

## Modern methods of determining the individual norm of volumes and premising intensity of the exercisable motor activity

Yaroslavna Puhach

Kharkiv State Academy of Physical Culture, Kharkiv, Ukraine

*The problem of individual approach in the organization of physical activities always assumes need of accounting of the current functional state, the level of preparedness and according to it the choice of available physical activity on intensity and duration and also admissible complexity of its performance for the purpose of improving orientation of their use. All these criteria can be defined with success on condition of accounting of dynamics and individual norm of course by adaptation reaction to the offered physical activity. The tasks still remain insufficiently resolved in many ways that defined orientation of the stated results of the conducted researches.*

**Purpose:** *determination of optimum volumes of load, its intensity, duration and admissibility of structure of the offered motive actions with the subsequent determination of nutrition state and rest sufficient for holding another training; determination of static stress providing a working pose necessary for the implementation of kinematic movements of parts of a body and dynamic efforts defining these movements.*

**Material & Methods:** *high-speed video filming; assessment of static stress on bending angle of biokinematic links; method of pliometric loads; method of creation of semantic spaces for ordered submission of empirical data; method of assessment of qualitative structure of a somatotype according to M. Ya. Breitman and Ch. Hirata; geometrical methods of ordered structuring of the empirical data revealing regularities of responses of organism to alteration influences.*

**Results:** *the consistent pattern of increment of size of lifting force on bending angle of knee joint is determined at control of change of static stress on bending angle of biokinematic couple "hip-shin". This pattern is expressed by a logarithmic spiral that is determined by the phylogenetic nature of morphofunctional dependence of dynamics of change of lifting force. Static stress is the most effective indicator of measure of exhaustion. The used standard pliometric exercises allow estimating an exhaustion measure for change of a way of damping of movement of body in a reaction phase with support at jumping off from the standard height. It is estimated on the basis of video filming of nature of movement of a supporting leg in a support phase in run or walking. The established exponential dependence allows determining the greatest possible volume of work and intensity of its performance in the current state of the individual by mathematical calculation. Such processing is carried out in real time. The technique is developed in KhSAPC.*

**Conclusions:** *the presented methods of assessment of individual norm of optimum volume of physical activity and its intensity in actual scale become possible as a result of use of modern technical means of video filming and computer programs providing creation of animation structure of movement of an object. This technique has no analogs in the world in practice of researches in sport now.*

**Keywords:** *static stress; dynamic effort; individual norm.*

### Introduction

The problem of individual approach in the organization of physical activities always assumes need of accounting of the current functional state, the available level of preparedness and according to it the choice of available physical activity on intensity and duration and also admissible complexity of its performance for the purpose of improving orientation of their use. All these criteria can be defined with success on condition of accounting of dynamics of individual norm of course of adaptation reaction to the offered physical activity.

Unfortunately, these tasks still remain insufficiently resolved in many ways that defined orientation of the stated results of the conducted researches.

Performance of any physical activity by all means is followed by power expenses and need of their subsequent recovery that is an integral part of improving effect of the organization of training process.

Thus, the making tasks in its construction are: determination of optimum volumes of load on its intensity, duration and availability of structure of the motive actions, which are offered for performance with the subsequent definition of nutri-

tion state and rest sufficient for holding training. Performance of any physical activity is possible only at the coordinated ratio of the statistical tension providing a working pose necessary for implementation of the dynamic efforts forming kinematic movements of parts of a body.

### Material and Methods of the research

Use of the adequate methods of the research, having necessary resolvability of objectives, was required for this purpose, to which were: high-speed video filming; assessment of static stress at change of bending angle between biokinematic links; method of pliometric loads; method of creation of semantic spaces for ordered submission of empirical data; assessment of qualitative structure of a somatotype according to the method of M. Ya. Breitman and Ch. Hirata; geometrical methods of ordered structuring of the empirical data allowing to determine consistent patterns of course them at influence of alteration factors.

