to note that for junior school age children a new approach STEAM is proposed. To establish the key foundations of this approach, research was conducted in scientific sources on the prerequisites of the STEAM-approach in the context of the worldwide STEM trend, its principles and key aspects of pedagogical implementation.

One of the initial stages of STEAM became the study of the pedagogical university John Hopkins (2009), who proved that during the study of artistic disciplines pupils improve their cognitive skills, memory and attention develops more dynamic, the range of educational and life skills expands. Thus, STEAM-approach to the organization of educational process covers the sphere of development of the personal creative potential, combining technical creativity, research and art activities and ensuring formation of horizontal links between different branches of knowledge. The actual directions of STEAM-education V.Zhukova considers web, audio and video design, interior and industrial design, animation, architecture, industrial esthetics, beauty and fashion industry, etc. (*Zhukova 2018*).

STEAM implements the principle of education through hands, which enables students to understand the reasons and consequences of their work, as well as its impact on the world around them. The main purpose of such training is to acquire self-education skills, to form adaptive features of character, to learn to perceive technologies and globalization process as modern conditions of mankind existence, to form conscious citizens of the world and their country. That is why the implementation of this approach requires the involvement of children in this type of activity from the preschool, which will create conditions for the full development of the child's personality and its preparation for further successful adaptation in rapidly changing conditions.

It should be noted that according to our opinion, the key importance in the forming of creative and technical competencies of the junior school age pupils in STEAM-approach should play not only modern information and communication technologies offered in many manuals, but mostly creativity and research activity. In the system of STEAM-education at classes for junior school age children on the first place is development of their abilities, creative thinking and freedom in research and creation. Therefore, when developing the content of the classes, it is necessary to take into account that the most effective is using of simple toys, constructors, cubes, etc.

Based on the study of V. Pikalova the main parameters for development of the content of the elementary-technical profile after-school class were established on the basis of

STEAM-approach, taking into account the key aspects of realization of this approach in the educational process, in particular:

- integration in the content of after-school education and teaching methodology of natural sciences, modern technologies (including information), engineering design and mathematical knowledge;
- development of the programmes on the interdisciplinary ground;
- integration of scientific knowledge within the framework of topics, not separate sections;
- using true technical, technological, economic and social problems in the educational process;
- concentration on the system formation of critical and engineering thinking (Pikalova, 2020: 95-103).

Studying pedagogical experience, it was established that introduction of educational STEAM-approach in after-school education requires changes to the traditional content of teaching in the hobby groups of the elementary- technical profile, by moving away from strict frameworks and taking into account psychological requirements to the content of teaching pupils of junior school age: flexibility of content, which provides the possibility of its saturation and transformation; distribution of topics and problems for studying by content modules, which have generalized character and occur the basis for further filling of educational material, which will correspond to age and individual needs; interdisciplinary approach to the specification of the studying content in a hobby group that meets the cognitive children needs of the preschool age, their creative possibilities and world-view development; integration of problems within one theme for establishing internal relations between scientific knowledge; high level of educational material problem, which corresponds to level of children development; fullness of content – it provides a high level of cognitive activity of pupils and intellectual loading (Polihun, Postova, Slipukhina, Onopchenko, 2019: 80).

At the same time, the development content of the educational program on technical creativity should take into account the basic spheres of the personality of the pupil. These spheres allow to outline different aspects of the hobby group program content of the elementary-technical profile, namely:

- development of the cognitive sphere: gradual complication of content due to greater abstraction and generalization; parity of tasks on divergent and convergent thinking; predominating of developing educational content over information load; development of productive thinking based on skills of practical use of knowledge;
- development of active brain-work and creativity: the predominance of research tasks over reproductive; the focus on revealing intellectual initiative of the pupil; the rejection of conformism;
- effective development: profound elaboration of the problem being investigated; support of independent educational activity; parity of criticality and loyalty in estimation of the pupils' ideas; orientation on competition and collective responsibility; actualization of pupils' leadership qualities.

The program of the hobby STEAM group opens up the current change of the elementary-technical profile of the science and technology directly, it is for the junior children of age 6–10 years. Its aim is the development of individual creative features of the pupils, working towards competencies in natural sciences, technology, engineering, science and mathematics.

STEAM-approach in the hobby groups of elementary-technical profile provides organization of game, research and project activity of pupils taking into account the following components:

- science of general knowledge in astronomy, chemistry, physics, biology, geography, etc.);
- technologies (general knowledge about production, production process, types of materials, human professions, stages of realization of the child creative ideas (projects); safety rules at work, with tools, etc.);
- engineering (general knowledge about modelling, design and scheming etc.);
- art (general knowledge about drawing, basic design, graphic drawing, architecture, culture and crafts, etc.);
- mathematics (general knowledge about mathematics, quantitative ratio, logic, calculation, measurements, logic and mathematical thinking, etc.).

The developing process of the hobby group content for children of the junior school age from the elementary-technical profile on the principles of STEAM-approach.

The objectives of the program of the hobby group STEAM are the development of competencies:

1) cognitive – formation of skills and experience of self-learning new knowledge in the process of technical-creative and research activity, development of cognitive activity during mastering of the personal new vectors of the project activity;

2) practical – formation and development of the pupils' choosing ability of means and technologies of technical design, methods of research activity and skills of solving practical tasks in the process of designing in accordance with specificity of technical-technological, natural-research and art activity;

3) creative – formation of pupils' ability to generate creative and research ideas, elimination of hypotheses, fantasy, determination of creative and technical contradictions, transfer of existing knowledge and skills into new situations, overcoming of the thinking inactivity, independence of judgments, critical thinking;

4) social – development of the experience of team cooperation, establishment of relationships in groups, constructive conflict resolution and fulfilment of different roles in collective; formation of skills to plan, develop and implement joint socially significant projects; development of skills to support mutual relations and solve problems in different cases.

#### 4. Conclusions

Summing up, we can say that the development of modern content of the program STEAM for the primary school children provides an opportunity to go beyond technical activities and promotes the comprehensive development of children's creative and technical thinking, which are extremely important at this age. The topic-educational plan of the hobby group is constructed in such a way as to cover all directions, which are important for education and development of dialectical thinking, and each component of STEAM plays an important role in realization of projects on sections and themes.

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## WORD-FORMATING AND SEMANTIC CHARACTERISTICS ENGLISH METHODOLOGICAL VOCABULARY

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### Summary

In this article the morphological term creation is analyzed: affixation, conversion, general vocabulary processes and lexical-semantic relations in the English term system of education are also analyzed. The English-speaking terminology system of education is characterized as complex, stable and dynamic. Its elements are units of autochthonous language and borrowing from other languages, and the structure is isomorphic to the structure of logical connections between the concepts of the field of education. This term system is an open set, which draws from the whole variety of language tools new opportunities for expressing the values arising in the process of further development of educational activity.

Semantic terminology has always been one of the main ways to replenish terminology. As a result of the semantic method of terminology, the terminological meaning is exhausted on the rights of the lexical-semantic variant, which develops on the basis of the adjacency of the signs of what is already indicated in the previous meaning of the word and the new one, which is denoted.

**Keywords:** methodological vocabulary, terminology, linguistic, semantic characteristics, word-formating.

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### 1. Introduction

Vocabulary is one of the most important linguistic mechanisms that ensure the endless replenishment of the vocabulary of the language. Word-building ensures the functioning of the language in time, satisfies the needs of native speakers in denoting new realities.

The meaning of word creation is not exhausted only by replenishing the vocabulary of the language. Vocabulary is a form of vocabulary.

According to O.S. Kubriakova, the main task of the study of vocabulary is "the study of regularities and features of vocabulary modeling... in all its aspects – formal and meaningful, on the one hand, genetic, procedural, as well as productive, stationary, structural and functional, on the other" (*Kubriakova, 1972: 350*).

The processes of terminology develop according to the same laws as word formation in general. New terms are created in the same ways from the commonly used language and from the well-known vocabulary.

Word-making processes in the English-language methodological system occur in different directions. First, it is semantic derivation – internal semantic word development; secondly, word-forming derivation is the external development of words, that is, the development of a morphological and word-forming structure; thirdly, the paradigmatic development of words, or the development of semantic relations between words.

## 2. Affixal method of term creation in English-language methodical vocabulary

The peculiarities of modern English are the great potential of vocabulary, including morphological wording: affixation, conversion, phrase. In this paragraph, we try to identify and systematize the most productive word-making affixes, with the help of which derived words are formed in the English-language terminology of the sphere of education. The derivative word, in the opinion of M.M. Poluzhin, usually being more complex in structure than the word simple, is more transparent and informative in meaning. They are easily formed on the basis of existing words in the language and are also easily decoded and remembered. To understand the derivative word, it is enough to know its original motivating word (*Poluzhin, 1999: 133*).

Affixation is a way of generating words using prefixes, infixes, and suffixes that attach to the basis that serves as the basis for them.

Prefixes are derivative morphemes prepositional attached to the base. Terms formed using prefixes are joined to a certain semantic series of words. When prefixed, the categorical meaning of a given word is most often preserved and it does not pass to the other part of the language (*Tsarev, 1984: 15*).

This type of prefix derivatives is called modification as opposed to transposition, in which the word is recategorized and is not typical of English. Prefixal wording in English has repeatedly been the subject of scientific research. A deep review of the existing literature on this issue was given by Poluzhin (*Poluzhin, 1999: 28-40*).

Formed with the help of prefixes teaching English terms WMS – on Classification – forge on various parameters: origin – especially English prefixes mis-, un- or borrowed co-, de-, dis-, hyper-, ir- non-, post-, pre-, sub-, super; semantically – negative prefixes ir-, non-, un-; plural prefixes multi, mega, poly-; redundancy hyper-, over-; temporal and spatial locativity pre-, post-, under-.

In the studied material we distinguish prefixes that form a semantic group with a common meaning of multiplicity and redundancy hyper-, mega-, multi-, over-, poly-. Divide the prefixes into two groups of values:

1) "Many" – **mega-**, **multi-**; with their help terms are formed, which denote large educational institutions:

– **megaversity** – a great university with a large number of studening its divisions (separate institutions) may be in different countries;

– **multiversity** – type of university consisting of many faculties, each of which constitutes an independent educational institution, and the addition or exclusion of any subdivision has little effect on the fate of the university as a whole (for example, the University of California).

– The prefix **multi** – joining the noun and adjective bases indicates plurality, comprehensiveness:

– **multiculturalism** – multiculturalism, diversity of cultures;

– **multilingual** – multilingual;

– **multimedia** – a system that combines different media – udio, video, printed, computer;

2) "more than" (deviation from the norm, standard)

– **hyperactivity** – overactivity;

– **hypertext** – the principle of organization of information retrieval masses led, in which certain information elements (including including full-text, factual, graphic and others) are interconnected by associative relationswe provide a quick search for the necessary informations. The term was proposed in 1967 by T. Nell – sonom (*Voroiskyi, 1998: 43*);



– **hypermedia (H-media)** – extension of the concept of "hypertext" to multimedia types of data records (text, audio, graphics, etc.) (*Voroiskyi, 1998:181*);

– **polyversity** – a university with a large number of faculties and by – divisions.

The prefix **over-** forms nouns, adjectives and verbs meaning "over – measures – ness, abuse of action that marked the foundation":

– **overactivity** – increased activity (activity), hyperfunction;

– **overage** – outgrowth;

– **overlearning** – excessive learning.

To convey the value of the wrong action, the prefix **mis-** is used: bad, wrong; marriage). He can join as names – us – co – ref bases and to the verb:

– **misbehavior** – bad behavior;

– **miseducation** – incorrect education (N. Chomsky's term);

– **misteach** – to teach incorrectly;

– **misunderstand** – misunderstand.

The next group of prefixes with the meaning of negation – **dis-**, **ir-**, **non-**, **un-** ("no") . Derivatives with the prefix **dis-** have the meaning "opposite to that expressed by the base":

– **disability** – incapacity, incapacity, impotence (*Nikoshkova, 2001: 88*)

– **disrespect** – disrespect;

This prefix is also involved in the suffix-word prefixes – utvo – ren – no:

– **disrespectful** – not worthy of respect;

– **disobedient** – disobedient;

Prefix **non-** conveys meaning no qual – those defined basis:

– **non-ability** – inability;

– **non-academic** – not academic;

– **non-literate** – illiterate;

– **non-professional** – an undergraduate specialist;

– **reader-non** – person who has not mastered reading skills after Navier – tun – ing conventional methods (*Nikoshkova, 2001: 206*);

– **non-attendance** – **non-attendance**:

– **curriculum-non** – an aspect of school life in which learning takes place outside the program and outside the educational institution (for example, in a school club).

The prefix **sub-** functions in non-transposing models and the terms formed with its help can have the following meanings:

– **subconscious** – subconscious;

– **subdean** – deputy dean;

Antonymic to this prefix is the prefix **super-** "higher official position":

– **superintendent** – commandant.

The given examples of word formation of pedagogical terms with the help of prefixes confirm the opinion of GA Ufimtseva that "in the case of prefixation, the essence of the name is contained in the motivating word, and the prefix only specifies the basis, but does not indicate the class of objects – the class of objects is marked by the defining word (basis)" (*Ufimtseva, 1977: 56*).

### 3. Suffix as a word-making method

The suffix is a post-root affixal morpheme separated from the word form. The suffix is characterized by its ability to classify certain semantic groups of words. Attaching the suffix to a productive basis includes this last class, which is marked with a given suffix, that is, the suffixes used to create terms, refer words to a certain lexical-morphological category, indicate the part of the language to which the terminological word belongs – they do not have their semantic meanings.

Suffixes can be classified according to several criteria. First, we select purely English suffixes -ness, -er; borrowed suffixes -able, -tion, -ism; secondly, productive in pedagogical terminology -action (-tion), -er, -ing, -ment; by common abstract categorical value: -er/-or agent suffixes, -ant, -dom prefix.

In modern English pedagogical terminology, the suffix -er (one who performs a certain action is bound, involved in a certain action) is characterized by a high level of productivity. With the help of agent suffixes, names of persons are formed by profession and type of activity, in particular, the names of persons associated with the process of training and education:

- beginner – **beginner**;
- crammer – **tutor**;
- learner – **a student**;
- lecturer – **lecturer**;
- teacher – **teacher**;
- chancellor – **rector**;
- educator – **educator**;
- instructor – **teacher, lecturer**;

The suffix – er with the value of qualification joins the adjective bases and provides specific characteristics, human characteristics: fresher – **freshman**.

With the help of suffixes – ism, – ness, – ship, – dom abstract nouns are formed. Productive suffix – ation / – tion at – connects – chys to verbal stems, forming nouns that are important "processes and activities":

- accreditation – **accreditation**;
- certification – **certificate, certificate**;
- collaboration – **cooperation**;
- education – **education**;
- explanation – **explanation**;
- evaluation – **evaluation**;
- promotion – **support, encouragement**;

The names of theories and concepts are formed with the suffix -ism:

- **behaviorism** – behaviorism;
- **essentialism** – a learning strategy that focuses on skills such as reading, writing, math at the initial stage.
- **existentialism** – a philosophy that studies the ways in which an individual creates his own view and purpose of life.

With this suffix are formed terms that have the meaning of a certain state: **passivism -assistantship** – postgraduate scholarship;

- **associateship** – the salary of an intern;
- **fellowship** – scholarship;
- **graduateship** – postgraduate scholarship;

- **instructorship** – educator's salary;
- **internship** – internship;
- **scholarship** – scholarship.

The purely English suffix -dom forms abstract nouns with the meaning of position, status or rank:

- professordom – **professor**;
- teacherdom – **teaching**;
- wisdom – **wisdom**.

Terms with the suffix -ing are mainly formed from verb bases and denote processes and actions:

- bus (s) ing – **transportation of schoolchildren by bus**;
- monitoring – **monitoring of the educational process**;
- passing – **successful passing of tests, exams**;
- rating – **rating**;
- reading – **reading**;
- schooling – **training**;
- streaming – **the distribution of students in different streams**.
- studying – **learning**;
- teaching – **teaching**;
- tracking – **the distribution of students according to their abilities, learning success**.

Thus, the most productive in the English terminology of education are the suffixes -ation / -tion, -er / -or, -ing. Timing formed on to – to – mo – hoyu considered suffix denoting person-figure process, action, acting – ness, the result of actions position.

As rightly noted by MM Polyuzhin, "native speakers learn not only the series of words, but also the rules of their birth, ... (there is) a mental representation of the derived words, which are stored not so much as individual elements as models of combinatorics of their constituent units" (*Poluzhin, 1999:47*).

#### 4. Conversion in English-language methodological terminology

Conversion is the process of creating new words in different parts of speech without adding any derivational elements, so that the basic form of the original words and the form of derived words are homonymous. Conversion in word formation is also interpreted as a morphological transposition, in which the transition of a word from one part of speech to another occurs without changing the basis of the word. O.I. Smyrnytsky considered the only word-forming tool in the conversion of only the paradigm, ie the morphological design of the word. The famous Ukrainian Englishman Yu.O. Zhluktenko made an in-depth analysis of the theory of conversion O.I. Smyrnytsky and came to the conclusion that modern English conversion is a morphological and syntactic way of word formation, in which word-forming means are both grammatical compatibility and word form – paradigm. The act of forming a new word by conversion is the use of the basis of the creative word to design it into another word in terms of another grammatical compatibility, typical of the second part of speech (*Zhluktenko, 1958: 64*).

This linguistic phenomenon is illustrated by the following pedagogical terms:

- **graduate** – a graduate and **to graduate** – **to graduate**;
- **lecture** – lecture and **to lecture** – to give a lecture;
- **schedule** – schedule and **to schedule** – to make a schedule;

- **tutor** – tutor and **to tutor** – to give private lessons.

The main reason for the widespread conversion in modern English, as noted by the famous Englishmen I. Arnold and O. Meshkov, is the lack of morphological indicators of parts of speech in the language. Even O. Jespersen vidmichav that every Englishman "recognizes the advantage that it is language, and self – shall make already existing words to serve in the new functions".

The question of the direction of derivation of conversion pairs remains important, especially for **N @discipline** – discipline, discipline; discipline as a branch of knowledge;

- **to discipline** – to establish strict discipline;
- **interview** – conversation;
- **to interview** – to talk;
- **overstudy** – overload with classes;
- **to overstudy** – to be overloaded with lessons, to study too much.

In modern methodical terminology, a large number of deadjective nouns function, which were formed not by conversion, but rather by an ellipse – instead of a phrase consisting of an adjective and a noun used:

- **academicals** – university form;
- **elective** – a discipline in a school, college, which is chosen at will;
- **extracurriculars** – extracurricular, extracurricular activities;
- **oral** – oral exam.

By their structure, most conversion terms are simple and non-derivative. Example:

- **test** – control work, exam;
- **to test** – to test, to check by means of tests;
- **control** – control, check and **to control** – to control.

But some converted terms are formed from bases, which in turn are formed by affixation: **understanding** – understanding, mind smart **N [V + ing] A**; **recall** – memory mention **N [re + V] A** ; **recall** – memory mention **N [re + V] → V**. In some cases, the base can be complex nouns of structural type **[N + N] → V**, for example: **timetable** → **to timetable** – schedule; schedule.

Thus, with the help of conversion, any noun can motivate a new verb, serve as a source of verb nouns, and an adjective that denotes a sign or property of a phenomenon, can form the basis of a new process or object.

## 5. Conclusions

Structural and semantic analysis of English methodological terms allowed us to draw the following conclusions. According to the word-forming structure, English-language methodological terms are divided into three types: time – simple word, term – a compound word, term. The terms of the first two types are created by means of morphological and lexical-semantic methods; the syntactic method is used to create terms of the third type. The most productive kind of morphological terminology – creation is affixed manner in which the most productive – suffix.

In affixal formations, prefixes have the greatest performance: re-, non-, un-, under- and extensions: **-ation / -tion, -er / -or, -ing**.

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## REFERENTIAL PROPERTIES OF ENGLISH DETACHED NONFINITE CONSTRUCTIONS WITH AN EXPLICIT SUBJECT: OPERATIONALIZATION AND QUANTIFICATION

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### Summary

This article presents the results of quantitative-corpus parameterization of reference properties of English detached nonfinite constructions with an explicit subject, carried out from the perspective of the cognitive-quantitative approach to language study. Through the prism of cognitive-constructive grammar, the syntactic patterns under scrutiny are recognized as *grammatical constructions*, i.e. complex semiotic units, non-compositional cognitively motivated pairings of form and conceptual meaning/ function, stored as holistic, conceptually connected, and interacting structures. Corpus-quantitative parameterization of referential properties of the given constructions presupposes the analysis of the linguistic means of expressing coreference between five micro-constructions and a corresponding matrix clause, reflected by the factors “Coreference” (COREF) and “Absence of coreference” (ØCOREF) of the parameter “Reference relations” (REFREL). Quantitative verification of the data involves a three-stage quantitative procedure incorporating 1) a multivariate analysis of variance (MANOVA), 2) a one-way analysis of variance (ANOVA), and 3) Tukey’s multiple comparison test performed with a computer statistical data analysis software R. The obtained results prove that the non-augmented constructions show a stronger semantic integration into a matrix clause, compensating lack of syntactic connection by closer reference relations, manifested by explicitly expressed full or partial coreference. The use of augmentors facilitates the identification of *with-*, *without-*, *despite-* and *what\_with-* augmented constructions as syntactic patterns, thus balancing the absence of coreference and ensuring adequate cognitive processing of constructions.

**Keywords:** construction grammar, quantitative corpus linguistics, coreference, parameterization.

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### 1. Introduction

The study of complex syntactic patterns and their components belongs to the most topical issues of contemporary grammar, given the significant changes taking place in linguistics under the influence of the recent theoretical frameworks and a tendency to master novel tools and methods of analysis. Linguistic studies are increasingly determined by the so-called “quantitative turn” (Janda, 2013: 2), which results in a paradigmatic shift towards an empirical approach to language analysis. The research tools of state-of-the-art grammar are enriched by the use of usage-based methodology, reference to the data of linguistic corpora, active implementation of quantitative methods, and specialized statistical software.

English detached nonfinite clauses with an explicit subject are specific syntactic patterns characterized by idiosyncratic morphosyntactic, semantic, and functional-pragmatic features.

These syntactic patterns can be illustrated by the following contexts drawn from the BNC-BYU corpus (1–5) (BYU-BNC):

(1) The weather forecast is hardly optimistic, [<sub>AUG</sub> [*with*] <sub>NP</sub> [*wind*] <sub>XP</sub> [*liable to play a strong role*]] (BYU-BNC; AKM 1);

(2) I yearn for a night beneath a sound roof, [<sub>AUG</sub> [*without*] <sub>NP</sub> [*insects*] <sub>XP</sub> [*crawling in my hair*] and <sub>NP</sub> [*vermin*] <sub>XP</sub> [*nibbling my toes*]] (BYU-BNC; GW2 1);

(3) In the past, [<sub>ØAUG</sub> <sub>NP</sub> [*other things*] <sub>XP</sub> [*being equal*]], improvement in a man's income removed obstacles to marriage (BYU-BNC; EDK);

(4) [<sub>AUG</sub> [*Despite*] <sub>NP</sub> [*the tables*] <sub>XP</sub> [*being somewhat dated*]], it is fairly safe to assume that in the case of Scotch Whisky production ... (BYU-BNC; J1V);

(5) She had a head start, of course, [<sub>AUG</sub> [*what with*] <sub>NP</sub> [*her mother*] <sub>XP</sub> [*being immaculate too*]] (BYU-BNC; HGJ).

The patterns under scrutiny represent a nonfinite secondary predication of a syntactically independent configuration. They are part of a minimally biclausal syntactic structure consisting of a matrix clause and a punctuationally or intonationally separated nonfinite clause with its own overt subject. The clauses are of a fixed binary structure [NP XP], where NP represents a secondary subject (Subj), different from the subject of the matrix clause SBJ<sub>M</sub>, and (XP) is a secondary predicate (Pred), expressed by a nonfinite verb form (NF) (participle I (PI), participle II (PII), infinitive (to-Inf)) or non-verbal part of speech (VL) (noun phrase (NP), adjective phrase (AdjP), adverbial phrase (AdvP) or prepositional phrase (PP)), and connected with a matrix clause through augmentors (aug) (*with*, *without*, *despite*, *what with*) or *asyndetically* (Øaug). In a sentence, the patterns perform the general syntactic function of an adverbial modifier elaborating, extending, or enhancing the matrix proposition.

In recent years, numerous studies shed light on the linguistic nature of English detached nonfinite clauses with an explicit subject (specifically in the frameworks of *descriptive grammar* (Ross (1893), Melten (1938), Aalto (1979), Stump (1985), Holland (1986), Popovich (1990), Serkina (2000), Timofeeva (2011), Kortmann (2013), van de Pol, Petré (2015), etc.), *generative grammar* (Beukema, Hoekstra (1984), Hanston (1992), Felser, Britain (2007)), *corpus-based studies* ((Duggley, Dion-Girardeau (2015), He, Yang (2015), Fonteyn, van de Pol (2015)), *functional systemic grammar* (He, Yang (2015), Khamesian (2016)), *construction grammar* ((Riehemann, Bender (1999), Bouzada-Jabois, Pérez-Guerra (2016)), etc. Such a far incomplete list of studies demonstrates that practically all linguistic frameworks have shown research interest in these syntactic patterns, and testifies to the specificity and complexity of this linguistic phenomenon. While considerable advances have been made in understanding morphological, syntactic, semantic, and functional features of the specified syntactic patterns, some issues need further study with the use of the recent advances of quantitative-corpus linguistics. This article reports on the results of the conducted quantitative-corpus parameterization of referential properties of English detached nonfinite constructions with an explicit subject, drawing on the cognitive-quantitative approach to language study that combines construction grammar as the cognitive linguistic view of grammar manifested by Langacker (1987, 1991); Fillmore (1988); Goldberg (1995, 2006); Croft (2008); Hilpert (2019) with the methodological perspective of quantitative corpus linguistics (Gries, Stefanowitsch (2004, 2013), Hilpert (2019), Stefanowitsch (2020), etc.).

Theoretical and methodological background for corpus-quantitative parameterization of a grammatical construction

The anthropocentric vector of contemporary linguistic paradigm opens new vistas in the study of language structures as “emergent clusters of lossy memory traces that are aligned within our high- (hyper!) dimensional conceptual space on the basis of shared form, function

and contextual dimensions” (Goldberg, 2019: 7) or form-meaning pairs, collectively referred to as *constructions* (Fillmore (1988); Goldberg (1995, 2006); Croft (2008); Hilpert (2021)).

The notion of construction has been reintroduced into linguistics by a recent cognitively oriented grammatical theory of construction grammar. A constructional approach to grammar has reinterpreted a conventional linguistic term “construction”, giving it a new extended understanding: a *construction* is recognized as the fundamental unit of language analysis and representation and postulated as a linguistic sign, a pairing of form (the plane of expression) and meaning (the plane of content) (Hoffmann, 2016; Östman, Fried, 2004). As non-compositional, (completely) productive, cognitively entrenched (automated) and complex pairings, *constructions* are “models for the representation of all grammatical knowledge – syntax, morphology, and lexicon” (Croft, 2008: 463), stored in the *construct-i-con*, a structured inventory of taxonomic structural networks (Goldberg, Croft, Cruse, 2004; Hoffmann, 2017), and serve as a cognitive-semantic interface to the structures of knowledge (cognitive structures) behind the plane of expression of constructions.

In light of construction grammar framework, English detached nonfinite clauses with an explicit subject are viewed as *grammatical constructions*, since they instantiate sufficiently frequent cognitively-motivated pairings of form (organization of constituents) and conceptual meaning/ function stored as holistic, conceptually connected, and interacting structures. As a clausal type of constructions, the patterns elaborate the meaning in a way of discourse functions rather than coded semantics:

FORM: [øaug/aug][Subj<sub>NP</sub>][Pred<sub>NF</sub>] ↔ MEANING: [...]<sub>FUNCTION</sub>

The *detached nonfinite with explicit subject* (DNFES) *constructions* constitute a taxonomic constructional network, with every node representing an individual type of a construction. The taxonomic constructional network is organized around a constructional schema, represented by a construction of the highest level of schematicity and abstractness – *macro-construction* (*dtcht-SubjPred<sub>NF</sub>-cxn*). The properties of the macro-construction are inherited by the constructions of a lower level *meso-constructions* (*dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn*, *dtcht-aug-SubjPred<sub>nf/vl</sub>-cxn* {AUG: *with, what with, without, despite*}), further acquired by individual *micro-constructions* (*dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn*, *dtcht-with-SubjPred<sub>nf/vl</sub>-cxn*, *dtcht-despite-SubjPred<sub>nf/vl</sub>-cxn*, *dtcht-without-SubjPred<sub>nf/vl</sub>-cxn*, *dtcht-what with-SubjPred<sub>nf/vl</sub>-cxn* {NF: *PI, PII, to-Inf; VL: NP, AdjP, AdvP, PP*}) and instantiated in specific realized constructions, i.e., *constructs* ([*his cheeks burning suddenly*], [*with thick spectacles perched at the end of his nose*], [*hands in pockets*]...).

One of the stages in the study of a grammatical construction presupposes quantitative-corpus parameterization of its lingual properties and involves the development of an appropriate formal model that reflects all possible linguistic parameters of a grammatical construction, collectively forming its linguistic profile, i.e. an organized set of linguistic properties (parameters) of a grammatical construction (morphosyntactic, positional, relational, referential, distributional, functional, collostructional, etc.) presented in a quantitative dimension. Corpus-quantitative parameterization of referential properties of the DNFES-*constructions* entails the analysis of the linguistic means of expressing coreference relations between the micro-constructions (*dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn*, *dtcht-with-SubjPred<sub>nf/vl</sub>-cxn*, *dtcht-despite-SubjPred<sub>nf/vl</sub>-cxn*, *dtcht-without-SubjPred<sub>nf/vl</sub>-cxn*, *dtcht-what with-SubjPred<sub>nf/vl</sub>-cxn*) and a matrix clause, reflected by the factors “*Coreference*” (COREF) and “*Absence of coreference*” (ØCOREF) of the parameter “*Reference relations*” (REFREL). The data for micro-constructions are generalized for the corresponding meso-constructions *dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn*, *dtcht-aug-SubjPred<sub>nf/vl</sub>-cxn*, which in turn become the basis for conclusions about the macro-construction (*dtcht-SubjPred<sub>NF</sub>-cxn*).



The frequency of constructions indicates the degree of their entrenchment in a language community and correlates with the number of tokens (constructs) within a corresponding parameter/ factor. Quantitative verification of the data and establishment of statistically significant indicators is carried out utilizing a three-stage quantitative procedure: 1) a multivariate analysis of variance (MANOVA), 2) a one-way analysis of variance (ANOVA) and 3) Tukey's multiple comparison test performed with a computer statistical data analysis software R (*R Core Team, 2017*).

ANOVA or analysis of variance is a parametric statistical procedure for comparing multiple samples on a metric scale. ANOVA test aims to find dependencies in experimental data by establishing the significance of differences in mean values. In our study, a one-way analysis of ANOVA is utilized to assess the influence of a particular factor level on the given micro-construction. ANOVA calculates statistics F, which reflects the ratio of variance caused by the factor and "random" variance. According to these statistics, the level of significance  $p$  is calculated based on which a conclusion about the homogeneity of the sample analyzed is made, that is, the absence of influence of the factor or the opposite. MANOVA or a multidimensional analysis of variance checks for group differences concerning several dependent variables. In the case of statistically significant differences ( $p < 0.05$ ), a posteriori multiple comparisons by Tukey's test (*Brezina, 2018*) is performed to determine which pairs of micro-constructions differ within the analyzed factor level. The obtained indicators allow to statistically substantiate the linguistic features that determine the functional dynamics and synchronic variability of the constructional network of English detached nonfinite constructions under study and its individual nodes. The study is based on 11,000 constructs selected from the corpus of modern English – the British National Corpus (BYU-BNC).

Operationalization and quantification of coreference parameter/ factors

By default, the DNFES-*constructions* are ascribed with an autonomous status, manifested by the absence of full integration into the syntactic structure of the matrix clause (*Quirk, et al. 1985: 1120*). These constructions are detached members of a sentence and do not depend on other sentence members (*Tronskiy, 2001: 346*); there is no reference correlation between the denotations of the DNFES-*constructions* and the denotations of the constituents of the matrix clause (*Visser, 1972: 1259*) (or coreference (*Kortmann, 1991*)). The syntactic patterns are independent of the subject of the main sentence, grammatically unrelated to the matrix sentence, and typically there is no visible connection with the matrix clause (*Martinčič, 2014: 22*).

However, B. Kortmann emphasizes that in most cases there is a certain reference correlation between the denotations of these structures and the denotations of the constituents of the matrix clause, or even the constituents of the surrounding linguistic context (*Kortmann, 1991:91*). B. Combettes is convinced that in such syntactic patterns at least one of the constituents is connected with the subject or object in the matrix clause by "part-whole" relations (*Combettes, 2005*). It is the formal or logical non-identity of the subject of [ $\emptyset$ aug/aug] [ $\text{Subj}_{\text{NP}}$ ][ $\text{Pred}_{\text{NF}}$ ]-*constructions* and the subject of the matrix clause that is a necessary condition for distinguishing these syntactic patterns as a separate class of syntactic structures.

Depending on the degree of coreference between the subject of the DNFES-*constructions* and the constituent of the matrix clause (*Kortmann, 1991: 92*), three types of reference relations are distinguished: 1) absence of coreference; 2) partial coreference; 3) full coreference.

The absence of coreference is recognized when the subject of the DNFES-*constructions* is not related to any constituent of the matrix clause or the entire matrix proposition or the immediate context. The logical difference with the matrix subject requires the use of lexical units that do not have an anaphoric function. In such cases, the subject of DNFES-*constructions*

is most often expressed by a common noun or a proper name (names and surnames, names of cities, companies, sports teams, etc.) or expletive pronouns *it* and *this*, the whole construction acquiring an idiomatic character (*all being well, weather permitting, permission granted, other things being equal*) (6–8):

(6) *With [the sun] warm on her face, [she] continued to sit there, a feeling of contentment replacing her earlier distress* [BYU-BNC, G1S];

(7) *By the end of the fifteenth century, [sugar] was a large export, [Flanders] being the biggest market* [BYU-BNC, CA7];

(8) *[This] being the case, [summer] weekends are not the best time to visit* [BYU-BNC, CHK].

Full coreference is observed when the constituent of the matrix clause and the subject of the DNFES-constructions are identical (repeat each other), synonymous (have somewhat similar meanings), or similar (have different meanings but are identical in reference) (9–11):

(9) *[The keys] fell to the ground just as fast as the paper, despite [the keys] being a lot heavier and needing more force* [BYU-BNC, FNW];

(10) *The steady stream of [visitors] to Max Gate continued, with many [sightseers] anxious for a glimpse of the great man, but also more welcome guests ...* [BYU-BNC, AS5];

(11) *I figured that I didn't have much of a chance to be the best player in [the US], [the country] being so big* [BYU-BNC, G2C].

Partial coreference is observed when the subject of the DNFES-constructions is partially coreferential with the subject of the matrix clause or with some other matrix constituent. Typically, partial coreference implies meronymic relations of two types: the “component – the whole object” (“part of the whole”) relations and the “member – assembly/ set” (“member of the whole”) relations. These relations are relatively similar because they denote the “whole” consisting of “parts”, but in each case the “whole” and “part” are different. In the “part of the whole” relations, the “whole” refers to the body of a human being/ animal, and in the “member of the whole” relations the “whole” is a group, team, company, army, team, etc. On the one hand, in the former type of relations the parts are inseparable from the whole, and in the latter one such relations are impossible. On the other hand, being individual “objects”, the entities in the “member of the whole” relations are always discrete, while the entities in the “part of the whole” relations are inherent parts of the “object” (12–13):

(12) *[Both coaching teams] have something to prove, [Cambridge] being led by John Wilson, who was last year's Oxford chief coach* [BYU-BNC, AHC];

(13) *[He] smiled, [his eyes] glowing, and she shivered in anticipation* [BYU-BNC, H8J].

Partial coreference of the “component – the whole object” type is observed when the subject of the DNFES-constructions is in relations of inalienable possession or pertinence (*Fabricius-Hansen, Haug, 2012*) with a referent of the matrix subject. Following (*Chappell, McGregor, 1996: 4*), the relations of inalienable possession are typical to objects closely connected with a person (or a thing), for example, 1) inherently associated objects, such as spatial relations (*'front', 'top', 'side'*); 2) objects that are an integral part of a person (thing) (e.g., body parts); 3) individuals with a biological or social connection between them, for example, family ties; 4) material objects that are in the inseparable possession of a person.

“Inalienable possession” relations are expressed by possessive or reflexive anaphora, controlled by a matrix subject and/or nouns denoting parts of a structured whole, inalienable things, etc. For example, a part of a human or animal body is naturally “connected” with the body as a holistic, discrete unit of reality (14–15):

(14) ‘I’ll tell you about it later,’ [Simone]<sub>i</sub> said, [*her face*]<sub>i</sub>, *a picture of embarrassment* [BYU-BNC; H8H];

(15) [Belemnites]<sub>i</sub> vary from small fossils a centimetre or two long to large specimens tens of centimetres long; of course these are only a fraction of the size of the living animal, *with [their tentacles]<sub>i</sub>, extending well beyond the guard* [BYU-BNC; AMM].

Such a connection is also registered in the case of portable alienable objects, which in some way characterize a person or a living being. Such alienable objects include clothing and its elements, accessories, personal belongings (16–17):

(16) [Male peasants]<sub>i</sub>, in the fields wear their distinctive broad-brimmed straw hats, *with [their coats]<sub>i</sub>, hanging loosely over their shoulders* [BYU-BNC; A64];

(17) [The Bergens]<sub>i</sub> went out first, then the RAOC men, [*their equipment*]<sub>i</sub>, *attached to them* [BYU-BNC; CDG].

The “member – assembly/ set” relations are displayed when the antecedent of the subject of the DNFES-constructions in the matrix clause denotes several referents (a plural entity, a group of individuals), and the subject of the construction is expressed by an inclusive pronoun (*all, every, each, either*, etc.) The pronominal subject in the DNFES-constructions refers to these referents as a whole (*both*) or each member individually (*each*). If the construction precedes the matrix clause, then the subject of the matrix clause is expressed by the pronoun *each* (18–19):

(18) At the bottom, wrapped in tissue paper, were [**two photographs**]<sub>i</sub>, [*both*]<sub>i</sub>, *showing the wedding of a young couple* [BYU-BNC; CE5];

(19) Almost [**all Western nuclear operating utilities**]<sub>i</sub> are involved, *with [each]<sub>i</sub>, having been appointed lead company for particular projects* [BYU-BNC; HBK].

