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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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ASSESSMENT OF REACTIVITY TO THE BODY UNDER CONDITIONS OF PHYSICAL ACTIVITY IN STUDENTS AGED 17-20 YEARS

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Abstract.

Introduction: Physical activity is such an essential socio-biological element, which provides a balance between the body and the external environment and contributes to the improvement of metabolic process regulation mechanisms. However, the abuse of physical activity often leads to unwanted changes in the basic physiological processes in the athletes' organism, due to the impact of a variety of reasons. The state of the organism's regulatory systems and the provision of the necessary adaptation of the organism to physical activity are crucial in assessing the athlete's physical fitness. It is known that during physical exertion, the functional state of the organism is determined by a reaction limiting the efficiency of the cardiovascular and respiratory systems. It was revealed that with long-term physical activity restriction, blood circulation regulatory mechanisms, as well as synocardial reflexes, are disrupted.

Approach: This research is devoted to the study of students' organism adaptive capabilities depending on the central or autonomous type of vegetative regulation. Registration and analysis of ECG of students by the method of variational heart rate monitoring were carried out. With the help of a special program, the students' heart rate integral indicators were analyzed. All studies were carried out twice: before physical exertion and immediately after physical exertion.

Purpose: In this study, we aimed to explore the adaptive capabilities of students bodies depending on the central or autonomous type of autonomic regulation.

Results: Three types of response to physical activity have been identified: optimal, paradoxical, and atypical. In all types of reactions, a certain level and direction of intensity of the processes of regulation of the athletes' organism is expressed. The study of the distinctive features of vegetative regulation makes it possible to assess athletes' organism functional state better and determine violations of their adaptive capabilities.

Conclusion: According to the research results, based on the primary signs of the athletes' organism adaptive capabilities and the corresponding reaction, it is possible to determine the optimal dose of physical exertion for athletes.

Key words. Vegetative regulation, registration and ECG analysis, physical exertion, adaptive reaction, integral indicators, heart rate.

Introduction.

Currently, the problem of preserving and strengthening health, as well as preventing various types of diseases, has received important social significance in the society [1-6]. Physical activity is such an important socio-biological element that provides a balance between the organism and the external environment and contributes to the improvement of metabolic process regulation mechanisms.

Due to the impact of various reasons, the abuse of physical activity often leads to unwanted changes in the basic physiological processes in the athletes' organism. The state of the organism's regulatory systems and the provision of the necessary adaptation of the organism to physical activity are crucial in assessing the athlete's physical fitness, early revealing the state of overloading, and controlling the process of fitness [7].

At the same time, efficient motor activities and physical exercises are not only means of active recreation, but they also enhance the functional and adaptive capabilities of the organism. An individual approach to determine the level of physical activity is also important. The workload that does not correspond to the capabilities of the body leaves a negative impact on the musculoskeletal, cardiovascular, respiratory, and neuropsychiatric systems. However, an objective assessment of the organism's functional capabilities and the performance measurement at various stages of sports training attracted the attention of many researchers [7-10]. It is known that during physical exertion, the functional state of the organism is determined by a reaction limiting the efficiency of the cardiovascular and respiratory systems. It was revealed that with long-term physical activity restriction, blood circulation regulatory mechanisms, as well as synocardial reflexes, are disrupted [8,11-13].

This research is devoted to the students' organism adaptive capability study depending on the central or autonomous type of vegetative regulation. In this regard, students' organism autonomous balance and autonomous reactivity were studied.

Three types of response to physical activity have been identified: optimal, paradoxical, and atypical. In all types of reactions, a certain level and direction of intensity of the processes of regulation of the athletes' organism is expressed. The study of the distinctive features of vegetative regulation makes it possible to assess athletes' organism functional state better and determine violations of their adaptive capabilities.

Materials and Methods.

