Ключевые слова: студенты, физическое развитие, антропо-физиометрические параметры, массо-ростовые индексы.

DYNAMICS OF PHYSICAL DEVELOPMENT IN YOUNG PEOPLE AGED 17-21 YEARS OVER THE PERIOD OF EDUCATION AT HIGHER EDUCATION INSTITUTIONS

Orlyk N. A., Bosenko A. I., Topchii M. S., Dyshel G. O.

Abstract. Modern scientists define physical development as a natural biological process of changing the forms and functions of the human body, which occurs throughout the life and is caused by internal factors, the natural environment and social conditions. Currently, the health level of the population in Ukraine is extremely low. It directly depends on the lifestyle of the population, namely, its level, quality, pattern of behavior and structure.

Most modern scientists are tend to believe that the lack of physical activity and limited possibilities to engage in physical activity and sports negatively affect the physical development, health and physical parameters of children, youth and the older generation. Therefore, the study of characteristic features of the physical development in student youth is relevant and does not lose its practical value.

The aim of the study was to conduct a comprehensive assessment of the physical development in students of the Educational and Scientific Institute of Physical Culture, Sports and Rehabilitation (ESIPCSR) of K. D. Ushynskyi University and to analyze the findings obtained in terms of current data regarding the physical development of young people aged 17-21 years studying at higher education institutions.

Object and research methods. The comprehensive study included 466 I-IV year students, among which 133 – the first-year students, 149 – the second-year students, 109 – the third-year students and 75 – the fourth-year students. Anthropometric examination included measuring the length and weight of the body, as well as the chest circumference at rest, on inhalation and exhalation. The dynamics of physical development was evaluated according to mass, dynamic and vital indicators. The data obtained were processed with descriptive methods of statistical analysis.

Results and discussion. The study determined that the physical development of the examined students according to the average group data corresponded to the regional and normative values for the age and gender groups.

Considering the individual and constitutional proportions, the dolichomorphic body type was characteristic of 7% first-year students, but in the second year of study, their body weight and chest circumference increased. According to the body mass index, there was a general tendency towards harmonious physical development. The study revealed that with age, the body structure of young men became more proportional, the number of students with underdeveloped chest decreased (Erisman index).

The data of the life index calculation indicated that with age, all the examined students had a tendency to decrease the life index value, which was caused by the increase in body weight and the decrease in the vital capacity of the lungs. This led to the general decrease in the reserve of external respiration functions.

The assessment of the power index determined that the level of muscle development in young men was at the low and low average levels. This trend indicated the decrease in the reserve function of the muscular system.

Conclusions. While conducting investigation, we determine the positive dynamics of body weight and chest circumference of the examined students, as well as the functional deterioration of the external respiration and the decrease in the level of muscular system development in young men of the Department of Physical Education of I-IV training courses.

Key words: students, physical development, anthropophysiometric parameters, mass-height index.

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THE LYOTROPIC ANIONS INFLUENCE ON THE STATE OF ERYTHROCYTE MEMBRANE

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Introduction. Any biosystems exist only in the water solutions and are very sensitive to their characteristics. At the cryostorage the solutions tonicity increase due to water freezing and the cell survival depends on their osmotic adaptation [1].

The cell safety is highly dependent on the conditions which precede the critical exposures [2,3]. The different pre-dehydration level changes the RBCs ability to survive at hypertonic conditions (4 M NaCl) multidirectionally [3]. There are also the lyotropic anions (LA) specific properties (cosmotropes $NaSO_4$, NaF, NaAc and chaotropes NaCl, NaBr, $NaClO_4$) [4-8] that influence on the RBC osmotic adaptation [3,9,10]. However, the laws of these influences haven't been explained yet [11].

The aim of our **investigation** was to study the effect of various anions on the erythrocyte membrane state in order to explain their disadaptation in hypertonic conditions. This is important for directional correction of the cells state using the lyotropic effect at their cryostorage.

Object and methods. The RBCs were obtained from the blood of the male donor having the blood type A (II).