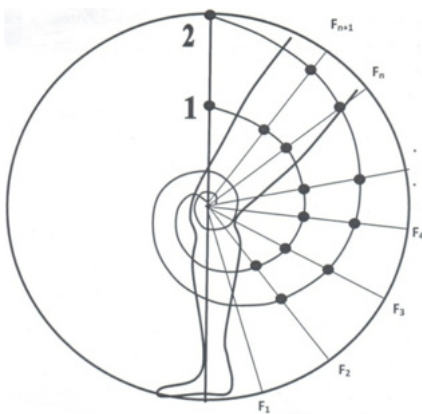
The stated tasks and methods of the research, adequate for their decision, were directed to achievement of the main objective, which consists in establishment of the regularities,

defining mechanisms of manifestation of individual norm of reactions of an organism to action of alteration factors of the environment of stay.

## Results of the research

Static stress is in the integral component at structure of creation of any motive act. It defined need more in details to consider its importance and features of participation in formation of course of process of creation of acting movement. In this regard it was necessary to develop allocation methods in structure of the controlled motive act as separately proceeding, but interdependent components of its construction which treat static stress forming a working pose and dynamic effort providing kinematic movement of links of a body and its general center of masses.

The dependence between bending angle of kinematic couple "hip-shin" and the developed statistical tension was defined for clarification of features of manifestation of static tension. The essence of the determined consistent pattern, connecting this dependence, consists that it is described by the logarithmic spiral reflecting communication of the developed static stress and bending angle of biokinematic couple "hip-shin". This pattern is defined by phylogenetic features of morphofunctional dependence reflecting dynamics of change of lifting force. (Fig. 1).



**Fig. 1. Dependence of size of static stress on bending angle of biokinematic couple "shin-hip"**

Importance of the opened pattern is that change of static stress as a compound component of any motive act is the most effective way of assessment of measure of exhaustion. The characteristic of logarithmic spiral carries strictly certain specific features in its construction which are expressed in coefficient of curvature of spiral. Depending on exhaustion measure, these characteristics don't change. Its indicator is the turn of the spiral concerning the pole, as acts as the quantitative characteristic of change of measure of exhaustion of rather previous state. The made interdependence between an angle of rotation of the fixed radius vector of spiral and the developed static stress, measured in kilograms, act as equivalent scales of assessment of measure of exhaustion. The made individual passport reflecting this pattern allows telling about the current state of weariness on change of an angle of damping at the movement in a reaction phase from a support when landing in the subsequent using standard test of jumping off from a certain height.

This control method of measure of development of exhaustion gives the chance to follow this process both in carrying out theoretical researches of kinematics of movements

and divisions of energy consumption leaving on static stress and providing on the kinematic movements, and directly in its practical application during training process by means of video filming of run or walking in real time. The method of plio-metric damping of movement and the established individual logarithmic spiral of increment of efforts to the bending angle of biokinematic couple "shin-hip" allow defining energy uses of performance of purely static stress of certain intensity and duration of its manifestation.

In practical application it found wide use in acrobatic rock'n'roll of the ancestor of this sport in Ukraine, the honored coach of Ukraine, the associate professor of the chair of gymnastics, sports dances and fitness of KhSAPC Kizym Piotr Nikolaievich and also the leading expert of federation of rock'n'roll of Ukraine, the associate professor of the chair of modern and ballroom choreography of Kiev national university of culture and art Bateieva Natalia Petrovna. They have developed the technique of definition of the optimum pose of a partner when using "fus" in which a sportsman can transfer the maximum impulse of strength of a partner at its throwing out up.

Determination of dependence of increment of force on bending angle between biokinematic couple is designated as  $\frac{dF}{d\varphi}$ . At each concrete moment static stress reflects entry and boundary condition of speed of increase of force that is designated as  $\frac{dF}{d\varphi}$ .

Boundary conditions of static stress determine that size of effort which can be reached at a concrete arrangement of kinetic couple. In the corresponding pose it can't be more some value of boundary size, but initial tension can be any in the range from zero to boundary value. Duration of deduction of boundary size of tension in each value of an angular extension is limited and remains the less, than closer to the maximum, that is has hyperbolic dependence described by the law "force-duration". The complexity of use consists in definition of zone of hyperbolic curve within which it acts. Now this task is solved [2; 3].