The purpose of this research was to study the adaptive capabilities of the athletes' organisms depending on vegetative regulation type. 20 male students from the 2nd to the 4th courses of the Armenian State Institute of Physical Culture and Sport at the age of 17-20 (ASIPCS) were examined. All the studies were carried out twice: before the physical exertion (physiological norm), and immediately after the physical exertion (20 squats). An electrocardiogram (ECG) was registered according to the second standard guide to study the features of cardiac activity regulation. ECG analysis and registration were carried out by the method of variation heart rate monitoring. They used a software complex specially developed at the Institute of Physiology of

the National Academy of Sciences of the RA, which includes a portable cardiograph «Bio-Arm 001", a personal computer and an automated program for recording and analyzing the ECG, which provides analyses of more than 30 heart rate indicators.

The students were divided into 4 groups, according to the classification of vegetative regulation types by N.I. Shlyk [14,15] (Table 1).

Table 1. *Types of vegetative regulation according to N.I. Shlyk.*

I type	**II type**	**III type**	**IV type**
Central regulation		**Autonomic regulation**	
Moderate Dominance	Expressed Dominance	Moderate Dominance	Expressed Dominance
SI>100 ms^2	SI>100 ms^2	SI<100 ms^2	SI<70 ms^2
VLF>240 ms^2	VLF<240 ms^2	VLF>240 ms^2	VLF>240 ms^2

As a result, the distribution of students according to the abovementioned indicators was unequal, so groups 1 and 4 included 4 students each, group 2 had 7 students, and group 3 had 5 students. Surveys of students in each group were carried out in several repetitions, to obtain reliable results, the average indicators of which are shown in Tables 2 and 3.

In each experimental situation, 5-minute ECG intervals were analyzed. The study and analysis of the ECG were carried out according to the instructions of the European Association of Cardiology and the North American Association of Electrophysiology and Cardiorhythmology based on heart rate variability (HRV).

The study of heart rate variability indicators has diagnostic and prophylactic, preventive significance in various pathological situations. The HRV indicator accounting method can be used to assess healthy people and athletes' fitness, as well as to carry out various medical and biological studies.

Considering the psychophysiological importance of HRV indicators, it becomes possible to estimate the physiological "significance" of various types of activities. Using the program, the following histographic (Mo, AMo, ΔX), integral (IN, IVR, VPR, PAPR) and spectral (HF, LF, VLF, TP, LF/HF) heart rate indicators were analyzed:

• Mo-mode, the most common value of cardio-intervals.

• AMo - mode amplitude, the number of cardio-intervals corresponding to the mode significance in % of the total sample size.

• ΔX - variation range, the difference between the maximum and minimum significance of cardio-intervals.

• tension index of regulating system (IN=AM0 /2ΔX×M0), which reflects the degree of tension of compensatory mechanisms.

• vegetative balance indicator (IVR=AM0/ΔX), reflecting the relationship of the sympathetic and parasympathetic links of the ANS.

• vegetative rhythm indicator (VPR=1/ M0×ΔX), which allows to judge the vegetative balance from the point of view of assessing the activity of the autonomous regulation circuit.

• Indicator of the validity of regulatory processes (PAPR = AM 0 /M 0), reflecting the relationship between the activity of the sympathetic part of the vegetative nervous system and the leading level of activity of the sinus node.

Spectral parameters of heart rate variability were also studied:

• HF (ms^2, %) - is the power of the range of high frequencies (0.15-0.4 Hz) associated with the act of breathing and reflecting the level of functioning of the parasympathetic nervous system in the process of the heart rate regulation.

• LF (ms^2, %) - is the power of the spectrum in the low-frequency range (0.04–0.15 Hz) associated with the blood pressure system and primarily expressing the degree of activation of the sympathetic link in the regulation of heart rhythm (although it has a mixed -sympathetic–parasympathetic origin).

• VLF (ms^2, %) - is the power of the spectrum in the range of very low frequencies (0.003-0.04 Hz), reflecting the influence of higher vegetative centers on subcortical centers of the cardiovascular system. This indicator can be used as a reliable marker to assess the relationship between the autonomous humoral-metabolic (hypothalamic-pituitary) and central ergotropic (cortical) levels of blood circulation regulation.

