

Адреса для кореспонденції

Марущак Марія Іванівна
Тернопільський національний медичний університет
імені І.Я. Горбачевського МОЗ України
Україна, 46001, м. Тернопіль, вул. Майдан Волі 1
Тел.: 0979981202
E-mail: marushchak@tdmu.edu.ua

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Nasibullin B. A., Gushcha S. G., Zabolotna I. B.

IDENTIFYING THE INTERRELATIONSHIP BETWEEN METABOLIC RESPONSES IN ANIMALS AND HUMANS TO THE CONSUMPTION OF LOW-MINERALISED NATURAL MINERAL WATERS

State Non-profit Enterprise “Ukrainian Research Institute of Rehabilitation and Balneology of the Ministry of Health of Ukraine” (Odesa, Ukraine)

gushchasergey11@gmail.com

At present, given the growth of the global pharmaceutical industry and research into the development and evaluation of the efficacy of non-pharmaceutical preparations, as well as modulators of both pharmacological and natural origin, it is necessary to conduct relevant studies. In accordance with generally accepted moral and ethical standards, conducting such research on humans is impermissible. Consequently, the first stage involves preclinical studies on laboratory animals. Only once the safety and efficacy of the drug or modulator under investigation have been established and the mechanisms of its effect on animals have been identified is the second stage – clinical trials – carried out. However, the question of whether it is appropriate to extrapolate data from comprehensive pathophysiological assessments – obtained by studying the animals’ physiological responses – to clinical trials remains unresolved. Based on the results of two series of clinical examinations involving 30 individuals and preclinical studies of 27 healthy rats that had undergone a course of treatment with natural modulators – the two low-mineralised natural mineral waters (MWs) – the authors identified correlations in metabolic responses. The results of the studies demonstrated that the use of the investigated (MWs) induces changes in metabolic parameters in humans and experimental animals that are similar in nature and direction. According to the authors, the slight differences in the indicators assessed when using MWs are related to the specific features of their physico-chemical composition. Furthermore, significant differences in the biology of the human subjects and the experimental rats accounted for the differences in quantitative characteristics and changes in indicators. However, the general nature and direction of metabolic changes make it possible to use the results of preclinical studies to predict the outcomes of clinical trials.

Key words: metabolism, preclinical assessment, white rats, clinical assessment, low-mineralised natural mineral waters.

Connection of the publication with planned research work.

This work forms part of the research project “Study of the health-improving effects in patients following the internal use of the natural mineral table water “Truskavetska”” (state registration number 0123U103364), “Medical and biological assessment of the quality and value of underground mineral waters from wells No. 2c and No. 4c in Truskavets, Lviv Region. Justification and preparation of a report on conditions during the reassessment of exploitable reserves of mineral waters in the Pomiretsky deposit (western section) in Lviv Region” (state registration number 0120U003531), “Study of the

health-improving effect in patients following the internal use of the natural mineral water “Buvet Vital”” (state registration number 0124U004154), “Predictive assessment of the safety and quality of diluted mineral water from wells No. 1164, No. 4N and No. 5 in the village of Maiborodivka, Kremenchuk District, Poltava Region” (state registration number 0117U005334).

Introduction.

The numerous differences between the body in a state of illness and health, as observed in clinical practice, led scientists and medical practitioners to question whether there was something new present in the body of a sick person that was not found in a healthy body

[1, 2, 3]. As a result of extensive research, it has been recognised that changes in certain metabolic reactions or in the structural organisation of tissues and organs alter the body's adaptability to environmental conditions, which forms the basis of the external manifestations of disease [4, 5]. Through evolution, the human body has developed into a large, complex system that is sufficiently stable and capable of adapting to changing environmental conditions [6]. Functional systems have developed within the body to implement the principle of sustainable adaptation. In a healthy body, these systems operate in a balanced and interconnected manner. In the event of disease, changes in the state of individual components within different functional systems disrupt their balance and interconnectedness [7, 8, 9]. Based on this premise, modern medicine has developed the thesis that treatment protocols should include not only drugs that act on the aetiological factors and pathogenetic mechanisms of the disease, but also modulators – compounds that help restore the interaction and balance of activity among functional systems [10–13].

