DYNAMICS OF FUNCTIONAL CAPABILITIES AMONG 17-22 YEARS OLD GIRLS WITH DIFFERENT VEGETATIVE STATUS DURING THE OVARIAN-MENSTRUAL CYCLE

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The condition of organism of girls throughout their reproductive years is constantly influenced by the dynamic fluctuations of their hormonal background. The effect from influence of cyclic changes of hormonal secretion on all organ systems has been studied for a long time [1]. As a rule, researchers are interested in adaptation changes in the organism of girls engaged in a certain sport or having a high level of sports qualification, but data on the functional state of girls with low motor activity are practically non-existent. It must be noted, that today there is still ambiguity in scientific data regarding the nature of changes in women's functional capabilities over the menstrual cycle [5,6,8,11,15–17], in particular, the adaptation reactions of the cardiovascular system (CVS) [2,3,14,18,23].

The study of the dynamics of the mechanisms of regulation of cardiac activity of girls with low motor activity (LMA) during the ovarian-menstrual cycle (OMC) has a certain scientific-theoretical and practical interest. On the one hand, the state of CVS can be considered as an indicator of the reserves of functional capabilities, because it is the most sensitive to a variety of different factors [1, 2], and the level of activity and the adequacy of CVS reactions, in particular, to physical activity, is determined by the state of control mechanisms of the autonomic nervous system, which is described by changes in the heart rate [2,3,14,22,25]. On the other hand, girls 17–22 years old with LMA are under the influence of more stable endocrine fluctuations compared to sportswomen.

Objective – to study the dynamics of functional capabilities of girls of 17–22 years old with different vegetative status during the ovarian-menstrual cycle.

Material and methods. 28 girls took part in research – there were students of Faculty of Primary Education, Preschool Pedagogy and Psychology, whose physical activity was limited to one physical activity per week. Among many classifications of the menstrual cycle (MC) phases the most optimal is the classification proposed by the Institute of Gerontology AMS of Ukraine, which consists in dividing the menstrual cycle into 5 phases: menstrual (I), postmenstrual (II), ovulatory (III), postovulatory (IV) and premenstrual (V), according to which the study was conducted. The menstrual cycle of girls was not violated for 3 months, which made it possible to use the calendar method of phase determination by N.V. Svechnikova [5,9,17].

All research was conducted on the basis of the Department of Biology and Health Protection at the Laboratory of Age Physiology of Sports of South Ukrainian National Pedagogical university named after K.D. Ushinsky (Odessa) with observance of the basic bioethical provisions of the Convention of the Council of Europe on Human Rights and Biomedicine (04.04.1997), the Declaration of Helsinki of the World Medical Association on ethical principles of scientific medical research with the participation of human beings (1964-2008), as well as the Order of the Ministry of Health of Ukraine № 690 of 23.09.2009.

The following methods were used to achieve this goal: questioning, anthropo-physiometry, electrocardiography with the following definition of the variability of the heart rate by R.M. Baevsky [2,3], cycle ergometry, the calendar method for determining the phases of the menstrual cycle,, blood pressure measurement of systolic, diastolic, pulse (ADs, ADD, PD), calculation of systolic and minute blood volume, statistical methods for processing research results.

Work on the cycle ergometer VED-12 was used as a muscle load according to D.N. Davidenko's methodology [7], modernized in our laboratory. Testing consisted in a smooth, continuous increase in load power from zero to heart rate (HFR) 150–155 beats per minute, after which, according to the program the operating power was reduced to the initial level with the same speed.

Heart rate variability (HRV) was studied before cycle ergometric loading (at rest), at the moment of reverse (at HFR=150–155 beats per minute), at the end of work and at the 5th minute of recovery, sitting on the cycle ergometer. To assess HRV, a series of indicators characterizing the state of the autonomic nervous system was determined: Mo (c), AMo (%), ΔX (c). Based on these indicators, the indices were calculated on the proposed R. M. Baevsky [2], which are used to assess the regulation and adaptation of the cardiovascular system to physical activity – activity of the humoral regulation channel (AHRC, c. u.), vegetative rhythm indicator (VRI, c. u.), vegetative equilibrium index (VEI, c. u.), indicator of the adequacy of regulatory processes (IARP, c. u.) and regulatory voltage index (RVI, c. u.).

