AUTONOMIC PROVIDING CARDIAC RHYTHM OF MIDDLE-AGED WOMEN WITH LONG-TERM REGULAR TRAINING EXPERIENCE OF AEROBIC ORIENTATION

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Aim. To study the influence of regular training with aerobic orientation on heart rate variability of middle-aged women with long-term training experience.

Materials and methods. In the work the results of research autonomic providing cardiac rhythm of 19 women, who were divided into two studied groups are presented. The first study group consisted of 10 women who had experience of regular training (3 times a week) aerobic orientation from 3 to 5 years, the average age of this group of women was 37,9±5,9 years. The second study group consisted of 9 women with regular training experience with aerobic orientation over 10 years, the average age of women – 44,6±5,5 years. At this stage we defined the specific features autonomic heart providing, that was characterized on the basis of the analysis of heart rhythm variability results. For this purpose it was used the device – spiroarteriocardiorhythmography, which in simultaneous mode register defines the parameters of heart rate, systolic and diastolic blood pressure for each heart reduction. According to data the measuring of sequences cardiac rhythm, systolic and diastolic blood pressure variability and data respiratory ventilation was conducted by Fourier's spectral analysis, which determines the capacity of regulatory influences on three frequency ranges: very-low-frequency (VLF, 0–0,04 Hz), low-frequency (LF, 0,04–0,15 Hz) and high-frequency (HF, 0,15–0,4 Hz), what are measured in the absolute values of power (ms2). Additionally there was a spectral method determined by data of sensitivity arterial baroreflex (SBR, ms/mmHg) – α-coefficient, what calculated in ranges high (SBRHF) and low (SBR LF) frequencies, connecting with a total activity, activity of over-segmental structures, parasympathetic and sympathetic branches of autonomic nervous system.

Results. Research results showed difference in heart rate variability of parameters observed only for high-frequency components, which was significantly (p<0,05) lower in second study group. In this case, women of that group had a tendency to a slight sympathetic predominance and in the first study group – parasympathetic influences. As for the other components the power spectrum of heart rate variability, it should be noted that there is a certain tendency that certifies reduction of general and all constituents power spectrum of heart rate variability in the second study group.

Results of determination of sensitivity arterial baroreflex of women demonstrate the positive impact of training on the mechanisms autonomic regulation in the high-frequency range, which because of long-term experience significantly reduced.

It can be asserted that increasing the term of training with aerobic orientation leads to increased low-frequency (sympathicotonic) but decreased high-frequency (vagotonics) effect on cardiac rhythm.

Conclusions. The studies which were conducted revealed, that women in second study group have, unreliable, but a significant increase in activity of regulatory impact in very-low-frequency range, that in our opinion could be predefined by physiological characteristics of an organism at the age that group of women. The biggest changes come from the decrease in activity of regulation in high-frequency range with increasing the term of training. The latter is confirmed by probable decrease in autonomous control for the indicators of sensitivity arterial baroreflex in a high-frequency range

Keywords: heart rate variability, women, middle-aged, aerobic exercises, autonomic providing

Вивчені особливості варіабельності серцевого ритму жінок середнього віку з урахуванням стажу регулярних фізичних навантажень аеробної спрямованості. Встановлено, що зі збільшенням стажу занять підвищується автономний контроль діяльності серця у низькочастотному діапазоні, відбувається вірогідне зменшення активності регуляції у HF-діапазоні. Останнє підтверджується зменшенням автономного контролю за показниками чутливості артеріального барорефлексу у високочастотному діапазоні

Ключові слова: варіабельність серцевого ритму, жінки, середній вік, аеробні вправи, вегетативне забезпечення

1. Introduction

At the present time instead of the monotonous physical exercises new ways of physical activity which became a part of the man's image have come. Among many physical activities the expediency and efficiency of the use of aerobic orientation loading are proven. Currently, the most popular physical activity is fitness-aerobics training which has a stable positive motivation and a large number of trends [1, 2]. Numerous studies convincingly testify that aerobic loading combined with a balanced diet and healthy lifestyle have a considerable influence on optimization of all functions of an organism: metabolic, homeostatic and behavioral. For woman's body the specific activities are characteristic, thus deci-

sive role at all the above-mentioned levels aerobic possibilities and adaptation potential of organism play [3, 4]. Cardiac rhythm (CR) is an integral adaptation criterion, in which genome and phenotypic information is encoded, it reflects the abilities of an organism and specifics of available influence of environmental factors on it [5, 6].