However, the introduction of a modulator into clinical practice requires an understanding of the mechanisms by which it affects the functioning of physiological systems and confirmation of its safety for the body.

Due to moral and ethical considerations, conducting such studies on human subjects is unacceptable. Therefore, in the initial stage of studying the modulator – whether pharmacological or natural – preclinical studies are conducted on laboratory animals, involving a comprehensive pathophysiological assessment of the response of laboratory animals (most commonly white rats) to the action of the natural modulator [14–17]. Only once the safety of the modulator under investigation has been established and the mechanisms of its action identified is the clinical trial phase conducted, i.e. the assessment of the human body's response to administration of this modulator. However, the question of the adequacy of extrapolating data from a comprehensive pathophysiological assessment of the modulator's biological activity – obtained from studies of the animal response – to clinical research data remains unresolved.

Natural mineral waters (MWs) were selected as the subject of the studies; these are regarded as natural modulators possessing biological activity of low intensity, but which, due to the characteristics of their physico-chemical composition, can influence the state of certain functional systems of the body [18, 19, 20].

The aim of the study.

To determine whether there were any correlations between the metabolic responses of healthy animals and humans who had undergone a course of treatment with low-mineralised natural mineral waters of varying chemical composition.

Object and research methods.

The data for this study were obtained from two separate studies. The first study involved 30 healthy individuals (21 women and 9 men aged 30–55), who were divided into three groups.

Group 1 (control group) – 10 people (8 women and 2 men) who, during the 30-day study period, consumed tap water (1 litre per day, ad libitum).

Group 2 – 10 people (7 women and 3 men), who received «Truskavetska» MW during the experiment for 30 days (1 litre per day, ad libitum).

Group 3 – 10 people (7 women and 3 men) who, during the experiment, were given «Buvet Vital» MW for 30 days (1 litre per day, ad libitum).

Written informed consent was obtained from all people who participated in the study.

The second study used white Wistar rats weighing 180–200 g, obtained from the licensed breeding facility «Dali 2001» (Kyiv). A total of 27 animals were included in the study. The care of the animals and the experimental studies were carried out in accordance with current regulatory documents – Directive 2010/63/EU, the Law of Ukraine «On the Protection of Animals from Cruel Treatment» (No. 3447-IV of 21 February 2006), the Order of the Ministry of Education and Science, Youth and Sport of Ukraine «On the Approval of the Procedure for the Conduct of Research and Experiments on Animals by Scientific Institutions» (No. 249 of 1 March 2012), and the Protocol of the Bioethics Commission of the State Non-profit Enterprise «Ukrainian Research Institute of Rehabilitation and Balneology of the Ministry of Health of Ukraine» (No. 1 of 2 June 2026). The animals were kept under standard lighting and temperature conditions in standard cages, with free access to food and drinking water in the institute's animal facility. The animals were divided into three groups [21].

Control group 1 – (7 animals) rats that were given tap water via free-access drinking bottles throughout the 7-day study period. Group 2 (10 animals) – rats that were given «Truskavetska» MW via free-access drinking bottles throughout the 7-day study period. Group 3 – (10 animals) rats which, during the study over a period of 7 days with free access to water dispensers, were given «Buvet Vital» MW.

At the end of the drinking regimen, biochemical blood tests were carried out in both study groups. The following were determined: alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activity; blood levels of bilirubin and its fractions, urea, creatinine, glucose, and malondialdehyde (MDA); catalase activity; and the content of molecules of average weight (MAW_{254} and MAW_{280}). The above indicators allowed for the assessment of liver function, the activity of carbohydrate metabolism, nitrogenous compound metabolism, the state of the lipid peroxidation/antioxidant system (LPO/AOS), and the level of endogenous intoxication.