Statistical processing of the results was carried out using the SPSS 16 application software. The obtained results are presented in the form of M±m, where M is average and m is average error. To compare the dynamics of the indicators were used to determine the Wilcoxon criterion and the Mann-Whitney U-test. Reliable differences were considered to be differences at $p<0.05$.

The work was done in accordance with the plan of research work of the Department of Biology and Health Protection of University named after K.D. Ushinsky «Systemic adaptation to physical and mental stress at certain stages of human ontogenesis» (N state registration. 0109U000206), «Adaptation of children and young people to educational and physical activities (boys aged 17–21)". (N state registration 0114U007158).

Results and their discussion. The physical development of the surveyed girls according to the mean group anthropo-physiometric data was in compliance with age and sex standards [5]. It is common knowledge, that women of reproductive age change the activity of the vegetative nervous system and the humoral regulatory channel during the menstrual cycle under the influence of estrogen and progestin concentration (gestogens) accordingly, parasympathetic and cholinergic influences predominate in the first half of the cycle, and sympathetic and adrenergic influences predominate in the second half [10,17,19,20,24]. In the state of relatively rested muscles, in each phase of MC, we determined the state of vegetative type of regulation (vagotony, normotonia, sympathicotonia) on the level of stress index. Other criterias, such as those integrated into the RVI calculation, had corresponding changes in RVI dynamics of fluctuations.

The first – vagotonic - type of regulation was observed in 35.7–60.7% of girls. It was mostly manifested in postmenstrual (60.7%) and postovulatory (53.6%), the lowest – in premenstrual (39.3%) and menstrual (35.7%) phases of MC. Eutonic type of influence included 7.1–35.7 % of the surveyed persons. This type of regulation was observed in a higher number of girls

in the premenstrual (35.7%), menstrual (32.2%) and ovulatory (32.2%) phases. The third type of regulation, sympathicotonic, indicated a reduction of adaptation possibilities in 21.4% of girls in the postmenstrual and ovulatory phases and in 32.1% in the menstrual phase, and 39.3% in the postovulatorial phase of OMC.

To assess the peculiarities of vegetative regulation of the cardiovascular system of girls and its reactions to muscular activity were tested in a closed cycle (with reversal) with dosed physical activity. The results of ergometry showed unreliable ($p>0.05$) higher efficiency, according to PWC_{170}, in postmenstrual (129.62±3.58 W) and premenstrual (133.52±3.37 W), and a little lower ($p>0.05$) – in ovulatory (127.08±4.17 W) and postovulatory (127.34±3.18 W) phases of MC, which can demonstrate the limiting role of menstruation and ovulation processes in the manifestation of functional capabilities [13,17]. However, the data obtained do not allow to fully assessing the degree of influence of vegetative regulation on the mechanisms of adaptation to physical activity in different phases of OMC. To solve this problem, we have divided the general group into subgroups in accordance with the type of heart rate regulation defined in the menstrual phase of MC.

As the results of individual analysis of initial HRV data have shown, the girls with predominance of the vagotonic type of vegetative regulation showed higher physical performance on the background of low estrogen-progesterone concentration in menstrual (I) and premenstrual (V) and lower - on estrogen peaks - in ovulatory (III) and postovulatory (IV) phases of OMC (Fig. 1). It is unreliable ($p>0.05$) that the higher physical performance of girls in phases I and V was followed by a significant tension of regulatory mechanisms, which is confirmed by the higher tension of regulatory mechanisms (RVI) during the whole testing in comparison with other phases of MC.