2. Substantiation of research

The study of the heart rate variability (HRV) of middle-aged women has a special interest to the gerontology for determining the role of regulatory mechanisms of the cardiovascular system acting while forming active longevity. At this age the changes in the functions of the organism take place, they create the foundation of the development of atherosclerosis, ischemic heart disease, and arterial hypertension, experiencing deterioration the respiratory function [7, 8].

Recent studies make it possible to mark a positive impact of aerobic loads on the risk factors of diseases of the women cardiovascular system. So, the influence of 12 weeks combined course of training, which included dancing- and step-aerobics, strength exercises was studied by means of examining general cholesterol concentration, triglycerides, and lipoproteins of the high- and low-density and percentage of body fat. The study found a significant increase of lipoproteins of the high-density and reducing the percentage of fat in the women's body, but there was no significant effect on total level cholesterol, triglycerides and lipoproteins of the low-density. Thus, facilities of fitness-aerobics help to reduce the risk factors for diseases of the cardiovascular system, also the necessity of further research concerning optimal levels of intensity, duration and types of the combined aerobic training is found out for achieving the desirable effects [8]. It should be noted, that at this time there are differences in the results of some researches, that are connected with various facilities and methods used in modern aerobics, different criteria estimation, descriptions of the examined women and duration of the research [9].

In modern scientific researches we didn't find any publications which study the impact of long-term experience aerobic training on middle-aged women. Besides it was noted the absence of comparison in the dynamics of adaptive changes in the states of the cardiovascular system of this women group. In connection with the above-mentioned material and with the necessity of practical work there is a need to study HRV as an assessment criterion for regulatory changes in the organism middle-aged women with long-term regular training experience of aerobic orientation.

3. Aim of research

To study the influence of regular training aerobic orientation on heart rhythm variability of middle-aged women with long-term training experience.

4. Materials and methods of research

The studies were conducted at the department of Theory and methodology of physical education, physical therapy and sports medicine of South Ukrainian National Pedagogical University named after K. D. Ushinsky.

The work presents the results of the examination of autonomic providing cardiac rhythm of 19 women, who had regular training of aerobic orientation in fitness club "Fit curves" (Odessa). They were divided into two study groups. The first study group (SG_1) consisted of 10 women who had experience of regular training (3 times a week) of aerobic orientation from 3 to 5 years, the average age of this group of women was 37,9±5,9 years. The second study group (SG_2) consisted of 9 women who had regular training experience of aerobic orientation over 10 years, the average age of women – 44,6±5,5 year old.

The estimation of physical state was conducted by means of the basic anthropometric measuring: lengths of the body (LB, cm) and the masses of body (MB, kg), body fat was determined by means of device OMRON (BF, %), body mass index (BMI, kg/m²) was calculated by correlation of masses of body (kg) to the lengths of the body (m²), vital capacity of lungs (VCL, ml) was determined by dry-air lung-tester.

At this stage we defined the specific features autonomic heart providing, that was characterized on the basis of the analysis research HRV results. For this purpose it was used the special device – spiroarteriocardiorhythmography (SACR), which in a simultaneous mode register defines the parameters of heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) for each heart reduction [10]. According to the data measuring sequences of cardiac rhythm (CR), systolic (SBP) and diastolic blood pressure (DBP) and data respiratory ventilation conducted Fourier's spectral analysis, which determines the capacity of regulatory influences in different frequency ranges that are measured in the absolute values of power (ms² – for CR, mmHg² – for SBP and DBP, (l/min)² – for spontaneous breathing). By the date of a lot modern authors very-low-frequency (VLF, 0–0,04 Hz) – characterizes activity of over-segmental structures on the CR, low-frequency (LF, 0,04–0,15 Hz) – activity in that range connecting with regulation of sympathetic branches of autonomic nervous system (ANS), high-frequency (HF, 0,15–0,4 Hz) – activity in that range connecting with regulation of parasympathetic branches of ANS, TP (ms²) – characterizes the total power of HRV and reflect of the general state of the ANS [10, 11].

The study of women was conducted in the morning with an empty stomach in sitting position in one day after training. Duration of the registration was 2 minutes.