The methodological approaches and techniques used in the experimental studies are published in the 'Guidelines' and Methodological Recommendations and were approved by Order of the Ministry of Health of Ukraine No. 692 of 28 September 2009 [22, 23].

Statistical analysis of the data was performed using Microsoft Excel software for biomedical research, with a significance level of $p < 0.05$ according to Student's t-tests.

The study was conducted using two samples of «Truskavetska» natural water, which is a slightly mineralised hydrocarbonate, sulphate-hydrocarbonate and chloride-hydrocarbonate water with varying cationic composition (with varying anionic and cationic composition). The total mineralisation of the water is 0.20–0.90 g/l [24].

The physical and chemical composition of the «Truskavetska» mineral water corresponds to the following formula:

$$M_{0.20-0.90} \frac{HCO_3 > 50 \ SO_4 < 50 \ Cl < 35}{Ca \ 10 - 95 \ Mg < 65 \ (Na + K) < 85}$$

The "Buvet Vital" is a low-mineralised hydrocarbonate, sulphate-hydrocarbonate magnesium-calcium-sodium, magnesium-sodium-calcium, and sodium-calcium water (with varying cationic composition). The total mineralisation of the water is 0.50–0.90 g/l [24].

$$M_{0.50-0.90} \frac{HCO_3 > 70 \ SO_4 < 25}{(Na + K) 30 - 50 \ Ca \ 30 - 45 \ Mg < 35}$$

Research results and their discussion.

The results of the overall changes in metabolic parameters in healthy individuals who took the MWs "Truskavetska" and "Buvet Vital" over a 30-day period are shown in the **table**. According to the data in the **table**, the activity levels of the enzymes ALT and AST at the end of the course of "Truskavetska" differed only slightly from those of the control group. This suggests that the MW "Truskavetska" has no effect on the condition of hepatocyte membranes and does not alter the intensity of transamination processes within them. At the same time, an increase in total bilirubin levels in the blood of 23.6% was observed, whereas in the control group the amount of indirect bilirubin exceeded that of direct bilirubin by a factor of 3.02, and after the course of MW "Truskavetska" this excess was 2.95 fold, i.e. there was a trend towards a decrease in the concentration of the toxic metabolite. The levels of urea and creatinine in the blood of people taking the MW "Truskavetska" remained virtually unchanged: urea increased by 4%, and creatinine by 5%, i.e. within the margin of error of the method. Similar changes were observed with regard to glucose. The LPO/AOS system parameters revealed a 33.9% decrease in MDA levels and an 18.1% increase in catalase activity. That is to say, it can be assumed that standard energy supply fully meets the needs of the tissues. Consequently, lipid peroxidation is inactivated, and the increase in catalase activity provides additional protection for cell membranes. At the same time, there is a significant reduction in the content of medium-molecular-weight molecules: MSM₂₅₄ by 7.5% and MSM₂₈₀ by 10%. Overall, there is a reduction in the xenobiotic burden on the human body, an increase in the protection of cell membranes, and a tendency towards the activation of transamination.

In individuals who consumed the "Buvet Vital" MW for 30 days, changes in certain metabolic parameters were also observed. In contrast to the effects of "Truskavetska" MW, ALT and AST levels remained completely unchanged compared to the control group (**table**).

Furthermore, the level of total bilirubin remained virtually unchanged, and the ratio of its fractions also corresponded to the control data. It can be concluded that the dietary supplement "Buvet Vital" does not affect liver function. Urea and creatinine levels also remained close to those of the control group, suggesting that the effect of this dietary supplement on nitrogen metabolism is minimal. Blood glucose levels in the subjects remained at the same level as the control group following a course of "Buvet Vital" MW. Evidently, the intensity of carbohydrate metabolism and the associated energy supply are sufficient for the functioning of the body's systems. At the same time, MDA levels decreased by 28.1%, meaning the changes are similar to the effect of "Truskavetska" MW. Furthermore, under the influence of "Buvet Vital" MW, just as under the influence of "Truskavetska" MW, catalase activity changes. In other words, the use of

"Buvet Vital" MW contributes to the preservation of cell membranes. However, unlike the effect of "Truskavetska" MW, under the influence of "Buvet Vital" MW, the content of medium-molecular-weight molecules tends to increase: MSM₂₅₄ by 8.3%, and MSM₂₈₀ by 7%. This trend may be associated as much with the preservation of liver activity at the control level as with methodological error.