Thus, based on the results of the operationalization, the parameter “Reference relations” (REFREL) for the DNFES-constructions is represented by the factors “Coreference” (COREF)

Table 1

**Quantitative distribution of constructions within the parameter “Reference relations”**

Factor	COREF		ØCOREF
	COREF <sub>Full</sub> (%)	COREF <sub>Part</sub> (%)	ØCOREF (%)
<b>Micro-construction</b>			
<i>dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn</i>	182 (1,65%)	2597 (23,61%)	1707 (15,52%)
<i>dtcht-with-SubjPred<sub>nf/vl</sub>-cxn</i>	41 (0,37%)	1229 (11,17%)	4734 (43,04%)
<i>dtcht-despite-SubjPred<sub>nf/vl</sub>-cxn</i>	5 (0,05%)	49 (0,45%)	295 (2,68%)
<i>dtcht-without-SubjPred<sub>nf/vl</sub>-cxn</i>	4 (0,04%)	10 (0,09%)	93 (0,85%)
<i>dtcht-what_with-SubjPred<sub>nf/vl</sub>-cxn</i>	–	4 (0,04%)	50 (0,45%)
<b>Meso-construction</b>			
<i>dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn</i>	182 (1,65%)	2597 (23,61%)	1707 (15,52%)
<i>dtcht-aug-SubjPred<sub>nf/vl</sub>-cxn</i>	50 (0,45%)	1292 (11,75%)	5172 (47,02%)

and “Absence of coreference” (ØCOREF). The factor “Coreference” is manifested on the levels of “Full coreference” (COREFFull) and “Partial coreference” (COREFPart). The level of the “Absence of coreference” factor (ØCOREF) coincides with the factor itself. The quantitative analysis of the implementation of the factors COREF and ØCOREF has shown significant differences in coreference relations between types of constructions and their matrix clauses. The results are given in Table 1 (the total number of constructs in the sample  $N = 11\ 000$  is taken as 100%).

The results of multivariate analysis of variance (MANOVA) performed using the programming language R show that the differences between the linguistic profiles of the micro-constructions *dtcht-øaug-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-with-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-despite-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-without-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-what\_with-SubjPred*<sub>nf/vl</sub>-cxn within the specified parameter are significant, and the identified differences are important and regular ( $\Pr(>F) = 1.327e-06 < 0.001$ ). As follows, the realization of the factors COREF and ØCOREF is important for distinguishing the investigated micro-constructions.

As can be seen from Table 1, the non-augmented micro-construction *dtcht-øaug-SubjPred*<sub>nf/vl</sub>-cxn is recorded in the largest number of contexts where it exhibits co-referential relations with the matrix clause. This is evidenced by a higher quantity of constructs with full and with partially coreferential links in comparison with contexts where the absence of coreference is observed. In addition, this micro-construction shows the highest rate of full coreference links with the matrix in the investigated sample.

In augmented *dtcht-with-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-despite-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-without-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-what\_with-SubjPred*<sub>nf/vl</sub>-cxn micro-constructions non-coreferential relations quantitatively prevail over coreferential ones. At the same time, in cases with coreference, partial coreference predominates, and full coreference is practically uncertified.

A similar situation is observed in the linguistic profiles of meso-constructions: unaugmented *dtcht-øaug-SubjPred*<sub>nf/vl</sub>-cxn shows a greater degree of coreference with the matrix clause in comparison with the augmented *dtcht-aug-SubjPred*<sub>nf/vl</sub>-cxn meso-construction.

In the linguistic profile of the macro-construction *dtcht-SubjPred*<sub>NF</sub>-cxn we record a significant quantitative domineering of noncoreference relations (62.54% of the total sample size) over fully/ partially co-reference (2.11% and 35.35%, respectively).

At the next stage of the research, a one-way analysis of variance (ANOVA) is employed to check whether the established quantitative differences in the realization of referential relations are statistically significant for distinguishing micro-constructions from each other. The results obtained do not demonstrate statistically significant differences ( $\Pr(>F) = 0.2090 > 0.05$ ) between the micro-constructions (*dtcht-øaug-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-with-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-despite-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-without-SubjPred*<sub>nf/vl</sub>-cxn, *dtcht-what\_with-SubjPred*<sub>nf/vl</sub>-cxn) in realization of the relationship of full coreference (COREFFull) with the matrix clause. Both augmented and non-augmented micro-constructions instantiate the smallest number of such relations in the sample and are considered statistically homogeneous in this respect.

ANOVA test also reveals statistically significant differences between the micro-constructions in the realization of the factor level “Partial coreference” (COREFPart) ( $\Pr(>F) = 3.7e-06 < 0.001$ ) and “Absence of coreference” (ØCOREF) ( $\Pr(>F) = 0.000215 < 0.001$ ).

The analysis of the factor “Coreference” (COREF) implementation at the level of “Partial coreference” by Tukey multiple comparison method reveals that the manifestation of semantic relations of partial coreference with the matrix clause is a statistically significant indicator of distinguishing the linguistic profiles of six pair of constructions (*dtcht-with-SubjPred*<sub>nf/vl</sub>-cxn vs *dtcht-despite-SubjPred*<sub>nf/vl</sub>-cxn; *dtcht-øaug-SubjPred*<sub>nf/vl</sub>-cxn vs *dtcht-despite-SubjPred*<sub>nf/vl</sub>-cxn;

*dtcht-with-SubjPred<sub>nf/vl</sub>-cxn* vs *dtcht-what\_with-SubjPred<sub>nf/vl</sub>-cxn*; *dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn* vs *dtcht-what\_with-SubjPred<sub>nf/vl</sub>-cxn*; *dtcht-without-SubjPred<sub>nf/vl</sub>-cxn* vs *dtcht-with-SubjPred<sub>nf/vl</sub>-cxn* vs *dtcht-without-SubjPred<sub>nf/vl</sub>-cxn* i *dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn*. The obtained indicators show that *with*-augmented and non-augmented *dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn* micro-constructions show the same tendency to be used in the contexts where they realize partially co-referential connections with a matrix clause but differ in this indicator from other constructions. However, *without*-, *despite*- and *what\_with* - augmented micro-constructions are also not differentiated by this factor, i.e. they demonstrate the same potential to actualize partially coreference relations with a matrix clause.

“Absence of coreference” (ØCOREF) is a distinctive feature for the micro-constructions *dtcht-with-SubjPred<sub>nf/vl</sub>-cxn* and *dtcht-despite-SubjPred<sub>nf/vl</sub>-cxn*; *dtcht-with-SubjPred<sub>nf/vl</sub>-cxn* and *dtcht-what\_with-SubjPred<sub>nf/vl</sub>-cxn*; *dtcht-without-SubjPred<sub>nf/vl</sub>-cxn* and *dtcht-with-SubjPred<sub>nf/vl</sub>-cxn*, indicating that the *with*-augmented construction differs from other augmented micro-constructions by the predominant implementation of non-referential links with a matrix clause. The other micro-constructions are homogeneous in this aspect, i.e. they show the quantitative differences between them are not statistically significant. The pair of micro-constructions *dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn* and *dtcht-with-SubjPred<sub>nf/vl</sub>-cxn* deserves special attention, for which at the 95% level of confidence statistically significant differences are not recorded, but the obtained *p*-value 0.0754513 is a little higher than a critical value of 0.05. Therefore, the absence of coreference between these micro-constructions and their matrix clauses can be recognized as a factor that distinguishes these two patterns, however, with a lower level of confidence. The *diff* index is negative, which indicates the predominance of constructs with absent coreference in the linguistic profile of the *dtcht-with-SubjPred<sub>nf/vl</sub>-cxn* micro-construction over *dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn*.

#### 4. Conclusions

The results of the conducted corpus-quantitative parameterization refute the traditional opinion of grammarians about the completely autonomous status of the English DNFES-*constructions* and the absence of reference relations between them and corresponding matrix clauses. The obtained data show that the cases of coreference (complete and partial) between the constituent of the matrix sentence and the subject of a DNFES-*construction* are relatively frequent, but are mainly registered in the linguistic profile of the *dtcht-øaug-SubjPred<sub>nf/vl</sub>-cxn* micro-construction. The non-augmented micro-construction shows a stronger semantic integration into the matrix clause, compensating lack of syntactic connection with a matrix by closer reference relations with it, which are manifested in the form of explicitly expressed full or partial coreference. Coreference relations (along with the corresponding determinant of the subject of the construction) provide adequate cognitive processing of this syntactic pattern. The use of augmentors, the list of which is limited in modern English (*with*, *without*, *despite*, *what with*), facilitates the identification of a DNFES-*construction* as a syntactic structure, thus balancing the lack of coreference. The application of a three-step corpus-quantitative procedure statistically verifies the determinant coreference factors for each micro-construction and provides a comprehensive linguistic-quantitative characterization of factors/ factor levels that determine a speaker’s choice of a particular DNFES-*construction*.

The findings presented in this paper point to the need of further research. Obviously, additional studies of the investigated syntactic patterns incorporating constructional approach with methods and tools of quantitative corpus linguistics will be of considerable interest. The next

stage of our research will be to validate the suggested computerized linguo-quantitative procedure to investigate other linguistic parameters (positional, distributional, collostructional, etc.) of the grammatical constrictions under study and statistically verify the determining parameters (factors), conditioning functional dynamics and variability of the network of detached nonfinite constructions with an explicit subject in present-day English.

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## INNOVATION, WORK, SOCIETY

## FIELDS AND LIMITS OF ECONOMIC HUMANISM

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**Summary**

The article is devoted to the search for formal criteria of economic humanization in the new millennium. The fields and limits of a human-oriented economy are defined as such criteria. Fields of economic humanization are considered as a system of economic relations in which socio-economic human rights are realized. As the results of comparative analysis, it is established that the list of socio-economic human rights is characterized by constant development. The set of these rights is most clearly outlined today in the Sustainable Development Goals. It is emphasized that due to a set of preconditions of objective nature (political, economic, biological, natural-ecological) humanization processes in the economy must be reasonable and rational, i.e. in some way limited. The limits of economic humanization are interpreted as restrictions on human-centered evolution of the modern economy caused by the need for sustainable economic development. It is argued that the principle of parity and proportionality between the factors of economic development and the factors of economic humanization should be the basis of economic humanism. It is proposed to take into account international and national factors in the formation of fields and limits of economic humanization. Attention is drawn to the need for a conduct of a separate study of state and legal regulation of fields and limits of economic humanization, in particular in entrepreneurship.

**Keywords:** Anthropocene epoch, human rights, humanization of the economy, socio-economic rights, sustainable development, economic relations.

**JEL Classification:** B40, F63, K30, O10, O35, Z13

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**1. Introduction**

The process of humanization of the economy of the new millennium is of an inevitable character today. At its center is a person with his/her needs and interests. Human rights are in a state of constant development permanently with the evolutionary processes taking place in

society. The issue of humanization is now the subject of comprehensive attention. An illustration of this, in particular, is that at the level of the UN, the modern period is recognized as the Anthropocene epoch. That is why one of the important issues of anthropology – the fields and limits of human rights due to the need for their formalization<sup>1</sup>. Examining the issue of economic humanization, it is obviously impossible to bypass the question of specifying its parameters.

For this **aim**, economic humanization in the context of its fields and limits is considered, in particular: through the definition of the concept of the field of humanization of the economy; separation of economic and social human rights in accordance with international standards as an object of humanization evolution and identification of the main directions of their implementation; finding out the reasons for the need to establish the boundaries of economic humanization, disclosing their content and basic principles. The **methodological** basis of scientific research is a set of general scientific and special scientific methods, namely: analysis and synthesis to clarify the fields and limits of economic humanization; comparisons to determine the list of economic and social human rights enshrined in international instruments; axiology to clarify the criteria for limiting economic humanization.

To begin with, a few key aspects should be outlined. First. Since the process of humanization is based on human-centeredness, the fields and limits of economic humanization will be considered through the prism of fundamental human rights. Second. Particularly economic human rights in the broadest sense should be the subject of consideration. Third. Economics is a multifaceted phenomenon. In the prism of humanization, it is advisable to pay attention to those components that are directly related to socio-economic human rights and the possible mechanism for ensuring them.

## 2. Fields of humanization of the economy

The field of humanization is the social space in which human rights are realized. The field of economic humanization is a system of economic relations in which socio-economic human rights are realized. Defining a list of such rights is the first step towards defining the fields and limits of humanization of the modern economy.

At the level of law, political science, philosophy a number of approaches have been developed regarding the classification of human rights and the assignment of certain rights to the category of economic and social. Without entering into a broad scientific discussion, to determine the list of basic economic and social human rights, the basic international legal acts, which deal with such rights, will be taken as a basis. At the level of the world community, economic and social rights as a separate type of fundamental human rights were first enshrined in the International Covenant on Economic, Social and Cultural Rights in 1966. These are rights such as the right to work, social security, adequate living standards and others. They have also been given some specification at the level of regional interstate associations. Thus, on May 3, 1996, the European Community adopted the European Social Charter in Strasbourg, which deals with virtually the same rights. In our opinion, the package of these rights should correspond to the complex of economic relations capable of securing them. These are, for example, social and labor relations, the humanization of which is manifested through: enrichment of labor content,

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<sup>1</sup> Such formalization is necessary for the legal definition and consolidation of fundamental human rights. It was developed for the first time in its entirety in the Universal Declaration of Human Rights, the Convention for the Protection of Human Rights and Fundamental Freedoms, the International Covenant on Civil and Political Rights, and the International Covenant on Economic, Social and Cultural Rights.



development of collective forms of labor organization, democratization of management, broad employee involvement in production management, labor improvement and rationalization of work and leisure modes (*Statyvka, 2012: 182*). Evidence of the efforts of the world community to outline certain fields of economic humanization is the adoption at the UN level in September 2015 of the UN Summit document “Transforming our world: an agenda in the field of sustainable development until 2030” (*Resolution adopted by the General Assembly, 2015*).

### 3. Economic and social human rights in international instruments

The Sustainable Development Goals define both the inalienable human rights of a socio-economic nature, which need to be paramount ensured particularly through the economic activities of the state, and directions of such activities, such as poverty reduction and global partnership development, formation of effective justice system and civil society control over state institutions. The logical connection between international documents on human rights and SDG in terms of outlining basic economic and social human rights can be seen through their comparison (see Table 1).

The comparison illustrates a certain evolution of the list of socio-economic human rights, especially when it comes to the Sustainable Development Goals. We see that this document already pays considerable attention to a number of important human ecological opportunities, issues of gender equality and effective justice. The emergence of new fields of necessary humanization is natural and caused by objective reasons. Thus, if in the second half of the twentieth century (at the time of the adoption of the International Covenant and the Social Charter) people were just starting to think about caring attitude to environment, the beginning of the XXI has been marked by the threat of a global ecological catastrophe and devastating climate cataclysms. Taking into account the tendency of constant growth of challenges regarding the possibilities of realization of social and economic rights of people, it is possible to assume further expansion of the necessary fields of economic humanization. Yes, today there are more and more conversations about quality drinking water. Here it is worth mentioning statistical studies according to which even in a number of European countries tap water is not suitable for human consumption (such countries include Ukraine).

Identifying of the main fields of humanization of the economy in the form of Sustainable Development Goals specifies the tasks of the state and civil society to determine the forms and directions of economic humanization.

When considering the fields of humanization of the economy, it is worth paying attention to the subjective composition of economic relations. The subject of economic relations can be not only an individual – a person (whose rights are the basis of the ideology of anthropocentrism), but also legal entities or even communities. Thus, today local communities have received significant independent economic rights. If we take into account that the basis of economic humanization is the development of the rights of subjects of economic relations, we can talk about three main groups of such subjects, namely: an individual (for example, a particular employee or entrepreneur); groups of people (collective), for example the same local community; enterprises, institutions, organizations with the status of a legal entity. For each of them, in our opinion, there should be a package of specific opportunities for humanistic development. For a person as an individual – it is the right to work, social protection, a healthy environment. For a collective subject – it is the right to property and proper conditions for its realization, the right to freedom of participation in economic activity. For enterprises and other entities in this category – the right to fair competition, incentive taxation, free access to credit, etc.

Table 1  
**Legal consolidation of economic and social rights human: a comparative aspect**

<b>International Covenant on Economic, Social and Cultural Rights                      (International Covenant, 1966)</b>	<b>European Social Charter                      (European Social Charter, 1996)</b>	<b>Sustainable development goals                      (Resolution adopted by the General Assembly, 2015)</b>
Art. 6 “right to work”	Art. 1 “right to work” Art. 9 “right to vocational guidance” Art. 10 “right to vocational training” Art. 18 “right to engage in gainful activity in the territory of the States of other Parties”	8. "promoting progressive, inclusive and sustainable economic growth, full and productive employment and decent work for all"
Art. 7 “everyone’s right to just and favorable conditions of work”	Art. 2 “right to fair working conditions” Art. 3 “right to safe and healthy working conditions” Art. 4 “right to fair remuneration” Art. 20 “right to equal opportunities and equal treatment in matters of employment and occupation without discrimination on grounds of sex” Art. 21 “right to information and consultation” Art. 22 “right to participate in the definition and improvement of working conditions and the working environment” Art. 26 “right to decent attitude at work” Art. 27 “right of workers with family responsibilities to equal opportunity and equal treatment” Art. 28 “right of employees’ representatives to protection at the enterprise and the conditions to be created for them” Art. 29 “right to information and consultation during collective release”	
Art. 8 “right to form trade unions for the exercise and protection of their economic and social interests”	Art. 5 “right to establish organizations” Art. 6 “right to conclude collective agreements”	

Продовження таблиці 1

Art. 9 “right to social security, including social insurance”	Art. 12. “right to social security” Art. 14 “right to use social services” Art. 19 “right of migrant workers and members of their families to protection and assistance” Art. 23 “right of the elderly to social protection” Art. 24 “right to protection in cases of dismissal” Art. 25 “right of employees to protection of their rights in the event of bankruptcy of their employer”	
Art. 10 “right to protection of family and maternity”	Art. 7 “right of children and adolescents to protection” Art. 8 “right of working women to maternity protection” Art. 16 “right of the family to social, legal and economic protection”	
Art. 11 “everyone’s right to an adequate standard of living for him/herself and his/her family”, “everyone’s right to freedom from hunger”	Art. 30 “right to protection from poverty and social exclusion” Art. 31 “right to housing”	1. “overcoming poverty” 2. “overcoming hunger, achieving food security, improving nutrition and promoting sustainable agricultural development” 10. “reduction of inequality”
Art. 12 “right of everyone to the highest attainable standard of physical and mental health”	Art. 11 “right to health protection” Art. 13 “right to social and medical assistance” Art. 15 “right of persons with disabilities to independence, social integration and participation in society life”	3. “ensuring a healthy lifestyle and promoting well-being for all at any age”
Art. 13 “right of everyone to education”		4. “ensuring comprehensive and equitable quality education and promoting lifelong learning opportunities for all”
Art. 15 “right to participate in cultural life; to use the results of scientific progress, to authorship”		5. “ensuring gender equality, expansion of rights and opportunities of all women and girls”

Продовження таблиці 1

<p>6. "ensuring the availability and sustainable management of water resources and sanitation"</p> <p>11. "ensuring the openness, security, viability and environmental sustainability of cities and other settlements"</p> <p>13. "taking urgent actions to combat climate change and its consequences"</p> <p>14. "conservation and sustainable use of the oceans, seas and marine resources for sustainable development interests"</p> <p>15. "protection and restoration of terrestrial ecosystems and promotion of their rational use, rational forest use, combating desertification, stopping and reversing the process of land degradation and stopping the process of biodiversity loss"</p>		
<p>7. "ensuring access to low-cost, reliable, sustainable and modern energy sources for all"</p>		
<p>9. "creating sustainable infrastructure, promoting inclusive and sustainable industrialization and innovation"</p>		
<p>12. "ensuring the transition to rational models of consumption and production"</p>		
<p>16. "promoting creation of a peaceful and open society for sustainable development interests, ensuring access to justice for all and creating effective, accountable and grounded on broad participation institutions at all levels"</p>		
<p>17. "strengthening the means of implementation and intensifying work in the framework of the global partnership for sustainable development interests"</p>		

The peculiarity of humanization processes in relation to the collective subjects of economic relations is that in this case there should be a combination of individual (personal) and group (general) interest. When it comes to a legal entity, there should be a unity of interests of the employee, the subject of the economic process (enterprise, institution, organization), the owner (private or state), society as a whole. This is one of the important factors of social harmony (compromise of social interests). A clear example of a violation of this approach is the fact that many enterprises privatized in Ukraine are idle or even destroyed, such as the Lviv Bus Plant. The question is: where are the investment obligations of “privatizers”?

When it comes to humanization, the unifying principle for all subjects of economic relations should be public values, natural rights, human needs and interests. Thus, ecological human rights should be taken into account even when it will entail additional costs for the enterprise, economic priorities should be formed by the state taking into account the possibilities of maximum employment of the able-bodied population (in this regard in Ukraine the development of entrepreneurship is crucial). The red line in the light of the humanization of the economy should be a person, his/her economic and social rights. Each component of humanization is designed to ensure a particular right of a person, group of people, society.

An analysis of international legal acts devoted to human rights illustrates that these documents, in addition to enshrining one or another inalienable right, also address the possibility of restricting it. Article 4 of the International Covenant on Economic, Social and Cultural Rights states that “the State may impose restrictions on these rights, which are defined by law, and only in so far as this is compatible with the nature of those rights, and solely with the aim to contribute the common welfare in the democratic society”. Article G “Restrictions” of the European Social Charter provides that “the effective implementation of the rights and principles set out in Part I and their effective exercise in accordance with Part II shall not be subject to any restrictions other than those provided for in those parts and those established by law and necessary in a democratic society to protect the rights and freedoms of others or to protect public interests, national security, human health or morals” (*European Social Charter; 1996*). This is not accidentally. It is necessary to mention the rule according to which “human rights end where the rights of another person and the interests of society begin”. So, when talking about economic humanization, it is worth mentioning its limits. These limits can be of objective or subjective character. An example of limits that have an objective basis may be that the increase in employee salary may be carried out in accordance with the capabilities of the enterprise, taking into account the need to accumulate funds for its development.

#### **4. The limits of humanization of the economy**

Utopian examples of formation a reward for work in accordance with the cellar approach, rather than depending on the quality and quantity of work performed, show that humanization must be reasonable and rational. Finally, an entrepreneur who does not receive the desired income from his business activity will not engage in it. The situation is more complicated with restrictions of a subjective nature. As we can see in the above-mentioned legal acts, the interests of the state and a democratic society, national security and morality are at stake. In this context, the practice of bringing people to justice in totalitarian states for not working seems justified and humane. Therefore, when it comes to limiting economic and social human rights, the preconditions for setting certain limits should have, above all, an objective nature. In our opinion, the main preconditions of an objective nature should include: political (for example, the need for citizenship to take the position of a civil servant), economic (for example, the economic

potential of the state to establish a living wage), biological (for example, age from which a person can work), natural and ecological (for example, restrictions on the use of the world's ocean resources).

The limits of economic humanization can be defined as caused by the need for sustainable economic development restrictions on human-oriented evolution of the modern economy. This definition, as we see, is evaluative in nature and needs to be specified. We will try to propose formal criteria, in particular of a material nature, first of all, those related to entrepreneurship, the effective development of which in Ukraine is a determining direction of humanization of the domestic economy. The need for sustainable development, in our opinion, is primarily related to the profitability of economic activity and the conditions for successful operation of the business entity. Of course, the income received can never be too large. However, its scope can be determined taking into account international and national factors - the average value by industry and type of activity. We call it a factor of economic development.

Human orientation should be based on international human rights standards, as Ukraine has declared its desire to implement these standards in national practice. Unfortunately, this does not mean that in Ukraine, for example, an employee can claim the same salary as his/her colleague in Western Europe for similar work<sup>2</sup>. Again, it is probably necessary to proceed from the average in the industry and type of business in each particular country. We call these human-oriented characteristics factors of humanization.

This gives grounds to argue that the limits of economic humanism should be based on the principle of parity and proportionality between the factors of economic development and the factors of economic humanization. This balance will ensure both the development of the national economy and its human-oriented evolution, the compromise of the interests of employer and employee. Deviation in one direction or another would have only mutual negative consequences. This should become a formula for successful sustainable development and part of the economic culture of all parties of economic activity.

As we have noted in previous studies, humanization has different forms of manifestation (*Kosovych, 2014; Kosovych and others, 2021*) and directions of implementation (*Statyvka, 2012: 182*). The question arises: does the above proposed formula of humanization have a universal character? In our opinion, the principle of proportionality and parity should be universal, the factors should have specific nature. Example. In order to reduce harmful emissions into the atmosphere, it is proposed to limit animal husbandry and switch to artificial "cultivation" of meat. This idea has begun to be actively implemented in some countries. In this case, it seems that the balance between the harm done by animals to the natural environment and the questionable usefulness of artificial meat products for the human body should be taken as a basis.

The issue of fields and limits of economic humanization should be one of the elements of economic education. It will prevent the formation of populist sentiments (populism is known to be a successful weapon in the hands of politicians) and will become an objective basis for reasonable expectations and demands of society.

## 5. Conclusions

Summarizing the above, we state that the process of humanization of the domestic economy, i.e. its human-oriented development, in today's conditions can be a reality, but not a kind of populism of individual political forces or social groups, provided its formalization through

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<sup>2</sup> This is a common practice that leads to a constant movement of capital and labor resources in the Europe.

the allocation of fields and limits. The field of economic humanization is a system of economic relations in which socio-economic human rights are realized. Currently, such fields are most clearly defined in international legal acts enshrining economic and social human rights and the Sustainable Development Goals. The limits of economic humanization can be defined as caused by the need for sustainable economic development restrictions on human-oriented evolution of the modern economy. Since today the grounds for establishing the limits of humanization are not formalized, it is advisable to base the limits of economic humanism on the principle of parity and proportionality between the factors of economic development and the factors of economic humanization. A separate study is required to clarify the issue of state and legal regulation of the fields and limits of economic humanization, in particular in entrepreneurship.

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## WOMEN'S PARTICIPATION IN POLITICS AND GOVERNMENT: THE EXPERIENCE OF THE UNITED ARAB EMIRATES AND OF CHINA

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### Summary

The article analyzed the political participation of women in the context of politics and governance in the UAE and China. A comparative analysis of women's political participation in the context of politics and governance in the UAE and China based on data analysis: official state information sources of these countries and reports of international monitoring missions, women's rights organizations, impartial scientists and researchers on women's rights, gender equality, women's representation in politics and government, their political participation. The author's hypothesis was confirmed: women are presented in state institutions in public positions, but they are not represented in local governments (they are not accepted in society itself), the real women's political participation and representation of women in politics and government of UAE and China is unsatisfactory, and the states deliberately produces false information about the situation regarding women's rights and gender equality.

**Keywords:** women's political participation, women's participation in decision-making, UAE policies and governance, China policies and governance, international standards.

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### 1. Introduction

The stereotypical perception of the UAE and China as traditionalist countries has been shattered for more than 20 years. Traditionally rigid patriarchal societies with a dominance of male power in the family and society, these countries have a long tradition of granting women fairly broad rights. These countries are innovating and empowering women as a result of demands dictated by changes in the world economy and under pressure from the international community. Both countries will make significant efforts to demonstrate and maintain the image of advanced countries in order to establish relations with the world community. On the contrary, are there representatives within the political elites who are really interested in building society and expanding women's political participation and representation in politics and government?

China and the UAE are implementing and developing initiatives for women's political participation and representation in self-government and government institutions, but the scale of these changes and women's real access to socially meaningful decision-making remain questionable. The aim of this study is to examine the patterns of public and political representation of women in government and in the political sphere at various levels to determine the credibility and sincerity of the UAE and China's intentions to build the legal system and achieve gender equality. Both countries demonstrate an intention to promote women in community initiatives and ensure their participation and representation: if women are in public institutions in public positions, but they are not represented in local governments (they are not accepted in society



itself), then real women's political participation and representation women in politics and government is unsatisfactory. Attention should be paid to the extent to which information on the situation of women's rights is controlled and whether each of the states deliberately produces fakes about the situation regarding the observance of women's rights and gender equality.

## 2. Methodology

The method of comparative research was used, based on existing relevant research and official statistics of state and international organizations. A critical analysis of the sources was also used: in the case where the data from the sources of the states under consideration could be biased, data collected by independent academic researchers were used. For each target country, official government sources on women's rights, gender equality, women's representation in politics and governance, their political participation, reports from international monitoring missions and women's rights organizations on the same subject were reviewed and compared. Government sources tend to cover externally oriented information (tailored to the needs of interaction with partners), while reports from international organizations and impartial scientists and researchers contain a realistic assessment of the situation.

## 3. Results and Discussion

### *Women's political participation in the context of politics and governance in China*

Chinese women play an important role in many aspects of socio-economic activity. However, the overall political participation of women in China has not improved significantly in recent decades. The heterogeneous form of women's representation in government will not support a steady improvement in women's participation in politics in China. The document argues that high-ranking women politicians will promote political gender equality, but greater participation in politics by the lower female population is more important and fundamental. Therefore, a proactive policy on women's participation in politics will work well only when it focuses not only on the middle level of government, but also on the participation of grassroots groups. A recent national survey in China revealed important information for an in-depth analysis of women's participation in politics. The most important documents that had a significant impact on political decisions and the direction of state policy in relation to gender equality were the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) and The Program of Action of the World Conference on Women in Beijing in 1995 (Zhao, 2017; Fan & Jiang, 2019).

This result is consistent with the official statistics above, which show the poverty of women in management positions. In decision-making positions, women are at a complete disadvantage. The dominant explanation for the underrepresentation of women in lower structures and in politics in general focuses on women's lack of self-confidence and the relentless involvement of "feudal" attitudes (for example, women are considered inferior to men). More than half of the people surveyed (61.6% of men and 54.6% of women) agreed that "the field for men is public and the domain for women is in the household" (All-China Federation of Women and National Bureau of Statistics of China 2011). This seems to suggest that people tend to believe that women are not by nature political or social creatures, which means that traditional ideology about the role of women hinders the improvement and promotion of gender equality, especially regarding women's participation in politics. It can be concluded that this situation is deteriorating, it should be noted that the number of people who adhere to this view has

increased by 7.7 and 4.4 percentage points, respectively, for men and women compared to 2000 (*All-China Federation of Women and National Bureau of Statistics*). *China 2011*). However, the real situation looks more complex as societal practices, economic structures, institutional norms, procedures, and political cultures reflect, revitalize, and reproduce gender perceptions of the proper place of women and men in political life (*Tong, 2021*).

Political participation is not only holding formally representative positions in parliaments or local governments, but also in a wider range of leadership roles, reflecting representation in management and citizenship, such as leadership in leading companies, membership in central government councils and bodies, and so on. From the general point of view of citizenship, political participation is the primary human right, duty and responsibility of citizens to engage in broad public affairs, which does not require them to take political positions. In this regard, women's participation in public and mass organizations and grassroots organizations is an important indicator of women's political participation (*Zhao, 2017; Fan & Jiang, 2019*).

The political representation of women in modern China reaches certain global averages and lags far behind the countries that have become leaders in implementing gender equality. In particular, the results of the elections to the representative party bodies before the 19th Congress of the CCP showed that in the 90 million CCP about 25% of women, about the same as in the Chinese Parliament. At the same time, only 33 women (9%) joined the Central Committee of the party, and only two (8%) joined the Politburo. It should be borne in mind that in terms of the level of political representation of women in higher authorities, China has significantly surpassed countries such as the United States, India and Russia (*Women in politics, 2021*). Today, Sun Chunlan's is alone woman among the four vice-premiers of the Chinese government, the State Council of the People's Republic of China. In accordance with the tradition of most gender-sensitive governments, which transfer to women areas that are not crucial in state policy, she oversees science and education, culture, health and sports. The State Committee for Health and Childbirth Planning is headed by Li Bin. Of the 31 members of the Chinese government, only one represents women (*Women in politics, 2021*).

An analysis of the real activities of Chinese women's organizations, including the AWF, as well as the personalities and social status of their leaders (in the case of the AWF, Shen Yuyue, one of the most prominent party functionaries close to former Chinese party leader Hu Jintao), points to their limitations. These organizations are mainly engaged in the fight against poverty, contribute to the construction of socialism "with a Chinese face" and so on. That is, their activities do not focus on women's issues and gender issues as such (*Yihong, 2020*).

Chinese researchers Qing and Hee point out that such an approach to the exercise of power in society is an attempt by the authoritarian government to implement "democratic" innovations in the form of "phantom democracy" or an analogue of Rodan's idea of participation in governance without democracy (*Qin & He, 2021*). Some Chinese researchers call the blatant demonstration of Chinese women's equality a "digital carnival" because it hides tight control over feminist organizations, suppresses attempts to spread the anti-harassment movement in the university environment, and opposes domestic violence (*Tan, 2017; Zhang & Xu, 2018*).

Women mostly join the party for career reasons while studying at university or at work. Public opinion gives a woman the place of a housewife, mother and wife, so do not expect ambition from her. It is extremely rare for women to be able to rise above the local, city or provincial level of government. At the same time, functional segregation, i.e. the restriction of women to certain types of administrative, managerial, or governmental functions, is not observed in China (*He & Wu, 2017*).

*Women's political participation and public presence in the context of politics and governance in UAE*

In the UAE, conventions protecting women's rights have been tariffed, in particular the Convention on the Elimination of All Forms of Discrimination against Women. A law has been in force since 2011, according to which children born to an UAE citizen and a man of another nationality can acquire national citizenship. Such changes meet the real demographic situation, as there are significantly more foreigners living in the UAE who have come temporarily or permanently to do business or perform employment contracts than locals (*Elessawy, 2018*). Most of the significant changes that have taken place in the UAE regard to the situation of women concern the economic side of life, education and the exercise of the right to self-disposition of property and property of various types. These changes have taken place over the last two decades, and today most young women seek education before marrying and having children. As a result, the average age of birth of the first child for the country has shifted to 28 years, while two decades ago, traditionally at 13 - 14 years, immediately after marriage, a woman gave birth to her first child. The traditional approach, which still dominates in some other countries in the region, is to completely isolate women from social life and focus on family life and caring for children and husbands (*Miller, Kyriazi & Paris, 2017*).

In the current UAE government, 8 of the 29 members of the government are women, the share of women in parliament was 23% in 2016, while in 1990 women were not represented in parliament at all. Women play a significant role in the diplomatic corps, where they make up 20% of the total diplomatic corps. However, there are no women with the rank of Ambassador Extraordinary and Plenipotentiary. The vast majority of young women receive higher education, in particular, 71.6% of students in UAE universities are women, and 95% of girls and 80% of men go to university after school. According to experts, the gender shift towards women is due to the fact that men in the UAE seek a prestigious education abroad, while women can only afford national higher education, which has a relatively lower level than in developed countries (*Abdulkadir & Müller, 2020*).

Legally, women in the UAE receive equal pay for equal work. They are free to work in their chosen jobs, including in government - but only with the consent of their guardian, who is usually their father. In fact, two-thirds of public sector jobs are held by women, and women make up about 40% of the total workforce. Pregnant women are guaranteed paid maternity leave, although the duration of the leave and its full or half payment depends on the place of work. There is no official leave for the father (*Carvalho Pinto, 2019*). Women in the UAE are free to start a business, and in recent years there has been a desire to support them. More and more groups of women-led entrepreneurs, such as Womena, are talking about women entrepreneurs in the Emirates. At present, women's business owners make up 10% of the UAE's private sector and hold 15% of seats on chambers of commerce and industry across the country (*Miller, Kyriazi & Paris, 2017*).

Financial and property rights women from the Emirates are free to buy real estate and get a mortgage. In fact, a recent study found that 30% of property in Dubai belongs to women. However, it is important for women to make a will, as Islamic law stipulates that the size of the inheritance depends on the sex of the heir; interest is higher for male heirs. The UAE is a highly literate country, with a literacy rate of about 95% for men and women. Women have access to all levels of education, including primary and secondary school. In fact, 77% of women in the Emirates enter higher education after high school. Women make up 70% of all university graduates (*Miller, Kyriazi & Paris, 2017*).

In the Gender Gap Ranking for 2021, the UAE ranks 135th on women's economic participation; by 89 in terms of educational opportunities; 130 for health and safety; the list of 155 countries by political representation of UAE women did not get into the ranking at all. China ranked 69th in terms of women's economic participation; according to opportunities for education - 103rd; by level of safety and health - 156 (last in the ranking); by level of political representation - 118 (*Global Gender Gap Report, 2021*). It is easy to see that, according to independent international experts, both countries, despite their economic power and persistent efforts to present extraordinary achievements in women's equality and their political representation and access to decision-making, are extremely vulnerable.

#### 4. Conclusion

The government and ruling elites of the PRC and the UAE are dominantly male but make great efforts to represent their efforts to achieve gender equality on the international stage. Analysis of statistical information and the real representation of women in local and supreme government bodies demonstrate that these efforts are more informational and presentational in nature. The status of women in both countries is improving significantly in the areas of education, legal rights and employment, and health care. At the same time, women's political representation and women's real access to the process of determining state or local policy and decision-making are extremely limited, which is confirmed by the corresponding ratings provided to both countries by international observers.

Women receive rights to manage property and broader rights to education, work in research institutions and for business; thus, they are more involved in the production of goods, but they practically do not get a greater opportunity to control the distribution of these goods or to pass legislation and make decisions.

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## CORRUPTION PREVENTION SYSTEM IN THE BORDER GUARD AGENCIES (STATE BORDER GUARD SERVICE OF UKRAINE AS AN EXAMPLE)

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### Summary

The article is devoted to the model of anti-corruption system building study using State Border Guard Service of Ukraine as an example. The content of this system certain elements depending on corruption risks and the factors that affect them is analyzed. This takes into account the corruption level and its prevention experience in the border guard agencies of some foreign countries. It is noted that the state border protection and defense effectiveness directly depends on the degree of anti-corruption system efficiency rate.

A number of theoretical and applied nature conclusions are formulated. Among them are the following ones:

State Border Guard Service of Ukraine anti-corruption system is characterized by international, domestic and departmental institutions and instruments interaction. It is a part of domestic anti-corruption system and includes such elements: object, goals, principles, legal framework, participators and prevention measures;

range of participators involved in State Border Guard Service of Ukraine corruption prevention extends beyond the borderguard agency. It is proposed to consider anti-corruption participators powers based on such classification: 1) international actors; 2) domestic actors: governmental institutions (special anti-corruption authorized agencies and state bodies involved in the corruption prevention); departmental bodies for corruption prevention; non-government organizations, individuals and legal entities;

corruption prevention in State Border Guard Service of Ukraine should be based on self-service activities for integrity and staff corruption resistance level increasing. Combating illegal activities at the state border is also actual for anti-corruption objectives achieving.

**Keywords:** border guard agency; corruption delicts; corruption prevention participators; general social and special criminological anti-corruption measures; anti-corruption resilience.

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### 1. Introduction

Within the corruption prevention framework there are three interrelated areas: 1) anti-corruption legislation formation that would meet international standards; 2) specialized anti-corruption institutions system creation; 3) public authorities (including military formations) system reforming based on integrity and transparency.