Additionally using the spectral method we determined the index of arterial baroreflex sensitivity (SBR, ms/mmHg) – α-coefficient, what was calculated in high (SBR_{HF}) and low (SBR_{LF}) frequencies ranges [12, 13].

$$SBR_{LF} = \sqrt{LF_{HRV}/LF_{SBPV}}, \qquad (1)$$

$$SBR_{HF} = \sqrt{HF_{HRV}/HF_{SBPV}}. \qquad (2)$$

Assessment of the received results was carried out with the help of STATISTICA program for Windows (version 10.0), Microsoft Excel 2012, MAT-

LAB 2015a. The comparison of quantitative indices in studied groups was realized using non-parametric criterion of Mann-Whitney.

5. Results of researches

The results of the analysis of women's physical state parameters in the studied groups are presented in Table 1, which shows, that the groups had great differences in the body masses (MB, kg) and body fat (BF, %), these indicators in SG_2 was lower. This fact allows to state, more favorable influence of training aerobic orientation with the increase of experience on the component body structure.

Table 1

Characteristics of the women's physical state in the studied groups

Indicator	SG_1	SG_2
MB, kg	62,5 (54,0; 71,0)	55,0 (54,5; 62,0)*
LB, cm	163,0 (160,0; 165,0)	163,0 (162,0; 172,0)
VCL, ml	3050,0 (2900,0; 3300,0)	3100,0 (3000,0; 3500,0)
BF, %	30,7 (27,0; 32,7)	23,6 (22,5; 28,2)*
BMI, kg/m²	23,7 (20,0; 26,8)	21,0 (20,8; 21,1)*

*Note: * – data probable differences, p<0,05*

Table 2 shows the characteristics of the basic routine parameters of activity cardiovascular and respiratory system, which showed more economic work of the first system at rest state, displayed a higher VO_{2max} (by the system of estimation of somatic health level (SHL)) [14], also the balanced state of autonomic regulation (by Kerdoe's vegetative index) in women of SG_2. But it is necessary to keep in mind that women in both groups were mainly in a satisfactory adaptation state considering adaptation potential of Baevsky (AP).

Table 2

Characteristics of routine parameters cardio-respiratory system studied groups of women

Indicator	SG_1	SG_2
HR, min⁻¹	79,4 (71,3; 89,2)	73,9 (72,6; 78,5)*
SBP, mmHg	110,0 (108,0; 120,0)	100,0 (98,0; 104,0)*
DBP, mmHg	70,0 (60,0; 80,0)	70,0 (66,0; 72,0)
Breathing rate (BR), min⁻¹	15,9 (14,4; 16,2)	15,1 (12,0; 15,7)
Total points according to the system of evaluation SHL	7 (6; 9)	11 (7; 13)**
Kerdoe's vegetative index	0,06 (–0,33; 0,17)	–0,03 (–0,06; 0,03)*
AP of Baevsky	2,25 (1,96; 2,43)	2,14 (1,77; 2,32)

*Note: * – p<0,05; ** – p<0,01*

However, today evaluation of activity of regulatory influences on cardiovascular system uses greatly researches of HRV. According to its indicators it can be found not only activity and prevalence of individual units of ANS, but also to identify the main mechanism of influence on CR taking into account various components of power HRV – very-low-frequency, low-frequency and high-frequency. Table 3 presents differences in HRV indicators in the experimental groups of women. Judging by the data from table 3 possible difference in HRV parameters are observed only for high-frequency (HF) components of HRV power spectrum, which are in SG_2 significantly (p<0,05) lower both as for absolute 368,6 (94,1; 900,0) ms² against 877,0 (453,7; 1714,0) ms² in SG_1, and for relative values 43,5 (27,7; 55,9) normal units (n.u.). In SG_2 against 55,7 (41,1; 72,7) n.u. in SG_1. The latter is reflected in the possible (p<0,05) differences in the ratio LF/HF, which is used to describe the prevalence of activity of sympathetic and parasympathetic parts of ANS. In this case, we can speak that women from SG_2 had a tendency to a slight predominance of sympathetic influences 1,21 (0,81; 2,56), and women from SG_1 had predominance of parasympathetic 0,81 (0,36; 1,44) influences.