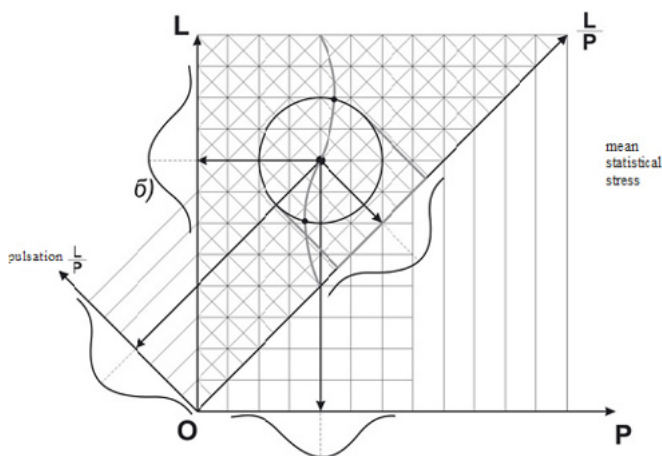
The geometrical solution of problem of manifestation of pattern of interdependent dependence of size of static stress and accompanying with its pulsation of dynamic efforts reflects the general pattern of manifestation of this phenomenon observed in any functional activity as it reflects process transitions of potential energy of the corresponding morphofunctional formation to its product of activity which reflects decrease in potential power depot in each concrete manifestation as the considered system, and complete organism when accounting of the pulsing activity of its functional systems [4].

The theoretical research of empirical data of pulsations of static stress and on its background of the corresponding dynamic effort providing kinematic movements of links of a body with use of method of geometrical ordering of their representation in special semantic spaces from the single measure of comparison of the considered characteristics entered into them allowed to open the general pattern of the interdependent relations in distribution of power uses of static stress and dynamic effort. Results of such construction allow to establish individual norm of size of static stress and adequate to its dynamic efforts; zone of functional optimum of their manifestation and control of current state of the person at the moment its activity when performing by its admissible complexity [5; 6].

This result is achieved on the basis of the fact that repre-

sensation of pulsation of static stress, its direct average value and borders of amplitude of changes of variation of dynamic efforts is carried out in the special nomogram. A perfect analogy of construction and use of such nomogram are acceptable for assessment of arterial blood pressure which is characterized by pulsation of wall of arterial vessels of rather some average pressure with concrete data of limits of maximum and minimum value of pulse.

The essence of creation of such nomogram consists in combination of two coordinate rectangular spaces for submission of empirical data. One of them is intended for reflection of values of maximum and minimum limit of pulse and reflects the size of pulse pressure at the arterial blood pressure corresponding to it average arterial blood pressure. The second coordinate space is turned concerning the first on 45° counterclockwise. In the joint zone of crossing of these coordinate spaces, each of four noted characteristics has the only general point reflecting them interrelation. The curve, representing pattern of behavior of the generalized point, is deleted in the course of its movement in this zone. This point in the movement reflects the general analytical dependence of all four indicators which are presented in Fig. 2.



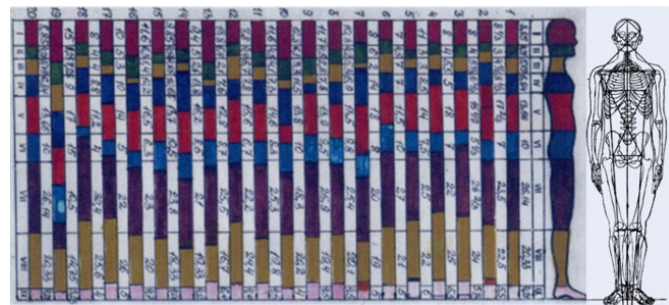
**Fig. 2. Pattern of movement of the generalized point of each of the considered four characteristics**

In all cases of representation of the pulsing behavior of any morphofunctional system these indicators have phylogenetic conditionality and are expression of long-term criteria for evaluation of abilities of mechanisms of trophic endurance of static stress with the indication of specific features of their course. Use of the presented patterns in essential measure allows to expand possibilities of creation of monitoring of physical development, physical fitness and physical condition of various groups of the population and promotes the solution of the problem of implementation of the directed formation of "physical activity of the individual taking into account his health". The essence of pattern is connected with reflection of individual adaptation opportunities as characteristics of the operational short-term energy potential directed to the focused adaptation to conditions of the environment and the long-term energy potential reflecting the level of its phylogenetic conditionality of the put physical health [7; 8].