When considering the borders guard agencies researchers emphasize such corruption risks of border protection activities: 1) insufficient external control; 2) a high level of autonomy and discretionary powers of these bodies; 3) economic factors motivating traders to corruption schemes; 4) organized crime pressure; 5) inadequate wages and working conditions of border guards; 6) specific organizational features of state border guard agencies' structure units. Consequently, border corruption has a detrimental impact on shipping costs, trade, revenue collection, illegal migration as well as organized crime and security (*Chene, 2018: 1*).

In view of this, it is important to form a border guard agency that is resistant to illegal influences. Such development vector was chosen by State Border Guard Service of Ukraine (hereinafter – SBGSU). In accordance with the existing threats, a system of "internal security" was formed. It includes preventing corruption system in SBGSU.

This article purpose is to study the characteristics of the corruption prevention system in SBGSU, including problems of its effectiveness.

To achieve this goal, there were used such research methods:

systemic and structural-functional methods using has ensured the consideration of elements of the corruption prevention system in SBGSU;

methods of analysis and synthesis application has helped to analyze the scientific literature about corruption prevention in border agencies, to identify the relationship between cross-border crime and corruption prevention system elements, to investigate this system elements structure and content;

comparative method was used in order to study of corruption risks and their impact in different countries border agencies corruption.

## 2. Review of scientific research to prevent corruption in the border agencies activity

Theoretical and practical problems of preventing corruption in the border agencies of the EU and the US paid attention by Chene M. (2018), Sharon I. Kwok (2020), Hennop E., Jefferson C., Mclean A. (2001), Martin Hrabalek (2010), Mungiu-Pippidi A. (2015), Morarou V. (2013), Komlavi Hahonou E. (2016), etc.

Many experts' researches deal with corruption in border and customs agencies due to their activities common features. In addition, structurally these agencies in many countries are part of the police (Austria, Belgium, Hungary, Germany, Greece, Denmark, Iceland, Spain, Italy, Cyprus, Norway, Portugal, Slovenia, France, Croatia, Sweden, Estonia) or the armed forces (Malta, the Netherlands).

In the United States there is a joint border agency that performs border and customs functions (US Customs and Border Protection, which is part of the Department of Homeland Security). Therefore, border guards and customs officers' delicts are also analyzed together.

For example, the San Diego State University researchers examined 156 cases taken from October 2004 to October 2015 – with the majority occurring in Texas, California and Arizona. According to the data, about two-thirds of the cases involved customs officers with the remaining third involving border patrol agents. Customs officers were typically paid for their help in getting drugs across the border while border patrol agents were bribed for their knowledge of smuggling routes and how border crossing security system works. The personal approach fruitfulness is also emphasized. So, David Janscics has come to the conclusion that the experience level of an official correlating to the type of corruption they would be involved in: younger agents (less than five years of experience) were more likely to be charged with drug or weapons trafficking offences, while more senior agents were more likely to be involved in human smuggling (*Wells, 2019*).

Interesting are the Dutch researcher M. Chene results. She studied corruption at the borders within the research of the anti-corruption association U4, created under Chr. Michelsen Institute (CMI) in Norway. Her work considers parallel forms customs and border guard agencies corruption, highlighting their common features. The author identifies increasing corruption risks factors and neutralizing these factors anti-corruption measures.

The scientist concludes that trafficking of drugs, natural resources, weapons, stolen vehicles or even consumer goods such as oil, alcohol or cigarettes also rely on smuggling and on avoiding investigation, which is facilitated by corruption, including border corruption. Corruption also plays a large role in facilitating cross-border the smuggling of weapons and insurgents, which are the used to undermine state stability and the functioning of state institutions (*Chene, 2018: 16, 18*).

Important conclusions about border agency formation on the professionalism and integrity basis on the example of the European Border and Coast Guard Agency (FRONTEX) makes Czech scientist Martin Hrabalek in his dissertation study "EU border protection and the role of FRONTEX in it" (*Hrabalek, 2010*).

However, since this study FRONTEX anti-corruption measures have been improved by defining provisions in the Regulation (art. 117, 118) concerning conflicts of interest prevention, the transparency register introduction and the principles of cooperation with the European Anti-Fraud Office (OLAF) in internal investigations (*Regulation (EU) 2019/1896*).

The Ukrainian model of border protection institutional providing envisages a separate agency – the SBGSU as a law enforcement agency of special purpose. It is a part of the security and defense sector of Ukraine. Corruption prevention researches in SBGSU have been carried out for a long time by such specialists as V. Khirny (2013), Y. Kuryliuk (2018, 2020), V. Zolka (2013), S. Khalymon (2017), S. Filippov (2019).

The scientific intelligence generalization permits to note activity approach dominance to corruption in SBGSU analysis. Such offenses are antisocial practice, which reveals corrupt border guard personal characteristics (*Filippov, 2019; Kuryliuk, 2019, 2020*). At the same time institutional approach seems also fruitful one. It is manifested in the SBGSU structure and powers bringing to international standards (*Filippov, Ziolka, 2013*).

Simultaneously scientific research tends to focus on specific issues, although corruption preventing is a part of delinquency avoiding. In addition, there are no analytics reflecting a holistic system for corruption preventing in border agencies, including SBGSU.

### 3. Model of corruption prevention system in SBGSU

Starting this issue analysis, it should be noted that statistics in Ukraine do not confirm the David Janscics' conclusion that border agencies all around the world are generally more corrupt than other public agencies (*Wells, 2019*). Thus, according to official statistics from 2008, 30-40 border guards are sentenced to criminal liability for committing various criminal offenses each year. Of all border guards convicted in 2014–2019, 25.77% (92 people) were found guilty of committing corruption offenses.

The corruption delinquency level in SBGSU was 38 criminal offenses during 2020. Most often, border guards accept the offer, promise or receive illegal benefits (over 75%). At the same time, there are positive trends in border guards' reaction to involving into illegal activities. Thus, during 2020, 583 attempts to provide illegal benefits for SBGSU staff were suppressed (*DPSU. Antykoruptsiyni biuletten, 2020, 2021*).



Thus, in no case can it be said that border guards are extremely corrupt compared to other law enforcement officers.

The corruption prevention system both in Ukraine as a whole and in SBGSU, in particular, is not reflected in a certain legislative act. This is a theoretical model based on a number of regulations and practical measures to prevent corruption.

In our opinion, the corruption prevention system in SBGSU covers the following elements: 1) object; 2) goals; 3) principles; 4) legal framework; 5) participators; 6) prevention measures.

1. The corruption prevention object in SBGSU – corruption-causing factors, corruption risks (*Golovkin, 2018: 254–260*) in the SBGSU activities, its staff illegal behavior.

Corruption risks considering border guard service as whole depend on authorities' official activity type. Thus, corruption risks in state border protection may be border guards' dishonest behavior in relation to:

suppression of offenses at the border leading to illegal movement of goods / objects and illegal migrants;

foreign citizens legalization in Ukraine;

passage through the state border of Ukraine citizens who are prohibited from entering or leaving its territory;

failure to enter information or entering inaccurate information into the departmental database of persons and vehicles crossing the state border;

illegal personnel decisions, etc.

These delicts are associated with unauthorized routes change or deliberate duty stations abandonment; insufficient level of knowledge requirements of anti-corruption legislation by SBGSU staff (*Zvit pro vykonannia Antykoruptsiinoi prohramy DPSU na 2020-2022 roky*).

Similar corruption risks can be identified for other states border agencies activities. Their detection in specific offenses depends on a number of factors. Analyzing border corruption, M. Chene identifies factors that increase corruption risks in border regions (*Chene, 2018: 2–6*):

a) *Geographic dispersion*. Border officials often lack resources and adequate supervision as they operate in remote and geographically dispersed areas that make careful supervision almost impossible while enjoying wide discretionary powers that provide them with opportunities to extract bribes. In many countries, this situation is exacerbated by poor infrastructure, lack of human and institutional capacity, low levels of automation and computerization, lack of training and professionalism, low public service salaries, and weak controls and oversight;

b) *Size of border configuration*. In the EU, for example, larger border crossings along the eastern land borders and major international seaports are typically well staffed, well resourced, with well developed infrastructure including sophisticated anticorruption measures such as video-monitoring. According to researchers at the Center for the Study of Democracy (2012), where corruption occurs at major border crossings, it requires more sophisticated and financially costly schemes that commonly involve cooperation between several border guards, or more complex collaboration between teams of border guards, customs officers and sea-port employees. At smaller border crossings, corruption more often involves doing favours for friends and family. In some cases, it is a family tradition that different generations or spouses work in the same agency, which also contributes to the existence of informal networks for the corruption development. However, in small units, border guards are more cohesive, so it is harder to hide corruption. In such units, border guard forces are either generally corruption-free, due to strong team ethics, or are institutionally corrupt;

c) *Administrative monopoly and discretionary.* Border guards enjoy comparatively fewer discretionary powers than customs officials. And they have fewer opportunities to extort bribes from legitimate businesses and individuals. There are three major areas where border guards may become involved in extortion: 1) migration control; 2) schemes where they become complicit with customs officials who extort money from legitimate companies and private persons; 3) administrative corruption regarding public contracts;

d) *Wages and working conditions.* The combination of low pay, difficult service conditions and low detection control rates encourages corruption;

e) *Complex regulatory frameworks.* Nontransparent, burdensome rules and procedures constitute vulnerabilities that;

g) *Pressure from organized crime.* The movement of illegal goods, people and animals is often controlled by organized criminal groups that engage officials in corrupt practices to facilitate illegal operations.

2. Goals of corruption preventing in SBGSU – transparency, integrity, corruption risks reduction mechanisms introduction and public confidence level in border guards' activity increasing; detection, neutralization, blocking, elimination of factors determining corruption, as well as corruption in SBGSU prevention and suppression.

3. The principles of corruption preventing in SBGSU are considered as a set of guiding requirements for activity organization in order to develop and apply a certain prevention strategy. As a basis for defining such principles are international acts' norms and domestic legislation.

For example, On The Twenty Guiding Principles For The Fight Against Corruption (*Council of Europe, 1997*) and Istanbul Anti-Corruption Action Plan for Armenia, Azerbaijan, Georgia, Kazakhstan, the Kyrgyz Republic, the Russian Federation, Tajikistan and Ukraine (*OECD, 2003*). The international principles reflection can be traced in Ukrainian legislation containing general, legal, managerial, economic principles of state and society interaction, and the anti-corruption activity principles (*Zapobihannia ta protydiia koruptsii, 2013*).

International anti-corruption standards and domestic legislation provisions were taken into account in SBGSU departmental documents development. Thus, the corruption prevention principles in SBGSU, in accordance with the SBGSU Anti-Corruption Program for 2020-2022 requirements, include: rule of law; integrity in the public service; a negative attitude to corruption formation; the punishment for corruption offenses inevitability; efficiency and legality of the budget funds use; transparent and open activities; public involvement in anti-corruption measures; creation of partnership with civil society institutions mechanisms (*Antykoruptsiina prohrama DPSU na 2020–2022 roky*).

4. The preventing corruption legal framework in SBGSU covers international acts and domestic legislation. The main international acts are the UN Convention against Transnational Organized Crime (2000), the UN Convention against Corruption (2003), Council of Europe Criminal Law Convention on Corruption (1999), and others. In addition, recommendation documents play a significant role, in particular, Council of Europe resolutions on standardization and control of anti-corruption activities, and the provision of technical assistance to countries.

The corruption preventing legislation basis in SBGSU is a system based on the Constitution of Ukraine and includes laws, bylaws (including departmental ones), as well as the Constitutional Court of Ukraine, the Supreme Court and the ECHR practice. This normative set structure is determined by these acts legal force and their action peculiarities.

This area laws can be classified according to the subject of regulation into laws that determine:

1) anti-corruption policy principles (Grounds of state anti-corruption policy in Ukraine (Anti-corruption strategy) (2014));

2) corruption prevention system functioning principles in Ukraine (Law of Ukraine "On Prevention of Corruption" (2014));

3) legal bases of anti-corruption bodies organization and activity (Laws of Ukraine "On the National Anti-Corruption Bureau of Ukraine" (2014), "On the Prosecutor's Office" (2014), "On the Supreme Anti-Corruption Court" (2018), etc.);

4) responsibility for offenses (Criminal Code of Ukraine, Code of Ukraine on Administrative Offenses, Civil Code of Ukraine, Disciplinary Statute of the Armed Forces of Ukraine).

Bylaws regulating corruption prevention in SBGSU include decrees of the President of Ukraine, resolutions of the Cabinet of Ministers of Ukraine, interdepartmental and SBGSU bylaws.

5. Participators of corruption prevention in SBGSU. They are created for anti-corruption measures use. At the same time, the range of participators involved in this activity goes far beyond SBGSU units, because of it is part of the fight against corruption in Ukraine.

The corruption prevention participators in SBGSU should include:

*International corruption prevention actors* (UN, OSCE, CE, GRECO, NATO);

*domestic anti-corruption actors:*

governmental institutions (special anti-corruption authorized agencies (NABU, NAZK) and state bodies involved in the corruption prevention);

departmental bodies for corruption prevention (heads of departments; units of internal and self-security; authorized units (persons) for the prevention and detection of corruption in SBGSU);

non-government organizations, individuals and legal entities

6. Corruption prevent measures in SBGSU. General social measures include management system reforming, government openness ensuring, civic consciousness level raising. All of them should be aimed at forming anti-corruption legal awareness and SBGSU staff resilience.

The corruption prevent general social measures influence is carried out on the border guard's personality formation until his entry into SBGSU service. But this influence continues during the service. Thus, the social reforms impact is transformed through the border guards' social support; educational activities – through educational work and psychological support etc.

In turn, special criminological measures are the subject of corruption prevention programs, plans, guidelines, etc. (*Melnyk, 2004: 268*). These measures content and intensity in SBGSU are correlated with corruption risks in official activity given area. Thus, in order to prevent corruption, during border control border guards are prohibited from: 1) accepting any items (things) from any persons and passing items (things) to anyone; 2) provide anyone with information about persons, vehicles, goods moving across the state border or through checkpoints of entry – exit, unless otherwise provided by law; 3) provide advantages in crossing the state border or entering and leaving the temporarily occupied territory to persons, vehicles and goods; 4) have any personal communication means are not part of the border guard equipment; 5) carry cash in excess of the amount established by the SBGSU Administration.

In order to corruption effects minimize in SBGSU, considerable attention is paid to work with staff:

providing staff with methodological and consulting assistance on compliance with anti-corruption legislation;

implementation of measures to identify conflicts of interest, promote its settlement;

ensuring the whistleblowers protection (*Stepanov, 2020*).

This personality approach (anti-corruption influence object is a concrete entity) demonstrates its effectiveness. Anyway, final decision has to be approved by each border guard himself. This is confirmed by the significant number of border guards' refusals from illegal benefits (*DPSU Antykoruptsiyni biuleten, 2020*).

At the same time, it should be recognized that there is an urgent need to improve approaches to SBGSU staff selection. Educational activities and training aimed to their anti-corruption resilience formation also extremely important. Today, there are staffing projects "New Face of the Border" and "New Face of Management", implemented with the US Embassy in Ukraine and IOM support.

However, there is need of the militaries' responsibility strengthening, the inevitability of criminal liability ensuring, and monitoring compliance with moral and ethical norms. It is also promising to improve the system tools for self-motivation and motivation based on a set of material and moral and ethical incentives, improving the border agency image and SBGSU prestige.

#### 4. Conclusions

In view of the above, it is possible to formulate a number of theses having a direct importance for current situation understanding and corruption prevention spheres in SBGSU:

SBGSU anti-corruption system is characterized by international, domestic and departmental institutions and instruments interaction. It is a part of domestic anti-corruption system and includes such elements: object, goals, principles, legal framework, participators and measures of prevention;

range of participators involved in SBGSU corruption prevention extends beyond the borderguard agency. It is proposed to consider anti-corruption participators powers based on such classification: 1) international actors; 2) domestic actors: governmental institutions (special anti-corruption authorized agencies and state bodies involved in the corruption prevention); departmental bodies for corruption prevention; non-government organizations, individuals and legal entities;

corruption prevention in SBGSU should be based on self-service activities for integrity and staff corruption resistance level increasing. Combating illegal activities at the state border (smuggling, drug trafficking, human trafficking) is also actual for anti-corruption objectives achieving.

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## THE ESTABLISHMENT OF A BALANCE BETWEEN PRIVATE INTERESTS OF THE AUTHORS AND PUBLIC INTERESTS OF THE SOCIETY IN THE DIGITAL AGE

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### Summary

The aim of this paper is to analyse the DSM Directive through the perspective of insurance the balance between private and public interests. The paper analyses how technological growth has led to the adoption of the DSM Directive, the goals set by the legislator and if they were met in the DSM Directive. The paper as well reviews key points of the DSM Directive and how it influences the interests of different parties in copyright. The article focuses on press publishers' rights, new exceptions and limitations and use of protected content by online content-sharing service providers, that were introduced by DSM Directive. The gaps of the DSM Directive are also reviewed in this article and how they impact the disbalance of interests in copyright. The article as well provides brief analysis how instruments brought up in DSM Directive may influence the copyright outside the EU. Methods used in this research: general scientific (analysis, induction, deduction), legal methods (legal comparison, formal legal method).

**Keywords:** copyright, digital age, interests, DSM Directive, online content-sharing service providers, exceptions and limitations, press publisher's rights.

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### 1. Introduction

In the context of constant scientific and technological progress and the inevitable globalisation, intellectual property is an important asset that needs proper legal regulation to stimulate market development and ensure the interests of all stakeholders. Copyright objects are potent drivers of both the economic and cultural development of society. In recent years, digital technologies have challenged copyright in various ways. The development of the information society has opened up a new way of using copyrighted works. It has led to the rapid growth of new business models, at the core of which are the objects of copyright. Nevertheless, on the other hand, this same development has opened the door to many new opportunities to infringe on the rights of exclusive rightsholders. However, the purpose of copyright remains the same: to protect the exclusive rights of rightsholders and to ensure a balance between their interests and the interests of society.

Unfortunately, the rapid development of the digital society does not match the pace of change in legal regulation, so legislators are critical to creating a flexible legal framework, both nationally and internationally, to ensure the rights and interests of all stakeholders, which will meet the rapid development of the information society.

As rightly noted by Ms Trotska, scholars still ignore the issue of balancing public and private interests in copyright in the digital age (*Trotska, 2019*).

In the scope of this article, the tendencies to balance the interests of society and the private interests of rightsholders within the framework of public relations that arise between them regarding works protected under copyright in the digital environment will be considered. We will focus on the instruments that were introduced by Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on copyright and related rights in the Digital Single Market (hereinafter – Directive (EU) 2019/790 or DSM Directive), how they are implemented in the Member States and how they influence the interests of rightsholders and society.

## **2. Instruments introduced in Directive (EU) 2019/790 for the establishment of a balance between private interests of the authors and public interests of the society in the digital age**

### **2.1. New exceptions and limitations**

Two years ago, the Directive (EU) 2019/790 was adopted. As stated in recital 3 of Directive (EU) 2019/790, rapid technological development continues to change the way copyright objects are created, distributed and used. New business models and new actors continue to emerge. Relevant legislation must be sound for the future to restrict technological development, but the objectives and principles set out in the Community framework on copyright remain unchanged. However, legal uncertainty remains for both rightsholders and users regarding the specific use of works and other objects in the digital environment, including cross-border use. The Directive (EU) 2019/790 lays down rules for the adaptation of certain exceptions and limitations to copyright and related rights in the digital and cross-border environment (*Directive (EU) 2019/790, 2019*).

It is worth noting that the Directive (EU) 2019/790 has provoked much discussion from both within the EU Member States and interested market players.

Thus, Directive (EU) 2019/790 amended the system of exceptions and limitations on the use of copyrighted works without the consent of the author, which was introduced by Directive 2001/29/EC of the European Parliament and the Council of 22 May 2001 on the harmonisation of certain aspects of copyright and related rights in the information society (hereinafter – Directive 2001/29/EC or InfoSoc Directive). As is well known, the Directive, as a type of legislative activity in the Union, has a framework character and allows the Member States to implement the provisions introduced into national law. Therefore, if the exceptions and limitations under Directive 2001/29/EC were optional (*Directive 2001/29/EC, 2001*), the new exceptions and limitations introduced by Directive (EU) 2019/790 are mandatory for implementation in national legislation by the Member States. Therefore, yes, Member States were required to implement the following exceptions and limitations:

- 1) Text and data mining for scientific research for reproductions and extractions made by research organisations and cultural heritage institutions (Art. 3 of Directive (EU) 2019/790);
- 2) Use of works and other subject-matters in digital and cross-border teaching activities (Art. 5 of Directive (EU) 2019/790);
- 3) Creation of copies of any works in any format or medium, for purposes of preservation of such works and to the extent necessary for such preservation (Art. 6 of Directive (EU) 2019/790) (*Directive (EU) 2019/790, 2019*).

As Mr Kapitsa duly noted it, it is not clear why the proposed list of exceptions and limitations was introduced in the new Directive (EU) 2019/790 as they could have been included by amending the relevant article of the Directive 2001/29/EC (*Kapitsa, 2019:65*).

Mr Ferri has properly indicated that the new exceptions and limitations may be used only if they will meet the proportionality test designed in InfoSoc Directive, meaning that the exception/limitation does not conflict with the normal exploitation of the work. Therefore, it does not cause unreasonable prejudice to the right holder's legitimate interests (*Ferri, 2020*).

## 2.2. Press publishers' rights

One of the most controversial innovations introduced in the DSM Directive is Article 15, which protects the press publications concerning online uses. Under Art. 15, Member States shall provide publishers of press publications established in a Member State with the reproduction right and right of communication to the public for the online use of their press publications by information society service providers. In addition, if the other person intends to use the protected work, the publisher is entitled to *bona fide* compensation (*Directive (EU) 2019/790, 2019*).

The reasoning for such an amendment is based on how the digital economy has changed news consumption and how press publishers have issues licensing their rights to online news aggregators, media monitoring services, and search engines.

The rationale in the preamble to DSM Directive is that news is an important asset of democracy, and commercial news publishers have suffered financially from the development of the digital environment (*Directive (EU) 2019/790, 2019*).

Such regulation is not new for some EU Member States. In Germany, for example, a law was passed in 2013 that required aggregators of news and search engines to pay a fee for the use of excerpts from publishers' texts (*Podszun, 2014*).

Accordingly, to the Art. 2(4) of DSM Directive, press publication means a collection composed mainly of literary works of a journalistic nature, but which can also include other works or other subject matter, and which: constitutes an individual item within a periodical or regularly updated publication under a single title, such as a newspaper or a general or special interest magazine; has the purpose of providing the general public with information related to news or other topics; and is published in any media under the initiative, editorial responsibility and control of a service provider (*Directive (EU) 2019/790, 2019*).

It should be noted that Article 15 of the DSM Directive does not enshrine publishers' right to remuneration as absolute. Periodicals published for scientific or academic purposes, such as scientific journals, do not press publications for the Directive (EU) 2019/790. The term of protection is limited within two years from 1 January of the year following the publication date. Also, it is assumed that this right does not apply to individual words or very short excerpts from a printed publication; an exception is the "non-commercial use" of news publications. Also, publishers' rights do not apply to hyperlinks.

It shall be noted that press publishers' right regulation is not new for some Member States as in 2013 the relevant law was passed by *Bundestag*, under which Internet content providers to pay fees, collected by a central clearinghouse, to publishers for displaying their content: fees would have been levied for even short snippets of news made available by news aggregators and web search engines (*Podszun, 2014*). While the main aim of the press publishers' right regulation in Germany was to receive the remuneration from Google, the search engine has noted that Germany has failed to meet certain formalities in introducing such law, and the EU Commission had not been notified of the German technical regulation. In Case C-299/17, the Court of Justice of the European Union (CJEU) was asked by the regional court of Berlin to consider the enforceability of the German press publishers' right in light of the requirement to notify the European Commission of any draft technical regulation on services as foreseen in article 8(1) of



the Directive 98/34/EC laying down a procedure for the provision of information in the field of technical standards and regulations. The CJEU found that the German press publishers' right is a rule specifically aimed at information society services (search engines) and a technical regulation which the EC should have been, but was not, notified of. Following the CJEU judgement, the German press publishers' rights became inapplicable and unenforceable (*C-299/17, 2019*).

The outcome of the Case C-299/17 took place in the timeframe of the acceptance of the DSM Directive. Therefore, after the implementation of the DSM Directive in the national legislations, the new requests may be raised by the CJEU as in our view, the content of Article 15 of the DSM Directive contains some vague points that will require assessment in the course of interpretation in national legislations of the Member States. While the goal of the legislators was to ensure the rights of the publishers, in the same type of uncertainty in the wordings chosen, will rather create more controversies.

### **2.3. Use of protected content by online content-sharing service providers**

One of the most discussed provisions of the DSM Directive is the establishment of the liability of online content-sharing service providers (OCSSPs), i.e. "providers of an information society service of which the main or one of the main purposes is to store and give the public access to a large amount of copyright-protected works or other protected subject-matter uploaded by its users, which it organises and promotes for profit-making purposes" (*Directive (EU) 2019/790, 2019*). The introduced notion of OCSSPs tries to cover all varieties of service providers online and targets worldwide available platforms.

Under the Art. 17 of the DSM Directive, Member States shall provide that an OCSSP performs an act of communication to the public or an act of making available to the public when it gives the public access to copyright-protected works or other protected subject-matter uploaded by its users. Therefore, OCSSP shall obtain an authorisation from the rightsholders. Therefore, the OCSSP is directly liable for copyright infringements of their uses. Furthermore, the DSM Directive requests OCSSPs to establish "upload filters" to check the legality of the content uploaded by users (*Directive (EU) 2019/790, 2019*).

This article raised the wide range of public protests and discussions by academics.

The key issue raised is how such provision will co-exist with the fundamental human rights to freedom of expression and information.

In our opinion, Article 17 of the DSM Directive is an example of the introduction of disbalance between private interests of the rightsholders and public interests of the society. It creates unfair preponderance into rightsholders field, partially at the cost of the freedoms of others.

The Member States also raised this problem; namely, Poland has brought an action before CJEU requesting the annulment of parts of Article 17 DSM Directive because they violate users' fundamental right to freedom of expression and information in Case C-401/19.

Currently, the case is still in consideration of the CJEU, and as the final decision is yet to come, the opinion of Advocate General Saugmandsgaard Øe was delivered on July 15, 2021. AG has properly noted that the Court will have to determine whether such filtering is compatible with that freedom and to ensure that a 'fair balance' is maintained between, on the one hand, the interest of rightsholders in the effective protection of their intellectual property and, on the other, the interest of those users, and the general public, in the free flow of information online (*ØE, 2021*).

The AG holds the alternative opinion the Court should rule that that provision is valid and, consequently, dismiss the action brought by Poland. AG Øe finds that the limitation on the right to freedom of expression and information in Article 17 is justified and necessary for insurance

of effective copyright protection. At the same time, he indicates that to avoid over-blocking, the safeguards for freedom of expression are necessary. AG has agreed that Poland has raised a valid point that Article 17 is a direct limitation of the freedom of expression. However, freedom of expression is not absolute, and limitations are permissible (*ØE, 2021*).

Ms Reda and her colleagues in their study on Article 17 have rightfully noted that it violates not also the freedoms of expression and information of the users, but the freedom to conduct a business of the OCSSP as basically puts on them the obligation to create recognition technologies, without the estimation of the costs and timeframe for such (*Reda, Selinger, Servatius, 2020*).

However, in his opinion, AG *Øe* presumably focuses on the freedom of expression and information and fails to assess the influence of Article 17 on other rights and freedoms.

AG Saugmandsgaard *Øe*'s opinion will now be considered by the CJEU, who usually agrees with the Advocate-Generals' opinions.

### 3. Conclusions

With the acceptance of the DSM Directive, the new span in copyright regulation is not only within the European Union. It is fair to say that any major legislative initiatives in the EU, have if not direct, then consequential impact on the system of copyright worldwide.

It also shall be noted while the established forceful and justified goals, the reverberations of such cannot be duly estimated without giving proper time for the Member States to adjust and implement. Still, the DSM Directive needs to be discussed and observed for proper appraisal of possible issues that will arise in its implementation and how it strikes a balance between private and public interests in copyright.

1) Firstly, it is necessary to say that while one of the goals of the Directive (EU) 2019/790 is partial harmonisation of the EU copyright law in matters related to digital activities. However, considering that the national regulations vary from one Member State to another and that definitions and criteria established in the DSM Directive give the Member States the room for national legal creativity, the goal is to harmonise the EU's copyright, at least concerning digital activities will not be reached. It will likely lead to different implementation of vague definitions and disbalance how public and private interests contradict and vary from one Member State to another.

2) Secondly, while the rationale after the new exceptions and limitations was to provide that in the new age of technical means, copyrighted works may be freely used in scientific research and cultural preservation, the way how new exceptions and limitations were introduced and the scope of them, lacks the proper insurance of the public interests and seems just like vague attempt, rather than the considerable legal instrument.

3) It is interesting, the reasoning behind new press publishers' rights is to ensure the flow of news as a core element of democratic society, i.e. protection of public interests; however, at the same time covers the right of publishing houses for fair remuneration for the exploitation of their works in the digital medium.

While new press publishers' rights are a good example of coordination between public and private interests, the proposed scope of its protection lacks clarity and requires proper implementation.

4) While points made above superficially tried to ensure the public interests, Article 17 at the time strikes obvious disbalance in favour of the rightsholders. The wordings of Article 17 leave some margin of discretion for interpretation and implementation, which is, in our opinion, a dangerous way to handle the matter related directly to key fundamental rights.

5) Finally, while one of the goals of the DSM Directive is to foster pluralism and endorse creativity and new models of copyright-driven business, it is clear that we will see clear contradictions and, as a result, disputes (nationally and in CJEU) between the fundamental rights and copyright. It shall be expected that CJEU will have to review the number of requests for interpretation and “fix” the gaps not filled by the legislators, and estimate the fair balance between private and public interests.

6) In addition, the impact of the legal doctrine of the European Union on the other jurisdictions, including the countries that entered into the association agreements with the EU, shall be noted. Namely, Ukraine, Moldova and Georgia, as countries that took the obligation to update national legislation according to the EU laws, shall consider how to consider DSM Directive in their national laws.

To sum up, it can be said that the review of the DSM Directive proves the complexity of the copyright and how it is necessary to consider the number of contradicting interests and how in the course of law-making to ensure the system that will not sway the interests of one to the detriment of another in the long-term perspective. The DSM Directive must have been transposed into national law by 7 June 2021. However, the European Commission must review the Directive no sooner than 7 June 2026.

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## HEALTH, ENVIRONMENT, DEVELOPMENT

**OPTIMIZATION OF DIAGNOSIS OF SECONDARY METABOLIC DISORDERS AND TREATMENT TACTICS IN PATIENTS WITH ANEMIA IN NEOPLASTIC DISEASE IN COLORECTAL CANCER****Artem Andriiaka**

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**Summary**

Colorectal cancer is one of the most common oncological diseases, therefore, the study of this problem is an important issue in clinical practice. This problem becomes especially urgent in case of the formation of anemic syndrome in patients, which causes the emergence of a mutual burden syndrome and increases the risks for a patient. The progressive nature of anemia in colorectal cancer is accompanied by secondary metabolic disorders. The material for the study was the blood plasma of 445 patients (228 men and 217 women). Among them, 53 patients (31 women and 22 men) with iron deficiency anemia were examined and included in the first observation group (I) and 392 patients (206 men (52,55 %) and 186 women (47.45 %)) with colorectal cancer whose course of the underlying disease was burdened with anemia in neoplastic disease were included in the second observation group (II). Among the patients in the second (II) observation group, there were 222 individuals (119 men and 103 women) with malignant neoplasms of the colon (ICD-10 code: C.18), 29 individuals (16 men and 13 women) with malignant neoplasms of the rectosigmoid junction (ICD-10 code: C.19), 138 individuals (82 men and 56 women) with malignant neoplasms of the rectum (code ICD-10 C.20) and 3 patients (2 men and 1 woman) with malignant neoplasms of the anus (ICD-10 code: C.21). The age of the examined patients was from 22 to 79 years.

It was found that prior to the initiation of treatment in patients with anemia in neoplastic disease, regardless of the course of colorectal cancer, there was a significant increase in the plasma level of free fractions of heparin, histamine and serotonin ( $p < 0,001$ ); the ratio of histamine: serotonin was also changed in comparison with the values in the control group ( $p < 0,05$ ), which indicated both an increased release of heparin, histamine and serotonin from the depot, and an impaired inactivation processes of these biologically active substances.

It was correctly concluded that in addition to the baseline therapy the administration of arginine glutamate which causes both antihypoxic and membrane-stabilizing action, reliably contributes to the normalization of secondary metabolic disorders of histamine, serotonin and heparin metabolism in anemia in neoplastic disease in patients with colorectal cancer.

**Keywords:** oncological diseases, anemia, metabolic disorders, serotonin, histamine, heparin, blood plasma.

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## I. Introduction

Anemia is one of the most frequent complications of cancer. It occurs both as a result of the onset, development and progression of the tumour process, and cytostatic and/or radiation therapy, which is used to treat cancer, the presence of hemolysis, splenomegaly, hemorrhagic syndrome, hemodilution, ineffective erythropoiesis, impaired regulation of iron metabolism in the patient's body, the key link of which is now considered to be changes in the hepcidin synthesis (*Berganaschi, 2017, Vydyborets, 2017, Gordienko, 2018*). This type of anemia is called anemia in neoplastic disease (AND), and the nosological form of this anemia is included in the headings of the International Classification of Diseases (ICD) under the code D63.0. It is believed that an essential link in the AND pathogenesis is the absence of a compensatory increase in the rate of erythrocyte production, as well as a negative effect on the bone marrow (BM) of cytostatic drugs.

Long-term studies of the causes of tumours have led to the conclusion that tumour progression is the result of loss of control over cell replication due to mutation, after which the cell has an inherent potential for uncontrolled proliferation (*Weiss G, 2019, Tymchenko A, 2019*).

Until now, there is a debate about whether metabolic changes are the primary factor triggering carcinogenesis, or the tumour transformation of cells initiated due to other reasons triggers pathological variants of cell metabolism (*Avni, 2015*). But the fact of the strict dependence of tumour cells on the supply of ATP as a result of intense glycolysis remains such that there is no doubt. Tumour cells are metabolically heterogeneous, that is, they are able to change metabolism to adapt to existence in conditions of competition for energy substances with cells of the normal microenvironment. It is known that different types of tumour cells can function by different bioenergetic mechanisms, for example, glycolysis and phosphorylation (*Borysenko, 2020*). In addition to glucose, tumour cells are able to metabolize alternative energy sources – fatty acids and amino acids. The mechanisms of regulation of these processes have not yet been sufficiently studied.

Anemia is accompanied by the development of hemic hypoxia, which in turn causes a wide range of metabolic disorders characteristic of the common pathophysiological process – hypoxia, in particular, excessive release of histamine, serotonin, heparin (the metabolism of which is closely related).

The aim of the work is to improve the efficacy of AND treatment in CRC by improving the drug therapy regimen with the use of pathogenetically targeted correction of disorders identified on the basis of a comprehensive study of biochemical parameters of patients' plasma level of free fractions of serotonin, histamine, heparin.

## 2. Material and methods of research

This clinical study was conducted on the basis of the Kyiv Regional Oncological Dispensary. The material for the study was the blood plasma of 445 patients (228 men and 217 women). Among them, 53 patients (31 women and 22 men) with iron deficiency anemia (IDA) were examined and included in the first observation group (I) and 392 patients (206 men (52,55 %) and 186 women (47.45 %)) with colorectal cancer (CRC) whose course of the underlying disease was burdened with anemia in neoplastic disease (AND) were included in the second observation group (II). Among the patients in the second (II) observation group, there were 222 individuals (119 men and 103 women) with malignant neoplasms of the colon (ICD-10 code: C.18), 29 individuals (16 men and 13 women) with malignant neoplasms of

the rectosigmoid junction (ICD-10 code: C.19), 138 individuals (82 men and 56 women) with malignant neoplasms of the rectum (code ICD-10 C.20) and 3 patients (2 men and 1 woman) with malignant neoplasms of the anus (ICD-10 code: C.21). The age of the examined patients was from 22 to 79 years. The mean age of the patients was  $(63,3 \pm 1,2)$  years. Anemic syndrome was present in the examined patients upon admission to the hospital. The presence of CRC of Stage III-IV according to S. E. Dukes (1956) was determined histochemically. All patients were examined prior to the initiation of any treatment.

The severity of anemia was determined according to the criteria proposed by the National Cancer Institute (USA) and was allocated as: mild anemia – hemoglobin 10–12 g/dL; moderate anemia – 8–10 g/dL; severe anemia – 6.5–8 g/dL; life-threatening anemia – below 6,5 g/dL. Among patients with IDA, 19 people were diagnosed with mild IDA, 15 people – with moderate IDA, 11 people – with severe IDA and 8 people – with life-threatening IDA. Mild AND in CRC was diagnosed in 172 patients (92 men and 80 women), moderate – in 114 patients (66 men and 48 women), severe – in 78 people (32 men and 48 women) and life-threatening – in 28 patients (16 men and 12 women). The control group consisted of 50 primary blood donors who had no history of oncological or chronic inflammatory diseases.

The plasma level of free fraction of heparin (FHN) of the examined patients was determined using the photocolorimetric method on photoelectric colorimeter FEC 56-M after its preliminary isolation by electrophoretic method according to the appropriate procedure. The plasma level of free fractions of histamine (FH) and serotonin (FS) of the examined patients was studied using the method of fluorometric analysis on the analyzer “BIAN-130”-“BIAN-100” according to the procedure of B. V. Mykhailychenko, S. V. Vydyborets (1999).

Patients with mild and moderate anemia ( $n=286$ ) received basic therapy with iron preparations intravenously under the control of peripheral blood parameters; in addition to the administration of iron preparations patients with severe AND ( $n=78$ ) received erythropoietin preparation; and in addition to iron and erythropoietin preparations patients with life-threatening anemia ( $n=28$ ) received transfusions of erythrocytes. Depending on the therapy, some patients (observation group IIA) with AND in CRC, in addition to the basic therapy, received arginine glutamate, which is well-known and has proven itself as a hepatoprotector, which is positive in this clinical situation and due to its composition causes both antihypoxic and membrane stabilizing action. The study results were processed using the methods of variation statistics by calculating the Student t-test ( $p<0,05$ ).

### 3. Results and its discussion

Data on the parameters of the plasma level of FHN, FH, FS of primary blood donors (control group) are given in Table 1.

The obtained data of biochemical parameters of blood on the plasma level of FHN, FH, FS of primary donors can be used as controls when conducting a comparative analysis.

The biochemical values of the plasma level of FHN, FH, FS prior to the initiation of treatment in patients with mild AND in CRC are given in Table 2.

As can be seen from Table 2 prior to the initiation of treatment in patients with mild AND in CRC, there was a significant increase in the plasma level of FHN, FH, FS ( $p<0,001$ ); the ratio of FH:FS was also changed in comparison with the values in the control group ( $p<0,05$ ), which indicated both an increased release of heparin, histamine and serotonin from the depot, and an impaired inactivation processes of these biologically active substances.