Table 3

Differences of HRV indicators of women from the studied groups

Indicator	SG_1	SG_2
TP, ms²	1775,6 (1036,8; 2601,0)	1267,4 (882,1; 1944,8)
VLF, ms²	307,2 (225,0; 384,2)	285,6 (282,2; 967,2)
LF, ms²	605,5 (228,0; 789,6)	237,2 (228,0; 681,2)
LFn, n. u.	43,2 (24,3; 57,5)	54,1 (41,3; 69,8)
HF, ms²	877,0 (453,7; 1714,0)	368,6 (94,1; 900,0)*
HFn, n. u.	55,7 (41,1; 72,7)	43,5 (27,7; 55,9)*
LF/HF	0,81 (0,36; 1,44)	1,21 (0,81; 2,56)*

*Note: * – data probable differences, p<0,05*

As for the other components of the power spectrum HRV, it should be noted that possible differences are absent, but there is a certain tendency that proves reduction of general and all constituents of power spectrum HRV in SG_2. The latter requires more careful analysis with taking into account age-old features of HRV in women.

With this aim the indicators of women in the experimental groups were analyzed taking into account the results of population studies which had been done before [7]. Figure 1 presents limits of the 1st (25 %) and 3rd (75 %) quartiles indicators TP (ms²) of women aged 30, 45 to 58 years old in comparing to the data which were got from the women of the experimental groups (SG_1 and SG_2), results of which are presented as limits of the 1st, 2nd (medians) and 3rd quartiles. It's necessary to recall, that the average age of SG_1 women was 37,9±5,9 years old and SG_2 women – 44,6±5,5 years old. First of all it is necessary to pay attention that in certain age ranges there is reducing of regulatory values of TP (ms²) that is characterized of decrease with age limits of the 1st and 3rd quartiles. Thus, value of the 1st and 3rd quartiles indicators TP (ms²) in experimental groups clearly fall into the relevant age limit. It means that, the tendency to reduction of this indicator marked earlier demonstrates its age-old character. Founded on it we can do supposition about positive influence of experience aerobic training under 5 years, in which women have the indicator of TP (ms²) similar to limits 30 year old women. At the same

time, in women of SG$_2$ the values TP fully correspond their age. It doesn't allow speak about positive influence of training aerobic orientation on reserve possibilities regulation of cardiac rhythm in comparing to the population of this age women.
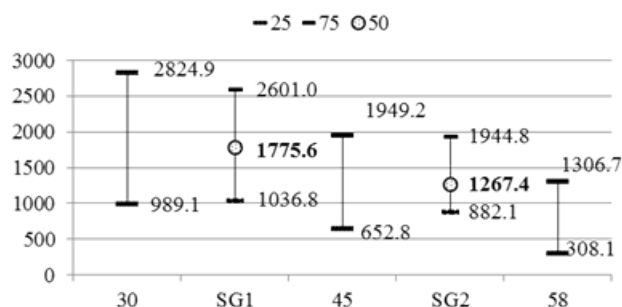

Fig. 1. Absolute values of limits of 1st (25 %),
2nd (50 %) and 3rd (75 %) quartiles of indicator TP (ms^2)
in women of SG$_1$ and SG$_2$ compared with the values of
1st (25 %) and 3rd (75 %) quartiles of 30, 45 and
58 year old women

Similarly, the total power spectrum HRV changes with age power in very-low (VLF, ms^2) frequency range (Fig. 2), the limits of quartiles of which diminish from 220,5–764,4 ms^2 at 30 year old age to 60,1–340,4 ms^2 at 58 year old age. At the same time age 45 year old the absolute values limits of quartiles occupy an intermediate place – 105,1–517,5 ms^2. As shown in Fig. 2 in women of SG$_1$, values of VLF-component HRV are in rather narrow limits which get in the normative limits of all age-related groups of women. At the same time in women of SG$_2$ the range of changes of components at the 1st and 3rd quartiles is wide enough, and getting by median values in the limit of normative age-old values, at the half of women substantially increases. Taking into account physiological characteristics of women of this age, it should be noted, that in the SG$_2$ there were 4 women in menopause and they had high values of VLF- component. Perhaps, hormonal changes in a woman's body have influence on the increase of activity regulatory of over-segmental effects on the CR.
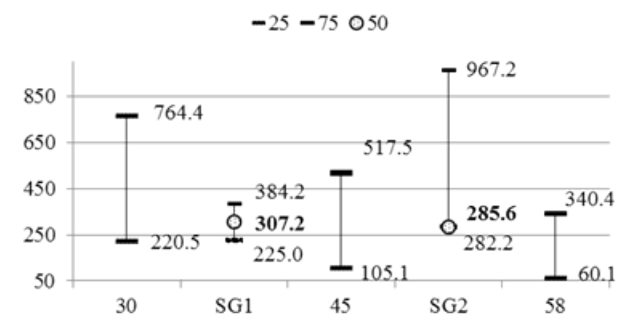