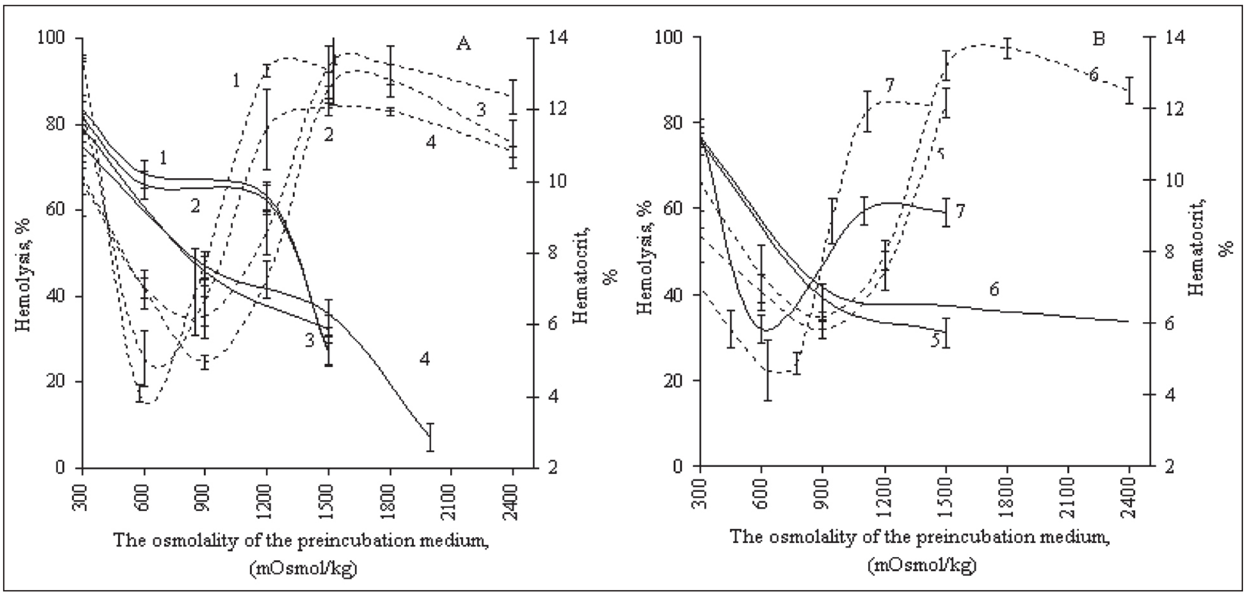

Figure 1 – The dependence of the erythrocyte suspensions hematocrit (solid lines) from the pre-incubation solutions osmolality in comparison with the level of hypertonic lysis **after the pretreatment at same solutions at 37°C (dotted lines) (A (chaotropes): 1 – SCN^-, 2 – ClO_4^-, 3 – Br^-, 4 – Cl^-; B (cosmotropes): 5 – F^-, 6 – Ac^-, 7 – SO_4^{2-}).**

Obtained erythrocytes were washed by three-time with 0.15 M sodium chloride solution (with 10 mM phosphate-buffer, pH 7.4) and centrifuged at 3000 rpm with a subsequent aspiration of supernatant and buffy coat.

The hypertonic lysis (HL) was realized by the transferring cells aliquot to 4 M sodium chloride solution for 5 min (at 37°C or 0°C) after the pre-incubation for 2 min at the mediums containing $NaSO_4$, NaF, NaAc (acetate), NaCl, NaBr, $NaClO_4$. The solutions containing the lyotropic anions had the tonicity 300-2400 mOsmol/kg. (The NaF has limited solubility and gives a maximum tonicity in 1500 mOsmol/kg solution). The solutions tonicity was monitored on a cryoscopic osmometer (OMKA 1C-01, Medlabortekhnika, Ukraine). The hemoglobin level in the supernatant was determined by spectrophotometry (λ = 543 nm).