The biochemical values of the plasma level of FHN, FH, FS prior to the initiation of treatment in patients with moderate AND in CRC are given in Table 3.

Table 1

**Plasma level of FHN, FH, FS of healthy subjects (M ± m)**

Studied parameter, unit of measurement	Total (n = 50)	Men (n = 29)	Women (n = 21)	Significance of differences (p)
Level of FHN, (µg/g)	21,28 ± 0,51	21,41 ± 0,75	20,96 ± 1,15	p > 0.1
Level of FH, (nmol/g)	1,45 ± 0,14	1,45 ± 0,16	1,46 ± 0,30	p > 0.1
Level of FS, (nmol/g)	0,59 ± 0,05	0,59 ± 0,09	0,57 ± 0,07	p > 0.1
Ratio FH: FS	2,8 ± 0,25	2,79 ± 0,30	2,76 ± 0,49	p > 0.1

Note: p – the significance of differences between values depending on gender.

Table 2

**The plasma level of FHN, FH, FS of patients with AND in CRC (mild course) and determination of their ratio in the period before the initiation of treatment (M ± m)**

Studied parameter, unit of measurement	Total (n = 172)	Men (n = 92)	Women (n = 80)	Significance of differences (p)
Level of FHN, (µg/g)	26,04 ± 0,35	26,17 ± 0,61	26,09 ± 0,41	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001
Level of FH, (nmol/g)	3,24 ± 0,77	3,35 ± 0,39	3,17 ± 0,52	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001
Level of FS, (nmol/g)	1,59 ± 0,04	1,65 ± 0,23	1,54 ± 0,08	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001
Ratio FH:FS	2,04 ± 0,03	2,03 ± 0,08	2,06 ± 0,07	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001

Notes: p<sub>1</sub> – the significance of differences between values depending on gender;  
p<sub>2</sub> – the significance of differences between values in comparison with the control group.

Table 3

**The plasma level of FHN, FH, FS of patients with AND (moderate course) in CRC and determination of their ratio in the period before the initiation of treatment (M ± m)**

Studied parameter, unit of measurement	Total (n = 114)	Men (n = 66)	Women (n = 48)	Significance of differences (p)
Level of FHN, (µg/g)	28,69 ± 0,39	28,17 ± 0,61	28,74 ± 0,41	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001 p <sub>3</sub> < 0,001
Level of FH, (nmol/g)	3,84 ± 0,75	3,85 ± 0,64	3,83 ± 0,52	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001 p <sub>3</sub> < 0,001
Level of FS, (nmol/g)	1,68 ± 0,02	1,75 ± 0,21	1,59 ± 0,07	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001 p <sub>3</sub> < 0,001
Ratio FH:FS	2,29 ± 0,04	2,20 ± 0,08	2,41 ± 0,07	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001 p <sub>3</sub> < 0,001

Notes: p<sub>1</sub> – the significance of differences between values depending on gender;  
p<sub>2</sub> – the significance of differences between values in comparison with the control group;  
p<sub>3</sub> – the significance of differences between values in comparison with the group of patients with mild AND.

As can be seen from the data given in Table 3, there were more significant impairments in the plasma level of the substances studied in patients with moderate AND in CRC in comparison with patients with mild anemia.

The biochemical values of the plasma level of FHN, FH, FS prior to the initiation of treatment in patients with severe AND in CRC are given in Table 4.

Table 4

**The plasma level of FHN, FH, FS of patients with AND (severe course) in CRC and determination of their ratio in the period before the initiation of treatment (M ± m)**

Studied parameter, unit of measurement	Total (n = 78)	Men (n = 32)	Women (n = 48)	Significance of differences (p)
Level of FHN, (µg/g)	36,49 ± 0,37	37,01 ± 0,64	36,14 ± 0,15	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001 p <sub>3</sub> < 0,001 p <sub>4</sub> < 0,001
Level of FH, (nmol/g)	5,11 ± 0,15	5,15 ± 0,64	5,03 ± 0,51	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001 p <sub>3</sub> < 0,001 p <sub>4</sub> < 0,001
Level of FS, (nmol/g)	1,64 ± 0,02	1,71 ± 0,11	1,51 ± 0,08	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001 p <sub>3</sub> < 0,001 p <sub>4</sub> < 0,001
Ratio FH:FS	3,11 ± 0,08	3,01 ± 0,05	3,33 ± 0,09	p <sub>1</sub> > 0,1 p <sub>2</sub> < 0,001 p <sub>3</sub> < 0,001 p <sub>4</sub> < 0,001

Notes: p<sub>1</sub> – the significance of differences between values depending on gender;

p<sub>2</sub> – the significance of differences between values in comparison with the control group;

p<sub>3</sub> – the significance of differences between values in comparison with the group of patients with mild AND; p<sub>4</sub> – the significance of differences between values in comparison with the group of patients with moderate AND.

As can be seen from Table 4 prior to the initiation of treatment in patients with severe ADN in CRC, there was a significant increase in the plasma level of FHN, FH, FS compared with the control group and patients with mild and moderate ADN; the ratio of FH:FS was also changed (p<0,001), which indicated both more significant impairments of heparin, histamine and serotonin release from the depot, and an impaired inactivation processes of these biologically active substances.

The biochemical values of the plasma level of FHN, FH, FS prior to the initiation of treatment in patients with life-threatening AND in CRC are given in Table 5.

As can be seen from Table 5 prior to the initiation of treatment in patients with life-threatening ADN in CRC, there was a significant increase in the plasma level of FHN, FH, FS compared with the control group and patients with moderate and severe ADN; the ratio of FH:FS was also changed (p<0,001), which indicated both more significant impairments of heparin, histamine and serotonin release from the depot, and impaired inactivation processes of these biologically active substances. Attention is drawn to the fact that the FH:FS ratio in this group of patients decreased in comparison with its values in patients with the severe course.



Table 5

**The plasma level of FHN, FH, FS of patients with AND (life-threatening course) in CRC and determination of their ratio in the period before the initiation of treatment ( $M \pm m$ )**

Studied parameter, unit of measurement	Total (n = 392)	Men (n = 206)	Women (n = 186)	Significance of differences (p)
Level of FHN, ( $\mu\text{g/g}$ )	41,03 $\pm$ 1,31	39,97 $\pm$ 1,69	42,19 $\pm$ 2,43	$p_1 > 0,1$ $p_2 < 0,001$ $p_3 < 0,001$ $p_4 < 0,001$ $p_5 < 0,001$
Level of FH, (nmol/g)	5,46 $\pm$ 0,48	5,45 $\pm$ 0,39	5,47 $\pm$ 0,59	$p_1 > 0,1$ $p_2 < 0,001$ $p_3 < 0,001$ $p_4 < 0,001$ $p_5 < 0,001$
Level of FS, (nmol/g)	2,49 $\pm$ 0,19	2,45 $\pm$ 0,29	2,44 $\pm$ 0,07	$p_1 > 0,1$ $p_2 < 0,001$ $p_3 < 0,001$ $p_4 < 0,001$ $p_5 < 0,001$
Ratio FH:FS	2,19 $\pm$ 0,07	2.22 $\pm$ 0,05	2,24 $\pm$ 0,08	$p_1 > 0,1$ $p_2 < 0,001$ $p_3 < 0,001$ $p_4 < 0,001$ $p_5 < 0,001$

Notes:  $p_1$  – significance of differences between values depending on gender;  $p_2$  – significance of differences between values in comparison with the control group;  $p_3$  – significance of differences between values in comparison with the group of patients with mild AND;  $p_4$  – significance of differences between values in comparison with the group of patients with moderate AND;  $p_5$  – significance of differences between values in comparison with the group of patients with severe AND.

It is known that there is a serotonergic regulation of the gastrointestinal motor function in the human body. The gastrointestinal motor function is an important component of the digestion process which ensures the uptake of food, its mechanical processing, movement along the alimentary canal in a strict sequence in accordance with the periods of chemical digestion of food ingredients in its segments. The large intestine, as an object of regulatory influence, carried out by serotonin, takes the leading place since the process of digestion in humans ends precisely in the distal colon.

Serotonin is one of the main intestinal neurotransmitters. A significant amount of serotonin is synthesized and accumulated in the mucosa of the large intestine. Serotonin is synthesized and deposited in enterochromaffin cells, the maximum content of which is found in the rectum and duodenum. Mechanical deformation of enterochromaffin cells with an increase in pressure inside the intestine causes the release of serotonin, which is confirmed by an increase in its amount, which is released into the intestinal cavity. In this case, the release of serotonin

is considered one of the intermediate stages in the action of various stimulating factors on the intestinal wall. Serotonergic neurons are widely represented in the enteric nervous system, in particular, in the Auerbach's plexus of the human intestine. Serotonergic preganglionic fibers are located mainly in the myenteric nervous plexus; a connection of this type of fibers with postganglionic neurons has been revealed. Serotonin-immunoreactive fibers form a plexus and can be traced to the circular muscle layer and submucosa of the intestine.

Considering the role of serotonin in peristalsis, one should take into account its ability to stimulate the excitability of myenteric neurons. The effect of serotonin is mediated by the activation of the corresponding 5-HT receptors. 5-HT 1A, 5-HT 3, 5-HT4 receptors are found on enteric neurons. Activation of receptors by serotonin stimulates the motor activity of the large intestine. Serotonin plays an important role in the regulation of afferent signals, motility and secretion in the digestive tract, and accordingly, disruption of biosynthesis, content, release and reuptake negatively affects the functions of the digestive tract. Serotonin is removed from the interstitial space by reuptake with the specialized transport protein SERT. The SERT transporter is characterized by a high affinity for serotonin, is a presynaptic protein that specializes in the removal of serotonin from the synaptic cleft. It is presented not only in central and peripheral neurons but also in intestinal epithelial cells and platelets. Serotonin binding systems are also found in the enteral sympathetic endings which release serotonin upon stimulation. It should be remembered that serotonin is not only a transmitter but also an important mediator of inflammation and immunity.

To date, the presence of 12 histamine derivatives has been discovered and identified in living organisms. Their presence is explained by the presence of two reactive centers in the histamine molecule: the nuclei of the amino group (NH-) and the side chain of the amino group (NH<sub>2</sub>-), thanks to which there is a certain spectrum of histamine derivatives. The existence of a certain relationship between the conformation of the histamine molecule and its biological activity has been established. It is believed that the histamine molecule is only active when the side chain is completely bent and is in transform, and the C atoms are coplanar with the imidazole ring, which provides the maximum distance between the nitrogen of the imidazole ring and the nitrogen atom of the amino group. Substitution of hydrogen in the presence of nitrogen atoms makes histamine inactive to the receptor.

Histamine is a constituent part of almost all tissues, biological fluids and faeces of animals and humans. Most of all it is in the skin, tissues of the digestive tract, lungs, that is, in the tissues which are in maximum contact with the external environment. Most often, histamine is determined in blood, plasma, urine, saliva, cerebrospinal fluid, tissues, less often – hair, sweat, mucus of the nasal passages, bile. In the blood, histamine is localized mainly in basophilic and eosinophilic leukocytes. The normal blood level of histamine in human is 40-70 ng/mL, and the plasma level – 1-2 orders of magnitude lower.

In animals and humans, histamine is synthesized from food proteins during the decarboxylation of histidine with bacteria of the intestinal flora of the *E. coli* group, and partially, in small quantities, directly from food – exogenously, and by intracellular decarboxylation of histidine with histidine decarboxylase – endogenously.

Histamine, released into the blood and tissues, is metabolized in three ways: deamination with diamine oxidase or histaminase with the formation of imidazole acid via 4-imidazolecarboxaldehyde; methylation with the formation of 1-methylhistamine or N-methylhistamine using the histamine-N-methyltransferase enzyme; acylation with the formation of 4-(beta-acetylami-noethyl)imidazole using the acetylase enzyme (in bacteria, not detected in vertebrates).

Histamine is a tissue hormone, a mediator in the nervous system, a stimulant and inhibitor of intracellular, tissue and organ transformations, as well as a pharmacological drug. The reactions caused by histamine often go beyond homeostasis and are accompanied by pathological disorders both in organs and in the body as a whole. Its presence in quantities exceeding the "pharmacological" ones often cause impairment in the normal vital functions. The toxic effect of histamine is enhanced by drugs such as monoaminooxidase inhibitors, alcohol and other biologically active amines.

The heparin synthesis in the human body mainly occurs in the cytoplasm of mast cells, where it can be in a free state or in the form of a heparin-zinc-histamine complex. In the peripheral blood, the depot of heparin is neutrophilic leukocytes. Heparin is part of the sulfated polysaccharides of tissues and its specific gravity is up to 5 %. In response to various stimuli, in particular, hypoxia, heparin is released from the depot granules. At the same time, eosinophil chemotactic factor, histamine, serotonin, dopamine, proteases (tryptases and chymases) and so on are simultaneously released. Mast cells are able not only to synthesize but also to absorb heparin from the blood circulation and incorporate it in the granules, as well as glycogen, inulin, dextrin, carboxymethyl cellulose. Depending on the structural characteristics of the polysaccharide part of the heparin molecule, the manifestation of the relationship between the internal structures of labrocytes and polymers, which have penetrated to them, are different; with the help of non-fractional 35S-heparin, it was demonstrated that heparin, which is accumulated by mast cells of the connective cell type, with increased coagulant potential of the blood, is released from them into the blood circulation and is involved in the reactions of providing hemostasis. The release of heparin from mast cells occurs with endocytosis and exocytosis. As we have already noted, one of the factors which can initiate processes of mast cell degranulation is hypoxia.

Hypoxia is a typical pathological condition that always accompanies anemic syndrome. Of course, the assumption about the importance of pathophysiological changes in the plasma level of histamine, serotonin and heparin in patients with colorectal cancer accompanied by the development of anemia of neoplasm disease will be reasonable. In our opinion, special attention should be paid to the correction of the detected secondary metabolic disorders at the stage of preparing patients for further treatment. Since such a correction should be a separate stage in the patient's treatment.

Currently, the main methods to treat anemia in oncological diseases, in particular, caused by chemotherapy, is the transfusion of media containing erythrocytes and/or the administration of preparations of erythropoietin which stimulate erythropoiesis in combination (or without) with iron preparations for parenteral (intravenous) administration.

Considering all of the above and the quite obvious reasons, namely, the secondary metabolic disorders of serotonin, histamine, heparin which manifested by a significant increase in their plasma level of patients with AMN in CRC, we suggested the need to use a medicinal product in a complex of therapeutic measures which can cause antihypoxic, membrane stabilizing and anti-edema action. Since we did not find such works in the scientific literature available to us, it was decided on the basis of clarifying the state of serotonin, histamine, heparin metabolism in the blood plasma of patients with AND in CRC, to increase the treatment efficacy by improving the drug therapy regimen.

As we noted above, all patients with AND in CRC were divided into two subgroups depending on the inclusion of arginine glutamate, which causes both antihypoxic and membrane stabilizing action, in addition to the basic therapy. The following groups were formed: a group of patients who received the indicated drug (IIA, (n = 180, 98 men and 82 women) and a group of patients who received the basic therapy only (IIB, (n = 212, 108 men and 104 women).

The safety study results of the arginine glutamate use in the treatment of patients with AND with CRC at the stage of preparation for further treatment are given in Table 6.

Table 6

**The plasma level of FHN, FH, FS of patients with AND in CRC after treatment with arginine glutamate use ( $M \pm m$ )**

Studied parameter, unit of measurement	Patients of IA group (n = 180)	Patients of IB group (n = 212)	Significance of differences (p)
Level of FHN, ( $\mu\text{g/g}$ )	$23,54 \pm 0,51$	$27,83 \pm 0,51$	$p_1 > 0,1$ $p_2 < 0,001$ $p_3 < 0,05$
Level of FH, (nmol/g)	$1,74 \pm 0,18$	$2,84 \pm 0,38$	$p_1 > 0,1$ $p_2 < 0,001$ $p_3 < 0,01$
Level of FS, (nmol/g)	$1,21 \pm 0,10$	$1,45 \pm 0,11$	$p_1 > 0,1$ $p_2 < 0,001$ $p_3 < 0,05$
Ratio FH:FS	$1,43 \pm 0,04$	$1,96 \pm 0,05$	$p_1 > 0,1$ $p_2 < 0,001$ $p_3 < 0,05$

Notes:  $p_1$  – the significance of differences between values depending on gender;  
 $p_2$  – the significance of differences between values in comparison with the control group;  
 $p_3$  – the significance of differences between values of patients in IIA and IIB groups.

As can be seen from Table 6, after the inclusion of arginine glutamate, which was administered at the beginning of treatment at a dose of 0,25 g orally three times a day after a meal for 14 days, in concomitant therapy of patients from IIA group, the plasma level of FHN, FH, FS significantly decreased ( $p < 0,05$ ) after 2 weeks and the FH:FS ratio in blood plasma normalized ( $p < 0,05$ ), which was indirect evidence of reduced severity of intoxication syndrome in patients of IIA group.

#### 4. Conclusion

Anemia in neoplastic disease in CRC is accompanied by significant changes in the metabolism of biologically active substances – free fractions of heparin, histamine, serotonin, and the ratio of free histamine to serotonin.

The main methods of treating anemia in cancer are the administration of iron preparations parenterally (intravenously), erythropoietin preparations, transfusion of erythrocyte-containing media.

The pathogenetically oriented method of treatment of patients with anemia in neoplasm disease in colorectal cancer has been improved and introduced into practice. It has a good perspective and consists of administration of a drug, which has an antioxidant, anti-edemic and membrane-stabilizing action, in the addition to the basic therapy.

The administration of arginine glutamate, which causes both antihypoxic and membrane-stabilizing action, in addition to the baseline therapy reliably contributes to the normalization of secondary metabolic disorders of histamine, serotonin and heparin metabolism in anemia in neoplastic disease in patients with rectal cancer.

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## MOLECULAR MECHANISMS UNDERLYING CANCER CELL RADIORESISTANCE

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### Summary

Radioresistance of the tumor cells remains a significant obstacle for the radiotherapy treatment of cancer. Radioresistance involves multiple genes, factors, and mechanisms that adapt cancer cells or tissues to radiotherapy-induced changes and develop resistance to ionizing radiation. The major studies of the effect of radiation on cells reported include the following areas: 1) the study of DNA damages and their repair; 2) mutations in tumor suppressor genes and radiation-induced oncogene expression; 3) the role of growth factors and cytokines; 4) violation of the cell cycle; 5) elucidation of the mechanisms of apoptosis and necrosis.

This review aimed to provide a theoretical basis, which may improve the sensitivity of cancer cells to radiotherapy. It focuses on the roles of tumor metabolism, DNA repair capacity, cell cycle checkpoints, and the tumor microenvironment in the development of radioresistance of cancer cells. Understanding the molecular alterations that lead to radioresistance may provide new diagnostic markers and therapeutic targets to improve radiotherapy efficacy.

**Keywords:** ionizing radiation, DNA repair, cell cycle, proliferation, radiotherapy.

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### 1. Introduction

According to the latest studies, the main factors involved in the development of radioresistance are the following: 1) DNA damage repair; 2) cell cycle arrest; 3) oncogene and tumor suppressor alterations; 4) changes in the tumor microenvironment; 5) autophagy (a proteasome-independent degradation of cellular components); 6) the generation of cancer stem cells (undifferentiated cancer cells with high oncogenic activity, with the self-renewal ability and multi-directional differentiation potential); 7) tumor metabolism alterations (*Chen et al., 2017; Fengsheng et al., 2016; Tang et al., 2018; Yoshida et al., 2016; Zhang et al., 2016*).

Ionizing radiation induces a number of DNA damage, including single-strand breaks (SSB) and double-strand breaks (DSB), damage of nitrogenous bases and sugar residues, the formation of inter-strand and intra-strand crosslinks of DNA-DNA and DNA-protein, the appearance of chromosomal aberrations (*Liu et al., 2021*). Radiotherapy directly induces DNA damage or indirectly causes oxidative stress. Free hydroxyl radicals are considered the ionizing radiation-induced mediators of DNA damage, including SSB and DSB, which disturb the DNA structure, triggering cell death (*Tang et al., 2018*). Like most normal cells, tumor cells have reparative systems capable of repairing damage and restoring the native structure of DNA through specific mechanisms and enzymatic complexes. DNA damage may be recognized by detectors specific to different types of repair.

Moreover, additional detector proteins are involved in the regulation of the cell cycle and are involved in the arrest or slowing of the cell cycle in the presence of DNA damage at various stages of the cell cycle. Here, an overview is provided to elucidate the interplay between tumor cell metabolism, DNA repair ability, microenvironment, and radioresistance.

## 2. Cell cycle redistribution in irradiated cells

Initial biological responses to radiation damage occur at the molecular, cellular, subcellular levels and at intervals ranging from seconds to hours or days. Among the many manifestations of the effect of ionizing radiation on cell viability, the most important is replicative cell death (suppression of the ability to divide).

The second type of replicative death of irradiated cells is the formation of so-called giant cells, which arise from the fusion of two neighboring, often "sister" cells. Such cells are capable of no more than 2-3 divisions, after which they die. Giant cells can form without fusion with a long delay in cell division of irradiated cells or their offspring. This method of cell death is inherent in aging cells and is observed after exposure to ionizing radiation. It is known that the sensitivity to radiation may also depend on the rate of proliferation of target cells (*Erenpreisa et al., 2001; Suzuki et al., 2001*).

As a result of DNA damage, cell growth may stop (*Sia et al., 2020*). At the heart of the events leading to cycle arrest in the G1 phase are reactions that increase the level of p53 protein, which, as a transcription factor, activates genes involved in cell cycle blockade (p21), induction of apoptosis (Bax), and repair (Gadd45). Ionizing radiation-induced ATM-dependent serine phosphorylation was found in p53 protein (*Khanna et al., 1998*). In addition, Chk2-catalyzed phosphorylation of serine 20 (*Chechab et al., 2000*) is also necessary for p53 stabilization, which inhibits p53 binding to MDM2. Chk2 kinase is activated by ATM (*Ward et al., 2001*), and thus, directly and indirectly, ATM is involved in p53 stabilizing by phosphorylation. Also, by phosphorylation of serine 395 in the MDM2 protein, ATM influences the ability of MDM2 to bind p53 (*Khosravi et al., 1999*). The final result of phosphorylation is the destabilization of p53-MDM2 binding, stabilization of p53 protein, and its activation as a transcription factor, which allows blocking the cell cycle in the G1 phase.

p21, an inhibitor of cyclin-dependent Cdk2 kinases, plays a fundamental role in blocking the cell cycle in the G1 phase. Inhibition of Cdk2/cyclin E kinases prevents phosphorylation of the Rb (Retinoblastoma) protein and the release of the transcription factor E2F. It blocks the transcription of many proteins needed to initiate DNA synthesis, thereby blocking the cell cycle at the G1 stage. In addition to induction of p21, the p53 protein also activates the transcription of other regulatory proteins: the 14-3-3 protein, responsible, among other things, for the removal of Cdc2 kinase from the nucleus, and the Gadd45 protein, which, apart from participating in the repair of DNA damage, also regulates the activity of Cdc2 kinase (*Al Bitar et al., 2019*). It was found that the different members of the 14-3-3 family of proteins could control p53 activity, and they could be alternative targets for the reactivation of p53 (*Falcicchio et al., 2020*). 14-3-3 $\sigma$ , a member of the 14-3-3 protein family, was closely associated with the radioresistance development by arresting cancer cells in the G2/M phase (*Chen et al., 2017*).

Mammalian cells exposed to ionizing radiation can be blocked in the G2/M phase by inactivating and translocating the protein phosphatase Cdc25C, an activator of CDK kinases, resulting from its phosphorylation (serine 216) by Chk2 kinase (*O'Connell et al., 2000*). Chk2 activation requires the presence of ATM and Nbs1 (*Buscemi et al., 2001*). It is impaired in AT (Ataxia-Telangiectasia) cells and in cells with inactive Nbs1 protein that is also defective at the G2/M checkpoint. The association of ATM with BRCA1 and the phosphorylation of BRCA1 by ATM increases under the influence of ionizing radiation (*Gatei et al., 2000*) and contributes to cell cycle arrest in the G2 phase.

The arrest of cells in the G1 phase under ionizing radiation occurs due to the transactivation of p21CIP/WAF1 by the p53 protein. p21CIP/WAF1 protein, in turn, inhibits

cyclin-dependent kinases and prevents the transition of cells to the S phase of the cell cycle, thus allowing DNA repair. (Al Bitar *et al.*, 2019; Morgan *et al.*, 2015; Shu *et al.*, 2007).

Cell arrest in the G1 phase of the cell cycle in response to ionizing radiation can also occur via the p53-independent signaling pathway. Thus, activated ATM kinase phosphorylates and activates c-ABL kinase, which, in turn, can activate p73, leading to transactivation of p21 and GADD45 (Dasika *et al.*, 1999; Lee *et al.*, 1999).

Irradiation of cells causes a slowdown in the S phase of the cell cycle. ATM, NBS1, CHK2, Cdc25A, BRCA1, SMC1, MRE11, and others are involved in this process (Falck *et al.*, 2002; Kastan *et al.*, 2001). It has been reported that BRCA1 phosphorylation by ATM kinase is necessary for the radiation-induced arrest of cells in the S phase of the cell cycle (Xu *et al.*, 2002).

Considering all the above, we can say that stopping cell growth due to exposure to ionizing radiation is also associated with either DNA repair or the apoptosis process required to eliminate cells that can't repair damaged DNA.

### 3. DNA damage and repair in irradiated cells

A signaling cascade is triggered in response to DNA damage, consisting of sensory, transducer, and effector proteins, which can stop cell growth, repair DNA or, trigger cell death (apoptosis). Sensory proteins (RAD9, RAD1, RAD17, HUS1, and others) recognize DNA damage and are likely to respond to it by directly linking double-stranded DNA breaks in mammalian cells. The RAD17 protein promotes the recognition of DNA damage by the RAD1-RAD9-HUS1 complex. ATM/ATR kinase phosphorylates the effector kinases CHK1 and CHK2, which phosphorylate the p53 protein on the Ser20 residue and other target proteins in mammalian cells (Liu *et al.*, 2021). A model was proposed, according to which changes in the structure of chromatin after DNA damage may contribute to the rapid activation of ATM kinase (Bakkenist *et al.*, 2003).

It has been reported that histone H2AX phosphorylation occurs at the sites of double-stranded DNA breaks with the participation of ATM kinase. H2AX is involved in creating specific DNA-repair complexes on damaged DNA (Sharma *et al.*, 2012). At the same time, p53 and the MDM2 protein, which mediates the degradation of p53, are phosphorylated directly by ATM kinase on Ser15 and Ser395 residues, respectively (Maya *et al.*, 2001). The phosphorylation sites of p53 (Ser15 and Ser20) and MDM2 (Ser395) are localized in the region of interaction of these proteins with each other. Thus, phosphorylation disrupts the binding of MDM2 to p53 and thus protects the p53 protein from ubiquitination and degradation (Marine *et al.*, 2010). It has been discovered that in the offsprings of human fibrosarcoma cells of the HT1080 line, survived after exposure to X-ray irradiation at a dose of 6 Gy, slow down of the activation of p53 protein occurs (Suzuki *et al.*, 2003).

Cells have many mechanisms that enable them to survive under genotoxic stress. The most important of these is the repair of DNA damage and blockage of the cell cycle. Restoration of a variety of DNA damage is possible thanks to the development of specialized repair systems, each of which is responsible for removing specific types of damage. Depending on the type of DNA damage, there are several main mechanisms of repair. Excision repair of nitrogenous bases is necessary to correct modified bases formed by the action of free radicals on DNA. This type of violation occurs by indirect damage of DNA by ionizing radiation. There are several stages of excision repair. In the first stage, the damaged nitrogenous base is cleaved by DNA glycosylases, which hydrolyze the N-glycosidic bond between the damaged base and the deoxyribose residue. Deoxyribose without a nitrogenous base, the so-called apurinic/aprimidinic



site (AP site), is excised by AP endonucleases. In the second stage, the formed “gap”, which has the size of one base, is repaired to the original sequence by the combined action of exonucleases, polymerase, and DNA ligase. Repair of single-stranded DNA breaks occurs using a complementary DNA strand as a template (Jasin *et al.*, 2013; Marsden *et al.*, 2017). The protein poly-ADP-ribose polymerase (PARP) plays an essential role in the initiation of enzymes of excision repair. Even before the activation of repair enzymes, PARP binds to the rupture of DNA and prevents the destruction of free end regions of DNA. In addition, PARP, along with DNA-dependent protein kinase (DNA-PK) and ATM protein, is involved in providing a delay in the cell cycle, which is necessary to complete the repair process (Javle *et al.*, 2011).

Single strand breaks (SSB) may arise via direct radiation-induced DNA damage or as intermediaries formed during the repair of other single strand lesions (e.g., base excision repair of oxidized bases) (Morgan *et al.*, 2015).

Double strand breaks (DSB) are the most dangerous type of DNA damage for a cell. They lead to the development of mutations and chromosomal rearrangements (aberrations), cell death, and the formation of genetic instability (Vitor *et al.*, 2020). In eukaryotic organisms, two main mechanisms of repair double-strand DNA breaks have been identified: homologous recombination (HR) and non-homologous end-joining (NHEJ). In the HR, using the undamaged homologous DNA fragment as a template with a sequence complementary to at least one broken end occurs, whereas NHEJ does not require a homologous template (Brandsma *et al.*, 2012; Frankenberg-Schwager *et al.*, 2009; Mao *et al.*, 2008).

The complex of proteins involved in double-stranded DNA breaks repairing by the HR mechanism includes ATM, BLM, BRCA1/2, c-ABL, RAD51/51C/51D/52/54, XRCC2/3, and others. Extensive studies have reported that radioresistance of hypoxic cancer cells is induced by the ATM-dependent DNA damage repair pathway, mainly through upregulation of HR mechanism of repair (Bencokova *et al.*, 2009; Hashimoto *et al.*, 2018; Olcina *et al.*, 2014). In response to DNA strand breaks, the activated form of ATM phosphorylates some HR-related factors, such as BRCA1 and FANCD2, triggering the DNA damage repair pathway. It has been suggested that ATM also plays a pivotal role in the radioresistance of cancer cells under hypoxic conditions (Suwa *et al.*, 2021).

A non-homologous joining occurs between ends of DNA that have non-homologous sequences or very short homologous regions. This reparation is not infallible and is often a source of genetic rearrangements (Mladenov *et al.*, 2011; Morgan *et al.*, 2015). Restoration of the original structure of DNA is possible only if the joining between the ends of the same strand of DNA occurs. If a process occurs between different molecules, it causes chromosomal aberrations, such as deletions, insertions, translocations, and inversions. NHEJ mechanism is carried out by a complex of proteins, including DNA-dependent protein kinase (DNA-PK), Ku70, Ku86, DNA ligase IV, XRCC4, and others. In addition, proteins MRE11, RAD50, and NBS1 (MRN complex) are involved in DNA damage repair by both the mechanism of HR and NHEJ (Her *et al.*, 2018; Morgan *et al.*, 2015). Tumor suppressors p53 and BRCA1 control the course of HR and NHEJ, but their effect on radioresistance remains the subject of intensive research (Gorodetska *et al.*, 2019; Moureau *et al.*, 2016).

The inability of cells to repair double-stranded gaps leads to genome destabilization and tumors. In some cases, double-stranded DNA breaks contribute to the induction of apoptosis. Some researchers attribute the resistance of many cells to radiation to the kinetics and repair efficiency of single- and double-stranded DNA breaks, which can also serve as an additional method of monitoring the radiotherapeutic response in the clinic (Huang *et al.*, 2020; Velegzhaninov *et al.*, 2020).

#### 4. Tumor metabolism alterations in irradiated cells

Cancer cells can obtain sufficient oxygen only when they are localized close to tumor blood vessels. On the other hand, cancer cells far from functional blood vessels can get the minimal oxygen level necessary for their survival but insufficient for active proliferation (Suwa *et al.*, 2021). Cancer cells in hypoxic regions produce ATP energy mainly via anaerobic glycolysis and generate lactate as a byproduct, leading to a unique microenvironment formation with a low pH. On the other hand, cancer cells farther away from blood vessels are deprived of oxygen and nutrients, and they die because of necrosis (Harada, 2011; Yeom *et al.*, 2012). Cancer cells adapt to hypoxic conditions by inducing the expression of hypoxia-inducible factor 1 (HIF-1), which causes the expression of various pro-angiogenic factors, such as vascular endothelial growth factor (VEGF) and platelet-derived growth factor (PDGF). Besides, HIF-1 mediates the activation of the pentose phosphate pathway (PPP) (Meijer *et al.*, 2012). The PPP, whose initial metabolite glucose-6-phosphate, is supplied via glycolysis, generates pentose sugars and ribose-5-phosphate and generates NADPH as a byproduct (Patra *et al.*, 2014). Because NADPH is a coenzyme of an antioxidant enzyme glutathione reductase, which converts oxidized glutathione (GSSG) into reduced form (GSH), and ribose-5-phosphate is essential for nucleotide synthesis, so HIF-1-mediated activation of the PPP is associated with the radioresistance of hypoxic cancer cells (Harada, 2016; Nakashima *et al.*, 2017; Telarovic *et al.*, 2021).

Glucose transporter 1 (GLUT1) protein is involved in the glucose transport through the cellular membrane into the cell, and it is upregulated under hypoxic conditions (Chung *et al.*, 2009). GLUT1 overexpression was reported to be associated with radioresistance and poor prognosis in patients with oral squamous cell carcinoma and head and neck squamous cell carcinoma (De Schutter *et al.*, 2005; Kunkel *et al.*, 2007). Radioresistant tumor cells often have high levels of GLUT1, which was associated with oncogene activation, tumor suppressor inactivation, hypoxia stimulation, and the regulation of different signaling pathways, such as MAPK and PI3K/AKT (Fang *et al.*, 2015).

The elevated glycolysis rate facilitates the rejoining of radiation-induced DNA strand breaks by activating NHEJ and HR repair mechanisms, thus reducing the radiation-induced cytogenetic damage in cancer cells (Bhatt *et al.*, 2015).

#### 5. Tumor microenvironment and radioresistance of cancer cells

Malignant tumor tissues consist of cancer cells and a wide variety of other cells responsible for the inflammatory response, angiogenesis, immune response, and support of the tumor tissue architecture, forming a complex cellular society (Suwa *et al.*, 2021). Many immunosuppressive processes increase the risk of tumor recurrence and metastasis, and immune evasion has emerged as a severe obstacle in cancer treatment (Tang *et al.*, 2017). Changes in the cytokine levels, epithelial-mesenchymal transition (EMT)-related processes, and hypoxic conditions can promote radioresistance in tumor cells (Goffart *et al.*, 2017; Krisnawan *et al.*, 2020; Zhang *et al.*, 2016).

Recent studies have shown that tumor-associated macrophages (TAMs), which exist abundantly in tumor tissues, promote tumor growth and enhance radioresistance in various cancers (Brown *et al.*, 2017; Dehne *et al.*, 2017). TAMs induce the expression of cyclooxygenase-2 (COX-2) – an enzyme participating in the synthesis of prostaglandin E2 (PGE2) which has been reported to accelerate tumor growth and induce radioresistance in cancers (Cook *et al.*, 2016). In addition, it has been suggested that TAMs induce high expression of tumor necrosis factor- $\alpha$

(TNF- $\alpha$ ), promote angiogenesis, and facilitate tumor recurrence after radiotherapy (Meng *et al.*, 2010). Vascular endothelial growth factor (VEGF) and platelet-derived growth factor (PDGF), secreted from M2-type macrophages, promote tumor regrowth after radiotherapy (Balkwill *et al.*, 2001). It has been reported that some factors secreted from cancer-associated fibroblasts (CAFs) induce radioresistance in cancer cells. For example, CAFs secrete epidermal growth factor (EGF), insulin-like growth factor 2 (IGF2), and fibroblast growth factor 4 (FGF4), which increase both the proliferation and the survival of cancer cells after irradiation (Chu *et al.*, 2014; Krisnawan *et al.*, 2020). Besides, stromal cell-derived factor 1 (SDF-1) and  $\beta$ -hydroxybutyrate secreted from CAFs induce autophagy in irradiated cancer cells and accelerate the regrowth of tumors (Wang *et al.*, 2017).

In addition, non-irradiated cells may receive apoptotic signals from neighboring irradiated cells through the bystander effect, inducing the non-irradiated cells to exhibit similar biological effects to those of the irradiated cells (Chevalier *et al.*, 2015).

## 6. Conclusions

Radioresistance of cancer cells can be provided by more than one mechanism. Radiotherapy may induce alterations in many molecules and signaling pathways involved in the tumor cell metabolism, and radiation-induced metabolic changes in cancer cells may affect the efficacy of radiotherapy. Cancer cells undergo a range of interphase and mitotic death after irradiation via direct and indirect effects of ionizing radiation. Although most radiation-induced DNA breaks in cancer cells are rapidly repaired, residual breaks or erroneous DNA repair lead to genetic instability, increased mutation rates, and chromosomal aberrations. An increased understanding of the molecular mechanisms of radiation-induced cell death will reveal novel opportunities for improving the overall anti-tumor efficacy of radiation therapy.

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## THE DIAGNOSTIC VALUE OF ANTIBODIES TO NEUTROPHIL ELASTASE IN NAFLD AND COPD PATIENTS

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### Summary

This article presents data on the influence of enzymatic activity of serum on the processes of liver fibrosis in patients with non-alcoholic fatty liver disease (NAFLD) and chronic obstructive pulmonary disease (COPD). Clinical, biochemical, immunological research methods and enzyme-linked immunosorbent assay (ELISA) were used in the work. All patients were determined for the degree of liver fibrosis using a non-invasive method – Fibromax. It was found that in patients with NAFLD and COPD with frequent exacerbations, the levels of CRP, IL-6, TNF- $\alpha$  and neopterin are significantly higher than in patients who had one or no exacerbation of COPD. Stably high levels of systemic inflammation markers of TNF- $\alpha$ , neopterin, CRP lead to the activation of TGF- $\beta$ , which increases with the deepening stage of liver fibrosis. The average values of IgG antibodies to neutrophil elastase significantly increase depending on the stage of fibrotic changes in the liver and the activity of inflammatory changes in it, with the highest concentration in fibrosis F2. In F3-4 fibrosis, the levels of antibodies to elastase are reduced, although they remain higher than the control values. Significant increase IgG antibody levels to neutrophil elastase depending on the stage of fibrosis and the activity of inflammatory changes indicates the role of serum enzymatic activity in the mechanisms of formation of more severe stages of NAFLD and can be considered as additional diagnostic markers.