Fig. 2. Absolute values of limits 1st (25 %), 2nd (50 %)
and 3rd (75 %) quartiles indicator VLF (ms^2) in women
of SG$_1$ and SG$_2$ compared with the values of
1st (25 %) and 3rd (75 %) quartiles of 30, 45 and
58 year old women

However, the limits quartiles of indicator VLF (ms^2) women of SG$_1$ and SG$_2$ even taking into account age-old physiology features tendencies to the decline are not observed in women when there is the increase of training experience aerobic orientation. The last supposition requires certain confirmation with the use other methods of research.

As shown in Fig. 3 when women are getting old activity in low-frequency (LF, ms^2) range of spectral power HRV diminishes. However, substantial reduction is marked at the age 58 year old. At the same time, in women in the age of 30 and 45 year old these differences are insignificant. But if to analyze the data of women with long-term training experience aerobic orientation (SG$_1$ and SG$_2$), we can see, that activity in LF-range has the clearly expressed tendency to the decline when there is the increase of training experience comparing to the women of SG$_1$. However, the results are not credible. Therefore, having regard to the physiological features of women of this age, we can assume, that training aerobic orientation although leads to the decrease in activity of the sympathetic part of the ANS, but it doesn't determine its influence to the CR, which can be related with hormonal alterations in the organisms of women.
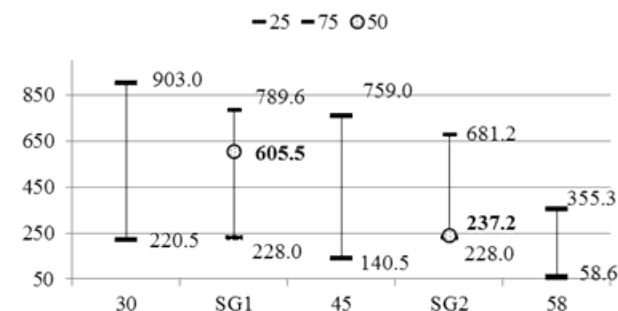

Fig. 3. Absolute values of limits of 1st (25 %),
2nd (50 %) and 3rd (75 %) quartiles indicator LF (ms^2)
in women of SG$_1$ and SG$_2$ compared with the values of
1st (25 %) and 3rd (75 %) quartiles of 30, 45 and
58 year old women.

Fig. 4 shows the results of analysis of indicator HF (ms^2), which is associated with the activity of the parasympathetic part of ANS. It also decreases with age like other components of the power spectrum HRV. The same dynamics is observed in experimental groups of women, who differ by age. Thus reduction of regulator influences in HF-range with the increase of training experience is reliable. At the same time, ranges of limits of quartiles indicator HF in SG$_1$ and SG$_2$ are significantly higher than these in population's age groups of women. It's possible to assert regarding absolute values HF, that in SG$_1$ they are significantly higher, than in 30, 45 and 58 year old women, but in SG$_2$ they have a tendency to the increase in comparing with the 45 year old women and don't differ significantly from women of 30 years old.

We should keep in mind that, estimation of autonomic providing of CR can be carried out both by HRV and SBP and by indicator of SBR which defines a mech-

anism of maintaining homeostasis in the vascular system and is the indicator of autonomous control [3].
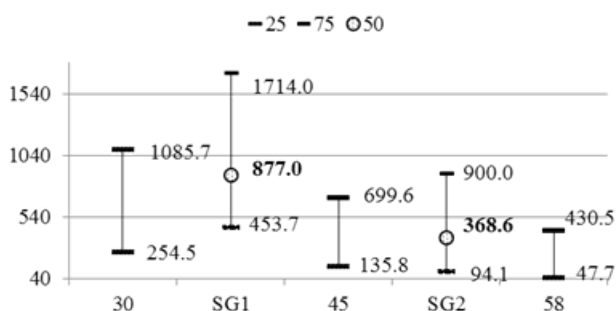

Fig. 4. Absolute values of limits of 1st (25 %), 2nd (50 %) and 3rd (75 %) quartiles indicator HF (ms²) in women of SG_1 and SG_2 compared with the values of 1st (25 %) and 3rd (75 %) quartiles of 30, 45 and 58 year old women.