Preclinical studies using white rats as test subjects revealed changes in metabolic parameters following a course of treatment with MW "Truskavetska" and MW "Buvet Vital". According to the data in the **table**, under the influence of MW "Truskavetska" and MW "Buvet Vital", ALT and AST activity decreased. Total bilirubin levels remained close to those of the control group, as did the ratio of its fractions. The exception was a reduction in direct bilirubin following treatment with the "Truskavetska" MW and an increase in indirect bilirubin following treatment with the "Buvet Vital" MW. Overall, the trends in changes to liver function parameters during a course of treatment with "Truskavetska" MW were generally similar in people participating in the clinical trial of this water and in animals in the preclinical study. Differences in the values of the parameters studied are clearly linked to differences in the biology of the subjects under investigation.

No statistically significant changes in urea and creatinine levels were observed in animals treated with the "Truskavetska" MW compared with the control group, nor were any observed in patients taking this mineral water (**table**). It is evident that this mineral water does not affect the metabolism of nitrogenous compounds in either group. A similar pattern was observed with regard to glucose levels. MDA levels in the blood of the animals decreased insignificantly; this decrease was smaller than in the patients examined. Catalase activity also remained close to that of the control group animals. In the patients examined, changes in these indicators were similar but more significant; that is, the direction of changes in the LPO/AOS system was similar in both groups, whilst the quantitative differences were most likely due to differences between the biological subjects of these studies.

The levels of medium-weight molecules in the test rats showed a downward trend, as was the case in humans; in other words, the use of "Truskavetska" MW in preclinical and clinical studies reduces the xenobiotic load.

Preclinical studies of "Buvet Vital" MW also revealed changes in metabolic parameters (**table**). In contrast to clinical studies, ALT and AST activity decreased compared with the control group. Total bilirubin levels tended to increase. The ratio of bilirubin fractions shifted, with the proportion of indirect bilirubin decreasing. In other words, the inactivation of toxic bilirubin increased, although bile formation and excretion remained close to normal. A similar pattern was observed in clinical studies of this MW.

As in the clinical trials, a 19% increase in blood urea levels was observed in the animals. Creatinine levels, however, remained within the normal range; in other words, the catabolism of nitrogenous compounds was enhanced, but not in all tissues, as was the case in the clinical trials. Glucose levels in the animals remained within the normal range following a course of treatment with the dietary supplement "Buvet Vital", as was the

Table – Metabolism indicators at the end of consumption of MWs “Truskavetska” and “Buvet Vital” in examined people and experimental animals