**Keywords:** liver fibrosis, hepatic steatosis, enzymatic activity of blood serum.

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### 1. Introduction

There is a strong justification for supporting the hypothesis of an increase in the prevalence of nonalcoholic fatty liver disease (NAFLD) in patients with chronic obstructive pulmonary disease (COPD) (*Chan, Stanley et al., 2019*). Frequent combination of COPD and NAFLD is due to the common links of pathogenesis, namely the presence of systemic inflammation. There is strong evidence that pneumonia during COPD leads to an increase the number of biomarkers associated with neutrophilic inflammation (MMP9, elastase, calprotectin) and proinflammatory cytokines (IL-6, IL-1 $\beta$ , IFN- $\alpha$ , CRP, TNF- $\alpha$ ,) not only "in the lungs and bronchi", but also in the peripheral blood, which indicates the presence of a systemic inflammatory reaction or systemic inflammation and plays an important role in pathophysiology of COPD and its comorbidities such as metabolic syndrome (*Yazici et al., 2020; Huang et al., 2019*). Several studies have reported that frequent exacerbations of COPD potentiate the progression



of NAFLD with high inflammatory activity and increased hepatic steatosis. Recently, there are conflicting data in the literature on the role of neutrophils in the human body. Traditionally, neutrophils are recognized as key components of the innate immune system, which exhibit antimicrobial functions and participate in the regulation of the adaptive immune response (Xu et al., 2020) and are the first-line protection in acute inflammation caused by infection (Amulic et al., 2020). However, other data show that neutrophils are heterogeneous and may be involved in tissue damage, as their activators may be not only infectious causes, but also other cell damage (Lehman et al., 2020). There have been isolated reports that infiltration of neutrophils into the liver with their autocrine, paracrine, and immune properties is a major pathological feature of various liver diseases, including nonalcoholic steatohepatitis (NASH), viral hepatitis, and alcoholic liver disease (Liu et al., 2021). That is, the function of neutrophils in various liver diseases can be not only protective but also damaging. Neutrophils release various serine proteases, including neutrophil elastase (NE), to activate hepatic macrophages and secrete chemokines and cytokines to induce peripheral blood macrophage aggregation and Kupffer cell proliferation (Wu et al., 2020). It has also been found that NE leads to activation of metalloproteinases (MMPs), connective tissue remodeling, activation of immune resistance mechanisms and is a regulator in maintaining the activity of pro- and anti-inflammatory cytokines. However, the exact mechanisms of the pathogenesis of the transition from steatosis to fibrosis in patients with NAFLD under the condition of comorbidity of COPD have not been fully established.

Despite the large number of studies to date, there is no effective treatment of NAFLD, which emphasizes the need for further study of the main pathogenetic mechanisms underlying the development and progression of hepatic steatosis in NASH in patients with COPD. The role of serum enzymatic activity, in particular neutrophil elastase, which may be important for the diagnosis and treatment of patients in this category, needs further study.

The aim of research was to establish the relationship between levels of antibodies to neutrophil elastase and markers of liver fibrosis in patients with NAFLD under the condition of comorbidity with COPD.

## 2. Materials and methods of research

The following parameters were studied – TNF- $\alpha$ , IL-6, neopterin, tissue growth factor (TGF) - $\beta$ , IgG antibodies to neutrophil elastase and tissue inhibitor of metalloproteinases-1 (TIMP-1) in the serum of 82 patients diagnosed with NAFLD and COPD of groups B and C. Among the surveyed were 61.0% (50) men and 40.0% (32) women. The mean age of patients was  $57.8 \pm 1.5$  years.

Depending on the nosology, patients were divided into two groups: group 1 (main,  $n = 52$ ) – NAFLD + COPD and Group 2 (comparison,  $n = 30$ ) – patients with NAFLD. Taking into account the frequency of exacerbations of COPD, group 1 was divided into: group 1a ( $n = 22$ ) – patients with NAFLD + COPD group II and group 1b ( $n = 30$ ) – patients with NAFLD + COPD group II C. The average exacerbation in group 1a –  $1.02 \pm 0.22$  and in group 1b –  $2.52 \pm 0.25$ . The groups were representative by age, sex and severity of the disease. The control group consisted of 30 healthy individuals (mean age  $35.3 \pm 1.4$  years). Patients were prescribed basic therapy for COPD in accordance with the order of the Ministry of Health of Ukraine №555 from 27.06.13 (fenoterol / ipratropium bromide 50/20 in one dose after 8 hours).

The studies were performed in the exacerbation phase of COPD and the remission phase – after 3 months after discharge from the hospital. Studies were conducted with the informed consent of patients, and their methodology complies with the Helsinki Declaration

of 1975 and its 1983 revision approved by the local Research Commission (Protocol №1 from 10.01.2020).

The inclusion criteria in the study confirmed the diagnosis of chronic obstructive pulmonary disease (GOLD II) and age over 40 and less than 70 years and / or NAFLD. Exclusion criteria were the presence of markers of viral hepatitis B and C, markers of autoimmune hepatitis / cross syndrome (anti-LKM-1, anti-SLA and anti-LC-1) and HIV infection, alcohol consumption, toxic liver damage and patient rejection. from research.

The diagnosis of COPD was made according to the International Classification of Diseases-10 revision and confirmed by spirometry, which recorded a decrease in the ratio of FEV1 / FVC <0.7 (70%) after taking a bronchodilator. The duration of the disease, the frequency of exacerbations of COPD during the last year was determined by retrospective study of the anamnesis (order of the Ministry of Health of Ukraine №555 from 27.06.13).

The diagnosis of NAFLD was established according to the unified clinical protocol "Non-alcoholic steatohepatitis" (2014) and the adapted clinical guideline based on the evidence "Non-alcoholic fatty liver disease" (2012), according to the recommendations of the European Association for the Study of the Liver (EASL).

Enzyme-linked immunosorbent assay (ELISA) was used to determine levels of C-reactive protein (CPR), concentrations of TNF- $\alpha$ , IL-6, neopterin and IgG antibodies to neutrophil serum elastase. The results of the studies were taken into account on an automatic enzyme-linked immunosorbent assay "STATFAX" according to the instructions included with the reagent kits Diagnostics Biochem Canada and DRG (USA). The functional state of the liver was assessed by biochemical analysis of blood – total bilirubin and its fractions, total protein and protein fractions, the activity of serum cytolytic enzymes alanine aminotransferase (ALT) and aspartate aminotransferase (AST) and activity of cholestatic enzymes (alkaline phosphatase and  $\gamma$ -glutamyltranspeptidase), the level of urea, creatinine, glucose, which was determined using an automatic biochemical analyzer and original reagents ChemWell, Awareness Technology INC (USA). The lipid composition of the blood was characterized by the concentration of total cholesterol, low-density lipoprotein cholesterol (LDL cholesterol), high-density lipoprotein cholesterol (HDL cholesterol) and triglycerides (TG), using kits "Bio-La-ChechA". Indicators of the general analysis of blood were defined according to the standard method using an automatic hematology analyzer BC-2800 (Mindray, China).

To determine the stage of steatosis and liver fibrosis used a non-invasive method of diagnosis – FibroMax, which includes: FibroTest, ActiTest, SteatoTest, AshTest, NashTest. The study is based on a comprehensive analysis of 10 biochemical parameters: alpha-2-Macroglobulin, haptoglobin, Apolipoprotein-AI, gamma-glutamyl transpeptidase, total bilirubin, ALT, AST, blood glucose, TG, cholesterol. All general clinical, biochemical and immunological tests were performed in certified laboratories, all medical equipment was under metrological control.

All patients underwent abdominal ultrasound examination according to the conventional method, which was performed on a Philips HDI-1500 with a scanning sensor with a frequency of 3.5 MHz. Depending on the ultrasound picture of fatty infiltration of the liver and the inflammatory process in all patients, steatosis was assessed as minimal, moderate and severe. To assess the trophological status of patients, height, weight, waist circumference, and body mass index (BMI) were determined, which was calculated according to the generally accepted formula. The BMI of 18.5-24.9 kg / m<sup>2</sup> was considered the norm. According to the criteria of the International Diabetes Federation (IDF) in 2005 to determine the criteria of abdominal or central obesity were assessed using waist circumference (WC), waist-to-hip ratio (WHR) and waist-to-height ratio (WHTR). The presence of abdominal obesity in patients was confirmed

by anthropometric data, namely: an increase in waist circumference (WC) in men from 94 to 130 cm, on average up to  $(102.8 \pm 1.2)$  cm, in women from 82 to 142 cm, on average up to  $(93.1 \pm 2.0)$  cm; as well as measuring the waist-to-hip ratio (WHR) and body mass index (BMI). Patients were diagnosed with abdominal obesity in accordance with generally accepted criteria for certain of central obesity indexes.

For statistical processing of the obtained data, parametric and nonparametric methods (Kruskal-Wallis test, Mann-Whitney test; Pearson's linear correlation coefficient, Student's t-test) were used in the SPSS 11.5 package environment. The mean values, standard errors and significance of differences that were considered probable at  $p < 0.05$  were estimated.

### 3. Results

Analyzing the data obtained, it was found that increased levels of markers of chronic inflammation were observed in all subjects. However, it is noteworthy that in patients with comorbid conditions, the increase in each indicator was significantly higher than in patients with one nosology. The levels of some markers depended on the frequency of exacerbations of COPD (Table 1).

Table 1

**The average values of individual blood parameters in the examined patients**

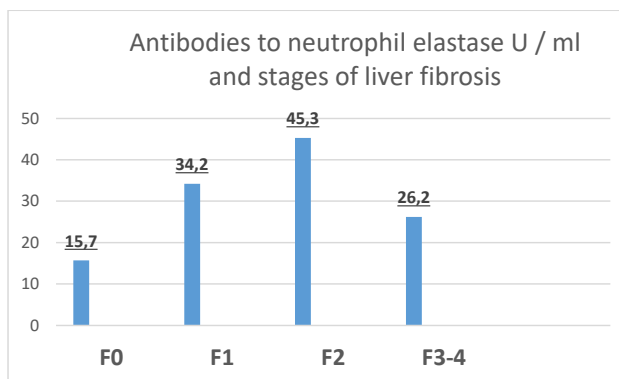
Parameters	Groups			
	NAFLD + COPD (main group, n=52)		NAFLD comparison group (n=30)	Control group of healthy individuals (n=30)
	group 1a n=22	group 1b n=30		
CRP, mg / l	$16,4 \pm 1,7^{*}$	$22,5 \pm 2,5^{**}$	$3,6 \pm 0,3$	$2,7 \pm 0,9$
ESR, mm / h	$15,3 \pm 0,3^{*}$	$18,0 \pm 0,3^{*}$	$8,2 \pm 0,3$	$8,5 \pm 2,8$
TNF-a, pg / ml	$207,5 \pm 10,3^{*}$	$565,3 \pm 12,5^{**}$	$175,6 \pm 5,4^{*}$	$9,5 \pm 0,7$
IL-6, pg / ml	$15,4 \pm 1,3^{*}$	$19,5 \pm 0,8^{*}$	$7,8 \pm 1,7^{*}$	$3,9 \pm 1,2$
Neopterin, nmol / l	$147,3 \pm 0,3^{*}$	$428,6 \pm 1,5^{**}$	$109,5 \pm 1,8^{*}$	$7,2 \pm 1,2$
TGF- $\beta$ , pg / ml	$357,3 \pm 58,9^{*}$	$429,8 \pm 95,2^{**}$	$245,4 \pm 15,7^{*}$	$154,0 \pm 22,7$
TIMP-1, ng / ml	$624,0 \pm 127,3^{*}$	$733,4 \pm 119,5^{**}$	$458,6 \pm 76,3^{*}$	$122,0 \pm 17,3$
Antibodies to IgG Neutrophil elastase, U / ml	$32,2 \pm 3,5^{*}$	$41,2 \pm 5,8^{*}$	$6,2 \pm 1,8^{*}$	$3,2 \pm 0,8$
Total cholesterol (TC), mmol / l	$6,2 \pm 0,5^{*}$	$5,9 \pm 0,7^{*}$	$5,5 \pm 0,4^{*}$	$4,2 \pm 0,7$
Triglycerides (TG) mmol / l	$3,2 \pm 0,4^{*}$	$2,8 \pm 0,3^{*}$	$2,6 \pm 0,2^{*}$	$1,3 \pm 0,3$
ALAT, IU / l	$89,8 \pm 12,4^{*}$	$75,5 \pm 18,2^{*}$	$65,3 \pm 10,2^{**}$	$20,5 \pm 3,4$
BMI, kg / m <sup>2</sup>	$28,5 \pm 0,7^{*}$	$26,5 \pm 0,5$	$27,5 \pm 0,3$	$22,5 \pm 0,4$
Waist-to-hip ratio (WHR)	$1,35 \pm 0,2^{*}$	$1,20 \pm 0,3^{*}$	$1,15 \pm 0,1^{*}$	$0,78 \pm 0,05$

Notes: Significance of the difference: \* – with the control group; \*\* – with group 1a;

• – with group 2 (the indicator is calculated by the Mann-Whitney test,  $p < 0,05$ )

The highest values of CRP were in the group of patients with NAFLD + COPD with frequent exacerbations (2 or more exacerbations per year), which required hospitalization and exceeded the norm by 8.3 times. TNF- $\alpha$  and neopterin levels in patients with frequent exacerbations of COPD with hospitalization were 2.7 times and 1.9 times higher than in patients with a small number of exacerbations ( $p < 0.05$ ) and 3.2 and 3.9 times respectively, higher than in patients with NAFLD without COPD. Patients with NAFLD combined with COPD, proinflammatory cytokines TNF- $\alpha$ , neopterin, and CRP levels are major in maintaining the inflammatory process during exacerbations. There was also a positive correlation between TNF- $\alpha$  and neopterin with the number of segmental neutrophils and levels of antibodies to neutrophil elastase ( $r = 0.38$ ;  $p < 0.05$  and  $r = 0.42$ ;  $p < 0.05$ ).

It should be noted that the concentration of IgG antibodies to neutrophil elastase is significantly higher in all patients with NAFLD, regardless of the frequency of exacerbations of COPD. However, it was found that the average values of IgG antibodies to neutrophil elastase significantly increase depending on the stage of fibrotic changes in the liver and the activity of inflammation ( $p < 0.05$ ), with its highest concentration in fibrosis F2 and directly correlate with BMI, cholesterol concentration, triglycerides and alanine aminotransferase ( $r = 0.43$ ;  $p < 0.05$  and  $r = 0.45$ ;  $p < 0.05$ ). In fibrosis F3-4, the levels of antibodies to elastase are reduced, although they remain higher than the control values (Fig. 1)



**Fig. 1. Concentrations of antibodies to elastase depending on the stage of fibrosis**

TIMP-1 levels also increase with the stage of fibrosis to F2 and are directly proportional to the concentration of antibodies to elastase ( $r = 0.46$ ;  $p < 0.05$ ) and do not depend on the frequency of COPD exacerbations.

The concentration of TGF- $\beta$  was significantly higher in patients with NAFLD + COPD with a predominance in group 1b, namely 3.4 times ( $p < 0.05$ ) more than in the control group and 2.2 times ( $p < 0, 05$ ) more than in patients of group 2. TGF- $\beta$  levels were significantly ( $p < 0.05$ ) increased in patients with F4 stage of liver fibrosis.

#### 4. Discussion

Studies have shown that high levels of antibodies to neutrophil elastase reflect an increase in metabolic inflammation of the liver, thereby contributing to the progression of NAFLD. The concentration of antibodies to neutrophil elastase in the serum was associated with TNF- $\alpha$ , neopterin, C-reactive protein and some components of the metabolic syndrome. The results

of this study showed that in patients with COPD comorbid with frequent exacerbations, the levels of CRP, IL-6, TNF- $\alpha$  and neopterin are significantly higher even in the remission phase of COPD, and than in patients who had one or did not tolerate any exacerbation for the last year. Stably high levels of markers of systemic inflammation in terms of TNF- $\alpha$ , neopterin, CRP lead to the activation of TGF- $\beta$ , which increases with the progression of liver fibrosis. Activation of profibrotic cytokine -TGF- $\beta$  supports liver fibrosis, proving the role of COPD in the progression of NAFLD. The data obtained coincide with the results of other scientists who found a correlation between systemic inflammation and the progression of comorbidities in patients with COPD, which includes NAFLD (Barnes & et al., 2009). The recorded consistently high concentration of IgG antibodies to neutrophil elastase may indirectly indicate a high level of activity of this enzyme in the serum in patients with NAFLD comorbid with COPD and confirms the participation of enzymatic activity of serum in liver fibrogenesis. Increased neutrophil elastase activity affects the activation of proteinase-activating receptors (PARs).

This leads to the start of the synthesis of transcriptional factors of connective tissue repair through reciprocal interaction between TGF- $\beta$  and EGFR-MEK-ERK signaling pathways, which is also an important factor in the development of tissue fibrosis (Hlapčić & et al., 2020). In F3-4 fibrosis, the levels of IgG antibodies to neutrophil elastase are reduced, although they remain higher than the control values, which may indicate the attenuation of inflammatory processes in the liver and the predominance of fibrosis processes. Our data coincide with scientific reports that in patients with severe liver fibrosis (stage III, IV) elastase activity is significantly lower than in patients with initial stages, but higher than the level of control (Wu et al., 2020).

## 5. Conclusion

Levels of IgG antibodies to neutrophil elastase increase with increasing stage of liver fibrosis and are predictors of the development and progression of fibrotic changes in patients with NAFLD on the background of COPD. The concentration of antibodies to neutrophil elastase in the blood directly correlates with the levels of TNF- $\alpha$ , neopterin, CRP, ALT and with such components of the metabolic syndrome as body mass index, hypercholesterolemia and hypertriglyceridemia. Significant increase IgG antibody levels to neutrophil elastase depending on the stage of fibrosis and the activity of inflammatory changes indicates the role of serum enzymatic activity in the mechanisms of formation of more severe stages of NAFLD and can be considered as additional diagnostic markers.

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## THE MODERN VIEW OF PHYSICAL THERAPY ON RECOVERY OF PATIENTS AFTER STROKE WITH UPPER LIMB SPASTICITY

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### Summary

The purpose of the article is to analyze recommendations for physical therapy methods after acute cerebrovascular accident. Most often, complications of the function of the upper limb occur, this causes difficulties in everyday and professional life. In most cases, the function in the arm is restored worse than in the leg. In case of insufficient restoration of hand function, an occupational therapist teaches the patient the basic skills of self-care: eating, bathing, personal toilet, dressing, controlling bowel movements and urination, using the toilet, moving around, the ability to move on a flat surface, climbing stairs. There are many technical devices that allow you to be independent: an anti-slip mat, prevention of falling in the bathroom, hand-rails, a step into the bathtub, seats in the bathtub, etc.

In the first month of the recovery period, people after a stroke develop complications – contractures of the affected limbs, pain and pulling sensations; spasticity develops, which impairs coordination and balance and, as a result, increases dependence on others. Spasticity increases unevenly, the patient develops a peculiar Wernicke-Mann posture: the upper limb is bent at the elbow and radial wrist joints, the fingers are clenched into a fist; the lower limb is straightened at the hip, knee and ankle joints. Unqualified recommendations and improper selection of a physical therapy program provoke an increase in spasticity.

**Objective.** To find effective evidence-based physical therapy methods that affect the restoration of upper limb function.

**Methods.** Scientific literature analysis, synthesis, generalization, pedagogical observation.

An important question for a physical therapist is the selection of effective methods that positively affect the restoration of functional movement of the upper limb, the patient receives an achievable request, and the specialist is able to prevent negative consequences and get good results in a short time.

**Keywords:** target, recovery, recommendations, hand, contracture, modified Ashworth scale.

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### 1. Introduction

According to the official statistics of the Ministry of Health, in Ukraine, cerebrovascular diseases are the cause of death №2. Every year there are 100,000-110,000 strokes, more than a third of them – in people of working age. 30-40% of people die within the first 30 days and up to 50% – within a year from the onset of the disease; 20-40% of survivors become dependent on outside help, and only about 10% return to a fulfilling life.

Stroke is an acute disorder of cerebral circulation, characterized by impaired motor, speech and social interactions.

Factors affecting the risk of stroke: high blood pressure, diabetes mellitus, high blood cholesterol, the presence of bad habits (smoking, excessive alcohol consumption), a sedentary lifestyle, obesity, constant stress. Lifestyle changes can prevent and significantly reduce the risk of stroke.

Thanks to the Uniform clinical protocols of medical care for ischemic, hemorrhagic stroke (scope of examinations, treatment plan and preventive measures), it is possible to prevent negative consequences. The multidisciplinary team builds a common goal and implements recommendations to prevent complications arising in the late period after stroke.

If you choose the right methods of physical therapy in patients after a stroke, the chance of positive dynamics in recovery and prevention of complications such as pressure sores, contractures, pulling pain in the affected limb, and the development of spasticity increases. Patients with spasticity have a loss of sensitivity, impaired balance and coordination, limited range of motion, muscle stiffness, and the inability to be independent in everyday life.

We need a modern view of the problem. Usually the request of patients after stroke: maximum recovery of motor functions. With the help of effective methods of physical therapy, patients after rehabilitation intervention should improve independence in their own body, the ability to use the affected limb and an increase in activity in everyday activities.

## 2. Evidence-based methods for upper limb recovery after stroke

Stroke has consequences at different levels of functioning. Violation of strength, amplitude of movement, leads to a decrease in functioning which affects the quality of life.

Physical therapists must be guided by the ethics of the physical therapist and the job description. Based on human rights in the field of health care, do not harm and carry out rehabilitation measures in the open access for patients who seek help.

Physical therapists work with stroke patients to restore sensorimotor function in the upper and lower extremities. Families and caregivers who are involved in the restoration of functional mobility provide training. Treatment of stroke patients is most effective when all members of the multidisciplinary team are involved. Professionals should understand that the patient is primarily a person who had his own responsibilities, functional capabilities, was responsible every day in the family, work, etc.

Short-term and long-term goal setting should be coordinated with the patient and his family. Each specialist in a multidisciplinary team should make every effort to help restore a person's lost motor functions, give him the opportunity to live independently in order to be socially in demand. Applying the International Classification of Functioning (ICF), which makes it possible to conduct an in-depth analysis of the existing disabilities.

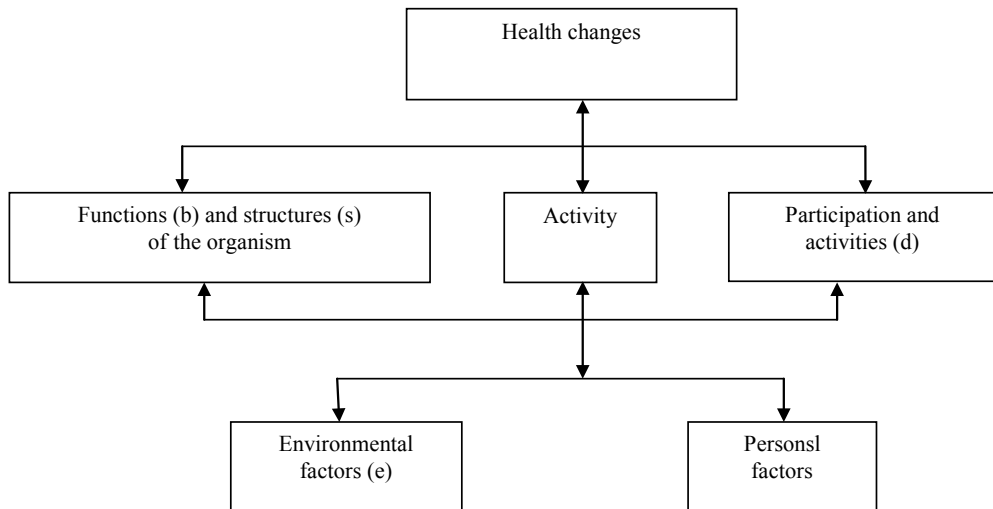
The ICF describes human-related functioning and limitations and serves as a structural basis for organizing information. The ICF combines information into two parts, each of which contains two components (Fig. 1):

Part 1, the component concerns – Functioning and limitation of vital functions: Functions and structure of the organism; Activities and participation.

Part 2 of the component concerns – Contextual factors: Environmental and personality factors (*International classification of functions, brief version, 2003*).

The international classification of functioning is aimed at restoring lost functions in the opinion of the patient and family, which is necessary for improving functioning, reducing the limitation of vital functions, maximizing the realization of activity and participation.





**Figure 1. Interaction between the components of the ICF (International Classification of functioning, 2003)**

Before starting rehabilitation, it is necessary to study the patient's history, conduct a physical therapy examination, assess the neurological and cognitive state using informative tests and scales.

The Academy of Neurological Physical Therapy, American Physical Therapy Association has developed guidelines for the use of clinical assessment tools in a variety of pathologies, patients in a variety of settings. Chedoke-McMaster Stroke Scale, NIH Stroke Severity Scale, Modified Rankine Scale, Modified Ashworth Scale, Berg Balance Scale (BBS), Visual Analogue Pain Intensity Scale, Arm, Shoulder, and Hand Disability (DASH), the Barthel Index, the Montreal Cognitive Scale (MoCo) and others (*Veerbeek et al 2014*).

During a general examination, attention is paid to the mode of movement, the nature of movements, the volume of passive movements, the condition of the skin, muscles, ligaments, joints (*Potekhin, Zhdanov, 2011*).

A neurological examination of the upper limb includes an examination of muscle strength, range of motion and functional capacity of the spastic limb. Tests and scales are used: modified Ashworth spasticity scale, Tardier scale, functional independence scale, test of 9 holes and rods, assessment of the functional activity of the affected limb according to the Frenh scale, and others.

After the examination, the physical therapist learns the patient about the request, goals are planned in SMART format – short-term and long-term (*Hertsyk A., 2016*). Usually, everyone has a desire, after an acute cerebrovascular accident, to restore movement in the affected limb. An individual rehabilitation program is formed and during each day, the patient and the physical therapist, by the time of discharge, make efforts to achieve the goal.

### 3. Analysis of evidence-based medicine methods

The use of aids: splinting, bandaging, wrist orthoses. The purpose of using orthoses is to reduce spasticity, reduce pain, influence functional results, prevent edema and contractures.

Treatment indicators were not significant, did not have statistical significance. Bandaging, splinting and the use of orthoses do not improve the motor function of the upper limbs, coordination and accuracy of movements, do not increase the range of motion, do not affect spasticity and muscle strength, and do not reduce edema (*Tyso, Kent, 2011*). The brace keeps the paretic limb in a passive state, and as a result, it forms contractures and provokes increasing spasticity and pain.

Robotic devices can help patients with active movements, to maintain range and flexibility of movements, and temporarily reduce hypertonicity or resistance to passive movements. The exoskeleton can help to carry out active movements, but cannot completely perform them independently (*Lum et al 2002*).

The exoskeleton in combination with therapeutic approaches is ineffective for the rehabilitation of the upper limbs after stroke. Evidence is ambiguous, the ability of the exoskeleton does not improve motor function, accuracy and coordination of movements, does not affect the reduction of spasticity (*Mehrholz et al 2012; Mehrholz et al 2015; Veerbeek et al 2014*).

The most common forms of virtual stimulators are head-mounted monitors or conventional computer models or projector screens.

The results showed that virtual reality had no significant effect on grip strength or overall motor function. Virtual reality does not improve the function of the upper limb, does not affect the coordination of movements, and has no effect on reducing spasticity, accuracy and muscle strength (*Laver et al., 2015*).

Functional electrical stimulation is used for the upper limb in hemiparetic lesions. In two studies, electrical stimulation was performed in combination with exercise therapy, and the program was based on exercise therapy. There were no significant differences between the groups (*Hsu et al., 2010, Kowalczewski et al., 2007*).

Using neuromuscular electrical stimulation that does not increase muscle strength and does not improve motor function. The literature provides mixed data on reduced spasticity and increased range of motion or improved outcomes after stroke severity (*Kwakkel et al 2016*).

Analysis of materials does not provide effective methods for restoring the function of a spastic upper limb. It is advisable to continue to study and research a topic that remains open to the consideration of scientists: physical therapy of patients after stroke with spasticity of the upper limb in the late period.

With the help of physical therapy methods, patients after a stroke with spasticity of the upper limb in the late period have the opportunity to restore the function of the affected limb for further use in domestic activities.

#### **4. Pain in the shoulder after a stroke**

One of the consequences of a stroke that leads to disability is shoulder pain (*Najenson et al., 1971*). The hand in the initial period with hemiplegic form is hypotonic or sluggish. The cause of the subluxation of the shoulder is not the stability of the rotator cuff of the muscle-tendon sleeve. The muscles of the shoulder do not perform their function, they do not contain the head of the humerus in the glenoid fossa. Also proper care and maintenance in bed, lack of support in an upright position contribute to shoulder subluxation (*Chaco, Wolf, 1971*)

The main factor in shoulder pain is spasticity, which is most common in patients with hemiplegia. Tense muscles inhibit movement, decrease amplitude, and muscle imbalance occurs. Contraction of all muscles located around the shoulder joint: shoulder adductors, subscapularis, pectoralis major, round and latissimus dorsi.

Stable support and static shoulder stretching are considered insufficient to reduce pain, and neuromuscular electrical stimulation has not been proven to be effective.

## 5. Conclusion

In the process of physical therapy, it is advisable to use methods that are aimed at improving the range of motion, reducing pain and improving the patient's muscular activity. Methods that are aimed at developing gross and fine motor skills, balance and coordination of movements. With the help of effective methods of physical therapy, as a result, an appropriate stereotype of movements is formed, does not have compensatory defects and, as a result, does not return the affected limb to the previous intolerable state.

After analyzing the methods of evidence-based medicine, we came to the conclusion that it is advisable to study the topic: physical therapy of patients after a stroke with the introduction of effective methods to help restore the lost motor function in the upper limb.

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## PROGNOSTIC CLINICAL, MORPHOLOGICAL AND IMMUNOHISTOCHEMICAL MARKERS OF LOW-GRADE SEROUS OVARIAN CARCINOMAS OF WOMEN WITH SEROUS BORDERLINE TUMORS IN ANAMNESIS

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### Summary

The problem of finding reliable clinical and morphological criteria for diagnosis and prognosis of serous borderline ovarian tumors, their relationship with the risk of developing of low-grade serous ovarian carcinomas (LGSC) in future is still relevant.

This study is devoted to research and highlight of precursors that allow dividing women with serous borderline ovarian tumors (SBOT) into risk group for occurrence of LGSC within next 5 years.

The study included 22 patients with FIGO stage I-II SBOT aged 24 to 46 years, 9 (39.13%) of whom were diagnosed with high-grade serous ovarian carcinoma next 5 years. Two study groups were formed: the control group (n = 13), which included patients with SBOT without further development of LGSC, and the main group (n = 9), which included women with emerging LGSCs. We studied expression of immunohistochemical markers Ki-67, MMP-9, p53, Bcl-2, E-cadherin, and also a diameter and localization of the tumor.

As a result of the study, it was found that patients with diameter of the SBOT  $\geq 10$  cm ( $\chi^2 = 6.0$ ,  $p < 0.03$ ), FIGO stage II ( $\chi^2 = 4.7$ ,  $p < 0.03$ ) and Ki-67 expression  $\geq 10\%$  ( $\chi^2 = 9.03$ ,  $p < 0.03$ ) have a high risk of developing LGSC within next 5 years. In the group of women who underwent LGSC development, there was a tendency to more pronounced expression of MMP-9 ( $\chi^2 = 4.18$ ,  $p < 0.04$ ) and moderate and pronounced expression of Bcl-2 ( $\chi^2 = 9.66$ ,  $p = 0.008$ ).

According to our data, markers Ki-67, MMP-9, Bcl-2 are prognostic and can be used as markers of LGSC risk in women with a history of SBOT. Tumor diameter  $\geq 10$  cm is also a predictor.

**Keywords:** SBOT, prognostic markers, LGSC, Ki-67, MMP-9, Bcl-2, p53

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### 1. Introduction

Borderline ovarian tumors (BOT) were first described by Howard Taylor in 1929 and had characteristics of "semi-malignant", since despite tendency to disseminate along peritoneum, they had a favorable prognosis. In 1971, the International Federation of Obstetrics and Gynecology (FIGO) also implemented this group of neoplasms in classification, calling them "tumors with low malignancy potential" (*Hauptmann et al., 2017*).

BOT stands at 15-20% of all tumors of the mentioned localization, while in histological structure the leading place (from 53 to 65%) is given to serous borderline ovarian tumors. (*Davydova et al., 2021*). Approximately 30% of SBOT are bilateral (*Davydova et al., 2021*)

(Ozer *et al.*, 2012) Women of reproductive age in the age range of 30-40 years are susceptible to development of SBOT, (Davydova *et al.*, 2021), the average age of patients, according to WHO, is 43 years old (Herrington, C. S., 2020). In contrast to malignant neoplasms of the ovaries, 75% of SBOT is diagnosed at an early stage (IA, IB stages according to FIGO) (Hauptmann *et al.*, 2017).

According to 2020 WHO classification of tumors of female reproductive system, a small percentage of women with low-grade serous carcinomas had a history of SBOT. Although, according to WHO data, LGSC stands at only 5% of all ovarian carcinomas, an interesting and clinically important aspect is the identification of possible objective clinical and morphological predictors of LGSC occurrence in patients with a history of SBOT.

Despite the relatively favorable prognosis of PCOS, there is still no consensus on the criteria for aggressiveness and prognostic markers for these neoplasms. The disputability of this section of tumors of the female reproductive system is also confirmed by repeated changes in the classification of the WHO.

Numerous previous studies have shown that tumor size, FIGO stage, morphometric parameters (nuclear area, cell area, nuclear-cytoplasmic ratio) and expression of certain immunohistochemical markers can serve as prognostic criteria for malignant and borderline tumors.

**The aim of our study** was to detect prognostic criteria for LGSC occurrence in patients with PCOS anamnesis I and II according to FIGO.

## 2. Materials and methods

### 2.1. Clinical material

Clinical material in our study was medical cards, paraffin blocks and slides of patients who underwent bilateral or unilateral oophorectomy in the period from 2013 to 2018 at the Kharkov Regional Clinical Oncological Dispensary, Kharkov Institute of Medical Radiology and Oncology named by S.P. Grigoriev and Kharkov Military Medical Clinical Center of Northern Region. The study included 22 tumors: 13 SBOT without subsequent development of LGSC within 5 years (control group) and 9 SBOT of patients in whom LGSC was found in the next 5 years (study group).

The histological type of tumors was determined on the basis of viewing slides stained with hematoxylin-eosin according to the standard technique.

SBOT and LGSC were staged according to FIGO classification. The age of patients and the diameter of the tumor were taken from pathologists' conclusion. The division of tumors by diameter into samples  $<10$  cm and  $\geq 10$  cm was performed in accordance to the study by Hatice Ozer *et al.* (Ozer *et al.*, 2012). From each clinical case, 1 block was selected for immunohistochemical (IHC) studies.

### 2.2. Immunohistochemical studies

The material for research by immunohistochemistry method was fixed with 10% neutral formalin for 24 h, embedded in paraffin, 4  $\mu$ m sections were prepared, which were applied to highly adhesive Super Frost glasses and dried at 37 °C for 18 hours. De-masking heat treatment was performed by boiling the sections in citrate buffer (pH 6.0). To visualize primary antibodies, an UltraVision Quanto Detection Systems HRP Polymer (Thermo scientific) detection system was used. DAB (diaminobenzidine) was used as a chromogen.

Primary monoclonal antibodies (MCAT) from DAKO (Denmark), ThermoScientific (Germany) and Diagnostic BioSystems (USA) were used. The expression of such markers was studied: Ki-67 (MiB-1, Thermo Scientific), MMP-9 (Collagenaza IV, Diagnostic BioSystems), p53 (SP5, Thermo Scientific), Bcl-2 (clone124, Dako Cytomation), E-cadherin (EP7004, Thermo Scientific).

To assess intensity of immunohistochemical label of markers Bcl-2, E-cadherin and MMP9, a semi-quantitative scale 0-3+ was used: 0 – no expression, + – weak, ++ – moderate, +++ – pronounced reaction. To assess the immunohistochemical label of p53, percentage of nuclei staining was considered: 0= no staining, 1= <10% of nuclei, 2 = 10-50%, 3 = 51-80% and more than 80% = 4.

To assess the immunohistochemical label Ki-67, percentage of stained nuclei was considered: ≤10% – absence or very weak proliferative activity, 11-50% – weak proliferative activity, 51-80% – moderate proliferative activity, more than 80% – high proliferative activity.

### 2.3. Statistical analysis

The relationship between the studied traits was researched using the nonparametric Pearson test with Yates' correction. The nonparametric Mann-Whitney test was used to process data of immunohistochemical studies and study relationship between the signs. A significance level of  $p \leq 0.05$  was considered significant.

## 3. Results and discussion

The patients' age in the control group varied from 24 to 44 years, the median was  $39.54 \pm 1.47$  years. The age range study group was from 32 to 46 years, the average age in this group is  $39.33 \pm 1.27$ . Age differences in two groups were insignificant ( $p > 0.05$ ). The age of occurrence of SBOT in the study groups was significantly lower than in Cirstea's A.E. et al. study, where the average age was 47.1 years (Cirstea et al., 2018), and according to the World Health Organization data (Herrington, 2020), which can be explained by the characteristics of a particular sample.

Table 1 presents the main clinical and morphological features of the patients.

Table 1

### Clinical and pathohistological characteristics of the studied cases

		Serous borderline ovarian tumors		Significance
		Control group (n=13)	Study group (n=9)	
Age		$39,54 \pm 1,47$	$39,33 \pm 1,27$	$p > 0,05$
Localization	Right	6 (46,1%)	4 (44,4%)	$\chi^2=4,3, p=0,1$
	Left	3 (23,1%)	5 (55,6%)	
	Bilateral	4 (30,7%)	-	
Size	<10 cm	11 (84,6%)	3 (33,3%)	$\chi^2=6,0, p<0,03$
	≥10 cm	2 (15,4%)	6 (66,7%)	
FIGO stage	I	9 (69,2%)	2 (22,2%)	$\chi^2=4,7, p<0,03$
	II	4 (30,8%)	7 (77,8%)	
	III	-	-	
	IV	-	-	

According to the literature (Herrington, 2020), approximately one third of SBOT is bilateral. In our study, the proportion of bilateral tumors in the control group accounted for 30.7% of cases, which roughly coincides with the indicated information. We did not find statistically significant differences between tumor localization and the probability of LGSC occurrence in the future ( $\chi^2 = 4.3$ ,  $p = 0.1$ ).

Tumor diameter less than 10 cm was observed in 11 (84.6%) cases in the control group and in 3 (33.3%) cases in the main group. A tumor of 10 cm or more in diameter was found in 2 (15.4%) cases in the control group and in 6 (66.7%) cases in the main group. When comparing the two groups, it was revealed that SBOT with subsequent development of LGSC is associated with a size of  $\geq 10$  cm ( $p < 0.03$ ). Our research findings are consistent with those of Ozer H. et al. (Ozer et al., 2012) There is also a direct strong correlation between the size of the tumor and its proliferative activity ( $r_s = 0.84$ ,  $p < 0.01$ ).