Fig. 5, 6, shows the results of determination of SBR_{HF} and low SBR_{LF} in women of SG_1 and SG_2 in comparing with the population's data, which show, that with age autonomous control over the heart activity is reduced. Thus more clearly it is determined by indicator of SBR_{LF} (Fig. 5). Less expressed, but clearly directed, this tendency is by indicator of SBR_{HF} (Fig. 6). Without going to interpretation of this mechanism, it should be noted, that in ontogeny of a woman's body there is a series of significant changes during certain the marked period of life. However, men have the same tendency [7]. Therefore we can assume that this mechanism is generally biological. In our case it is important to estimate how long-term trainings of aerobic orientation affect on realization of this mechanism.
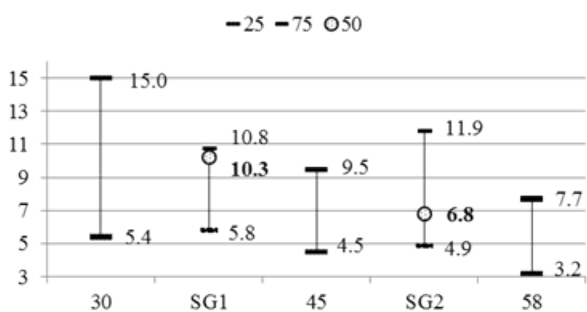

Fig. 5. Absolute values of limits of 1st (25 %), 2nd (50 %) and 3rd (75 %) quartiles indicator SBR_{LF} (ms/mmHg) in women of SG_1 and SG_2 compared with the values of 1st (25%) and 3rd (75 %) quartiles of 30, 45 and 58 year old women

First of all, analyzing the data presented in figures 5 and 6, we can assert that for the lower limit of normative values SBR, which are located at 1st quartile, women of different age groups were not significantly different, except of 58 year old women. However, the range of standard values, which is determined by the 3rd quartile, decreases with age. So, from 30 to 58 year old its value for SBR_{LF} (ms/mmHg) decreases from 18,9 till 9,9, it

means almost twice. But at the age of 45 year old these indicator have intermediate values.
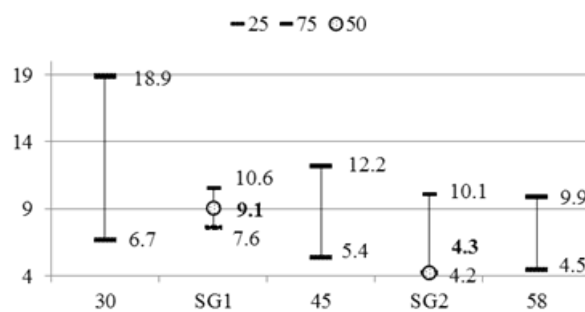

Fig. 6. Absolute values of limits of 1st (25 %), 2nd (50 %) and 3rd (75 %) quartiles indicator SBR_{HF} (ms/mmHg) in women of SG_1 and SG_2 compared with the values of 1st (25 %) and 3rd (75 %) quartiles of 30, 45 and 58 year old women

From these positions results determination SBR of women with consideration of experience training aerobic orientation should be described as those which demonstrate a positive impact of training on the mechanisms of autonomic regulation, first of all, with consideration of SBR_{LF}, which has a tendency to the increase comparing to the group of women of the same age. On the other hand, autonomous regulation in the high-frequency range significantly reduced with long-term experience.

Thus, it can be asserted with a certain degree of probability that activity of regulatory influences with consideration of autonomous control of the heart with increasing the term of training with aerobic orientation leads to increasing low-frequency (sympathicotonic) influences and decreasing high-frequency (vagotonics) effect on CR.