Table 2. *Changes in indicators of vegetative balance of I and II group students in terms of physical exertion.*

	I Group		***II Group***	
Indicators	**At rest**	**After physical exertion**	**At rest**	**After physical exertion**
M_O	0.68±0.02	0.56±0.02***	0.51±0.02	0.56±0.02***
AM_O	54.76±4.21	70.70±5.31**	55.26±3.28	68.70±4.81**
ΔX	0.30±0.02	0.170.02**	0.28±0.02	0.17±0.02**
V_K	7.87±0.13	6.09±0.40***	7.48±0.16	6.86±0.61***
IN	141.21±13.57	244.92±75.31**	128.39±11.69	287.63±14.96**
IVR	5.59±0.48	12.84±2.21***	4.78±0.48	9.78±1.91***
PAPR	80.99±6.47	126.50±8.01***	74.25±5.78	118.96±7.78***
VPR	193.21±15.56	288.40±77.14**	158.96±14.78	368.29±45.84**
TP	1774.01±93.90	780.40±22.01***	1549.01±69.90	690.47±18.01***
HF	34.20±3.67	29.15±5.69	46.20±2.78	34.58±2.69
LF	46.85±1.81	58.15±2.34**	39.59±2.01	42.15±1.94**
VLF	269.25±19.69	188.75±11.58	209.10±13.76	198.75±12.07
LF/HF	1.63±0.21	2.08±0.55**	1.64±0.17	3.08±0.45**

Note: *Significance of differences in groups *-p<0.05, **-p<0.01, ***-p<0.001*

• TP (ms^2) - is the total power of the spectrum, which characterizes the degree of heart rate variability. Activation of the parasympathetic link increases the TP significance, but in the case of an increase in the influence of the sympathetic nervous system, the reverse result is observed.

• LF/HF - is the indicator of vegetative relationships, conditionally characterizing the percentage contribution of sympathetic and parasympathetic influences on the mechanisms of heart rhythm autonomous regulation (an indicator of sympathetic-parasympathetic balance).

The obtained data were statistically processed through the "Biostat" program according to the Student's t-criterion (M±m).

Results.

The results of the studies showed that changes in most indicators were optimal in group 1 (Table 2).

As it can be seen from Table 2, students of the first group had a reliable increase in the parameters characterizing the activity of the sympathetic link regulating the heart rhythm after physical exertion. Indicators of IN and AM0 increased by 73.44% and 29.01%, correspondingly. The latter was followed by a marked decrease in the activity of the parasympathetic (ΔX) and humoral (M0) mechanisms regulating heart rhythm by 43.4% ($p<0.001$) and 12%, correspondingly.

There was a considerable increase in the indicator IN in group II, more than 2 times (by 124.02%), and AM0 – by 24.32%. The value of the indicator M0 had hardly changed, while ΔX had decreased by 39.28% (Table 2).

The significance of analogous indicators underwent the following changes in group III: IN and AM0 increased, correspondingly, by 43.48% and 2.25%. M0 and ΔX decreased, correspondingly by 12,5% and 48,0%.

Changes in LF and VLF indicators had controversial characteristics (Table 3).

As it can be seen from Table 3, there was a decrease in the indicators characterizing the activity of the parasympathetic link regulating the heart rhythm after physical exertion in group IV. The indicators of ΔX and M0 decreased by 17.39% and 45.28%, correspondingly. Indicators of IN and AM0 increased by 48.06% and 32.03%, correspondingly.

Discussion.

According to the research results, the applied physical exertion makes it possible to analyze the functional resources of vegetative regulation.

Using the concept of the two-heart rate control circuit model, N.I. Shlyk identifies four groups of autonomous regulation: two with central control circuit dominance and two with autonomous control circuit dominance (with moderate and clear dominance in each case) [14,15] (Table 1).