Indicators	Clinical trial			Pathophysiological trial (white rats)		
	1 group control	2 group MW “Truskavetska”	3 group MW “Buvet Vital”	1 control group (intact rats)	2 group MW “Truskavetska”	3 group MW “Buvet Vital”
General bilirubin, $\mu\text{mol/l}$	18.13 $\pm$ 1.22	22.50 $\pm$ 0.90*	16.83 $\pm$ 0.65	4.18 $\pm$ 0.27	3.84 $\pm$ 0.29	4.39 $\pm$ 0.14
Direct bilirubin, $\mu\text{mol/l}$	4.50 $\pm$ 0.31	5.70 $\pm$ 0.66	4.15 $\pm$ 0.13	1.23 $\pm$ 0.12	1.48 $\pm$ 0.10	1.61 $\pm$ 0.11*
Indirect bilirubin, $\mu\text{mol/l}$	13.60 $\pm$ 1.10	16.80 $\pm$ 2.12	12.69 $\pm$ 0.47	2.93 $\pm$ 0.15	2.36 $\pm$ 0.14*	2.78 $\pm$ 0.11
ALT, U/l	32.63 $\pm$ 1.33	29.40 $\pm$ 1.60	32.83 $\pm$ 0.64	175.37 $\pm$ 1.55	160.80 $\pm$ 1.07*	136.57 $\pm$ 1.32*
AST, U/l	33.80 $\pm$ 0.48	33.20 $\pm$ 0.55	34.46 $\pm$ 0.89	265.40 $\pm$ 7.81	223.06 $\pm$ 9.15*	209.78 $\pm$ 4.41*
Urea, $\mu\text{mol/l}$	5.24 $\pm$ 0.12	5.45 $\pm$ 0.19	5.52 $\pm$ 0.17	2.85 $\pm$ 0.15	2.94 $\pm$ 0.168	3.51 $\pm$ 0.13*
Creatinine, $\mu\text{mol/l}$	84.72 $\pm$ 2.46	89.30 $\pm$ 1.75	84.85 $\pm$ 3.32	47.80 $\pm$ 0.63	47.36 $\pm$ 1.57	47.38 $\pm$ 1.26
Glucose, $\mu\text{mol/l}$	5.20 $\pm$ 0.13	5.45 $\pm$ 0.14	5.25 $\pm$ 0.07	6.21 $\pm$ 0.15	6.33 $\pm$ 0.20	6.38 $\pm$ 0.17
MAW254, c.u.	0.229 $\pm$ 0.005	0.212 $\pm$ 0.008*	0.248 $\pm$ 0.007*	0.34 $\pm$ 0.02	0.28 $\pm$ 0.05	0.30 $\pm$ 0.08
MAW280, c.u.	0.270 $\pm$ 0.004	0.243 $\pm$ 0.009*	0.289 $\pm$ 0.002*	0.22 $\pm$ 0.01	0.17 $\pm$ 0.02	0.19 $\pm$ 0.03
MDA, $\mu\text{mol/l}$	6.58 $\pm$ 0.30	4.35 $\pm$ 0.47*	4.75 $\pm$ 0.26*	5.94 $\pm$ 0.21	5.62 $\pm$ 0.15	5.70 $\pm$ 0.11
Catalase, %	65.30 $\pm$ 2.10	77.40 $\pm$ 1.33*	75.6 $\pm$ 1.00*	76.70 $\pm$ 1.52	75.88 $\pm$ 1.66	77.38 $\pm$ 1.80

Notes: a statistically significant difference ($p < 0.05$) was observed between the results of the control group and those of groups 2 and 3 following the completion of a course of treatment with the respective mineral waters.

case in clinical trials. In other words, this dietary supplement had virtually no effect on carbohydrate metabolism in the test animals or in humans. Since this dietary supplement does not cause changes in carbohydrate metabolism, it can be assumed that the energy supply for vital processes is not disrupted. This assumption is confirmed by the maintenance of LPO activity at the control level (based on MDA content) and high catalase activity. In clinical trials, changes in LPO/AOS system indicators showed the same trend but were more pronounced.

Indicators of endogenous intoxication – the concentration of medium-molecular-weight substances in pre-clinical studies, in contrast to clinical trials – showed a downward trend; in other words, the “Buvet Vital” MW reduced the xenobiotic load and created conditions conducive to a reduction in endogenous intoxication.

Thus, the results of the studies showed that the course treatment with MW “Truskavetska” and MW “Buvet Vital” induces changes in metabolic indicators in humans and experimental animals that are similar in nature but not identical in direction. Some differences in the assessed indicators when using “Truskavetska”

MW and “Buvet Vital” MW are evidently linked to the specific features of their physicochemical composition. Furthermore, the biology of the human subjects and experimental animals examined exhibits significant differences, which account for the discrepancy in the direction of the quantitative characteristics of the changing indicators.

Conclusions.

Overall, it can be stated that, despite minor differences, the direction of metabolic responses in animals (preclinical studies) and in the human subjects (clinical studies), it is possible to extrapolate the data obtained from the pathophysiological assessment of the biological activity of mineral waters as a prognosis for clinical studies, whilst taking into account the specific biological characteristics of the study subjects.