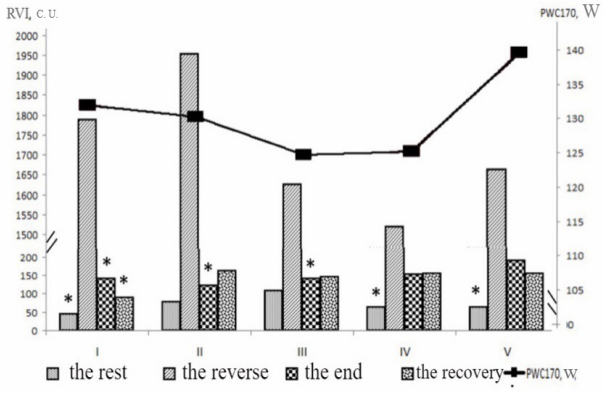

*Fig. 1. Dynamics RVI and PWC_{170} girls 17–22 years old with vagotonic type of heart rate regulation during the ovarian-menstrual cycle (I–V phases of OMC) during closed cycle testing (with reverse). Note: * – there are significant differences between vagotonic and normotonic girls ($p<0.05$)*

It must be noted that in the menstrual phase the recovery processes were more intensive than in the premenstrual phase of MC and were characterized by the increased influence on the cardiac activity of the parasympathetic part of the autonomous nervous system, which indicates the resistance of girls of 17–22 years old with a vagotonic type of heart rate regulation to physical activity and a higher potential reserve (increase of RVI values by 50.1% and 59.1%, correspondingly, in phase I and V). The low performance of the vagotonics in phases III and IV was determined, on the one hand, by a moderate level of regulation voltage before testing and on the other hand, by the high reactive mobilization of adaptive reserves in the process of muscular work. At the same time, adaptation to the stress varying in a closed cycle was accompanied by more costly physiological mechanisms due to the activation of sympatho-adrenal system, which is indicated by the fixed values of cardiac rhythm at rest and at the end of the stress (increase in the values of RVI by 23.2% and 58.3%, respectively, in phases III and IV).

The girls with normotonic type of ANS have performed a larger volume of work and accordingly, have demonstrated high values of PWC_{170}, in menstrual (133,47±3,68 W) and ovulatory (135,2±8,4 W) and smaller – in postmenstrual (129,22±7,44 W) and postovulatory (126,45±7,18 W) phases of MC (Fig. 2) that testifies to significant adaptation reserves in the physiological stress phases, in spite of the established opinion [5,12,17,21].

The higher work capacity of normotonics in the menstrual phase, as compared to vagotonics, was accompanied by a higher tension of regulatory mechanisms (RVI) at rest (111.93±5.84 c. u.), on the reverse of the load (1551.12±180.3 c. u.) and a low intensity of regenerative processes (196.62±35.24 c. u.). The initial state of HRV of girls-normotonics in the ovulatory phase corresponded to the middle of the age norm (89.18±11.36 c. u.) and was characterized by a significant, but smaller reaction to the load in relation to the shifts in the menstrual phase (RVI on the reverse increased to 1088.2 c. u.). By the time of leaving the load RVI decreased to 883.95 c. u. and significantly decreased after 5 minutes of rest after work (to 94.8 c. u.), which indicates a more optimal level of functional capacity mobilization in this phase for the manifestation of general physical performance and preservation of homeostasis.

The decreased adaptive capacity, and consequently the PWC_{170}, in the postmenstrual (129.22±7.44 W) and postovulatory (126.45±7.18 W) phases was accompanied by a high reactive response (RVI 1838.08±196.41 c. u. and 1541.42±177.21 c. u., correspondingly) and slower processes of restitution (150.85±26.34 c. u. and 185.4±22.06 c. u., correspondingly).

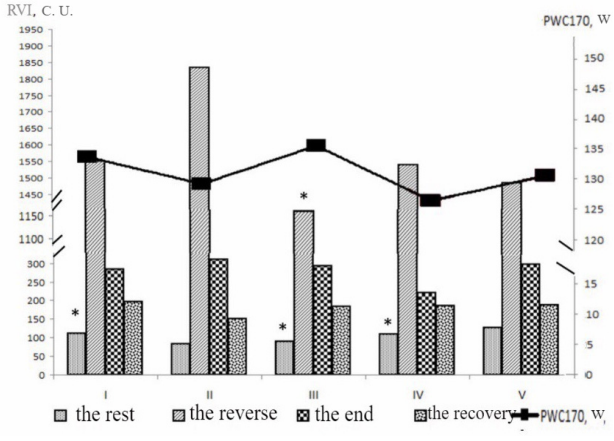

*Fig. 2. The dynamics of RVI and PWC_{170} girls of 17–22 years old with normotonic type of heart rate regulation during the ovarian-menstrual cycle (I–V phase of OMC) during the closed cycle testing (with reverse). Note: * – the significant differences between the data of nortotonic and sympathicotonic girls ($p<0.05$)*

The examined persons with ANS sympathicotonic type in contrast to normotonics carried out muscle loading with better results in postmenstrual (129.39±5.69 W) and postovulatory (130.95±7.27

W) phases and with the worst results in menstrual (119.17±8.14 W) and ovulatory (121.94±6.48 W) phases of MC (Fig. 3). The same results were obtained by other researchers, who indicate a natural decrease in stress in these phases [5,11,13,17].