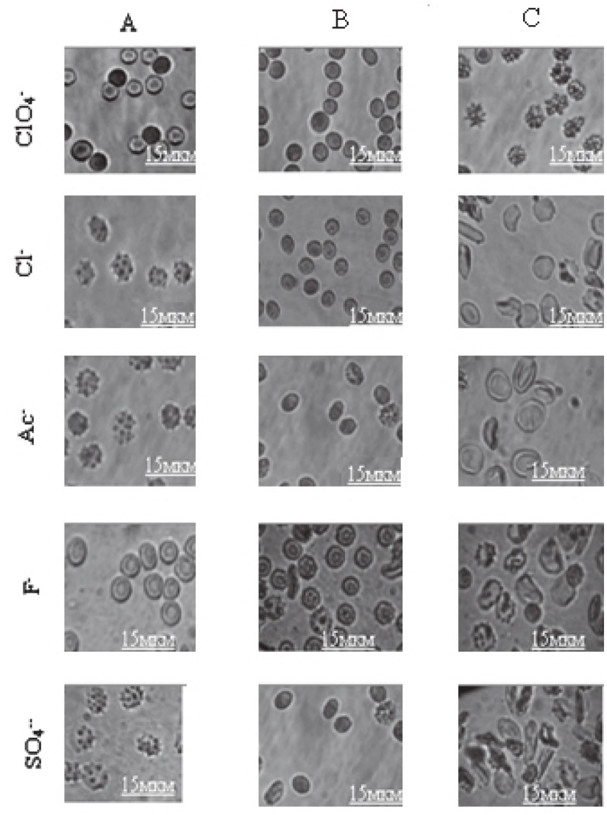

Figure 2 – The morphology of the RBC incubated for 10 min at 37°C in the solutions with osmolality corresponding to: A – physiological conditions; B – the minimum HL level (for ClO_4^- and SO_4^{2-} – 600 mOsmol/kg, for Cl^-, Ac^- and F^- – 900 mOsmol/kg); C – the maximum HL level (for ClO_4^- and SO_4^{2-} – 1200 mOsmol/kg, for Cl^- and F^- – 1500 mOsmol/kg and for acetate$^-$ – 1800 mOsmol/kg).

The relative RBC volume was measured by microhematocrit method. The cell morphology was studied by light microscopy (STUDARE microscope, Poland) and recorded with a CANON PowerShot A510 digital camera.

Statistical analysis was performed using the Mann-Whitney test. The experimental data are presented as arithmetic mean ± standard deviation (U <0.05).

Results and discussion. The RBC sensitivity to HL in 4 M NaCl (after partial dehydration by the NaCl solutions series with increasing tonicity) non linearly varies. There are a three adaptation phases: dynamic, stabilization (at 800 mOsmol/kg) and sensitization (at 1400 mOsmol/kg). At the other anions in media these phases measure up other osmolality [12].

In **fig. 1** (dotted lines) shows the effect of pretreatment at solutions with LA on the RBC adaptation to the HL at physiological temperature.

Obviously, the shift of the adaptation phases depends on the lyotropic properties of the anions. Despite the differences, the strong lyotropic properties both cosmotropes and chaotropes make cells more sensitive to the HL at 4 M NaCl.

In order to clarify differences on the cell osmotic state at the cosmotropes and chaotropes effect we studied the RBC volume parameter (**fig. 1** (solid lines)).

A positive correlation is observed between the hematocrit in the pre-incubation solutions and the HL level, prior to the sensibization phase. The cells stability acquirement is clearly associated with the end of the initial cell volume decrease that achieved at the individual media tonicity values for every LA. As for cell volume level, it gradually decreases level from chaotropes (10%

for ClO_4^-) to cosmotropes (6% for SO_4^{2-}). Thus, there is no the single critical RBC volume that is the stability marker or the destruction cell trigger.

In the adaptation phases sensitization the change in hematocrit level was radically different. An explanation of such effects was obtained by examining the morphology of the RBC, which gives an idea of their membranes architecture **(fig. 2).**

It can be seen at the high tonicity **(fig. 2, C)** the cells transform by the chaotropes and cosmotropes in the different ways. In case of the ClO4- the RBC take the highly compressed echinocytes form with a lot of spicules, i.e. with the labile lipid bilayer. On the other hand, cosmotropes make RBC highly dehydrated disco-echinocytes with a stable membrane. Excessive stabilization of the erythrocyte membrane leads to fragility of the cells, and the membrane destabilization – to the cell adhesion during sensitization to the HL. Under these critical conditions, the form factor significantly affects the hematocrit, which doesn't give an idea of the true cells volume [11].

Conclusions. Thus, under the influence of anions with different lyotropic characteristics, the cells acquire differences in the structural state, changes in the volume characteristics, and the ability to withstand HL. The incubation with the kosmotropes was accompanied by the lipid bilayer structure stabilization and the membrane permeability decrease and there are opposite changes for the chaotropes. Such effects can be explained by the fact that the state of biostructures at the cellular level largely depends on the properties of the surrounding water, which are affected by lyotropic anions.

Prospects of further research. Based on this, it can modulate the state of cells using the properties of lyotropic anions or other particles, combining their different characteristics ones in solution and using in various fields of the cryobiology and biotechnology.

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ВПЛИВ ЛІОТРОПНИХ АНІОНІВ НА СТАН МЕМБРАНИ ЕРИТРОЦИТІВ

Пакулова О. К., Бондаренко В. А., Костіна І. О.