Prospects for further research.

Research in this field holds great promise, and further studies will be conducted to calculate the correlation coefficients between experimental and clinical indicators.

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ВИЯВЛЕННЯ ВЗАЄМОЗВ'ЯЗКУ РЕАКЦІЙ МЕТАБОЛІЗМУ У ТВАРИН ТА ЛЮДИНИ НА ВЖИВАННЯ СЛАБКОМІНЕРАЛІЗОВАНИХ ПРИРОДНИХ МІНЕРАЛЬНИХ ВОД

Насібуллін Б. А., Гуща С. Г., Заболотна І. Б.

Резюме. Існуюча на сьогодні практика введення до протоколів лікування не тільки лікарських засобів, але й природних модулаторів, потребує визначення механізмів його впливу на стан функціональних систем і його нешкідливість для організму. Оскільки проведення подібних досліджень на людині не можливе, виникає необхідність їхнього проведення з залученням лабораторних тварин. В цьому випадку виникає проблема екстраполяції результатів доклінічних досліджень на заплановані клінічні випробування.

Метою досліджень було визначення наявності кореляцій реакцій метаболізму здорових тварин і людей, які отримували курс слабкомінералізованих природних мінеральних вод різного хімічного складу.

Матеріалом роботи слугували результати, отримані в двох дослідженнях. Перші дослідження – оцінка змін показників метаболізму у 30 здорових людей, які протягом 30 діб вживали слабкомінералізовані природні мінеральні води (МВ) «Трускавецька» або МВ «Бювет Вітал». Друге дослідження – оцінка змін таких самих показників метаболізму у 27 здорових щурів, яким застосовували ті ж самі МВ.

За аналізом проведених досліджень встановлено, що у обстежених людей і досліджених щурів при застосуванні МВ «Трускавецька» та «Бювет Вітал» має місце тенденція до неоднаковій спрямованості змін деяких з досліджених показників і невелика різниця в кількісних характеристиках змін цих показників (в межах 10–17%). Визначені відмінності, мабуть, пов'язані з різницею фізико-хімічного складу використовуваних МВ, так як різниця складу обумовлює різницю і в кількості різних макро- та мікроелементів, що в свою чергу визначає силу реакції ланки метаболізму, на яку цей елемент здійснює вплив. Крім того, біологія щурів та людей має дуже суттєву різницю, яка мабуть і може обумовлювати розбіжність на рівні тенденції спрямованості змін деяких показників метаболізму при застосуванні досліджених МВ. Оскільки в обох дослідженнях вживання МВ викликає реакції з боку метаболізму, то результати доклінічних досліджень доцільно екстраполювати на клінічні дослідження, що прогножуються, в якості маркера біологічної активності МВ. Наявність невеликих різниць кількісних змін показників і розбіжність спрямованості змін (на рівні тенденцій), потребує подальших досліджень з метою обчислення коефіцієнтів кореляції, необхідних для формування програм клінічних досліджень.

Ключові слова: метаболізм, доклінічна оцінка, білі щури, клінічна оцінка, слабкомінералізовані природні мінеральні води.

IDENTIFYING THE INTERRELATIONSHIP BETWEEN METABOLIC RESPONSES IN ANIMALS AND HUMANS TO THE CONSUMPTION OF LOW-MINERALISED NATURAL MINERAL WATERS

Nasibullin B. A., Gushcha S. G., Zabolotna I. B.

Abstract. The current practice of including not only medicinal products but also natural modulators in treatment protocols necessitates the identification of the mechanisms by which they affect the state of functional systems and their safety for the body. As it is not possible to conduct such studies in humans, there is a need to carry them out using laboratory animals. In this case, the problem arises of extrapolating the results of preclinical studies to planned clinical trials.

The aim of the research is to determine the presence of correlations between the metabolic responses of healthy animals and humans who have undergone a course of treatment with low-mineralised natural mineral waters of varying chemical composition.