In fact, as in the postmenstrual (121.96±26.48 c. u.), as in the postovulatoriual (67.7±11.5 c. u.) phases, the level of regulation mechanisms tension at rest was reliably ($p<0.05$) lower, and its increase in the process of cycle ergometric test was characterized by a smaller diapason in comparison with other phases (RVI in these phases was, respectively, on the reverse and at the end of the load 1334.88 c. u. and 1223.25 c. u.; 1105.88 c. u. and 1085.86 c. u.). The recovery was also faster than in other phases of the menstrual cycle.

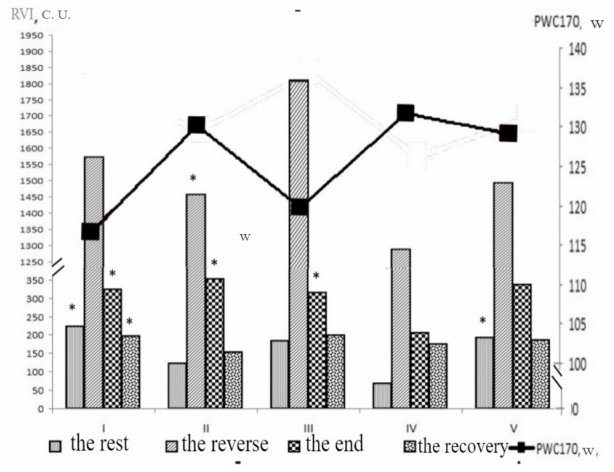

*Fig. 3. The dynamic of RVI and PWC_{170} of girls 17–22 years old with sympathycotonic type of cardiac rhythm regulation during the ovarian-menstrual cycle (I–V phases of CMCs) during closed cycle testing (with reverse). Note: * – there are significant differences between the data of sympathicotonic girls and vagotonics ($p<0.05$)*

Significant level of activation of heart rate regulation mechanisms in relative rest in menstrual, ovulatory and premenstrual phases, according to the criteria of R. M. Baevsky, indicates a significant strain on regulatory systems, which was more likely to be detected and maintained throughout testing when girls were exposed to physical activity. It is notable that during these phases a part of the studied (44.4–66.7%) had lower IN by 5.68–25.88 c. u. during the recovery period than at rest, which indicates the imbalance of the regulation mechanisms and significant exhaustion of the reserve capacity of both the nervous and humoral channels of heart rate regulation.

Conclusions. 1. The absence of reliable differences between the obtained data on the work capacity girls of 17–22 years old with a low level of motor activity during the ovarian-menstrual cycle in each group of the selected types of cardiorhythm regulation (vagotony, normotonia, sympathicotonia) testifies to the insignificant degree of the influence of hormonal oscillations on the functionality of girls with low motor activity, independent of the type of vegetative regulation. The analysis of the cardiovascular system reaction to the cycle ergometric test indicates different "cost" of adaptation to muscle load in different phases of OMC for girls with different types of vegetative regulation. According to the results of cycle ergometric testing, it was found out that vagotonics are characterized by higher (130.28±6.1 W), and sympathicotonics – by lower (126.1±6.37 W) values of PWC_{170} as an integral indicator of the body's functional capabilities.

2. The data of individual analysis indicate the existence of different levels of homeostasis and mechanisms of its support in patients with different types of vegetative regulation throughout the OMC. The optimal phases of physical performance for girls with vagotonic type of regulation are menstrual and premenstrual, with normotonic – menstrual and ovulatory, with sympathicotonic – postmenstrual and post-menstrual phases of OMC. Physical activities in other phases of the cycle increase the level of functional stress and can provoke pre-pathological and pathological conditions.