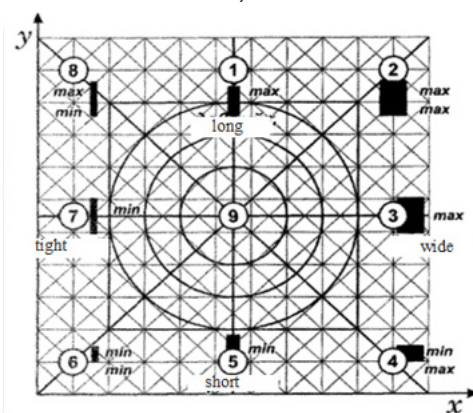
The ratio of short-term operational adaptation potential as dynamic characteristics of the pulsing behavior directed to preservation of an equilibrium condition of viability of organism in the environment of its stay and long-term energy potential as an indicator of static stock of viability of organism fully corresponds above the described analytical depen-

dence. Based on theoretical provisions of Geoffroy – Saint – Hilaire, Behncke, Sheldon, M. Ya. Breitman, Ch. Hirata that the structure of somatotype is external display of exchange processes of organism and also donosological constitutional diseases bears in itself information on features of course of biological maturing, the modified general concept of these provisions was developed [9; 10].

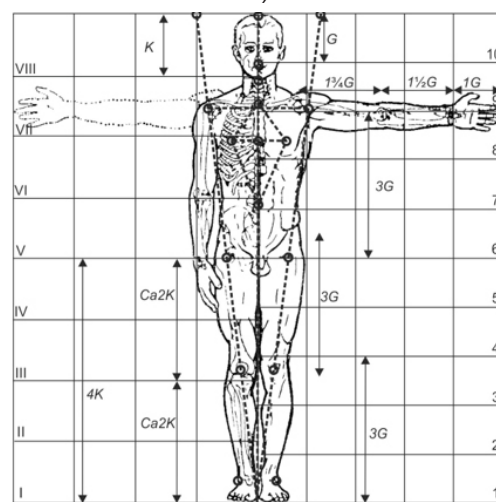
The idea of course of physical development as two independent, but interdependent processes as which growth of body weight and its shaping acts, was its basis. In this case growth of body weight acts as static expression of the saved-up potential of viability of the developing organism. This process can lag behind or advance chronological norm of the



a)



b)



c)

**Fig. 3. Graphical representation of variation of structure of a somatotype:**

- a) Body structure variation concerning his growth (M. Ya. Breitman).
- b) Body structure variations concerning his mass of the determined chronological age (Ch. Hirata).
- c) Human body proportions relative to height (Heller).



development.

The process of shaping of development of a body, having three-dimensional focus, can also create the most various morphofunctional structures of body from one volume of a body, as defines features of individual biological development from the corresponding available volume of accumulation of mass of chronological age. The third independent making characteristic of process of physical development is the intensity of course of shaping (maturing of structure) that generates emergence of such concept as "biological" age. It should be noted that intensity of course of process of maturing of morphofunctional structures of systems of organism demands a certain synchronization from interaction in the interdependent joint relations. Violation of such synchronization brings to different pathological violations [11; 12]. Graphical representation of variations of high-quality structural shaping of somatotype is presented in Fig. 3.

The integrated technique of assessment of biological age which allows to carry out the ranged creation of level of deviation of various criteria in assessment of biological age of separate morphofunctional systems from norm of the development with any degree of accuracy that is the cornerstone of manifestation of pathological changes in their functioning is developed on the basis of passport modifications of techniques of assessment of qualitative structure of a body.

### Conclusions / Discussion

Two components, to which static stress and dynamic efforts belong, are allocated in the mode of implementation of any motive acts. These characteristics are strictly interdepen-

dent analytical dependence that allows establishing individual norm of their course.

The main power uses of potential opportunities of an organism are spent for static stress of a working pose in any motive act. The static stress defines boundary and entry conditions of speed of development of force. In turn, static stress increases the value according to logarithmic spiral on the uniform growth of bending angle of biokinematic couple.

This pattern has broader application, except assessment of motive activity, it is shown in all cases when there is an expense of energy potential of a complete organism against the background of a certain static stress to the pulsing its fluctuations of rather current adaptive activity of morphofunctional systems of an organism and also at the description of features of course of biological age as a possible variation of process of shaping of potential of chronological growth of body weight.

The existence of modern technical means of receiving and processing of materials of the carried out researches, computer programs providing fast data processing, the developed new methods of representation of results of researches, the determined mathematical consistent patterns of morphofunctional interconditionality of the relations allowed considerably increase resolvability of the used technologies that allows to conduct more in-depth knowledge in the field of the organization of the mass forms of physical culture, taking into account specific features which are engaged regardless of their age.