The study was based on the results obtained from two studies. The first study assessed changes in metabolic parameters in 30 healthy individuals who consumed the low-mineralised natural mineral waters (MWs) "Truskavetska"

or “Buvet Vital” for 30 days. The second study assessed changes in the same metabolic parameters in 27 healthy rats administered the same MWs.

Analysis of the studies revealed that in both the human subjects and the rats, the use of “Truskavetska” and “Buvet Vital” MWs showed a tendency for changes in some of the investigated parameters to follow different trends, with a slight difference in the quantitative characteristics of these changes (within the range of 10–17%). The identified differences are likely related to the difference in the physico-chemical composition of the mineral waters used, as the difference in composition accounts for the difference in the quantity of various macro- and microelements, which in turn determines the strength of the reaction of the metabolic pathway on which this element exerts an influence. Furthermore, there is a very significant difference between the biology of rats and humans, which may well account for the divergence in the trend of changes in certain metabolic indicators when the studied MWs are administered. Since in both studies the use of MWs elicits metabolic responses, it is appropriate to extrapolate the results of preclinical studies to the anticipated clinical trials as a marker of the biological activity of MWs. The presence of minor differences in quantitative changes in indicators and the divergence in the direction of changes (at the trend level) requires further research to calculate the correlation coefficients necessary for the formation of clinical research programs.

Key words: metabolism, preclinical evaluation, white rats, clinical assessment, low-mineralised natural mineral waters.

ORCID and contributionship:

Nasibullin B. A.: <https://orcid.org/0000-0003-3963-2374> ^{ABCD}

Gushcha S. G.: <https://orcid.org/0000-0003-3097-5258> ^{BDE}

Zabolotna I. B.: <https://orcid.org/0000-0002-0159-2058> ^{BCF}

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The authors declare no conflict of interest

Corresponding author

Gushcha Serhii Hennadiyovych

State Non-profit Enterprise “Ukrainian Research Institute of Rehabilitation and Balneology of the Ministry of Health of Ukraine”

Ukraine, 65000, Odesa, 6 Dzhevetskogo Lane

Tel.: 0956262722

E-mail: gushchasergey11@gmail.com

A – Work concept and design, **B** – Data collection and analysis, **C** – Responsibility for statistical analysis, **D** – Writing the article, **E** – Critical review, **F** – Final approval of the article.

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Нікітін О. Д., Квач М. Д.

МОРФОМЕТРИЧНІ ХАРАКТЕРИСТИКИ СПЕРМАТОЗОЇДІВ У ЧОЛОВІКІВ ІЗ ХРОНІЧНИМ ПРОСТАТИТОМ: КЛІНІЧНЕ ЗНАЧЕННЯ ДЛЯ ОЦІНКИ ФЕРТИЛЬНОСТІ

Національний медичний університет імені О.О.Богомольця (м. Київ, Україна)

nikitinuro@gmail.com

Хронічний простатит належить до поширених захворювань чоловічої репродуктивної системи та може супроводжуватися структурно-функціональними змінами сперматозоїдів, що негативно впливають на репродуктивний потенціал чоловіків. Перспективним підходом до поглибленої оцінки таких порушень є визначення морфометричних характеристик сперматозоїдів. Метою дослідження було оцінити морфологічні та морфометричні характеристики сперматозоїдів у чоловіків із хронічним простатитом, встановити їх зв'язок з інфертильністю та визначити найбільш інформативні показники порушення репродуктивної функції. Обстежено 351 чоловіка віком 22–50 років: 46 здорових фертильних чоловіків, 111 пацієнтів із хронічним простатитом зі збереженою фертильністю та 194 пацієнти з хронічним простатитом і підтвердженою інфертильністю. Морфологічне дослідження еякуляту проводили відповідно до рекомендацій WHO (2021) із застосуванням комп'ютерної морфометрії сперматозоїдів. Встановлено, що найбільш виражені морфометричні відхилення характерні для пацієнтів із хронічним