3. The determination of the predominant type of autonomic nervous regulation in a state of relative muscle rest allows a more objective assessment of the functional capabilities of girls aged 17–22 years with low level of motor activity and to carry out on their basis control and dosing of physical activity, which will provide optimal health effects of muscular activity without the development of tension or failure of adaptation. The obtained information can be used by specialists in the area of physical culture and sports, fitness coaches, and employees of health-improving rehabilitation centers.

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SUMMARY

DYNAMICS OF FUNCTIONAL CAPABILITIES AMONG 17-22 YEARS OLD GIRLS WITH DIFFERENT VEGETATIVE STATUS DURING THE OVARIAN-MENSTRUAL CYCLE

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The aim of the research is to study the dynamics of functional capabilities of 17–22 year old girls with different vegetative status during the ovarian-menstrual cycle. By the use of questionnaires and anthropo-physiometry, 28 girls with low motor activity and a regular (more than 3 cycles) menstrual cycle were selected, which allowed to determine the phases by calendar method. All of the surveyed people were in the main medical group of health. The modernized method of D. N. Davidenko muscular load was used. The heart rate was recorded at rest when the heart rate was reached at 150–155 beats per minute, at the end of testing and on the 5th minute of recovery, sitting on the cycle ergometer. To estimate the variability of the heart rate, a number of indicators proposed by R. M. Bayevsky were calculated to characterize the state of the vegetative nervous system. The degree of centralization of heart rate control was determined by means of a stress index, on the basis of which the group of patients was divided into subgroups depending on the type of regulation in the state of relative rest in the first (menstrual) phase of the menstrual cycle. It has been identified that vagotonics are characterized by higher, and sympathicotonics – by low values of PWC_{170}, as an integral indicator of the body's functional capabilities.

The optimal phases of physical performance for girls with vagotonic type of regulation are menstrual and premenstrual, with normotonic – menstrual and ovulatory, with sympathicotonic – postmenstrual and postovulatory phases of OMC. Physical activity in other phases of the cycle increases the level of functional stress and can provoke pre-pathological and pathological conditions.

Keywords: ovarian-menstrual cycle, variability in heart rate, hormone, cycle ergometry, functional capabilities.

РЕЗЮМЕ

ДИНАМИКА ФУНКЦИОНАЛЬНЫХ ВОЗМОЖНОСТЕЙ ДЕВУШЕК 17–22 ЛЕТ С РАЗНЫМ ВЕГЕТАТИВНЫМ СТАТУСОМ В ПЕРИОД ОВАРИАЛЬНО-МЕНСТРУАЛЬНОГО ЦИКЛА

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Исследования посвящены изучению динамики функциональных возможностей девушек 17–22 лет с разным вегетативным статусом в период овариально-менструального цикла (ОМЦ). С помощью анкетирования и антропо-физиометрии выбрано 28 девушек с низкой двигательной активностью и регулярным (более 3-х) менструальным циклом, что позволило определить фазы по календарному методу. Все обследован-

ные женщины относились к основной медицинской группе здоровья. В качестве мышечной нагрузки использовалась модернизированная методика Д.Н. Давиденко. Запись сердечного ритма осуществлялась в покое, в момент достижения ЧСС=150–155 уд/мин, в конце тестирования и на 5 минуте восстановления, сидя на велоэргометре. Для оценки вариабельности сердечного ритма рассчитывался ряд показателей, предложенных Р.М. Баевским, характеризующих состояние отделов вегетативной нервной системы. Степень централизации управления ритмом сердца определялась с помощью индекса напряжения, на основе чего группа обследованных была разделена на подгруппы в зависимости от типа регуляции в состоянии относительного покоя в первой менструальной фазе цикла. Выявлено, что ваготоники характеризуются более высокими, а симпатикотоники – низкими значениями PWC_{170}, как интегрального показателя функциональных возможностей организма.

Оптимальными фазами проявления физической работоспособности для девушек с ваготоническим типом регуляции являются менструальная и предменструальная, с нормотоническим – менструальная и овуляторная, с симпатикотоническим – постменструальная и постовуляторная фазы ОМЦ. Физические нагрузки в других фазах цикла увеличивают уровень функционального напряжения и могут спровоцировать предпатологические и патологические состояния.