**Further development of scientific research** in this direction will be connected with practical reaction of the received results of researches.

**Conflict of interests.** The author declares that no conflict of interest.

**Financing sources.** This article didn't get the financial support from the state, public or commercial organization.

### References

1. Bateieva, N.P. & Kyzim, P.N. (2012), *Acrobatic rock'n'roll*, KhSAPC, Kharkov.
2. Markushевич, A.I. (1978), *Remarkable curves*, Moscow.
3. Babskiy, B.B., Zubkov, A.A. & Kositskiy, G.N. (1966), *Human physiology*, Moscow.
4. Markushевич, A.I. (1978), *Remarkable curve*, Moscow.
5. Yefimov, N.V. (1971), *The highest geometry*, Moscow.
6. Ashanin, V.S. & Puhach, Ya.I. (2014), *Creation of semantic spaces for the description of psychosomatic activity of the person in extreme and special conditions*, KhSAPC, Kharkov.
7. Puhach, Ya.I. (2013), "Basic provisions of creation of semantic spaces for ordered representation of results of the research", *Materials of the IX international scientific and practical conference. Бъдещето въпроси отсета на науката*, Sofia, pp. 5-14.
8. Azhippo, A.Yu., Puhach, Ya.I., Pyatisotskaya, S.S. & Druz, V.A. (2015), *Ontology of the theory of creation of control and assessment of level of physical development and physical state*, KhSAPC, Kharkov.
9. Druz, V.A., Artemyeva, G.P. & Puhach, Ya.I. (2013), *Theoretical and applied bases of creation of monitoring of physical development, physical fitness and physical condition of various groups of the population*, HGAFK, Kharkov.
10. Breitman, M.Ya. (1949), *Clinical semiotics and differential diagnosis of endocrine diseases*, Leningrad.
11. Hirata, Ch. & Kaku K. (1968), *The evaluating method of physique and physical fitness and its practical application*, Tokyo.
12. Frolkis, V.V. (1982), *Physiological mechanisms of aging*, Leningrad.
13. Blehman, I.I. (1981), *Synchronization in the nature and technique*, Moscow.

Received: 15.01.2020.

Published: 29.02.2020.

**Анотація.** Ярославна Пугач. Сучасні методи визначення індивідуальної норми обсягів і допустимої інтенсивності виконуваної рухової діяльності. Проблема індивідуального підходу в організації фізичних навантажень з метою оздоровчої спрямованості їх використання завжди передбачає необхідність врахування поточного функціонального стану, рівня підготовленості і відповідно до цього вибору доступного фізичного навантаження за інтенсивністю та тривалістю, а також допустимої складності її виконання. Усі ці критерії можуть бути з успіхом визначені за умови врахування динаміки та індивідуальної норми протікання адаптаційної реакції на пропоноване фізичне навантаження. Дані питання багато в чому залишаються ще недостатньо вивченими, що визначило спрямованість викладених результатів проведених досліджень. **Мета:** визначення оптимальних обсягів навантаження, його інтенсивності, тривалості і допустимості структури пропонованих рухових дій з подальшим визначенням режиму харчування і відпочинку, достатніх для проведення чергового тренувального заняття; визначення статичної напруги, що забезпечує робочу позу,