6. Discuss of the results of research
The studies which were conducted revealed, that by the common activity of regulatory effects on the CR, women with experience of training of aerobic orientation under 5 years (SG_1) and more than 10 years (SG_2) doesn't differ from the women of the same age in a population. Women in SG_2 have, unreliable, but a significant increase in activity of regulatory impacts in very-low-frequency range that in our opinion could be predefined by physiological characteristics of an organism at the age of women of SG_2. It is shown that in women of SG_2 the autonomous heart control of the heart in low-frequency (LF) range increases. The biggest changes come from the activity of regulatory influences in the high-frequency (HF) range. Namely, limits of the 1st and 3rd quartile values HF (ms²) of women of SG_1 and SG_2 are significantly more than in the population. Besides, with increasing the term of training there is probable decrease in activity regulation in HF range. The last confirmed probable decrease in autonomous control for the indicators of SBR in a HF range.

7. Conclusions
1. The studies of modern scientific researches revealed the absence of information about impact of long-

term experience aerobic training on middle-aged women and comparison in the dynamics of adaptive changes in the states of the cardiovascular system of this women group. In connection with the above-mentioned there is a need to study heart rate variability as an assessment criterion for regulatory changes in the organism middle-aged women with long-term regular training experience of aerobic orientation.

2. The studies which were conducted revealed, that women in second experimental group have, unreliable, but a significant increase in activity of regulatory impact in very-low-frequency range, that in our opinion could be predefined by physiological characteristics of an organism at the age that group of women.

3. The biggest changes come from the decrease in activity of regulation in high-frequency range with increasing the term of training. The latter is confirmed by probable decrease in autonomous control for the indicators of sensitivity arterial baroreflex in a high-frequency range.

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ОСОБЛИВОСТІ ЗМІНИ ПАРАМЕТРІВ F-ХВИЛІ З ЛІКТЬОВОГО НЕРВА У ДИНАМІЧНОМУ СПОСТЕРЕЖЕННІ ЗА ПАЦІЄНТАМИ З ГОСТРИМ ІШЕМІЧНИМ ІНСУЛЬТОМ

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Досліджено динаміку змін електронейроміографічних параметрів F-хвилі з ліктьового нерва, як показник стану збудливості спінальних мотонейронів, у пацієнтів на 1–3-тю, 19–21-шу добу та протягом 6-го місяця після церебрального ішемічного інсульту залежно від наявності післяінсультної спастичності та без неї. Виявлено: у найгострішому періоді на паретичній стороні порівняно зі здоровою збудливість спінальних мотонейронів була нижчою, однак достовірне зниження спостерігалось лише у групі без спастичності
Ключові слова*: електронейроміографія, параметри F-хвилі, спінальна функціональна активність, ішемічний інсульт, післяінсультна спастичність*

F-wave is a motor response of the muscle to the supramaximal electrostimulation and by its physiological nature presents a muscle response to the reciprocal excitation that occurs in the result of antidromic excitation of spinal motoneurons. Thereby, F-wave's parameters characterize the functional state of spinal motoneurons depending on the spinal and supraspinal influences they are exposed to.
The aim of this research *was to evaluate dynamic alterations in F-wave parameters in stroke survivors on the 1–3rd, 19–21st days and during the 6th month, depending on the presence or absence of post-stroke spasticity.*
Methods*. 97 patients with first-ever cerebral ischemic stroke were included. For spinal motor neurons excitability ulnar nerve F-wave was investigated (F mean ampl F/Mmax). During the 6th month patients were divided into 2 groups: those who developed post-stroke spasticity and without it. Mann-Whitney test was used to define significant changes between groups. p<0,05 was determined as a considerable level.*
Results*. In the current study we observe that patients who do not develop post-stroke spasticity on the 6th month had a significant decrease of ulnar nerve F-wave's parameters on the paretic side on the 1–3th day after stroke, comparing to the patients with spasticity, who did not show a significant decrease. At the end of acute phase and during the 6th month both groups of patients showed gradual increase in spinal motoneuron's excitability on the paretic side, but it was less pronounced in patients without spasticity.*
Conclusions*. Investigated changes in spinal motoneurons excitability between patients who in 6 month suffer from post-spasticity and who do not can be used for developing predictors of spasticity subsequently.*
Keywords*: post-stroke spasticity, F-wave, spinal motoneurons excitability, dynamic changes.*