რეზიუმე

სხვადასხვა ვეგეტატური სტატუსის მქონე 17-22 წლის გოგონების ფუნქციური შესაძლებლობების დინამიკა ოვარიულ-მენსტრუალური ციკლის პერიოდში

ა.ბოსენკო, ნ.ორლიკი, ი.პალშკოვა

სამხრეთ უკრაინის კ.უშინსკის სახელობის ეროვნული პედაგოგიური უნივერსიტეტი, ოდესა, უკრიანა

კვლევა ეძღვნება სხვადასხვა ვეგეტატური სტატუსის მქონე 17-22 წლის გოგონების ფუნქციური შესაძლებლობების დინამიკის შესწავლას ოვარიულ-მენსტრუალური ციკლის (ომც) პერიოდში. ანკეტირების და ანთროპოფიზიომეტრიის საშუალებით შერჩეულია 28 ახალგაზრდა ქალი დაბალი მოძრაობითი აქტივობით და რეგულარული მენსტრუალური ციკლით, რამაც შესაძლებელი გახადა ომც-ის ფაზების დადგენა კალენდარული მეთოდით. კუნთოვანი დატვირთვის სახით გამოყენებული იყო დ. დავიდენკოს მოდერნიზებული მეთოდი. გულის რიტმის რეგისტრაცია ხორციელდებოდა მოსვენების მდგომარეობაში, გულის ცემის სიხშირის მიღწევისას 150-155-მდე წუთში, ტესტირების ბოლოს და აღდგენის მეხუთე წუთზე, ველოერგომეტრზე ჯდომის პირობებში.

გულის რიტმის ვარიაბელობის შეფასებისათვის გამოითვლებოდა რ. ბაევსკის მიერ ვეგეტატური ნერვული სისტემის განყოფილებების დახასიათებისათვის მოწოდებული მაჩვენებლები. გულის რიტმის მარითვის ცენტრალიზაციის ხარისხი განისაზღვრებოდა დაძაბვის ინდექსით, რომლის საფუძველზე გამოკვლეულთა ჯგუფი დაიყო ქვეჯგუფებად, რეგულაციის ტიპის მიხედვით შედარებითი მოსვენების მდგომარეობაში ომც-ის პირველ ფაზაში. დადგენილია, რომ ვაგოტონიკები ხასიათდებიან PWC_{170}-ის – ორგანიზმის ფუნქციურ შესაძლებლობების ინტეგრალური მაჩვენებლის - უფრო მაღალი, ხოლო სიმპათიკოტონიკები – უფრო დაბალი სიდიდით.

ფიზიკური შრომისუნარიანობის გამოვლინების ოპტიმალურ ფაზას ვაგოტონიური ტიპის ახალგაზრდა ქალებში წარმოადგენს ომც-ის მენსტრუაციის და წინამენსტრუალური ფაზები, ნორმოტონიურში – მენსტრუაციის და ოვულაციის, სიმპათიკოტონურში კი – პოსტმენსტრუალური და ოვულაციის შემდგომი ფაზები. ფიზიკური დატვირთვა ომც-ის სხვა ფაზებში ზრდის ფუნქციურ დაძაბვას და, შესაძლოა, გახდეს პათოლოგიისწინა და პათოლოგიურ მდგომარეობათა პროვოცირების მიზეზი.

ON THE ISSUE OF STANDARDIZATION OF UTERINE NATURAL KILLER CELL MEASUREMENT IN PATIENTS WITH RECURRENT PREGNANCY LOSS

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Recurrent pregnancy loss (RPL) affecting 2-5% of women of reproductive age is still big clinical challenge for gynaecologists worldwide. Despite the extensive research up to 50% of cases still remain unexplained, the vast majority of which is thought to be due to immunological causes [9,10]. Disturbed endometrial factor, as a result of altered number and proportion of uterine Natural Killer (uNK) cells and its subtypes, is regarded as one of the most controversial immunological pathways of RPL [2,11,23]. Methods of measurement of uNK cells during the last decades have been challenged with many factors that have produced various types of investigational errors and differences in results between the research centres worldwide [8,12,18].