необхідну для здійснення кінематичних переміщень частин тіла і динамічних зусиль, що визначають ці переміщення. **Матеріал і методи:** швидкісна відеозйомка; оцінка статичної напруги на кут розгинання біокинематичних ланок; метод пліометричних навантажень; метод побудови семантичних просторів для упорядкованого уявлення емпіричних даних; метод оцінки якісної структури будови соматотипа за М. Я. Брейтману і К. Хірата; геометричні методи упорядкованого структурування емпіричних даних, які виявлятимуть закономірності реакцій організму на альтеруючий вплив. **Результати:** при контролі зміни статичної напруги на кут розгинання біокинематичної пари "стегно-гомілка" встановлено закономірність збільшення величини становий сили на кут розгинання колінного суглоба. Ця закономірність виражається логарифмічною спіраллю, що визначено філогенетичної природою морфофункціональної залежності динаміки зміни станової сили. Статична напруга є найбільш ефективним показником міри стомлення. Використання стандартних пліометричних вправ дозволяють оцінювати міру стомлення зі зміни шляху демпфування руху тіла у фазі реакції з опорою при зістрибуванні зі стандартної висоти. У бігу або ходьбі це оцінюється на підставі відеозйомки характеру руху опорної ноги у фазі опори. Встановлена експоненціальна залежність дозволяє математичним розрахунком визначити максимально можливий обсяг роботи і інтенсивність її виконання у поточному стані індивіда. Така обробка здійснюється в реальному масштабі часу. Методика розроблена в ХДАФК. **Висновки:** представлений метод оцінки індивідуальної норми оптимального обсягу фізичного навантаження її інтенсивності у реальному масштабі стала можливою у результаті використання сучасних технічних засобів відеозйомки і комп'ютерних програм, що забезпечують побудову анімаційної структури переміщення об'єкта. Дана методика у даний час не має аналогів у світі в практиці досліджень в спорті.

**Ключові слова:** статична електрика, динамічне зусилля, індивідуальна норма.

**Аннотація.** Ярославна Пугач. **Современные методы определения индивидуальной нормы объемов и допустимой интенсивности выполняемой двигательной деятельности.** Проблема индивидуального подхода в организации физических нагрузок с целью оздоровительной направленности их использования всегда предполагает необходимость учета текущего функционального состояния, уровня подготовленности и в соответствии с этим выбора доступной физической нагрузки по интенсивности и продолжительности, а также допустимой сложности ее выполнения. Все эти критерии могут быть с успехом определены при условии учета динамики и индивидуальной нормы протекания адаптационной реакции на предлагаемую физическую нагрузку. Данные вопросы во многом остаются еще недостаточно разрешенными, что определило направленность излагаемых результатов проведенных исследований. **Цель:** определение оптимальных объемов нагрузки, ее интенсивности, продолжительности и допустимости структуры предлагаемых двигательных действий с последующим определением режима питания и отдыха, достаточных для проведения очередного тренировочного занятия; определение статического напряжения, обеспечивающего рабочую позу, необходимую для осуществления кинематических перемещений частей тела, и динамических усилий, определяющих эти перемещения. **Материал и методы:** скоростная видеосъемка; оценка статического напряжения на угол разгиба биокинематических звеньев; метод пліометрических нагрузок; метод построения семантических пространств для упорядоченного представления эмпирических данных; метод оценки качественной структуры строения соматотипа по М. Я. Брейтману и К. Хирата; геометрические методы упорядоченного структурирования эмпирических данных, выявляющих закономерности ответных реакций организма на альтерирующие воздействия. **Результаты:** при контроле изменения статического напряжения на угол разгиба биокинематической пары "бедро-голень" установлена закономерность приращения величины становой силы на угол разгиба коленного сустава. Эта закономерность выражается логарифмической спиралью, что определено филогенетической природой морфофункциональной зависимости динамики изменения становой силы. Статическое напряжение является наиболее эффективным показателем меры утомления. Использование стандартных пліометрических упражнений позволяет оценивать меру утомления по изменению пути демпфирования движения тела в фазе реакции с опорой при спрыгивании со стандартной высоты. В беге или ходьбе это оценивается на основании видеосъемки характера движения опорной ноги в фазе опоры. Установленная экспоненциальная зависимость позволяет математическим расчетом определить максимально возможный объем работы и интенсивность ее выполнения в текущем состоянии индивида. Такая обработка осуществляется в реальном масштабе времени. Методика разработана в ХГАФК. **Выводы:** представленные методы оценки индивидуальной нормы оптимального объема физической нагрузки и ее интенсивности в реальном масштабе стала возможной в результате использования современных технических средств видеосъемки и компьютерных программ, обеспечивающих построение анимационной структуры перемещения объекта. Данная методика в настоящее время не имеет аналогов в мире в практике исследований в спорте.

**Ключевые слова:** статическое напряжение; динамическое усилие; индивидуальная норма.

## Information about the Authors

**Yaroslavna Puhach:** PhD (Physical Education and Sport); Kharkiv State Academy of Physical Culture: Klochkivska str. 99, Kharkiv, 61058, Ukraine.

**ORCID.ORG/0000-0001-5460-772X**

**E-mail:** sanadruz@gmail.com