These regulation groups correspond to the classification adopted on the basis of the IN amount: types of sympathotonia, normotonia and vagotonia. At the same time, the type of normotonics is studied in two variants – sympatho-normotonic (group I) and vago-normotonic (group III). This classification is based not on the sympathetic and parasympathetic parts of the autonomic nervous system, but on the mechanisms of central and autonomous regulation of autonomic functions [10].

Thus, the participation of various links in the process of autonomic regulation is emphasized by Shlyk as a single mechanism of regulation, which is a systematic approach to a complex mechanism for analysing heart rate variability data. Such an approach provides important information about the assessment of the functional and adaptive capabilities of the athlete's organism, and also allows to identify the primary signs of their impairments [15].

The analysis of heart rate variability indicators reflecting the vegetative balance of the organism allowed the classification of athletes according to vegetative regulation type: athletes with central regulation were assigned to groups I and II, and with autonomous regulation - to groups III and IV.

In terms of physical exertion (20 squats), the study of vegetative reactivity revealed a number of changes signifying students' organisms regulatory adaptive capability level.

Vegetative balance among the students of the first group was expressed by moderate tension of the regulatory system of the organism, at the same time, against the backdrop of decreasing the autonomous regulation circuit activity, the dominance of the central regulation of the heart rate was observed. The observed changes indicate a high activity of sympathetic mechanisms of

Table 3. *Changes in indicators of vegetative balance of III and IVgroup students in conditions of physical exertion.*

	III Group		***IV Group***	
Indicators	**At rest**	**After physical exertion**	**At rest**	**After physical exertion**
M_O	0.72±0.03	0.63±0.02	0.53±0.01	0.29±0.01
AM_O	75.50±3.21	77.20±4.02	66.502.98	87.80±1.97
ΔX	0.25±0.01	0.13±0.02	0.23±0.01	0.19±0.01
V_K	7.81±0.16	6.49±0.61*	8.51±0.16	6.94±0.61*
IN	96.52±2.16	138.49±1.98**	66.52±1.97	98.49±3.89**
IVR	6.27±0.09	8.09±1.02**	7.78±0.05	9.09±0.09**
PAPR	129.80±4.59	225.02±5.39**	150.37±5.78	217.02±7.60**
VPR	258.17±11.29	392.52±10.98**	258.17±7.58	392.52±6.78**
TP	1124.01±61.45	989.28±37.01***	1347.01±51.45	989.28±27.01**
HF	44.18±2.59	29.78±1.89	54.18±3.59	36.78±2.89
LF	40.19±1.84	49.81±1.54**	42.89±1.84	37.81±1.54
VLF	298.00±11.76	220.75±9.47	258.0011.76	220.75±9.47
LF/HF	2.44±0.57	2.880.35**	2.44±0.57	2.88±0.35

Note: *Significance of differences in groups *-p<0.05, **-p<0.01, ***-p<0.001*

heart rate regulation after physical work and a decrease in the activity of the parasympathetic and humoral links. This is also evidenced by a significant decrease in the coefficient of variability of cardiointervals (V_k) by 22.62% ($p<0.001$) (Table 2).

Vegetative balance of the II group student organism reflects the state of autonomic malfunction with the dominance of sympathetic regulation of the heart rate and an abrupt increase in the activity of central regulation compared to autonomous (Table 2). Paradoxical reaction is observed after physical exertion - a decline in the functional state of regulatory systems.

Studies of some authors also indicate that during physical exertion, wrestlers and athletes have a significant shift in sympathetic-parasympathetic balance towards sympathicotonia, due to the multidirectional dynamics of changes in the power of vasomotor waves LF [16].

Vegetative balance of the III group student organism corresponded to the optimal state of regulatory systems with moderate dominance of parasympathetic activity (Table 3). Nevertheless, 3 types of reactions were revealed after physical exertion. 55% of athletes showed an optimal response, 20% - paradoxical, and 25% of athletes - only an increase in LF and VLF significance.