Резюме. Будь-які біосистеми існують лише у водних розчинах і дуже чутливі до їх характеристик. При кріозберіганні тонічність розчинів збільшується через замерзання води, а життєздатність клітин залежить від їх осмотичної адаптації, котра, у свою чергу, керується умовами, що передують критичному впливові. Так, різний рівень попередньої дегідратації змінює здатність RBC виживати при гіпертонічних умовах (4 М NaCl). Існують також специфічні властивості ліотропних аніонів (космотропних SO_4^{2-}, F^-, Ac^- та хаотропних Br^-, ClO_4^- та SCN^-), що впливають на осмотичну адаптацію RBC. Відомо, що аніони, які мають виражені ліотропні властивості не сприяють осмотичній адаптації клітин у 4 М NaCl відносно ліотропно-нейтрального хлорид-аніону, однак закономірності та причини цих впливів ще не пояснено.

Тому метою нашого дослідження було вивчення впливу різних аніонів на стан мембрани еритроцитів з метою пояснення їх дезадаптації в гіпертонічних умовах, що важливо для спрямованої корекції стану клітин за допомогою ліотропного ефекту аніонів у середовищі при кріозберіганні.

Показано, що позитивна кореляція спостерігається між гематокритом в інкубаційних розчинах та рівнем гіпертонічного лізису. Набуття стійкості клітин пов'язане з закінченням зменшення початкового об'єму клітини, що досягається при індивідуальних значеннях тонічності середовища для кожного ліотропного аніону. Що стосується об'єму клітин, то він поступово знижується від хаотропних (10% для ClO_4^-) до космотропних (6% для SO_4^{2-}).

Морфологічний аналіз довів, що інкубація супроводжувалася стабілізацією структури ліпідного бішару та зменшенням проникності мембрани для космотропної, та протилежними змінами для хаотропної групи частинок.

Т.ч., механізм пошкодження при гіпертонічному лізисі для цих видів аніонів різний та залежить від стану води у розчині, змінюючи який за допомогою аніонів, або інших ліотропних частинок можна спрямовано керувати мембраною клітин та їх осмотичною поведінкою. Оскільки вони мають різні алгоритми впливу, то комбінуючи їх характеристики в розчині можна досягти різноманітних ефектів, що є потрібними у широкому спектрі напрямків.

Ключові слова: еритроцити, аніони ряду Гофмейстера, осмотична адаптація, гіпертонічний лізис, клітинна мембрана.

ВЛИЯНИЕ ЛИОТРОПНЫХ АНИОНОВ НА СОСТОЯНИЕ МЕМБРАНЫ ЭРИТРОЦИТОВ

Пакулова О. К., Бондаренко В. А., Костина И. А.

Резюме. Известно, что анионы с выраженными лиотропными свойствами не способствуют осмотической адаптации клеток в 4 М NaCl, поэтому исследовали изменения в морфологии и объеме эритроцитов в средах с космотропными (F^- и SO_4^{2-}) и хаотропными (ClO_4^- и SCN^-) анионами. Инкубация сопровождалась стабилизацией структуры липидного бислоя и уменьшением проницаемости мембраны для первой, и противоположными изменениями для второй группы анионов. Т.о., механизм повреждения при гипертоническом лизисе для этих видов анионов различен и зависит от состояния воды, изменяя которое посредством лиотропных частиц можно направленно управлять клеткой.

Ключевые слова: эритроциты, анионы ряда Гофмейстера, осмотическая адаптация, гипертонический лизис, клеточная мембрана.

THE LYOTROPIC ANIONS INFLUENCE ON THE STATE OF ERYTHROCYTE MEMBRANE

Pakulova O. K., Bondarenko V. A., Kostina I. O.

Abstract. It is known that anions with pronounced lyotropic properties don't contribute to the cells osmotic adaptation in 4 M NaCl. Therefore, the changes in the red blood cells morphology and volume in media with cosmotropic (F^- and SO_4^{2-}) and chaotropic (ClO_4^- and SCN^-) anions were studied. The incubation was accompanied by the lipid bilayer structure stabilization and the membrane permeability decrease for the first anion group and there are opposite changes for the second one. Thus, the hypertonic lysis damage mechanism for these anion types is different and depends on the state of water. So, the cell can be controlled by changing the state of water using particles with various lyotropic properties.

Key words: erythrocytes, anions of the Hofmeister series, osmotic adaptation, hypertonic lysis, cell membrane.

Рецензент – проф. Міщенко І. В.

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