The development of LGSC in women with a history of SBOT is associated with FIGO stage II ( $p < 0.03$ ).

Table 2 shows distribution of cases according to the degree of expression of the immunohistochemical label Ki-67 and p53.

Table 2

**Distribution of cases by the degree of expression of the immunohistochemical label Ki-67 and p53**

IHC-marker	Control group (n=13)	Study group (n=9)	Significance
	<b>Ki-67</b>		
			$\chi^2=9,03, p<0,03$
0	5	0	
<10%	4	1	
10-50%	3	3	
51-80%	1	5	
$\geq 80\%$	0	0	
	<b>P53</b>		
0	5	6	$\chi^2=2,96, p=0,2$
<10%	5	3	
10-50%	3	0	
51-80%	0	0	
$\geq 81\%$	0	0	

Ki-67 is a protein, whose expression is traditionally associated with the proliferative activity of tumors (Menon et al., 2019) and their aggressiveness (Li et al., 2015) (Sun et al., 2018). In our study, the SBOT group with subsequent development of LGSC showed a significantly higher expression of Ki-67 compared to the control group with an increase of number of observations with marker expression more than 80% ( $n = 5/9$ ). When comparing the study group with the control group, it was revealed that SBOT, which were subsequently associated with the development of LGSC, is characterized by Ki-67 expression  $\geq 10\%$  ( $\chi^2 = 7.24$ ,  $p < 0.007$ ). So, the expression of Ki-67  $< 10\%$  was observed among the control group in 9 (69.2%) cases out of 13, and in the study group it was in 11.1% ( $n = 1/9$ ). According to many studies, level of Ki-67 expression is a more sensitive predictor of malignant phenotype



and possible tumor recurrence compared to its size. (Lowe *et al.*, 2012) (Grimm *et al.*, 2019) (Gottwald *et al.*, 2013). Also, according to the study by Yu N. *et al.*, Increased expression of Ki-67 and E-cadherin play an important role in oncogenesis and progression of serous borderline tumors (Yu *et al.*, 2017).

Numerous studies have noted the important role of p53 gene as a tumor suppressor due to the control of cell proliferation (Jin, 2005). Mutations in this gene are most likely genetic breakdown, found in many human tumors; therefore, level of p53 expression is one of the most studied in immunohistochemical panel for malignant neoplasms diagnosis of various localization (Corney *et al.*, 2008). A few studies indicate a high frequency of p53 mutations in poorly differentiated serous ovarian carcinomas and a rare occurrence of such genetic abnormalities in LGSC and SBOT. (Zeren *et al.*, 2014) (Corney *et al.*, 2008). Many researchers describe more pronounced expression of p53 in SBOT and serous ovarian carcinomas in its absence in benign and borderline serous tumors of female gonads (Kaygusuz, 2011) (Ozer *et al.*, 2012). In our study, there was a weak and moderate degree of p53 expression in SBOT without further development of LGSC, while in SBOT group with the subsequent development of highly differentiated serous ovarian carcinoma, expression p53 was absent in 6 (66.67%) cases or there was a weak degree of expression in 3 (33.33%) cases. Changes in p53 expression were not significantly different in two study groups ( $p = 0.2$ ).

Table 3 shows the expression intensity of markers MMP-9, bcl-2 and E-cadherin.

Table 3

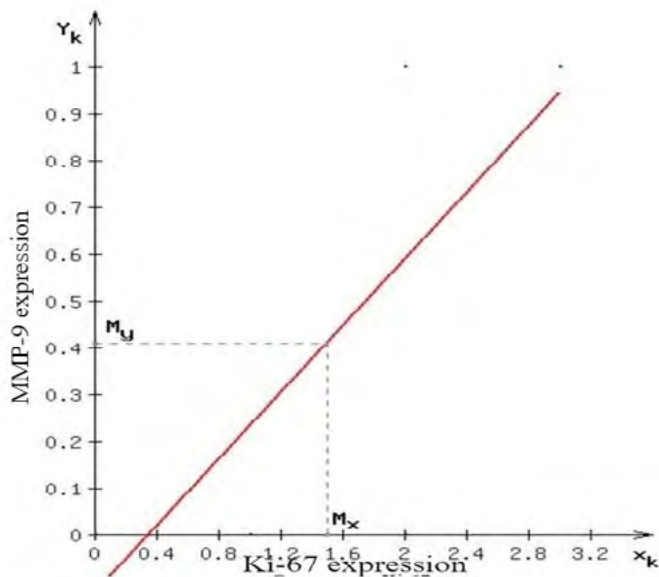
**Distribution of cases by the intensity of expression of IHC markers MMP-9, bcl-2, and E-cadherin**

IHC-marker	Control group (n=13)	Study group (n=9)	Significance
	<b>MMP9</b>		
			$\chi^2=4,18, p<0,04$
0	10	3	
Low	3	6	
Moderate	0	0	
Pronounced	0	0	
	<b>Bcl-2</b>		
			$\chi^2=9,66, p=0,008$
0	0	0	
Low	6	0	
Moderate	5	2	
Pronounced	2	7	
	<b>E-cadherin</b>		
			$\chi^2=9,89, p=0,007$
0	0	0	
Low	0	4	
Moderate	5	5	
Pronounced	6	0	

Matrix metalloproteinase MMP-9 is a remodeling endopeptidase that promotes local invasion and metastasis in tumors (Pârvănescu *et al.*, 2015). It is one of the main biomarkers of serous ovarian cancer. (Huang H., 2018) According to literature, in serous borderline ovarian tumors, lower expression of MMP-9 is observed than in serous cancers (Sakata, 2000).

In our study, the PCOS group with the subsequent development of highly differentiated serous carcinomas was characterized by a more pronounced expression of MMP-9 ( $p < 0.04$ ). Weak expression was observed in the main group in 6 (66.67%) cases out of 9, while the control group was characterized by the absence of MMP-9 expression in 10 (76.92%) cases out of 13. The obtained results, in our opinion, may indicate malignancy of the SBOT followed by the development of LGSC with an increase in the level of MMP-9 expression. Such fact requires more close clinical observation of the patient.

Graph 1 shows a direct strong correlation between the expression level of Ki-67 and MMP-9 of the studied tumors ( $r_s = 0.84$ ,  $p < 0.05$ ). This dependence, in our opinion, may be associated with a higher capacity of SBOT for microinvasion.



**Graph 1. Linear dependence of the expression of the IHC marker MMP-9 and Ki-67**

Expression of apoptosis regulator Bcl-2 also has conflicting values. In some studies, its more pronounced expression in malignant tumors is noted as compared to borderline serous neoplasms of ovaries (Zeren *et al.*, 2014)(Kaygusuz *et al.*, 2011), in others, more pronounced expression is noted in borderline tumors compared to benign and malignant neoplasms (Ozer *et al.*, 2012). The trend towards moderate and pronounced expression of Bcl-2 was observed in the study group ( $\chi^2 = 3.87$ ,  $p < 0.05$ ). In general, the group of SBOT with the subsequent development of LGSC is characterized by an increase in the level of expression of bcl-2, which, in our opinion, may indicate a more aggressive biological behavior of SBOT in this category of patients.

Higher expression of E-cadherin in many studies is observed in borderline tumors compared to serous ovarian cancers. In our study, decrease of E-cadherin expression in the main group compared with the control group was insignificant ( $p = 0.07$ ). The group SBOT without further development of LGSC is characterized by a pronounced and moderate expression of E-cadherin ( $\chi^2 = 4.36$ ,  $p < 0.04$ ), which was observed in 38.46% ( $n = 5/13$ ) of cases and in 15.38% ( $n = 2/13$ ) cases, respectively.

Insignificant associated signs were relationship between tumor diameter and expression of p53 ( $r_s = 0.149$ ,  $p = 0.1$ ) and relationship between tumor FIGO stage and expression of E-cadherin. ( $r_s = -0.284$ ,  $p = 0.1$ ).

#### 4. Conclusions

Currently, issue of diagnosis and prognosis of borderline serous ovarian tumors remains insufficiently studied. The available literature about recommended panel of immunohistochemical markers and their significance as predictors are contradictory. There is also insufficient information about biological behavior of SBOT and their relationship with occurrence of LGSC in future. Clinically, ability to predict appearance of highly differentiated serous ovarian carcinoma in women is very important, because it will allow detecting malignant neoplasms at earlier stages with constant monitoring of patients at risk.

In our study, it was found that the risk of LGSC occurrence within 5 years in women with a history of serous borderline tumors increases with tumor diameter  $\geq 10$  cm. Also, women who have SBOT proliferative activity  $\geq 10\%$  should be regularly monitored. At risk are also patients with SBOT, detected at FIGO stage II of disease. In women with developed LGSCs, a moderate and pronounced expression of bcl-2 was observed in BOT, which can also serve as a predictor.

Interest in further research into LGSC risk in women with SBOT anamnesis is evident. Evaluation of morphometric parameters in serous borderline ovarian tumors in women with the subsequent development of low-grade serous ovarian carcinoma and correlation of the obtained data with expression of immunohistochemical markers are promising for subsequent studies.

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## THE ROLE OF PEPSINOGENS IN THE FORMATION OF GERD IN PATIENTS WITH COPD

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### Summary

The article presents data on the role of pepsinogen-1 and -2 and bilirubin in the formation of gastroesophageal reflux disease (GERD) in patients with chronic obstructive pulmonary disease (COPD). Clinical, biochemical, immunological research methods were used in the work. The activity of pepsinogens 1 and 2 and bilirubin in saliva was determined in all patients with combined pathology. It has been established that the presence of concomitant GERD in patients is an independent aggravating factor for the function of external respiration. In patients with concomitant GERD, a significant increase in acute phase parameters in the serum, indicating active systemic inflammation. Increased activity of the cytokine IL-6 and IFN $\gamma$  indicates the activation of the cellular immune system, with an unregulated immune response that supports chronic inflammation in the bronchi even in remission. Increased levels of IL-4 are compensatory in nature, as IL-4 inhibits the production of macrophages of proinflammatory cytokines, including IL-6. Detection of correlations between the concentration of total bilirubin in saliva with a decrease in external respiration, namely FVC, FEV-1, as well as the presence of shortness of breath allows us to consider bilirubin as a possible marker of reflux and respiratory inflammation in the bronchi, until obstruction. The positive correlation of pepsinogen-1 in saliva with an allergic history, and pepsinogen-2 in saliva with cough, shortness of breath and smoking, and a negative correlation of pepsinogen-1 with the value of FEV1 / FVC, allows to consider pepsinogen-1 and pepsinogen-2 as markers of non-acid reflux and respiratory inflammation with bronchoobstruction

**Keywords:** pepsinogen-1, bilirubin, saliva, chronic obstructive pulmonary disease, non-acid reflux.

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### 1. Introduction

In the general structure of morbidity, a significant percentage of all diseases are respiratory diseases. According to general data, their share is about 60% (*Chorna et al., 2020*). This is due to the increase in the number of non-specific lung diseases, and is particularly noticeable in the growing number of patients with chronic obstructive pulmonary disease (COPD). According to the WHO, COPD is a disease with a high level of social burden (*Tolokh, 2017*). The progression of COPD is accompanied by the development of pathological processes in various

organs, including the digestive system. The presence of concomitant pathology in patients with COPD increases the risk of exacerbations, hospitalizations and disabilities, reduces their activity, impairs quality of life and survival, and therefore has important prognostic value (*Golpe et al., 2017*). Gastroesophageal reflux disease (GERD) is one of the most common gastrointestinal diseases in the general population. The prevalence of GERD in the population is determined in the range of 7-20%, in Western countries – varies on average between 10% and 25%. The issue of comorbidity of chronic obstructive pulmonary disease with gastroesophageal reflux disease as an interdependent pathological condition is attracting increasing attention. These diseases are combined in 25 – 60% of cases (*Shevchuk-Budz, 2018, Lin et al. 2019*). According to numerous studies, the presence of GERD is associated with a deterioration in the quality of life in this cohort of patients, worsening of symptoms, deterioration of external respiration, which leads to more frequent exacerbations of COPD (*Makarova et al. 2019, Francis, 2016*). Occurrence of GERD in patients with COPD can be both primary-independent diseases (due to combined lesions of the mucous membranes of the respiratory and digestive systems, associated with unidirectional metabolic and allergic changes and dysregulation of the nervous, immune and endocrine systems) and as primary-dependent pathological processes (when lung obstruction with the appearance of GERD may be exacerbated by microaspiration of gastric contents into the trachea and bronchi, as well as in the process of stimulation of nervus vagus receptors of the distal part of the esophagus. On the other side, the pathology of the pulmonary system, provoking cough, leads to changes into intrathoracic pressure and, consequently, to a decrease in the tone of the lower esophageal sphincter, which is one of the pathogenic factors in the formation of GERD (*Katzka et al. 2011, Aras et al., 2010*).

Microaspiration of gastric contents and hydrochloric acid is just one of many factors that can cause respiratory damage. Other damaging factors may be pepsinogen, pepsin, pancreatic enzymes and bile acids / salts (*Kusano et al., 2011*). However, aspiration of duodenogastric contents may be accompanied not only by cough but also by acute respiratory distress syndrome. It should be noted that the upper parts of the digestive system (pharynx) and respiratory tract (larynx and bronchi) are more sensitive to reflux than the mucous membrane of the esophagus (*Kravchenko et al., 2011*). Laryngo-pharyngeal reflux, which is the result of the effects of various components of gastric and duodenal reflux on the mucous membrane of the pharynx, larynx and respiratory tract, is considered one of the most likely mechanisms of extraesophageal complications of GERD. (*Pearson et al., 2011*). The pharynx and larynx are extremely sensitive to weak acid reflux, especially in the presence of pepsin. There is no doubt that pepsin will have a greater detrimental effect on the respiratory epithelium in acid reflux. However, the association of pepsin with inflammation of the laryngeal epithelium in non-acidic forms of GERD has been observed even in patients taking high doses of Proton pump inhibitors (PPIs). It was previously thought that pepsin causes damage only because of its proteolytic activity. However, further studies have shown that pepsin is captured by laryngeal epithelial cells by endocytosis. (*Wang et al., 2020*). It shows a new mechanism of cell damage, which involves the development of new treatments for reflux disease, namely use of receptor antagonists and / or pepsin inhibitors (*Ye et al., 2017*).

The above data provide clear evidence for the role of GERD in the development of chronic obstructive pulmonary disease, but there are still many controversial and unresolved issues. The mechanisms of development and pathogenesis of these two diseases, diagnostic methods, rational schemes of drug therapy continue to be actively discussed.

The need for in-depth study of the pathogenic mechanisms of parallel development of COPD and GERD diseases (with determination of the activity of the cytokine system) determines the scientific and practical relevance of this study.

**The aim of research** was to establish the pathogenic mechanisms of obstructive pulmonary disease with gastroesophageal reflux disease.

**Materials and methods of research.** The observation included 138 patients who were hospitalized in the pulmonology department due to exacerbation of COPD and outpatient treatment by a gastroenterologist.

All subjects signed an informed consent, the methodology of which was in line with the Helsinki Declaration of 1975 and its revision in 1983 and was approved by Uzhhorod National University's Commission on Bioethics (Protocol №1 of 10.01.2020).

The inclusion criteria in the study confirmed the patients with exacerbation of COPD stage 2 (GOLD II), age > 40 years, forced expiratory volume per 1 second (FEV<sub>1</sub>) was <60% of normal and the ratio of forced expiratory volume per 1 second to forced vital capacity lungs (FEV<sub>1</sub> / FVC ratio) <70%, increase in FEV<sub>1</sub> after inhalation of short-acting  $\beta_2$ -agonist less than 12% compared to baseline.

The exclusion criteria in the study were malignancy, systemic connective tissue diseases, heart block, congenital malformations and heart failure above functional class II according to the classification of the New York Association of Cardiologists.

In turn, the diagnosis of COPD was confirmed according to the order of the Ministry of Health of Ukraine №555 from 27.06.2013 "On approval of clinical protocols for medical care in the specialty" Pulmonology "and the provisions set out in the document GOLD [2017]. The diagnosis of gastroesophageal reflux disease (GERD) was made in the presence of relevant complaints and the results of instrumental studies – a positive test with rabeprazole, fibrogastro-duodenoscopy (FGDS) and intragastric pH-metry, taking into account the Montreal Consensus (2006), as well as in accordance with domestic protocols for medical care (order of the Ministry of Health of Ukraine № 943 of 31.10.2013).

We formed 3 groups of patients: 1 group (n = 60) – patients with COPD in combination with GERD, 2 group (n = 42) – patients with COPD without signs of GERD, who were treated in the pulmonology department for exacerbation of the disease and Group 3 (n = 36) – patients with GERD who were treated on an outpatient basis. Patients were homogeneous in age, stage of disease and duration of illness. The mean age of the subjects was  $55 \pm 1.64$ . Among the examined patients, men predominated by sex – 78.3% (108 out of 138).

Patients also underwent additional determination of indicators of inflammation (CRP, leukocytes, neutrophils, ESR, procalcitonin), cytokine activity (IL-4, IL-6, IFN $\gamma$ , IFN $\gamma$  / IL-4, TNF-alpha and levels of pepsinogen-1, pepsinogen-2 and bilirubin in saliva).

Statistical analysis of the data was performed using Jamovi, version 2.0.0 using the paired Student's t-test, Pearson's  $\chi^2$ -test and Fisher's exact test, depending on the type of source data. The average values of the numerical data were represented as  $M \pm SD$ . The normality of the distribution was evaluated by the Shapiro-Wilk test. The critical level of reliability was considered to be  $\alpha = 0.05$ .

## 2. Results

The clinical characteristics of patients with combined pathology (COPD with GERD) were evaluated, and 60 patients (48 men and 12 women) were selected. In the age range, patients from 44 to 59 years were examined, the average age was  $55 \pm 1.64$  years (women –  $57 \pm 0.9$  years, and men –  $54 \pm 1.2$  years).

The main symptoms of the disease were respiratory symptoms, namely shortness of breath in 59 of 60 patients (98.3%) and cough in 57 of 60 patients (95.0%). Shortness of breath occurred

during exercise in 49 of 60 (81.7%) patients, and at rest in 11 of 60 (18.3%), respectively, at  $p < 0.05$ . The most common type of cough was unproductive – in 30 of 60 (51.7%) patients, which worsened when changing body position from horizontal to vertical and when eating, the intensity was the same during the day. The presence of sputum was detected in 43 of 60 (71.7%) patients. Macroscopic examination of sputum was mucous, viscous, white in 17 of 60 (28.3%) patients, which caused difficulty in coughing. A feeling of tightness in the chest with the inability to fully exhale was found in 40 of 60 (66.6%) patients. Patients were also concerned about complaints of difficulty breathing, especially at night with increased shortness of breath in 38 out of 60 (63.3%) patients, weakness and decreased tolerance to exercise, which limited the ability to work in 52 out of 60 (86.6%) patients. Chest pain, which worsened after coughing, had 18 of 60 (30%) patients.

In patients with COPD and GERD, gastroenterological symptoms were dominated by heartburn in 30 out of 60 (50%) and / or acid regurgitation in 33 out of 60 (55.5%), sorethroat in 31 out of 60 (51.6%), cases of patients at  $p < 0.01$ , as well as dysphagia in 28 of 60 (46.6%) cases of patients at  $p < 0.05$ . Extraesophageal manifestations of GERD were detected in 26 of 60 (43.3%) patients with COPD, manifested by sorethroat in 7 of 60 (11.6%), hoarseness in 4 of 60 (6.6%), unproductive cough, which is exacerbated at night in 14 of 60 (23.3%), chest pain in the esophagus and heart failure in 2 of 60 (3.3%).

A positive family history of allergy was found in 19 out of 60 (31.7%), women – in 4 out of 60 (6.7%), men – in 15 out of 60 (25.0%).

51 out of 60 (85.0%) patients were prone to smoking, of which 45 out of 60 (75.0%) were men and 3 out of 60 (5.0%) were women. Smoking experience according to the smoker index was  $22 \pm 2.48$  years; in men  $22 \pm 4$  and in women  $21 \pm 5.3$  years, respectively.

In most patients with combined pathology, the upper limit of the BMI was exceeded in 42 out of 60 (70.0%).

Table 1 presents a comparative characterization of patients with COPD and GERD and patients with isolated COPD.

Table 1

## Clinical characteristics of the patients

Parameters	group 1 (n = 60) COPD + GERD		group 2 (n=42) COPD	
	male	female	male	female
<b>Gender</b> male / female (abs./%)	48/80,0	12/20,0	32/76,2	10/27,8
<b>Age (years)</b>	54±1,2	57±0,9	53±2,1	56±1,6
<b>Smokers (abs /%)</b>	45/75,0	3/5,0	30/71,4	4/9,5
<b>Smoking experience (smoker index) (years)</b> Frequency of exacerbations per year	22±4,7	21±5,3	23±6,6	24±3,4
<b>Body mass index (BMI) (kg) / height (m)<sup>2</sup></b> 18.5-24.9 (abs /%)	10/16,7	1/1,7	16/38,1	4/9,5
<b>Body mass index (BMI) (kg) / height (m)<sup>2</sup></b> 25.0-29.9 (abs /%)	26/43,3	6/10,0	11/26,2	3/7,1
<b>Body mass index (BMI) (kg) / height (m)<sup>2</sup></b> more than 30 (abs /%)	12/20,0	5/8,3	5/11,9	3/7,1
Frequency of <b>exacerbation</b> per year	2,1±0,3	1,8±0,6	1,7±0,4	1,8±0,3
Frequency of <b>hospitalization</b> per year	1,7±0,3	2,0±0,7	1,6±0,5	1,7±0,5

Note. Significance of the difference: \* – in comparison with patients of group 2 at  $p < 0,05$ .



When comparing groups by sex, age and smoking history, no statistically significant differences were found in patients with a combination of COPD and GERD ( $p > 0.05$ ). Patients with symptoms of GERD compared with patients without GERD had a higher frequency of exacerbations of COPD ( $2.1 \pm 0.9$  and  $1.7 \pm 1.0$ , respectively,  $p < 0.001$ ). Also in patients with COPD and concomitant GERD there was a higher frequency of hospitalizations ( $1.6 \pm 1.0$  and  $1.0 \pm 0.9$ , respectively,  $p = 0.005$ ) (table 1). Correlation analysis revealed a significant relationship between the frequency of GERD and exacerbations of COPD ( $r = 0.323$ ,  $p = 0.001$ ), the severity of bronchial obstruction ( $r = 0.331$ ,  $p = 0.001$ ), the frequency of hospitalizations for COPD ( $r = 0.258$ ,  $p = 0.006$ ). However, there was no correlation with the severity of GERD. Patients with COPD with concomitant GERD have a higher frequency of exacerbations. It was found that the severity of bronchial obstruction was higher in patients with concomitant GERD. In addition, a correlation was found between the frequency of GERD symptoms and the severity of bronchial obstruction.

Also in these groups of patients was measured of the function of external respiration (FER) (tabl. 2).

Table 2

**Distribution of spirometry values between groups**

Indication	Group 1 n=60	Group 2 n=42
FEV1 %	63,2±1,8*	66,1±1,4
VC%	75,5±1,2	78,1±0,7
FVC %	73,3±1,9*	75,4±1,7
FEV1/ FVC ratio %	63,2±0,9*	65,2±0,7
FEF25 %	40,1±1,4*	43,3±1,5
FEF 50 %	34,3±1,5	36,5±1,3
FEF 75 %	33,2±1,7*	33,4±2,0

Note. Significance of the difference: \* – in comparison with patients of group 2 at  $p < 0,05$ .

The processing of spirometry data in patients with combined GERD revealed a significantly more pronounced decrease in the main indicators of external respiration: FEV1, FVC, forced expiratory flow over the middle one half of the FVC ( FEF) 25%, 50%, 75% , FEV1 / FVC ratio compared to normal values in people of the appropriate sex, age, height and body weight (FEV1> 80%, FEV1 / FVC> 70%). In the group with combined pathology, FEV1, VL, FVC, FEV1 / FVC, respectively, were  $63.2 \pm 1.8$ ,  $75.5 \pm 1.2$ ,  $73.3 \pm 1.9$ ,  $63.2 \pm 0.9\%$  and made a significant difference ( $p < 0,05$ ) with similar indicators of group 2 (patients with COPD without signs of GERD), in which these indicators averaged  $66.1 \pm 1.4$ ,  $78.1 \pm 0.7$ ,  $75.4 \pm 1.7$ ,  $65.2 \pm 0.7\%$ , respectively.

In patients with comorbid pathology of COPD and GERD, a negative correlation was found between age and FVC, age and FEV1 by Pearson's ratio,  $p < 0,005$ .

In the study of laboratory indicators of inflammation, the following data were obtained (table 3).

Patients in groups 1 and 2 showed an increase in acute phase and pro-inflammatory parameters compared with group 3, where all these indicators were within normal limits at  $p < 0.05$ .

Procalcitonin levels in patients of all groups are not prognostically significant at  $p < 0.05$ .

A direct correlation was found between the content of IL-4 and IL-6 ( $r = 0.60$ ,  $p < 0.05$ ).

Table 3

**Evaluation of laboratory parameters in groups**

Indication	Group 1 n=60	Group 2 n=42	Group 3 n=36
<i>Leukocytes 10 * 12 / l</i>	12,3±1,3*	11,2±0,8**	6,5±1,3
<i>Neutrophils %</i>	74,1 ±2,6	72,2±2,1	67,2±3,1
<i>Lymphocytes %</i>	15,2 ±2,4	18,2 ±1,1	19,2±1,1
<i>ESR mm / year</i>	18 ±3,4*	16±2,3**	6±4,1
<i>CRP mg / l</i>	15,3 ±1,8*	14,3 ±1,2**	3,3 ±1,5
<i>Procalcitonin ng / ml</i>	0,1±0,03	0,04±0,02	0,03 ±0,01
<i>IL-4, pg / ml</i>	12,7±1,3*	9,8±1,1**	4,1±0,6
<i>Interferon gamma (IFN<math>\gamma</math>) pg / ml</i>	346,2±13,5*	289±14,8**	126,9±12,4
<i>IFN<math>\gamma</math>/ IJ-4</i>	28,3±3,2*	15,1±4,1**	7,1±1,4
<i>IL-6, pg / ml</i>	17,3±2,2*	14,3±2,4**	6,8±1,7
<i>TNF-<math>\alpha</math> pg / ml</i>	10,1±3,4	13,1±2,5	5,4±1,4

Note. Significance of the difference: \* – in comparison with patients of group 2 and 3 at  $p < 0,05$ , \*\* – in comparison with patients of group 1 and 3 at  $p < 0,05$ .

Table 4

**Indicators of pepsinogen and bilirubin in the groups**

Indication	Group 1 n=60	Group 2 n=42	Group 3 n=36
<b>Pepsinogen-1 in saliva, ng / ml</b>	0,83±	0,22±	0,360,11
<b>Pepsinogen-1 in saliva, ng / ml</b>	2,26±	1,99±	2,20,70
<b>Total bilirubin in saliva, <math>\mu</math>mol / l</b>	1,2±	0,91±	0,98±

Note. Significance of the difference: \* – in comparison with patients of group 2 and 3 at  $p < 0,05$ , \*\* – in comparison with patients of group 1 and 3 at  $p < 0,05$

There was a positive relationship between decreased FER levels, namely FVC and FEV1 values, clinical symptoms of COPD, and values of pepsinogen-1, pepsinogen-2 and total bilirubin in saliva. Thus, in patients with COPD found a direct correlation with the presence of shortness of breath (Pearson's ratio,  $p = 0,011$ ; ANOVA,  $p < 0,001$ ; test

Cruscalla-Wallis,  $p < 0,001$ ); as well as reduced FEV-1 (Pearson's ratio,  $p < 0,001$ ; t-test,  $p < 0,001$ ; z-score,  $p = 0,046$ ).

A comparison of total bilirubin in saliva and FER revealed a statistically significant positive correlation between total bilirubin, on the one hand, and FVC and FEV1 (Pearson's ratio,  $p = 0,011$ ) and FEV-1 (Pearson's ratio,  $p = 0,044$ ).

The study of the presence of pepsinogen-1 in saliva revealed a statistically significant positive correlation with the presence of smoking (rank correlation coefficient,  $p = 0,002$ , Mann-Whitney test  $p = 0,004$ ) and a negative correlation between FEV1 and FVC (t-test,  $p < 0,001$ ; Pearson,  $p < 0,001$ ).

Subsequent analysis revealed that the level of pepsinogen-2 in saliva was positively correlated with clinical symptoms such as cough (rank correlation coefficient,  $p = 0,012$ ), shortness of breath (rank correlation coefficient,  $p = 0,026$ ) and smoking (rank correlation coefficient,  $p = 0,006$ ), as well as with the frequency of exacerbations per person (Pearson's ratio,  $p = 0,027$ ).

It is noteworthy that the level of total bilirubin in saliva showed a statistically significant positive correlation with the value of pepsinogen-1 in saliva (Pearson's ratio,  $p = 0.019$ ; Kruscal-Wallis test,  $p = 0.024$ ), and with the value of pepsinogen -2 in saliva (Pearson's ratio,  $p = 0,049$ ).

The study revealed a statistically significant positive correlation of total bilirubin in saliva, on the one hand, and a decrease in FVC, FEV-1, as well as with the presence of shortness of breath.

The value of pepsinogen-1 in oral saliva showed a statistically significant positive correlation with an allergic history, and a negative correlation with the value of FEV1 / FVC ratio.

The level of pepsinogen-2 in saliva showed a positive correlation with symptoms such as cough, shortness of breath and smoking.

A statistically significant positive correlation was found between the levels of total bilirubin and the values of pepsinogen-1 and pepsinogen-2 in saliva.

**Discussion:** Thus, the detection of a negative correlation between age and FVC, age and FEV1 in patients with combined pathology, suggests that the presence of concomitant GERD is an independent aggravating factor for the function of external respiration.

In patients with COPD in combination with GERD, there is a marked increase in acute phase parameters, namely leukocytes, ESR, the level of C-reactive protein, which indicate active systemic inflammation.

Also in this group of patients there is an increase of almost 3 times the level of IFN $\gamma$ , which involves the activation of the cellular immune system.

Increased, almost 3 times compared to group 3 control, the ratio between IFN $\gamma$  / IL-4 indicates the presence of an imbalance in the immune system, which is also more pronounced in patients with concomitant GERD.

Also, the increase in the pro-inflammatory cytokine IL-6 by almost 2 times stimulates an excessive and unregulated immune response, which in turn supports chronic inflammation in the bronchi even in remission.

Increased levels of IL-4 are compensatory in nature, as IL-4 inhibits the production of macrophages of proinflammatory cytokines, including IL-6.

Direct correlation of the concentration of total bilirubin in saliva with a decrease in external respiration, namely FVC, FEV-1, as well as with the presence of shortness of breath allows to consider bilirubin as one of the possible markers of reflux and respiratory inflammation in the bronchial tree, up to obstruction.

A positive correlation of pepsinogen-1 in saliva with an allergic history, and pepsinogen-2 – with symptoms such as cough, shortness of breath and smoking, and a negative correlation of pepsinogen-1 with FEV1 / FVC ratio, allows to consider pepsinogen-1 and pepsinogen-2 as markers of non-acid reflux and respiratory inflammation with bronchoobstruction.

### 3. Conclusion

1. The presence of GERD in patients with COPD is an aggravating factor that increases the frequency of exacerbations in patients with combined pathology.

2. Total bilirubin, pepsinogen-1 and pepsinogen-2 in saliva should be considered not as separate, but combined markers of duodeno-gastroesophageal and laryngo-pharyngeal reflux and additional causes of inflammation and bronchoobstruction.

3. Determination of pepsinogens 1 and 2 and bilirubin in saliva are non-invasive methods for detecting duodeno-gastroesophageal and laryngopharyngeal reflux in patients with GERD.

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## CHANGES IN METABOLIC EFFICIENCY IN SKILLED ATHLETES DURING INTENSE EXERCISE

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### Summary

The body's predominant choice of substrates and the rate of their oxidation in the working muscle are largely influenced by physical activity intensity. The higher the intensity of work, the more important role in energy supply processes are played by carbohydrates. It is suggested that the ability to most effectively use fat as an energy substrate at rest and during exercise allows athletes to save carbohydrates to perform high-intensity work. This study investigated the efficiency of metabolism in skilled athletes at rest and during the exercise of increasing intensity. 99 body composition assessments (via bioelectrical impedance) and 99 incremental exercise tests using a gas analysis system were performed in 90 male national- and international-level athletes (age 16-35 y.o.) of sports related to endurance and combat sports. The respiratory exchange ratio in skilled athletes at rest significantly correlates with the values of respiratory exchange ratio when reaching the anaerobic threshold ( $r = 0.52, p \leq 0,05$ ) and respiratory exchange ratio when reaching the maximum oxygen consumption ( $r = 0.52, p \leq 0,05$ ) and with the maximum oxygen consumption ( $r = -0.26, p \leq 0,05$ ).

The obtained data shows that efficient resting metabolism creates the preconditions for more efficient use of energy substrates during intense muscle activity. The respiratory exchange ratio is an informative indicator of the efficiency of metabolism, which can be used in the complex control of the functional condition of the athlete.

**Keywords:** metabolism, physical exercise, fat oxidation, carbohydrate oxidation

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### 1. Introduction

Significant energy expenditure due to intense physical activity increases the metabolism of skilled athletes both during physical activity and in their recovery period. Athletes spend at least 1000-2000 kcal per day on physical activity. During intense training, total daily energy expenditure (TDEE) can exceed 10,000 kcal (*Burke et al, 2015*). However, all essential nutrients – proteins, fats, and carbohydrates – can provide substrates for energy production in muscles. The body's predominant choice of substrates and the rate of their oxidation in the working muscle is influenced by many factors, primarily the duration and intensity of exercise, the athlete's fitness, and nutrition. The intensity of physical activity largely determines the choice of substrates for energy. The higher the intensity of work, the more important role in energy supply processes are played by carbohydrates (*Shils&Shike, 2006*).

Recently, the term "metabolic efficiency" has come into use, meaning the ability to most effectively use fat as an energy substrate both at rest and during exercise, thus saving glycogen stores (*Seebohar, 2014*). It is believed that this type of metabolism allows one to save

carbohydrates to perform high-intensity work. Most often, the respiratory exchange ratio (RER) is used to assess the use of oxidation substrates, which allows determining the contribution of carbohydrates and fats to the energy supply (Carpenter, 1964). Thus, the value of RER can be considered an informative indicator of metabolic reserves of the athlete.

The study by Helge et al. (1999) demonstrates significant individual variability in the ratio of the use of energy substrates during the same intensity of activity. In this case, physically active and trained people usually have lower RER than untrained during the same activity load (Jeukendrup et al., 1997; Bergman&Brooks, 1999). In addition, endurance training can reduce the value of RER while also increasing the oxidative activity of enzymes and oxygen consumption, as well as help delay the development of fatigue during exercise (Messonnier et al., 2005). Meanwhile, even athletes who specialize in endurance sports demonstrate great variability of RER at rest and during exercise of varying intensity (Romijn et al., 2000; Carter et al., 2001). The study by Goedecke et al. (2000) has shown significant fluctuations in resting RER in the range from 0.93 to 0.72, which corresponds to energy production due to fat oxidation from 23% to 93% .

In the study by Rauch et al. (1999) with the participation of qualified cyclists, it was demonstrated that not all athletes use the same amount of fat as an energy substrate when performing the same work. Athletes whose contribution of carbohydrates to energy production was higher at rest and during exercise showed an earlier development of fatigue compared to those with lower RERs (and consequently a higher contribution of fat to energy production). This is due to their faster depletion of glycogen stores.

Therefore, it is of scientific interest to study the efficiency of athletes' metabolism. The aim of this study is to determine the efficiency of metabolism in skilled athletes at rest and during exercise of increasing intensity.

## 2. Materials and methods

### *Participants*

99 incremental exercise tests were performed in 90 male national- and international-level athletes (age 16-35 y.o.) of sports related to endurance (biathlon (n = 40), triathlon (n = 4), rowing (n = 13), canoeing (n = 12), modern pentathlon (n = 12), and combat sports (boxing [n = 14], taekwondo [n = 4]).

### *Procedure*

The study was performed in the morning, 2 hours after breakfast. After measuring anthropometric parameters (length [cm], body mass [kg], and body composition (mass [kg] and percentage of body fat, lean body mass (LBM) [kg]), we performed a test to determine subjects' maximum oxygen uptake ( $VO_{2max}$ ,  $ml \cdot min^{-1} \cdot kg^{-1}$ ).

The test to determine the maximum oxygen consumption ( $VO_{2max}$ ,  $ml \cdot min^{-1} \cdot kg^{-1}$ ), used exercise of increasing intensity on the rowing ergometer Concept II (USA) for rowers, on the manual ergometer Technogym (Italy) for the kayak and canoe athletes, on the LE 500 treadmill, (Viasys Healthcare, Germany) for the biathlon, triathlon, modern pentathlon, boxing, and taekwondo athletes. The exercises lasted until the athletes reached the  $VO_{2max}$ . The sign of reaching  $VO_{2max}$  was the lack of increase in oxygen consumption with increasing power or its fluctuations within  $100 ml \cdot min^{-1}$ . Respiratory system parameters were recorded using an Oxycon mobile gas analyzer (Care fusion, USA; Jeager, Germany). Before performing the test load, a 6-minute warm-up was performed, and after the test was completed, the rate of recovery processes was assessed for three minutes via measurement of heart rate, blood lactate concentration, oxygen consumption, and carbon dioxide excretion.

The magnitude of the initial exercise load on the Concept rowing ergometer was  $1.5 \text{ W} \cdot \text{kg}^{-1}$  body mass, at each subsequent stage the load increased by  $30 \text{ W}$ ; initial load on the running ergometer was  $2.0 \text{ W}$  per  $\text{kg}$  body mass (running speed –  $10 \text{ km} \cdot \text{h}^{-1}$ ). The duration of each step of the test load was two minutes (testing on a treadmill) or three minutes (testing on a rowing ergometer).

To assess the effectiveness of metabolic processes, we determined the respiratory exchange ratio, which reflects the use of energy substrates. To find out the changes in the structure of energy expenditure during muscular activity, the RERs of the athletes were examined both at rest and during exercise.

The study determined the following metabolic parameters:

$\text{VO}_2$ ;  $\text{ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$  – oxygen consumption at rest and during exercise with increasing intensity;

$\text{RER}_{\text{rest}}$  – respiratory exchange ratio at rest;

$\text{RER}_{\text{AT}}$  – respiratory exchange ratio when reaching the anaerobic threshold;

$\text{RER}_{\text{VO}_{2\text{max}}}$  – respiratory exchange ratio when reaching maximum oxygen consumption;

$Q$ ,  $\text{kcal} \cdot \text{min}^{-1}$  – energy consumption;

$Q_c$ ,  $\text{kcal} \cdot \text{min}^{-1}$  – energy obtained from carbohydrates;

$Q_f$ ,  $\text{kcal} \cdot \text{min}^{-1}$  – energy obtained from fat;

*Statistical analysis*

The data obtained were analyzed using methods of mathematical statistics: mean values method, correlation analysis, two-way ANOVA post-hoc Tukey test.