In group IV, tension of vegetative balance with a clear dominance of the parasympathetic nervous system was observed. However, the reaction of the students' organism to physical activity was optimal with a fairly high activity of regulatory systems with autonomous regulation circuit dominance (Table 3).

In our opinion, vegetative balance, and a similar case of vegetative regulation of athletes, reflects a high level of fitness. It should be noted that when the autonomous control circuit dominates, less effort is spent to maintain the optimal functional level than when the central regulation circuit dominates.

As it can be seen from the data of 4 presented groups in Table 3, physical activity contributes to a decrease in the overall range of heart rate regulation mechanism activity (TR) by 26.56%, which reflects the influence of the autonomic nervous system on heart rate. The latter was accompanied by a simultaneous decrease in all components of the range (VLF, LF, HF).

The disadvantages and limitations of our research include the following aspects:

- Despite the fact that we used a special software package for ECG registration and analysis providing analysis of more than 30 heart rate indicators, we limited ourselves to only some indicators.
- When choosing the students for the research, their belonging to a particular sport was not taken into account.
- For some students, for various reasons, it was not always possible to register indicators twice: in the norm and after physical activity.
- To obtain reliable statistical data, it was necessary to extend the scheduled research time due to the implementation of several repetitions.

Conclusion.

From the data we obtained it follows that the picture of vegetative balance without studying vegetative reactivity cannot provide complete information about the state of regulatory systems. When studying autonomous reactivity, both optimal and paradoxical reactions were discovered with indicators corresponding to those described in the works of N.I. Shlyk and M.G Agadzhanyan et al. [17].

Against the background of optimal changes among some students, an increase in LF and VLF was observed.

The optimal reaction of the students of the III group to physical exertion indicates a normal level of fitness; the paradoxical reaction reflects a sharp predominance of central regulation and indicates overload and overexertion.

The increase in the amplitude of slow waves (LF and VLF) reflects the tension of the vasomotor and ergotropic regulation centers. VLF is closely related to psychoemotional and functional stress. Such reactions reflect changes in individual parts of the regulation process, and they are commonly called atypical.

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Резюме

Актуалность. Физическая активность является таким важным социально-биологическим фактором, который обеспечивает равновесие между организмом и внешней средой и способствует усовершенствованию механизмов регуляции процессов метаболизма.

Однако, злоупотребление физической нагрузкой часто приводит к нежелательным изменениям основных физиологических процессов в организме спортсменов, обусловленые влиянием ряда факторов. Состояние регулирующих систем организма и обеспечение необходимой адаптации организма к физической активности являются определяющими в оценке физической подготовленности спортсмена.

Известно, что при физической нагрузке функциональное состояние организма обусловлено реакцией, ограничивающей работоспособность сердечно-сосудистой и дыхательной систем. Выявлено, что при длительном ограничении физической активности нарушаются регуляторные механизмы кровообращения, а также синокардиальные рефлексы.

Целью исследования является изучение адаптационных возможностей организма студентов в зависимости от центрального или автономного типа вегетативного регулирования. Осуществлялись регистрация и анализ ЭКГ студентов по методу вариационной пульсометрии. При помощи специальной программы анализировались интегральные показатели сердечного ритма студентов. Все исследования были проведены дважды: до физической нагрузки и сразу после физической нагрузки.

Результаты и заключение. Выявлены три типа реагирования на физическую нагрузку: оптимальный, парадоксальный и атипичный. Во всех типах реагирования выражается определенная степень и направленность напряженности процессов регуляции организма спортсменов. Исследование отличительных признаков вегетативной регуляции позволяет лучше оценить функциональное состояние организма спортсменов и определить нарушения их адаптационных возможностей.

По результатам исследования, исходя из первичных признаков адаптационных возможностей организма спортсменов и проявленной соответствующей реакцией, можно определить оптимальную дозу физической нагрузки спортсменов.

Ключевые слова

Вегетативная регуляция; регистрация и анализ ЭКГ; физическая нагрузка; адаптационная реакция; интегральные показатели; ритм сердца