### 3. Ethics

The research was conducted following the basic bioethical norms of the Helsinki Declaration of the World Medical Association on Ethical Principles of Scientific and Medical Research, as amended (2000, as amended in 2008), the Universal Declaration on Bioethics and Human Rights (1997), and the Council of Europe Convention on Human Rights and Biomedicine. 1997). Each study participant provided written informed consent to participate in the study.

## 4. Results

RER variability at rest, during anaerobic threshold, and maximum oxygen uptake was recorded (Table 1).

Table 1

### RER in skilled endurance athletes at rest, during AT and $\text{VO}_{2\text{max}}$

Condition	$\bar{X} \pm \delta$	- 95%*	+ 95%
Resting	$0.81 \pm 0.10$	0.79	0.83
AT	$0.96 \pm 0.07$	0.95	0.97
$\text{VO}_{2\text{max}}$	$1.09 \pm 0.09$	1.07	1.11

\* Confidence interval of 95%

In this study, the average value of RER at rest in skilled athletes was  $0.81 \pm 0.10$ , which corresponds to the use of 65% of energy from fat, while the range of confidence interval (0.79- 0.83) shows that the contribution of fat to production energy at rest ranges from 58-71%.

The average values of  $\text{RER}_{\text{AT}}$  were  $0.96 \pm 0.07$ , which indicates a 14% contribution by fat to energy supply. The range of RER oscillations at the level of AT (0.95-0.97) is smaller compared to at resting state and corresponds to a 10-17% contribution of fat to energy production.

It is traditionally believed that 100% of energy at the level of  $VO_{2max}$  is provided by carbohydrates [1, 2]. Our average data ( $1.09 \pm 0.09$ ) confirms this fact, but there were some athletes for whom RER when reaching their  $VO_{2max}$  was 0,96-0,99, and in some cases 0,93, which indicates a possible contribution of fat to energy production even during high-intensity exercise.

Energy consumption and use of energy substrates during intense physical activity at the level of AT and  $VO_{2max}$  are in Table 2.

Table 2

**Energy expenditure in skilled athletes associated with the manifestation of endurance when reaching the anaerobic threshold and  $VO_{2max}$  (n = 99)**

Measurement	AT		$VO_{2max}$	
	$X \pm \delta$	95% CI	$X \pm \delta$	95% CI
$VO_2, ml \cdot min^{-1} \cdot kg^{-1}$	46,93±8,65	45,21-48,66	56,90±9,26	55,05-58,75
Q, kcal·min <sup>-1</sup> ·kg <sup>-1</sup>	0,22±0,06	0,21-0,24	0,27±0,07	0,26-0,29
$Q_c, kcal \cdot min^{-1} \cdot kg^{-1}$	0,18±0,06	0,17-0,20	0,27±0,07	0,26-0,29
$Q_f, kcal \cdot min^{-1} \cdot kg^{-1}$	0,04±0,04	0,03-0,05	0,00±0,01	0,00-0,01

As can be seen from Table 2, the standard deviation of the fat utilization rate when reaching the AT is equal to the average value, which indicates a large variability in the values of this indicator.

For the  $VO_{2max}$  level, the value of the quadratic deviation Qf is associated with isolated recorded cases of  $VO_{2max}$  achievement with RER of less than 1.

In order to determine whether these differences in muscle metabolism affect the metabolic reserves and performance of athletes, we performed a correlation analysis (Table 3).

Table 3

**Significant (p < 0.05) correlation between energy consumption, contribution of energy supply substrates and capacity at AT and  $VO_{2max}$**

Measurement		AT		$VO_{2max}$	
		$VO_2, ml \cdot min^{-1} \cdot kg^{-1}$	Power output, W·kg <sup>-1</sup>	$VO_2, ml \cdot min^{-1} \cdot kg^{-1}$	Power output, W·kg <sup>-1</sup>
RER <sub>rest</sub>		-0,21*	-0,16*	-0,26	-0,17*
AT	RER <sub>AT</sub>	-0,13*	0,02*	-0,22	-0,02*
	Q, kcal·min <sup>-1</sup> ·kg <sup>-1</sup>	0,97	0,78	0,84	0,67
	$Q_c, kcal \cdot min^{-1} \cdot kg^{-1}$	0,60	0,56	0,45	0,45
	$Q_f, kcal \cdot min^{-1} \cdot kg^{-1}$	0,30	0,15*	0,37	0,18*
$VO_{2max}$	Q, kcal·min <sup>-1</sup> ·kg <sup>-1</sup>	0,87	0,73	0,99	0,74
	$Q_c, kcal \cdot min^{-1} \cdot kg^{-1}$	0,82	0,70	0,95	0,72

\* Marked correlations are not significant at  $p < 0,05$

We found that athletes with higher use of fat as an energy substrate at rest tend to more intensively use fat for energy at AT and  $VO_{2max}$ : The RER resting value has a reliable relationship with RER<sub>AT</sub> ( $r = 0.52, p \leq 0.05$ ) and RER <sub>$VO_{2max}$</sub>  ( $r = 0.52, p \leq 0.05$ ). An even greater reliable relationship was found between the RER<sub>AT</sub> and the RER <sub>$VO_{2max}$</sub>  ( $r = 0.86, p \leq 0.05$ ).



In addition, there is a relationship between resting metabolic efficiency and  $VO_{2max}$  ( $r = -0.26$ ,  $p \leq 0.05$ ). Athletes with higher metabolic efficiency at rest have the advantage of using different sources of energy during intense muscular activity. In the case of efficient use of fat as a substrate of energy at rest, the share of their contribution to energy supply remains significant (up to 37%) even when reaching the AT.

Table 4

**Body composition, energy expenditure and level of performance in athletes with different metabolic efficiency at rest ( $X \pm \delta$ ; 95% CI)**

Conditions	Measurement	Groups		
		1 (n=56)	2 (n=17)	3 (n=26)
Resting	Body mass, kg	75,02±11,28 (72,00-78,04)	78,56±13,44 (71,65-85,47)	79,33±10,74 (74,99-83,67)
	LBM, kg	66,56±8,55 (64,27-68,85)	69,00±10,78 (63,46-74,54)	70,72±8,34 (67,35-74,08)
	Fat,%	10,53±3,78 (9,51-11,54)	11,92±3,11 (10,32-13,51)	10,64±2,93 (9,45-11,82)
	RER *	0,74±0,06 (0,73-0,76)	0,85±0,01 (0,84-0,86)	0,94±0,06 (0,91-0,96)
AT	RER **	0,93±0,05 (0,92-0,94)	0,99±0,06 (0,95-1,08)	1,00±0,07 (0,97-1,03)
	Oxygen uptake, ml·min <sup>-1</sup> ·kg <sup>-1</sup>	48,30±8,84 (45,94-50,67)	44,76±6,84 (41,24-48,28)	45,40±9,01 (41,76-49,04)
	Power output, W·kg <sup>-1</sup>	3,31±0,93 (3,06-3,56)	3,35±0,94 (2,87-3,84)	3,06±1,02 (2,63-3,49)
	Q, kcal·min <sup>-1</sup> ·kg <sup>-1</sup>	0,24±0,05 (0,23-0,25)	0,22±0,03 (0,21-0,24)	0,23±0,05 (0,21-0,24)
	Q <sub>c</sub> , kcal·min <sup>-1</sup> ·kg <sup>-1</sup>	0,18±0,05 (0,17-0,20)	0,20±0,05 (0,18-0,23)	0,20±0,05 (0,18-0,22)
	Q <sub>p</sub> , kcal·min <sup>-1</sup> ·kg <sup>-1**</sup>	0,06±0,04 (0,05-0,07)	0,02±0,03 (0,01-0,04)	0,02±0,03 (0,01-0,03)
VO <sub>2max</sub>	RER **	1,05±0,06 (1,04-1,07)	1,12±0,11 (1,06-1,17)	1,15±0,09 (1,12-1,19)
	Oxygen uptake, ml·min <sup>-1</sup> ·kg <sup>-1</sup>	58,66±9,52 (56,11-61,20)	54,47±9,08 (49,80-59,13)	54,71±8,28 (51,37-58,06)
	Power output, W·kg <sup>-1</sup>	4,50±1,31 (4,14-4,85)	4,62±1,46 (3,86-5,37)	4,13±1,41 (3,54-4,72)
	Q, kcal·min <sup>-1</sup> ·kg <sup>-1</sup>	0,30±0,05 (0,28-0,31)	0,28±0,05 (0,25-0,30)	0,27±0,04 (0,26-0,29)
	Q <sub>c</sub> , kcal·min <sup>-1</sup> ·kg <sup>-1</sup>	0,29±0,05 (0,28-0,30)	0,27±0,05 (0,25-0,30)	0,27±0,04 (0,26-0,29)
	Q <sub>p</sub> , kcal·min <sup>-1</sup> ·kg <sup>-1</sup>	0,01±0,01 (0,00-0,01)	0,003±0,01 (-0,002-0,008)	0,00±0,00 (0,00-0,01)

\* Difference is significant between all groups (Tukey honestly significant difference,  $p \geq 0.05$ )

\*\* Difference is significant between 1st group and 2nd group, and 1st group and 3rd group (Tukey honest significant difference,  $p \geq 0.05$ )

As significant variability was found between the indicators of resting RER in the surveyed athletes, the athletes were divided into 3 groups according to their RER in order to determine the value of metabolic efficiency for the metabolic reserve (Table 4):

Group 1 – RER  $\leq 0.82$  (energy supply from fat – 60% and more)

Group 2 – RER 0.83-0.87 (energy supply from fat – 44-58%)

Group 3 – RER  $\geq 0.88$  (energy supply from fat 41% and below)

As can be seen from the Table 4, the groups are homogeneous in body weight and composition. Differences in resting RER values are significant between all groups. The greater contribution of fat to energy production in athletes of the first group has been established not only at rest, but also during exercise. Thus, significantly lower values of RER were registered when reaching AT and  $VO_{2max}$ . The contribution of fat to energy supply was substantive during exercise at the level of the anaerobic threshold in athletes with the highest metabolic efficiency. Thus, the contribution of fat to the energy supply when reaching AT was 24% for athletes of the 1st group; 4% for the 2nd group and 0% for the 3rd group.

It is worth noting the fact that oxygen consumption was higher in athletes with the highest metabolic efficiency (group 1) both when achieving AT and  $VO_{2max}$ . So  $VO_2$  averaged 48.3; 44.8 and 45.4  $ml \cdot min^{-1} \cdot kg^{-1}$ , respectively, in groups 1, 2, and 3 when reaching AT and 58,6; 54.5 and 57.7  $ml \cdot min^{-1} \cdot kg^{-1}$  when reaching  $VO_{2max}$ . These differences in  $VO_2$  values are not significant. At the same time, this fact needs further research, as the study revealed a significant correlation between the efficiency of metabolism (RER<sub>rest</sub> and RER<sub>AT</sub>) and maximum oxygen consumption (Table 3).

## 5. Discussion

The study found a link between RER and the use of energy substrates at rest and when achieving AT and  $VO_{2max}$  in the athletes. The largest range of RER differences is registered at rest. Thus, the coefficient of variation was 12.3%, 7.3% and 8.3%, respectively, at rest, when reaching AT and  $VO_{2max}$ . The variability at the level of AT and  $VO_{2max}$  is lower, as the contribution of carbohydrates to energy production increases, but the differences in the use of fat between groups with different metabolic efficiencies persist. It should be noted that for untrained people at rest is characterized by RER 0.85, which corresponds to the use as energy substrates of 49% carbohydrates and 51% fat (*Shils&Shike, 2006*). In athletes at rest, the RER averaged  $0.81 \pm 0.10$ , which reflects the use of 65% of energy from fat. Such differences indicate a greater efficiency of metabolism of skilled athletes at rest.

Increasing the efficiency of metabolism in skilled athletes at rest plays a significant role during intense exercise, as evidenced by the established in this study a significant correlation between RER at rest and when achieving AT and  $VO_{2max}$  (for both  $r = 0.52$ ,  $p \leq 0, 05$ ). This fact indicates the importance of increasing the contribution of fat to energy for the more efficient use of glycogen stores during intense and especially long-term muscle activity.

Restoration of energy and substrate resources in the athlete's muscular activity is important to ensure his special performance: it is known that the duration of training can exceed 6 hours a day with energy expenditures that can exceed 10,000 kcal and while internal glycogen stores are limited, so the use of fat as a substrate of energy is of great importance (*Seebohar, 2014*). Thus, increasing metabolic efficiency can increase the energy supply of muscle activity, and thus increase metabolic reserves while reducing glycogen expenditure.

Given the limited amount of carbohydrate reserves on the one hand and the duration of training and competitive activities on the other, the efficient use of fat can be of particular

importance for maintaining efficiency. This is confirmed by the reliable relationship between RER at the level of the anaerobic threshold and  $RER_{VO_{2max}}$  ( $r = 0.86, p \leq 0.05$ ). The efficiency of metabolism significantly affects the values of  $VO_{2max}$  and the use of fat as a substrate of energy during intense exercise. This fact deserves special attention because the use of fat as a substrate of energy can play a crucial role in increasing metabolic reserves and prevent glycogen depletion, which allows for the delayed development of fatigue.

For comparison, in the case of the same glycogen stores in athletes of the 1st group when performing the exercise load at the level of the anaerobic threshold, they will be enough for 120 minutes, for 102 minutes in the second group, and for 99 minutes for the 3rd. Therefore, with the same level of metabolic and other reserves, with efficient metabolism, athletes can extend the duration of intense exercise, which is especially important for sports with a predominant manifestation of endurance.

It is clear that creating conditions for maintaining the efficiency of metabolism is one of the ways to increase metabolic reserves and possibly increase the special performance of skilled athletes, as well as to increase the duration of intense exercise and delay the manifestations of decompensated fatigue during training and competition. As the data obtained in the study indicate a close, reliable relationship between metabolic efficiency at rest and during exercise of varying intensity, the determination of respiratory exchange ratio is appropriate to assess the metabolic reserves of qualified athletes.

This study is not without limitations. With an RER above AT, it is impossible to accurately determine the contribution of fat to energy supply, because the value of RER in this state is significantly affected by non-metabolic  $CO_2$  increase. However, the relationship between lower  $RER_{rest}$  and lowering values of  $RER_{AT}$  and  $RER_{VO_{2max}}$  allows us to assess this value indirectly. The results of the study would be more significant in practice if the nutrition of athletes is taken into account, which may also affect the efficiency of metabolism. However, the aim of this study was to investigate the efficiency of metabolism in a relatively large sample. Assessment of the impact of nutrition on metabolic efficiency a promising area of further research.

## 6. Conclusions

1. Metabolic efficiency is an important component of metabolic reserves and sports performance in athletes with the predominant manifestation of endurance. Efficient resting metabolism creates the preconditions for more efficient use of energy substrates during intense muscle activity.

2. The respiratory exchange ratio in skilled athletes at rest significantly correlates with the values of RER when reaching the anaerobic threshold and  $VO_{2max}$  and with the maximum oxygen consumption.

3. The respiratory exchange ratio is an informative indicator of the efficiency of metabolism, which can be used in the complex control of the functional state of the athlete.

## 7. Conflict of interest

The author reports no conflicts of interest associated with this manuscript.

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## CHARACTERISTICS OF BLOOD DONORS, ACCORDING TO THE RESULTS OF COMPLEX LABORATORY TESTS OF PERIPHERAL BLOOD

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### Summary

Nowadays, there is a significant storage of donated blood in the world. According to the recommendations of the WHO, adequate and reliable supply of save donated blood can only be carried out on the base of regular voluntary non-paid donations. This particular category of donations is the safest from the point of view of the prospect of having infectious diseases that can be transmitted through blood. Recruiting and retaining the donors who make voluntary non-paid donations is a priority for the blood service on the way to achieving 100% voluntary non-paid donation of blood and its components.

Blood transfusion service and its social component – donor ship must be the priority areas of the state policy because the results of its work are of paramount importance. The main task of the blood transfusion service is supply of high quality components for blood transfusion therapy. Quality of blood components is compliance of properties and specifications of the blood component supplied to the recipient with the set standards. Strict order of conformance with the approved regulations and procedures is important at all technological states and is a cornerstone of blood transfusion service products quality. All actions, planned and implemented, starting with planning donor ship and ending with the finished product manufacturing and storage conditions, are important for ensuring the quality as the final result.

**Keywords:** blood donation, erythrocytes, metabolic disorders, ferritin, transferrin, serum iron.

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### 1. Introduction

In spite of the lately increasing number of scientific research programs on donor blood storage, integrated solution of this problem remains a challenging open issue. We studied parameters indicative of iron metabolism in donors, and glycolytic processes in peripheral blood erythrocytes depending on history of donations, donors' health at the time of plasma donation via automatic plasmapheresis, issues of donorship optimization, and its medical and social aspects (*Masse, 2014, Yin, 2015, Ngoma, 2017*).

Potential donors reserve decrease negatively affects the volumes of donor blood collected by the blood transfusion service of Ukraine. Reducing number of donors in contrast to the increasing need for blood components and products is a topical issue of present-day transfusion medicine because the number of donors is decreasing by 10-15% annually worldwide.

Pathogenic factor of iron deficiency is its negative balance caused by the discrepancy between resorption and intake, or high losses (*Magnussen, 2015, Karpenko, 2017*). Iron deficiency leads to erythrocyte transport function impairment (oxygen and carbon dioxide transporting), shortening of their life cycle from 120 to 56 days, and reduction of resistance to different physical and chemical factors, in particular impact on erythrocytes in donors with latent iron deficiency: freezing at ultra-cold temperatures leads to hemolysis increase to over 30% when reference rate is 2-5%. Acid resistance of erythrocytes decreases almost 2-fold (acid erythrograms demonstrate destruction of the main erythrocyte mass during the first 8 minutes instead of 15-16 minutes). In iron deficiency, erythropoiesis intensity is not accompanied by increased production of erythrocytes, but causes metabolic, functional and morphologic changes in them, which is of particular importance for blood donors because, on an average, 5% of donors stop donating for the reason of deterioration of the peripheral blood parameters. Erythrocyte destruction caused by metabolic, functional and morphologic changes in them leads to macrophage system overstraining. Besides, the above-mentioned changes in the erythrocytes of the blood donors result in donor blood quality lowering and, consequently, lower quality of blood components containing erythrocytes, which can affect the results of blood transfusion therapy and recipients' health (*Magnussen, 2015, WHO, 2020*).

Iron metabolism evaluation method used for blood donors by the Ukrainian blood transfusion service and approved legally provisions measurement of hemoglobin parameter pathophysiology of which changes only at the stage of overt iron deficiency. Peripheral blood parameters abnormality detected by the establishments of the blood transfusion service in more than 5% of blood donors is a cause of denial of donations, while iron deficiency was found in 25-50% of the active donors.

Study of the latent abnormalities of iron metabolism and related changes of physical properties of erythrocytes, rheological abnormalities and energy processes in erythrocytes of blood donors, as well as development of correction and prevention methods is a topical issue for the state blood transfusion service. Their impact on functional capacity of peripheral blood erythrocytes in the body of active donors, the study of this problem has just started, which calls for the development of diagnostic methods for detection of the above-mentioned changes and methods of their correction.

Goal: upon the study of laboratory, morphologic, biochemical and biophysical properties of donor blood erythrocytes, determine pathogenesis of metabolic abnormalities in erythrocytes of blood donors depending on how long they have been donating blood and increase effectiveness of early diagnostics and prevention of the above changes for donors' health protection.

## 2. Material and methods of research

The study included 459 donors who donated in clinical centers of the chair of hematology and transfusiology of Shupyk National Healthcare University of Ukraine. All donors were examined pursuant to the Medical Examination Procedure for Donors of Blood and (or) its Components approved by Decree of the Health Ministry of Ukraine № 385 dated 01.08.2005 – «On Infectious Safety of Donor Blood and its Components» as donors whose blood is used for production of components. Before donation, blood donors filled questionnaire and were examined by qualified specialists pursuant to the requirements of the applicable Medical Examination Procedure for Donors of Blood and (or) its Components. Hemoglobin was measured for all the donors (RR: M – no less than 130 g/l, F – no less than 120 g/l). Blood donation volume was determined on the basis of hemoglobin test (max volume – 450 ml excluding blood volume

drawn for the test (up to 40 ml). For active blood donors, it is necessary to consider the interval before the donations that should not be less than 60 days from the date of the previous donation, as well as number of donations per year – no more than 5 for men and 4 for women.

After blood donation, alanine aminotransferase (ALT, RR 0,1 – 0,68 mmol/h-l) level was measured in donors' blood; it was also tested for hemotransmissible infections (HIV ½, hepatitis B, hepatitis C, syphilis).

459 blood donors (231 men and 228 women) were examined, among which 299 were active donors (148 men and 151 women) donating on regular basis, no less than 3 times a year and 160 first-time registered donors (83 men and 77 women). According to age classification (*WHO, 1991*), first-time donors were divided into three subgroups: young donors – 48 (26 men and 22 women aged 20-34), middle-aged donors – 62 (30 men and 32 women aged 35-44) and ripe-age donors – 50 (27 men and 23 women aged 45-59). First-time registered donors made the control group of our research.

Mean age of the first-time donors from the control group was (38,90±1,31) (20-59 years old). Mean age of the male donors was (39,66±1,53) (22-59 years old). Mean age of female donors was (37,56±2,45) (20-57 years old).

All 160 first-time donors were practically healthy and eligible for donation subsequent to the result of survey, examination by specialists and hemoglobin level. Markers of hemotransmissible infections were all negative. ALT level was within the normal limits.

Since the control group was made by first-time donors, for convenience of systematization and reflection of the results of scientific research, objectivation in research data comparison, all the examined active donors were divided into three groups depending on the number of years they were donating and, consequently, increasing risk of latent metabolic abnormalities: group I – 146 donors (76 men and 70 women) donating from 2 to 5 years (number of donations in men was (10,41±0,96) (from 3 to 24), in women – (10,41±0,96) (from 3 to 18). Mean age of Group I active donors was (38,49±1,43) (20 – 58 years old). Mean age of male donors was (39,18±1,65) (20-58 years old). Mean age of female donors was (36,25±2,89) (22-58 years old). Groups of the examined donors were similar in terms of age and sex distribution.

Research was approved by the Ethics Committee of Shupyk National Healthcare University of Ukraine.

The following methods were used: general blood tests, blood chemistry, specific blood chemistry, radioimmune and enzyme-immunoassay, statistic methods.

Devices and chemical agents used for the research were registered and certified in Ukraine. Devices were subjected to metrological monitoring in the due time.

Hemoglobin measuring, erythrocyte, leukocyte, platelet count and calculation of RBC indices were performed in the laboratory on the automated analyzer PCE-210 (ERMA, Japan). Determination of serum iron was performed according to beta-phenantroline method. Total iron binding capacity (TIBC) was evaluated by transferrin (TF) saturation with three-valence iron. Unsaturated (latent) iron binding capacity (UIBC) was calculated as difference between TIBC and iron concentration. Transferrin saturation coefficient (TSC) was calculated as serum iron (SI)/TIBC ratio. Serum TF was determined by TIBC value. Serum ferritin (FN) was evaluated by radioimmunoassay technique using ИРМО-ФЕРРИТИН set (Belarus). Optical transmission of erythrocytes (OTE) was determined in accordance with Danop-Marikovaski method (1964). Physical and chemical parameters of erythrocyte membrane penetrability (PEMP) was evaluated in accordance with Kulapina et al. method (2006). Red blood cell distribution width (RDW) was determined automatically on automated hemo analyzer PCE-210 (ERMA, Japan). Effectiveness of erythropoiesis value (EEV) was evaluated in accordance with Kozinets

et al. method (1988). All data obtained in the course of research were statistically processed. Research scope sample was analyzed by Student's t-test and Mann-Whitney nonparametric U-test, correlation and dispersion analyses. For data analysis, IBM SPSS Statistics 22,0 and Excel XP were used.

### 3. First-time blood donors pattern based on the results of laboratory, morphologic, biophysical and biochemical peripheral blood tests

459 blood donors (231 men and 228 women) were examined. 160 of them (83 men and 77 women) were first-time donors and they made the control group (I), while 299 donors (148 men and 151 women) were regular blood donors donating for more than two years (no less than 2 times a year) – they made the study group (II). According to the age classification (*WHO, 1991*), first-time donors (control group, n=160) were divided into three subgroups: young donors – 48 (26 men and 22 women) aged 20-43, middle-aged donors – 62 (30 men and 32 women) aged 35-44, ripe age donors (27 men and 23 women) aged 45-59.

Active donors (n=146) were divided into groups: I – donating from 2 to 5 years: young donors – 41 (22 men and 19 women), middle-aged – 56 (29 men and 27 women), ripe age – 49 (25 men and 24 women). In first-time donors, mean hemoglobin level was (138,88±0,95) g/l: in men – (142,72±0,81) g/l (135 g/l – 150 g/l), in women – (132,06±0,89) g/l (127 g/l – 140 g/l). Hemoglobin level was higher in male than in female donors ( $p<0,001$ ). In first-time donors, erythrocyte count was, on an average,  $(4,63±0,03) \times 10^{12}/l$ . In the examined male donors it was, on an average,  $(4,76±0,03) \times 10^{12}/l$  ( $4,5 \times 10^{12}/l$  –  $5,0 \times 10^{12}/l$ ), in female –  $(4,40±0,03) \times 10^{12}/l$  ( $4,2 \times 10^{12}/l$  –  $4,7 \times 10^{12}/l$ ). Erythrocyte count was higher in men than in women ( $p<0,001$ ). In the examined male donors, leukocyte count was in the mean  $(6,86±0,21) \times 10^9/l$  ( $4,4 \times 10^9/l$  –  $8,6 \times 10^9/l$ ), in female –  $(6,79±0,29) \times 10^9/l$  ( $8 \times 10^9/l$  –  $9,2 \times 10^9/l$ ). Average leukocyte count in the group of first-time donors was  $(6,83±0,17) \times 10^9/l$ . In first-time donors, platelet count was, on an average,  $(203,40±1,97) \times 10^9/l$ . In the examined male donors it was, on an average,  $(204,38±2,69) \times 10^9/l$  ( $180 \times 10^9/l$  –  $230 \times 10^9/l$ ), in female –  $(201,76±2,71) \times 10^9/l$  ( $190 \times 10^9/l$  –  $210 \times 10^{12}/l$ ). Erythrocyte count was higher in men than in women ( $p<0,001$ ).

In the group of first-time donors, reticulocyte count was, on an average,  $(0,88±0,05) \%$ . In the examined male donors, mean reticulocyte count was  $(0,87±0,05) \%$ , in female –  $(0,88±0,04) \%$ . There were no significant age- or sex-dependent differences between mean leukocyte, platelet and reticulocyte counts in the examined first-time donors ( $p>0,05$ ).

In the first-time donors, mean cell hemoglobin (MCH) was, on an average,  $30,63±0,25$  pg (27-33 pg). In female donors, mean MCH was  $(29,40±0,42)$  pg (27-31 pg), in male –  $(31,13±0,24)$  pg (28-33pg). There was no significant sex-dependent difference in MCH in the examined first-time donors ( $p>0,05$ ).

In all first-time donors, mean corpuscular volume (MCV) was, on an average,  $(93,41±0,91)$  fl (84-97 fl). In female donors, mean MCV was  $(94,22±1,69)$  fl (89-97 fl), in male –  $(92,29±1,01)$  fl (84-96 fl). There was no significant sex-dependent difference in MCV in the control group ( $p>0,05$ ).

In all first-time donors, mean corpuscular hemoglobin concentration (MCHC) was, on an average,  $(34,38±0,23) \%$  (33-35%). In female donors, mean MCHC was  $(34,35±0,31) \%$  (33-35 %), in male –  $(34,41±0,41) \%$  (33-35%). There was no significant age- or sex-dependent difference in MCHC in this group ( $p>0,05$ ).

We performed cytometry of peripheral blood erythrocytes of the first-time donors. Mean corpuscular diameter was, on an average,  $(7,192±0,06)$  mcm<sup>3</sup>, micro- and schistocytes –  $(4,80±0,14)$  fl, anisocytosis –  $(4,02±0,14) \%$ , discocytes –  $(80,41±0,45) \%$ , abnormal



shape – (19,59±0,55) %. There was no significant age- and sex-related difference between average mean corpuscular diameter, micro- and schistocyte count, % of anisocytosis, discocytes and abnormally shaped erythrocytes in first-time donors ( $p>0,05$ ).

In first-time donors, mean serum iron (SI) was (20,04±2,03)  $\mu\text{mol/l}$ , and it was higher in male donors ( $p<0,01$ ). In first-time donors, TIBS was, on an average, (57,25±2,49)  $\mu\text{mol/l}$ . In the examined male donors, TIBS was, on an average, (56,52±2,37)  $\mu\text{mol/l}$  (52,05 – 61,03  $\mu\text{mol/l}$ ), in female – (58,55±2,20)  $\mu\text{mol/l}$  (54,87 – 62,05  $\mu\text{mol/l}$ ). TIBS was higher in females ( $p<0,01$ ). In the examined male donors, UIBS was, on an average, (35,77±4,07)  $\mu\text{mol/l}$  (28,05 – 43,37  $\mu\text{mol/l}$ ), in female – (39,78±3,53)  $\mu\text{mol/l}$  (34,18 – 45,65  $\mu\text{mol/l}$ ). In general, the mean UIBC for the group of the first-time donors was (37,21±4,31)  $\mu\text{mol/l}$ . UIBC was higher in females ( $p<0,01$ ). In first-time donors, TSC was, on an average, (35,18±4,90) %. In the examined male donors, mean TSC was (36,88±4,74) % (28,60 – 46,10 %), in female – (32,17±3,63) % (26,40 – 38,30 %). TSC was higher in male donors ( $p<0,01$ ). In first-term donors, serum TF was, on an average, (2,23±0,10) g/l. In the examined male donors, serum TF was (2,20±0,09) g/l (2,03 – 2,38 g/l), in female – (2,28±0,09) g/l (2,14 – 2,42 g/l). Serum TF was higher in female donors ( $p<0,01$ ).

In the examined male donors, serum FN was, on an average, (24,91±2,14) mcg/l (20,64 – 30,12 mcg/l) in female – (19,19±1,41) mcg/l (17,15 – 21,82 mcg/l). In general, the mean serum FN in the group of first-time donors was (22,85±3,36) mcg/l. Serum FN was higher in male donors ( $p<0,001$ ).

In young donors, serum iron was, on an average, (21,43±1,56)  $\mu\text{mol/l}$  (19,1 – 24,0  $\mu\text{mol/l}$ ), in middle-aged donors – (20,17±1,860)  $\mu\text{mol/l}$  (17,4 – 24,6  $\mu\text{mol/l}$ ), in ripe age donors – (18,03±1,14)  $\mu\text{mol/l}$  (16,4 – 19,8  $\mu\text{mol/l}$ ).

Serum iron level in young first-time donors was higher than in middle-aged ( $p<0,05$ ) and ripe age ( $p<0,001$ ) donors. The level of serum iron in middle-aged donors was higher than in the ripe age donors ( $p<0,01$ ).

Average level of serum TF in young donors was (2,13±0,06) g/l (2,03 – 2,24 g/l) in middle-aged – (2,15±0,05) g/l (2,15 – 2,35 g/l), in ripe age – (2,35±0,05) g/l (2,26 – 2,42 g/l).

Average level of serum FN in young donors was (24,01±4,17) mcg/ml (17,21 – 30,12 mcg/ml), in middle-aged donors – (22,88±3,08) mcg/ml (17,49 – 26,55 mcg/ml), in ripe age donors – (21,34±2,18) mcg/ml (17,15 – 24,21 mcg/ml).

Serum FN in young donors was higher than in the ripe age ( $p<0,05$ ). There was no significant difference in serum FN level between first-time young and middle-aged donors and middle-aged and ripe age donors.

In all first-time donors, RDW was 79,81±0,81 fl (79,01 – 80,71 fl). There was no significant sex-related difference in RDW in the examined first-time donors ( $p>0,05$ ).

The margin of errors for mean values for erythrocyte populations varied between 0,4 – 4,1% of the reference value. In most cases, it did not exceed 1-2%. According to the criteria approved for biology and medicine, accuracy achieved in the process of research is quite high. The data obtained is reliable and can be used both in practical work and as reference points.

In first-time donors, OTE was 0,006±0,001 g/ml (0,005±0,001 – 0,007±0,001 g/ml). There was no significant sex-related difference in OTE in the examined first-time donors ( $p>0,05$ ). There was no significant sex-related difference in erythrocyte aggregation, platelet aggregation index and hematocrit in first-time donors ( $p>0,05$ ).

We established that in the group of first-time donors erythrocyte fragmentation was, on an average, (1,74±0,09) % (0,75 – 3 %). There was no significant sex-related difference in erythrocyte fragmentation in first-time donors ( $p>0,05$ ).

We established that in the group of first-time donors EEV was  $(0,070\pm 0,0010)\cdot 10^{12}/l$ : in female donors it was, on an average,  $(0,069\pm 0,0021)\cdot 10^{12}/l$ , in male donors –  $(0,071\pm 0,0019)\cdot 10^{12}/l$ . First of all, EEV of  $(0,07\pm 0,001)\cdot 10^{12}/l$  in first-time donors demonstrates that this is the number of erythrocytes formed and is released daily into one liter of peripheral blood in this category of donors (hence in healthy people).

#### **4. Pattern of active blood donors donating for 2-5 years based on the results of laboratory, morphologic, biochemical and biophysical tests of peripheral blood**

In group I active donors hemoglobin concentration was, on an average,  $(138,18\pm 8,98)$  g/l. There was no significant difference in hemoglobin concentration, erythrocyte and platelet count between Group I donors and control group donors ( $p>0,05$ ), reticulocyte count was, on an average  $(0,88\pm 0,05)$  %: examined male donors –  $(0,87\pm 0,05)$  %, female donors –  $(0,88\pm 0,04)$  %.

There was no significant sex-related difference in the mean leucocyte, platelet and reticulocyte count in the examined group I active donors ( $p>0,05$ ).

In group I active donors, mean MHC was  $(30,63\pm 0,25)$  pg (27 – 33 pg). In female donors, MHC was, on an average  $(29,40\pm 0,42)$  pg (27 – 31 pg), in male donors –  $(31,13\pm 0,24)$  pg (28 – 33 pg). There was no significant sex-related difference in MHC in the examined group I active donors ( $p>0,05$ ). In group I active donors, mean MCV was  $(93,41\pm 0,91)$  fl (84–97 fl). In female donors, MCV was, on an average  $(94,22\pm 1,69)$  fl (89–97fl), in male donors –  $(92,29\pm 1,01)$  fl (84–96 fl). There was no significant sex-related difference in MCV in the examined group I active donors ( $p>0,05$ ). In group I active donors, mean MCHC was  $(34,38\pm 0,23)$  % (33–35%). In female donors, MCHC was, on an average  $(34,35\pm 0,31)$  % (33–35%), in male donors –  $(34,41\pm 0,41)$  % (33–35%). There was no significant sex-related difference in MCHC in the examined group I active donors ( $p>0,05$ ).

In young active donors, the results of the peripheral blood test were within the normal limits. It was established that mean hemoglobin concentration as well as erythrocyte and platelet count was higher in male donors ( $p<0,05$ ), while average leucocyte count was the same in both sexes ( $p>0,05$ ). There was no significant difference in peripheral blood parameters between young active donors and control group donors ( $p>0,05$ ).

In middle-aged active donors, the results of the peripheral blood test were within the normal limits. It was established that mean hemoglobin concentration as well as erythrocyte and platelet count was higher in male donors ( $p<0,05$ ), while average leucocyte count was the same in both sexes ( $p>0,05$ ). There was no significant difference in peripheral blood parameters between middle-aged active donors and control group donors ( $p>0,05$ ) as well as between young and middle-aged active donors ( $p>0,05$ ).

Extended peripheral blood test was performed for all ripe age active donors of study group I. Hemoglobin concentration was, on an average,  $(137,84\pm 7,90)$  g/l, erythrocyte count –  $(4,60\pm 0,27)\times 10^{12}/l$  ( $p<0,001$ ). There was no sex-related significant difference in reticulocyte count between group I ripe age active donors ( $p>0,05$ ). There was no significant difference in reticulocyte count between Group I ripe age active donors and control group donors ( $p>0,05$ ). In group I ripe age active donors, the results of the peripheral blood test were within the normal limits. It was established that mean hemoglobin concentration as well as erythrocyte and platelet count was higher in male donors ( $p<0,05$ ), while average leucocyte count was the same in both sexes ( $p>0,05$ ). There was no significant difference in hemoglobin concentration, erythrocyte, reticulocyte and leukocyte count between young, middle-aged and ripe age active donors ( $p>0,05$ ), while man platelet count in ripe age active donors was higher than in young and middle-aged donors ( $p<0,05$ ).

We performed cytometry of peripheral blood erythrocytes in this group of donors. Mean corpuscular diameter was, on an average,  $(7,192 \pm 0,06) \text{ mcm}^3$ , micro- and schistocytes –  $(4,80 \pm 0,14) \text{ fl}$ , anisocytosis –  $(4,02 \pm 0,14) \%$ , discocytes –  $(80,41 \pm 0,45) \%$ , abnormal shape –  $(19,59 \pm 0,55) \%$ . There was no significant age- and sex-related difference between average mean corpuscular diameter, micro- and schistocyte count, % of anisocytosis, discocytes and abnormally shaped erythrocytes in group I donors ( $p > 0,05$ ).

In group I active donors, SI was  $(20,04 \pm 2,03) \mu\text{mol/l}$ . In the examined male donors, SI was  $(20,75 \pm 1,94) \mu\text{mol/l}$  ( $17,30 - 24,60 \mu\text{mol/l}$ ), in women –  $(18,77 \pm 1,53) \mu\text{mol/l}$  ( $16,40 - 21,30 \mu\text{mol/l}$ ). SI was higher in male donors ( $p < 0,01$ ). In group I active donors, TIBS was, on an average,  $(57,25 \pm 2,49) \mu\text{mol/l}$ . In the examined male donors, TIBS was, on an average,  $(56,52 \pm 2,37) \mu\text{mol/l}$  ( $52,05 - 61,03 \mu\text{mol/l}$ ), in female –  $(58,55 \pm 2,20) \mu\text{mol/l}$  ( $54,87 - 62,05 \mu\text{mol/l}$ ). TIBS was higher in females ( $p < 0,01$ ). In group I active blood donors, UIBS was, on an average,  $(37,21 \pm 4,31) \mu\text{mol/l}$ . UIBC was higher in females ( $p < 0,01$ ). In group I active blood donors, TSC was, on an average,  $(35,18 \pm 4,90) \%$ . In the examined male donors, man TSC was  $(36,88 \pm 4,74) \%$  ( $28,60 - 46,10 \%$ ), in female –  $(32,17 \pm 3,63) \%$  ( $26,40 - 38,30 \%$ ). TSC was higher in male donors ( $p < 0,01$ ).

In group I active blood donors, serum TF was, on an average,  $(2,23 \pm 0,10) \text{ g/l}$ . In the examined male donors, serum TF was  $(2,20 \pm 0,09) \text{ g/l}$  ( $2,03 - 2,38 \text{ g/l}$ ), in female –  $(2,28 \pm 0,09) \text{ g/l}$  ( $2,14 - 2,42 \text{ g/l}$ ). Serum TF was higher in female donors ( $p < 0,01$ ). In the examined male donors, serum FN was, on an average,  $(24,91 \pm 2,14) \text{ mcg/l}$  ( $20,64 - 30,12 \text{ mcg/l}$ ), in female –  $(19,19 \pm 1,41) \text{ mcg/l}$  ( $17,15 - 21,82 \text{ mcg/l}$ ). In general, the mean serum FN in group I active blood donors was  $(22,85 \pm 3,36) \text{ mcg/l}$ . Serum FN was higher in male donors ( $p < 0,001$ ).

In middle-aged donors, mean SI was  $(20,17 \pm 1,86) \mu\text{mol/l}$  ( $17,4 - 24,6 \mu\text{mol/l}$ ). In ripe age donors, mean SI was  $(18,03 \pm 1,14) \mu\text{mol/l}$  ( $16,4 - 19,8 \mu\text{mol/l}$ ). SI in group I young donors was higher than in middle-aged ( $p < 0,05$ ) and ripe age ( $p < 0,001$ ) donors. SI in middle-aged donors was higher than in ripe age donors ( $p < 0,01$ ). In young donors, TIBS was, on an average,  $(54,60 \pm 1,54) \mu\text{mol/l}$  ( $52,05 - 57,44 \mu\text{mol/l}$ ). TIBS in ripe age donors was higher than in middle-aged ( $p < 0,001$ ) and young donors ( $p < 0,001$ ). TIBS in middle-aged donors was higher than in young donors ( $p < 0,001$ ).

In middle-aged donors, UIBS was, on an average,  $(37,29 \pm 3,00) \mu\text{mol/l}$  ( $31,30 - 42,60 \mu\text{mol/l}$ ). In group I ripe age active donors, UIBS was higher than in middle-aged ( $p < 0,001$ ) and young donors ( $p < 0,001$ ). UIBS in group I middle-aged active donors was higher than in young donors ( $p < 0,001$ ).

In young donors, TSC was, on an average  $(39,34 \pm 3,77) \%$  ( $33,9 - 46,1\%$ ), in middle-aged donors –  $(35,17 \pm 3,88) \%$  ( $29,0 - 44,0 \%$ ), in ripe age donors –  $(30,02 \pm 2,47) \%$  ( $26,4 - 33,7 \%$ ). TSC of young donors was higher than in middle-aged ( $p < 0,01$ ) and ripe age ( $p < 0,001$ ) donors. TSC of middle-aged donors was higher than in ripe age donors ( $p < 0,001$ ).

In young donors, serum TF was, on an average,  $(2,13 \pm 0,06) \text{ g/l}$  ( $2,03 - 2,24 \text{ g/l}$ ), in middle-aged donors –  $(2,24 \pm 0,05) \text{ g/l}$  ( $2,15 - 2,35 \text{ g/l}$ ), in ripe age donors –  $(2,35 \pm 0,05) \text{ g/l}$  ( $2,26 - 2,42$ ). In group I ripe age active donors, TF was higher than in young ( $p < 0,001$ ) and middle-aged ( $p < 0,001$ ) donors. In middle-aged donors, TF was higher than in young donors ( $p < 0,001$ ).

In group I young active blood donors, serum FN was, on an average,  $(24,01 \pm 4,17) \text{ mcg/ml}$  ( $17,21 - 30,12 \text{ mcg/ml}$ ). In group I young active blood donors, FN level was higher than in ripe age donors ( $p < 0,05$ ). There was no significant difference between FN level in group one young active blood donors and middle-aged active donors as well as between middle-aged and ripe age active donors ( $p > 0,05$ ).

Main parameters of iron metabolism in group I active blood donors were within normal limits except for elevated UIBS. Mean SI, TSC and FN were higher in male donors ( $p < 0,05$ ), while mean TIBS, UIBS and TF were similar ( $p > 0,05$ ). However, max levels of TIBS, UIBS and TF were elevated, while minimal levels of TSC and FN were low. Mean SI, TSC and TF in group I active donors were lower than in the control group ( $p < 0,05$ ), while mean TIBS, UIBS and TF were higher than in the control group ( $p < 0,05$ ).

Our research revealed sex-dependent peculiarities of peripheral blood parameters and iron metabolism in active blood donors.

In all group I active blood donors, RDW was  $(79,81 \pm 0,81)$  fl ( $79,01 - 80,71$  fl). There was no significant age-related difference in RDW between the examined active blood donors of group I ( $p > 0,05$ ) as well as between them and control group ( $p > 0,05$ ).

In group I active blood donors, OTE was  $(0,006 \pm 0,001)$  g/ml ( $0,005 \pm 0,001 - 0,007 \pm 0,001$  g/ml). There was no significant sex-related difference in OTE and coefficients calculated from it between group I active blood donors ( $p > 0,05$ ) as well as between them and control group ( $p > 0,05$ ).

There was no significant sex-related difference in erythrocyte aggregation, platelet aggregation index and hematocrit between group I active blood donors as well as between them and control group ( $p > 0,05$ ).

We established that in group I active blood donors erythrocyte fragmentation was, on an average,  $(1,73 \pm 0,12)$  % ( $0,76 - 2,9$  %) –  $(1,74 \pm 0,11)$  % and  $(1,72 \pm 0,17)$  % in male and female donors respectively. There was no significant sex-related difference in erythrocyte fragmentation between group I active blood donors as well as in comparison with control group ( $p > 0,05$ ).

There was no significant difference in EEV between group I active blood donors and control group donors ( $p > 0,05$ ).

## 5. Conclusions

Study of the latent abnormalities of iron metabolism and related changes of physical properties of erythrocytes, rheological abnormalities and energy processes in erythrocytes of blood donors, as well as development of correction and prevention methods is a topical issue for the state blood transfusion service. In spite of paramount importance of the energy processes progress in erythrocytes, their impact on functional capacity of peripheral blood erythrocytes in the body of active donors, the study of this problem has just started, which calls for the development of diagnostic methods for detection of the above-mentioned changes and methods of their correction.

## 6. Practical recommendations

In order to preserve health of active donors and ensure quality of blood components received at the time of donation, thorough checkup of donors, including, apart from the main and biochemical peripheral venous blood parameters, morphologic, biophysical and rheological parameters of erythrocytes is highly recommended before donation.

For iron metabolism monitoring, it is recommended to measure serum ferritin, transferrin of peripheral venous blood. Timely detection of iron deficiencies and prescription of preventive treatment will result in prevention of iron deficiency anemia in active donors.

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## TECHNOLOGY, CREATIVITY, IMPLEMENTATION

### HUMAN FACTORS: THE PROBLEM OF MAN-MACHINE INTERACTION UNDER THE DIGITALIZATION CONDITIONS

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#### Summary

The main attribute of a modern labour paradigm is a new type of man-machine interaction – the digital ecosystem. However, despite the improvement of man-machine interaction, the human factor remains the most difficult issue in ensuring the safety of such systems. Moreover, the digitalization process complicated the problem of the human factors because it led to a decline of the human’s subjective responsibility for the actions performed because of a significant increase in the share of artificial intelligence in decision-making. As a result, the number of accidents in recent years has decreased but insignificantly. In most cases, the research methods of the human factor are focused on environmental and technical problems of the system functioning, leaving a human unattended. In this regard, the research aims at the peculiarities of human activity in the digital ecosystem. The research was carried out in two directions. The first one is the study of human needs in the digital ecosystem, due to which it was established that a person needs digital safety. This need determined the emergence of a new phenomenon – the safety culture in the digital space. The second direction is the study of the person’s resources. The study of this issue showed that the “cycle” of resources and, in particular, its balanced affects the manifestation of the “human factors” phenomenon.

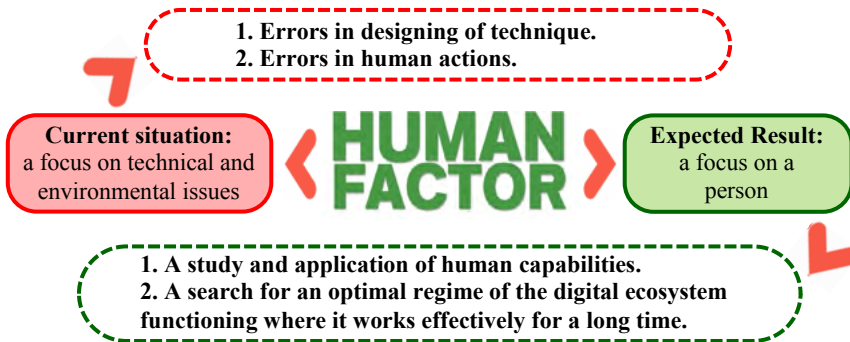
**Keywords:** human factors, digital ecosystem, viability, resources, hardiness, eco-ergonomics, safety.

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#### 1. Introduction

One of the main problems in man-machine interaction is the human factors (*Petrillo et al., 2018*). The human factor is a multicomponent phenomenon that is difficult to investigate. At the same time, the problem of the human factor becomes more complicated due to digitalization conditions. The complication lies in the emergence of a new type of man-machine system – a digital ecosystem, which necessitates a rethinking of the decision-making function. At the

stage before digitalization, the man-machine system functioning depended mainly on human decisions. The digitalization conditions led to the necessity of separation of decision-making between person and machine, significantly increasing the share of artificial intelligence. As a result, on the one hand, the man-machine system functioning became safer, on the other hand, a new model of the relationship between person and technology emerged. As a consequence, it led to the emergence of new types of dangers. For now, approaches to solving the problem of human factors include two groups (Fig. 1).

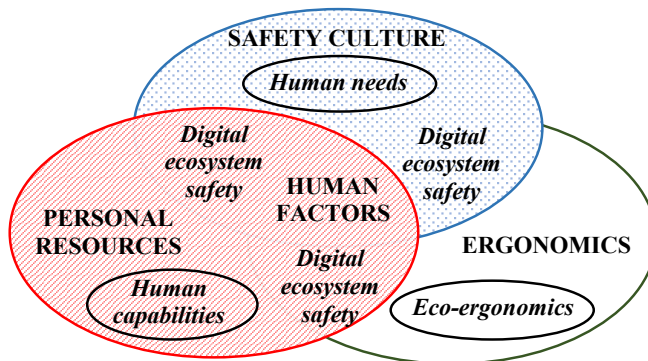


**Fig. 1. Approaches to solving the problem of the human factors in the digitalization conditions**

In the digitalization conditions in the study of the human factor, a focus of research on the person and his capabilities is prospective (Teperi et al., 2018) because an increase in the share of artificial intelligence in decision-making creates only the illusion of raising in the man-machine system safety. Focusing on a person (anthropocentrism) means:

1. Researching human needs and capabilities in the digital ecosystem.
2. Studying the transformation of safety culture in the digitalization conditions.
3. Investigation of the impact of the digital ecosystem environment on the person.
4. Studying the human factor in the digitalization conditions.

The presented research directions are interrelated and together determine the safety of the digital ecosystem (Fig. 2).



**Fig. 2. An anthropocentric approach to the problem of human factors**

## 2. Transformations of human needs and safety culture

**Human needs in the digitalization conditions.** The starting point of research is the study of the person needs since they determine most of his decisions. The increasing role of digital technologies leads to a gradual change in a person socio-economic, psychological and cultural needs. As a consequence, it affects a person perception of the concept of “safety”. Thus, it is not enough for a person just the working conditions corresponding to the current standards. The person has a new need – digital security. Researchers in various scientific fields emphasize the necessity to study this need (*Johnsen et al, 2018; Minchev, 2017; Raziq et al, 2015*). For example, in research (*Minchev, 2017*), the author investigated the issue of the person needs and their influence on his life. Among the needs, social ones are presented separately. They reflect the needs of a person for spatial comfort and safety of the working environment. The author showed the influence of the satisfaction degree of these needs on human health. Also, the researcher expressed the opinion about the need for safety culture formation in digital ecosystems.

At the same time, researchers in the field of ergonomics/human factors point to changes in the employees’ requests. It manifests in the employees’ desire to understand whether the confidentiality of their data while working in the organization is preserved, which way usage of digital technology at a workplace affects mental health, etc.

It should be noted, today a change in the needs of society itself is happening, which is associated with the need to ensure its sustainable development. The key to the successful development of modern society is a capability to ensure the highest level of human needs realization for safety, including in the digital environment.

**Safety culture in the digitalization conditions.** Requests and needs influence the formation of a safety culture in society. At the same time, the trend for increasing safety culture has different manifestations. For example, in West European countries, the USA, Canada, this process is conducting faster than in the countries of the post-Soviet area. Such a situation is connected with the insufficient level of public awareness of safety issues. This problem is a consequence of a lack of access to relevant information, state and social projects designed to attract attention to safety issues, etc. In recent years, the rise in safety culture in the countries of the post-Soviet area is happening. However, it goes slowly and covers only a part of the population, who mainly lives in large cities, where there is access to information and the possibility of its

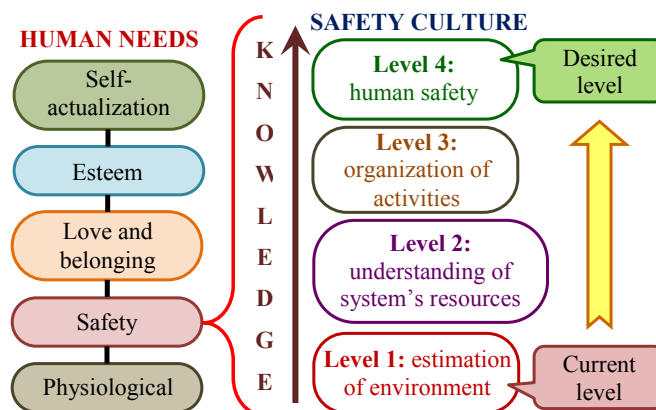


Fig. 3. Human needs and safety culture



propagation. It is also necessary to name another factor that hinders the growth of a safety culture in society – it is the people’s psychological unpreparedness. The main reason for this is the quality of education. Culture is an acquired person’s characteristic, not innate, and it is formed throughout life. The same concerns the safety culture, which should be formed by teaching the relevant disciplines in educational institutions. In this case, society can reach a level where safety culture is an integral part of life (Fig. 3).

It should be noted that safety culture is an integral part of the human factor because the development level of safety culture is an indicator of a person’s understanding of the importance of ensuring safety during interacting with technical devices. Consequently, the effectiveness of human factor management depends on the level of safety culture.

### 3. A resource-based approach to the research of the digital ecosystem

The problem of the human factor in digital ecosystems is determined by many phenomena and processes (De Vasconcelos et al., 2018; Dempsey et al., 2006; Hancock et al. 2011; Myhal et al., 2020). They can be divided into two groups: internal (associated with physiological, psychological, spiritual, intellectual, social and cultural aspects of human life) and external (environmental factors). Internal factors are the most difficult to study because of the complexity of their identification and assessment. Since each person is an individual and his behaviour in different circumstances is difficult to predict. However, if we analyse the problem by applying a resource-based approach, we can identify ways to solve the human factor problem in the digital ecosystem (Bodrov, 2006; Vodopyanova, 2009; Holmgreen et al., 2017; Hobfoll et al., 1993; Hobfoll et al., 2011; Hobfoll et al., 2015; Protasenko et al., 2020).

Today, there are different views on the problem of resources. However, the most widespread approach is Hobfoll’s conservation of resources theory. Its basic principle is obtaining and investing a person’s resources to maintain a subjective sense of safety and well-being (Holmgreen et al., 2017; Hobfoll et al., 1993; Hobfoll et al., 2011; Hobfoll et al., 2015). In other words, human safety depends on the efficiency of the “cycle” of resources, i.e. the person’s ability to receive and spend resources constantly. In most cases, a person receives and invests the resources guided on intuitive feeling, rather than practical knowledge. It can lead to positive results (multiplication of existing and obtainment of new resources) and negative ones (loss of resources without the possibility of rapid recovery). Low efficiency of the “cycle” of resources is often the cause of erroneous human actions. As a consequence, dangerous situations happen. To avoid such situations, a person needs to train in resource



Fig. 4. Resource management skill and digital ecosystem safety

management. The goal of resource management is the most effective usage of human capabilities during activities. Human activity in the digital ecosystem causes a significant transformation of the requirements for himself. It leads to an increase in the likelihood of dangerous situations emergence. Therefore, training a person in resource management skills is a prerequisite for ensuring digital ecosystem safety (Fig. 4).

To choose the optimal system of a person's learning in resource management skill, first of all, it needs to explore the features of man-machine interaction in the digital ecosystem.

### 3.1. Features of man-machine interaction in the digital ecosystem

To study the features of man-machine systems functioning it is used ergonomics. It has a significant number of methods for this purpose. However, the functioning of the digital ecosystem is studied insufficiently. Currently, ergonomics has no methods for studying and estimating such systems. Also, it found out that the impact of the human factor on a person's safety in the digital ecosystem does not decrease. Moreover, the human factor acquires a new meaning in the digitalization conditions (*Protasenko et al., 2018; Myhal et al., 2019; Myhal et al., 2021*). This fact conditions the necessity of methods for the research and estimation of the digital ecosystem functioning.

The digital ecosystem is an adaptive, open socio-technical system with the properties of self-organization, scalability and resilience, which is like natural ecosystems. Among the properties of the digital ecosystem, our attention attracted viability. Assessing the viability of a self-organizing system allows us:

1. To analyse the interaction of the system with the external environment.
2. To investigate the internal structure of the system and the hidden connections that affect the reliability of the digital ecosystem operation;
3. To estimate the system properties such as efficiency, usefulness, self-organization, controllability, reliability, etc.

In addition, viability can explain the existence of the "human factor" and the appearance of failures in digital ecosystems (*Johnson, 2006; Kalantari, 2020; Protasenko et al., 2021*).

The functioning and properties of various system components determine the "viability" of a self-organizing system. Therefore, viability is an emergent property. Accordingly, the issue raises about methods for researching, analysing and estimating the viability. Literary research on this issue showed that in the study of the viability of the self-organizing system, the emphasis is on determining the person's viability (*Mahnach, 2017; Laktionova, 2017*). However, this is only one element, not the system as a whole. And here, it is necessary to mention the emergent principle, which is a determine special properties (in this case, viability) of the study object, learning their sources (external and internal), understanding their genesis (*Korosov, 2012*). Thus, it is important to find such properties of each component of the system that affect its viability formation.

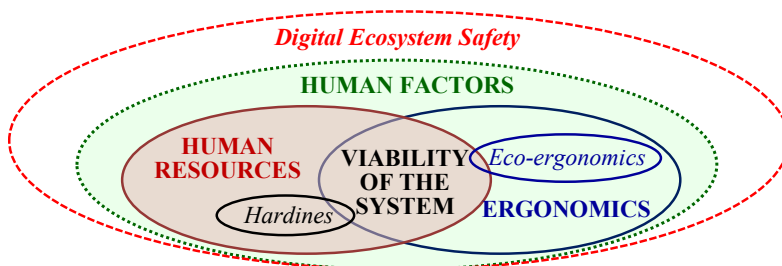
A person is a component of a self-organizing system. He has many properties and characteristics that affect the formation of system viability. However, hardiness deserves special attention because it is an integral characteristic of a person, which allows him to resist situations, overcome life difficulties, transforming them into situations of development (*Protasenko et al., 2020; Maddi et al., 1994; Nayyeria et al., 2011*). Viability is a crucial personality trait that mediates the influence of stressors, allows coping with distress effectively and is always in the direction of personal growth. It follows that human viability depends on resources and the capability to manage them.

The role of a machine in the self-organizing system functioning is to raise the efficiency of a person's activity; therefore, it should be comfortable and safe to operate, which is realized in its ergonomic characteristics. There are a lot of studies investigating the impact of machine ergonomic characteristics on the man-machine system functioning. The research aims to figure out machine characteristics that need to be changed to reduce the possible negative consequences of their impact on the system functioning. According to the available research results (Raziq et al., 2015; Garbie, 2014), we marked out the following pattern: the raise in the self-organizing system viability occurs when the machine ergonomic properties correspond to the person's innate physiological and psychological characteristics.

The working environment is one more component of a self-organizing system. Usually, it is investigated according to the established list of indicators: air temperature, relative humidity, illumination of the work surface, noise and vibration levels, etc. However, in recent years, the issue of greening the working environment has become widespread. As a result, new indicators for estimating the safety of the working environment have arisen, which determine the ecological impact of the working conditions on the employee (Protasenko et al., 2018; Protasenko, 2018). For now, the eco-friendliness of the working environment is an integral characteristic of the working environment because for completeness of information it must estimate both traditional characteristics (temperature, humidity, etc.) and new ones (eco-friendliness of the working environment). Thus, we can talk about the eco-friendliness of the working environment as a characteristic that affects the formation of viability of self-organizing system (Protasenko et al., 2020).

In addition to these points, research of digital ecosystems has to consider the impact of Industry 4.0. In this case, it is not just man-machine interaction, but, as mentioned above, it is a man-machine union. At the same time, in digitalization conditions, a person no longer has a priority role in decision-making. Hence, the problem of a person's perception of controlling decisions from the side of artificial intelligence arise. According to forecasts, in a few years, it can lead to problems in the interaction of a person with the machine because of the too-close intertwining of human and machine, blurred boundaries between human and machine decisions, which will complicate understanding: where human error, and where organizational or technical miscalculation.

Summing up, viability is an emergent property of the digital ecosystem that is determined by hardiness, the working environment ergonomics and eco-friendliness and the degree of manifestation of the human factors (Fig. 5).



**Fig. 5. The digital ecosystem viability as a tool to ensure its safety**

Thus, the digital ecosystem is a special type of man-machine interaction, in which the system viability ensures its safety.

PERSONAL RESOURCES			
New knowledge, skills, capabilities	<input type="checkbox"/>	Application of knowledge, skills, abilities in practical activity	<input type="checkbox"/>
Health, well-being	<input type="checkbox"/>	Achieving certain goals	<input type="checkbox"/>
Lifestyle (sports, habits, etc.)	<input type="checkbox"/>	Health, well-being	<input type="checkbox"/>
High level of working capacity	<input type="checkbox"/>	Achieving certain goals	<input type="checkbox"/>
Self-motivation	<input type="checkbox"/>	Application of knowledge, skills, abilities in practical activity	<input type="checkbox"/>
Understanding life meaning	<input type="checkbox"/>	Achieving important goals	<input type="checkbox"/>
Hardiness	<input type="checkbox"/>	Development of skills to control the current situation	<input type="checkbox"/>
<b>Sum:</b>	<input type="checkbox"/>	<b>Sum:</b>	<input type="checkbox"/>
SOCIAL RESOURCES			
Financial income	<input type="checkbox"/>	Creating a “financial cushion”	<input type="checkbox"/>
Social support at work	<input type="checkbox"/>	Forming a sense of confidence in the future	<input type="checkbox"/>
Social guarantees (medical care, paid leave, etc.)	<input type="checkbox"/>	Health, well-being	<input type="checkbox"/>
Social status	<input type="checkbox"/>	Obtaining new knowledge, skills, abilities	<input type="checkbox"/>
<b>Sum:</b>	<input type="checkbox"/>	<b>Sum:</b>	<input type="checkbox"/>
OBJECTS RESOURCES			
The psychological climate at home	<input type="checkbox"/>	Health, well-being	<input type="checkbox"/>
Residence place	<input type="checkbox"/>	Stability of the current situation	<input type="checkbox"/>
Availability of necessary household items	<input type="checkbox"/>	Stability of the current situation	<input type="checkbox"/>
Rational and complete nutrition	<input type="checkbox"/>	Health, well-being	<input type="checkbox"/>
Rest (enough sleep, regular weekends)	<input type="checkbox"/>	Health, well-being	<input type="checkbox"/>
Savings	<input type="checkbox"/>	Safety, health, well-being	<input type="checkbox"/>
The level of social safety	<input type="checkbox"/>	Health, well-being	<input type="checkbox"/>
<b>Sum:</b>	<input type="checkbox"/>	<b>Sum:</b>	<input type="checkbox"/>

Fig. 6. A resource map

ENERGY RESOURCES			
Time	<input type="checkbox"/>	Personal development, health, well-being	<input type="checkbox"/>
Money	<input type="checkbox"/>	Personal development	<input type="checkbox"/>
Current opportunities (self-education, social elevator, etc.)	<input type="checkbox"/>	Professional development	<input type="checkbox"/>
External circumstances (change of residence, etc.)	<input type="checkbox"/>	Hardiness	<input type="checkbox"/>
<b>Sum:</b>	<input type="checkbox"/>	<b>Sum:</b>	<input type="checkbox"/>

Fig. 6. A resource map (continuance)

**3.2. Hardiness is a component of the digital ecosystem safety**

According to S. Muddy, hardiness is a person’s integral characteristic, which allows him to cope with situations, overcome difficulties transforming them into opportunities for development. In other words, hardiness provides a person with reliable and safe functioning in different conditions. And, as mentioned above, the digital ecosystem viability is related to hardiness, so it is necessary to pay attention to its study.

Attempts to estimate the hardiness using classical methods (Muddy’s survey and its adapted versions) do not allow obtaining an adequate result. This fact takes place because the statements in the hardiness surveys do not consider a person’s emotional state (emotional uplift or depression), which may influence accurate results. Therefore, it is necessary to find alternative methods of hardiness studying. As an option, in this case, we use the study of the forming process of a person’s management resources skill. This is conditioned by two facts:

1. Resource management is the optimal distribution and usage of individual capabilities and opportunities in different conditions of activity to ensure hardiness.
2. Tracking and control of the resource management process make it possible to obtain the dynamics of changes in the hardiness level because, unlike other psychological characteristics, hardiness is not an innate but an acquired characteristic, i.e. can change significantly over a lifetime.

Researching the process of forming resource management skill is a difficult task. In this case, visualizing information about resources and their investment make the process easier. For this purpose, we created a “Resource Map” (Fig. 6).

According to Hobfall’s conservation of resources theory, the resource map contains four blocks of resources – personal, social, objects and energy. Statements in the blocks have two parts. The first part is a resource that a person obtains. The second one is a resource that a person invests. The person under the test needs to read each statement, estimate the availability of resource and the possibility of its investment. According to the obtained value, the person determines the balance or imbalance of resources at the moment. In addition, the survey helps to determine which resources are "problematic", i.e. what resources a person actively invest but does not restore them or, conversely, which resources he receives but does not use. Such a procedure a person can perform independently every 2-3 months. The analysis of this information allows a person to choose corrective actions concerning the achievement of resources balance and raise a hardiness level.

The verification of the proposed “Resource Map” was carried out while performing the project on the implementation of the occupational health and safety management system at

the enterprise on the provision of energy source to the population (Protasenko et al., 2021). The object of the study was the heads of the enterprise departments.

A preliminary study of the hardiness level of enterprise management (according to the “Resources Map”) showed an average level of hardiness. It was proposed to apply the principles of training in resource management skill. For this, we focused on a study of stress resistance. It allowed us to estimate the possibility of reducing the negative effects of stress and find ways to raise the hardiness.

The study included three stages. At the first stage, we preliminary investigated the subject’s level of stress and hardiness. For this purpose, methods of psychological testing were used: personality surveys, methods of sociometric research, and assessment of neuropsychological stability. Based on these data, we did a general psychological profile of each subject. In the second stage, we carried out individual work with each probationer. In particular, we informed the probationer about the level of stress, identified and understood its causes. At the third stage, we applied a training course to develop the probationer’s skill of resources assessment and management. The purpose was to stimulate and motivate the employee to work by himself in order to maintain and improve hardiness and occupational health.

The results of repeated research showed a significant decrease in probationers’ anxiety, tensity and stress, an increase in their functional reserve. Repeated testing probationers on the “Resource Map” showed a rise in their hardiness levels. Thus, the main result of the work was the development of resource management principles, which allowed forming in probationers a safe model of behaviour. Such a type of behaviour is a basis for improving safety culture and, consequently, reducing the risk of danger emergence.

The study of the process of forming resource management skill makes it possible to estimate the hardiness level, which is a component of human factor management. Thus, hardiness is a tool for ensuring digital ecosystem safety (Fig. 7).

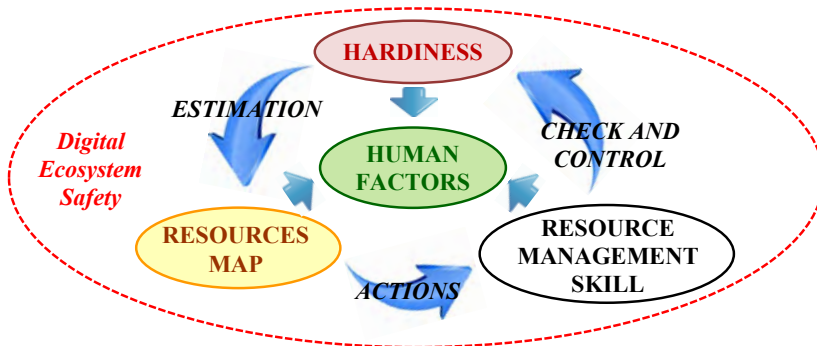


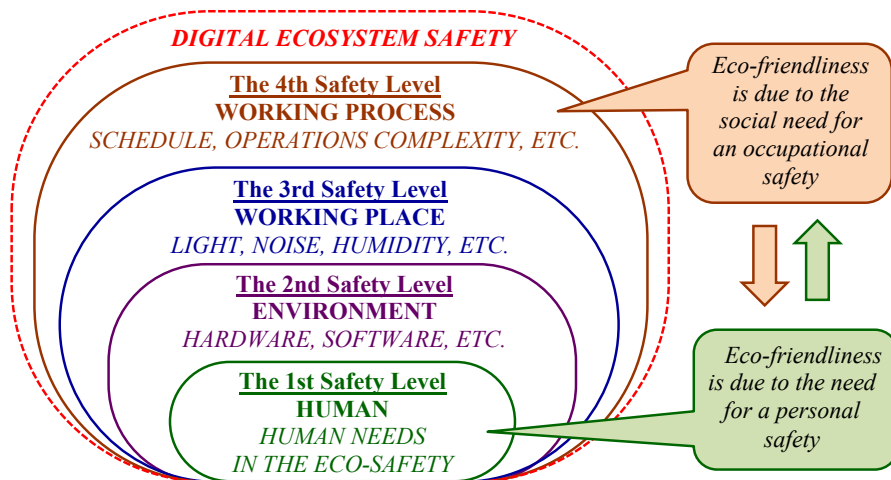
Fig. 7. Hardiness as a tool for ensuring digital ecosystem safety

### 3.3. Eco-ergonomic study of the digital ecosystem

The working environment is a complex system, where different physical, chemical, biological and psychophysiological factors constantly influence humans. It often has negative consequences for human health. As a result, it stimulates the rapid development of an eco-approach to the working environment study. For now, the working environment parameters of the digital ecosystem significantly affect humans and society. It determines the relevance of a person’s eco-thinking formation and rising of his eco-culture level.

The eco-ergonomic method of studying the digital ecosystem allows us to find the optimal combination of working conditions and technical support at the workplace, which meets modern psychophysiological, social, engineering and environmental requirements. Moreover, the application of principles of eco-ergonomic method in the digital ecosystem research makes it possible to implement the triune necessary for the maintenance and preservation of human health – eco-friendliness, comfort and safety.

It should be noted that until recently, the issue of safe work was the application of technical, sanitary and social measures at the workplace. Today, workplace safety is a set of economic, social, technical and environmental solutions aimed at preserving human health, the environment and the progress of the sustainable development concept (Raziq et al., 2015; Protasenko et al., 2020). It conditioned the study, analysis and estimation of the digital ecosystem safety through the prism of environmental safety (Fig. 8).



**Fig. 8. Eco-safety of the digital ecosystem**

Thus, eco-friendliness in the digital ecosystem is realized, on the one hand, through a person's awareness of the need for his eco-safety that is a necessary condition for human safety. On the other hand, at the society level, eco-friendliness is implemented through the eco-quality control of equipment, materials and other elements of the working process. Therefore, we can conclude that with such a two-way approach to the issue of eco-friendliness, it is possible to raise the human safety level in the digital environment. In addition, a high level of eco-friendliness contributes to raise the safety culture of society.

The eco-ergonomic method was tested at several companies. The following jobs were studied: printing designer, programmer, web designer and system administrator. These jobs were chosen because they are examples of digital ecosystems. Research showed the following results:

1. The eco-ergonomics indicators of workplaces were an optimal or acceptable level, which indicated the awareness of workers on safety and a conscious approach to ecological and occupational safety at the workplace.
2. According to the results of assessing the degree of implementation of eco-ergonomic needs of employees in the workplace, 98% of probationers determined that they have comfortable working conditions.

3. The probationers identified that periodic eco-ergonomic estimation of the workplace is a necessary element to ensure an adequate level of safety.

The study confirmed the importance of carrying out an eco-ergonomic study of the working environment of the digital ecosystem to improve its safety.

#### 4. Conclusions

One of the issues in man-machine interaction is the methods of researching the human factor. In most cases, researchers consider technical and environmental problems of the system's functioning. Within the framework of this research, attention is on the factors of human activity in the digital ecosystem. The research had two directions.

The first is the study of human needs in the digital ecosystem. We figured out that the change in the activity conditions led to the formation new request – the person's need for digital safety, which determined the emergence of a new phenomenon – the safety culture in the digital environment. The article substantiates that safety culture is a component of the human factor, therefore, the level of its development affects the effectiveness of human factor management.

The second direction was the study of a person's resources. We figured out that an important point is a person's resources and the possibility of their usage and recovery. The factor of ensuring the man-machine system safety is the “cycle” of resources. The human factor depends on the person's resources balance. It was shown that it is possible to use the study of the process of hardiness formation for resource estimates. Hardiness is not innate, but an acquired person's characteristic, which is formed under the influence of external factors and with the usage of a person's resources. To estimate the process of hardiness formation a “Resource Map” is proposed.

One of the factors affecting the efficiency of man-machine interaction is the working environment. We proposed to use an eco-ergonomic method to study the working environment. The method essence is to study the parameters of the working environment and search for the optimal combination of working conditions and technical procuring, which correspond to modern psychophysiological, social, engineering and environmental requirements. Practical testing of the proposed methods for hardiness estimating and eco-ergonomics of the working environment confirmed the reliability of the obtained results.

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THE EXAMPLE OF THE DESIGN OF MATERIALS**NEW ECONOMIC SYSTEM OF SOCIETY DEVELOPMENT****John Sitdson**

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**Summary**

The article deals with the information economy as a new economic system wherein information and knowledge are the main products. It is proved that a central component of an economic system is work with information and use of information systems in the process of management. The author substantiates the requirement for the search of new approaches to the solution of problems of development of institutional structures of information economy.

**Keywords:** knowledge, information, system, information economy, management.

*DOI: <http://dx.doi.org/10.23856/xxxxxxxxxxxx>*

**Introduction**

Global growth of information and telecommunication technologies, on the one hand, and also the necessity of development of scientific knowledge in the area of theory, methodology and practice of informative approach of study of information economy and society, on the other hand, determines topicality of consideration of the process of formation of information economy. Information turns into a strategic resource and factor of acceleration of scientific, technical and technological development and becomes a part of the real economy.

**Subtitle of the body**

It presupposes the conceptual comprehension of the process of establishment of an informative and technological method of production and related to it forming of an information paradigm in a modern economic science.

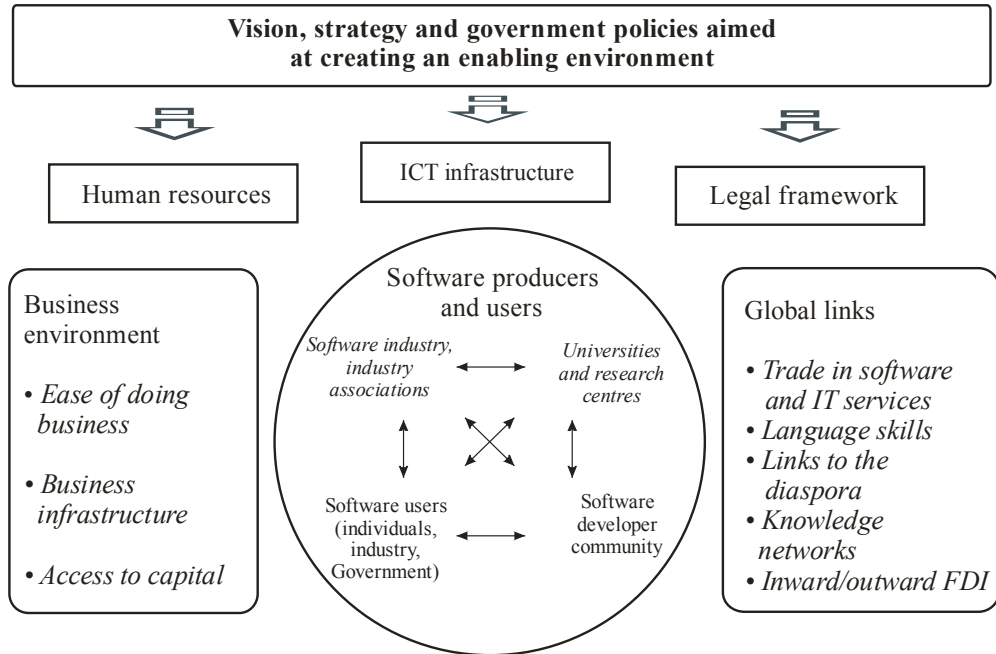
The evolutionary process of the establishment of information society is represented in researches of P. Drucker, who used a notion “information revolutions” (Drucker, 1989). He worked out the theory of the stages of development, which allows deeper understanding of the logic of establishment of information economy.

The term “information economy” was first used in 1976 in works of Mark Porat, an employee of the Stanford Centre and designated by him as a cluster of industries, engaged in the production of modern databases and facilities which provide their application and functioning (Porat, 1978). He is given the credit for introducing a distinction between the primary and secondary information sector of economy. A primary sector, according to his opinion, can be estimated quantitatively, while everything is much more difficult with the secondary one.

The Revolution in the development of information technologies allowed to talk about a global network, which materialized the globalization of economy. New information technologies, in fact, are not simply becoming the instruments of application, but also the

processes of development. The system-oriented analysis of the information economy with due regard to the forming informative paradigm of the economic theory requires additional consideration.

**Figure. 1. A national software system (Information Economy Report, 2012)**



### Conclusions and suggestions

Conception of information economy includes fundamental definition of information society. It's defined as a system of connections and relations between individuals, which appear in the process of interchange of information concerning social and economic activity. Information economy is simultaneously defined as a system of public relations, wherein the information is a basic productive resource.

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