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Heart Rate Variability in Athletes Specializing in Middle-Distance Running during Mesocycle.

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ABSTRACT

The analysis of heart rate variability provides important information on the status of autonomic regulation of the cardiovascular system and the body in general.It is known that adaptation processes in women's bodies differ from those in men's. Indicators of spectral analysis of heart rate variability of men and women who specialize in the middle distance race (aged 17 to 24 years) were determined using Polyspecter program (Neurosoft, Russia).For women, the study was carried out in each phase MC, men - similar in each microcycle in the same terms as that of women.It is established that women functional state of the cardiovascular system according to the results of index stress increase in postmenstrual, postovulatory and ovulatory phases and decrease - in the menstrual and premenstrual ones. As for men, their functional state increases during the first and second microcycles, decreases in the third and fourth ones and increases again in the fifth microcycle. Thus, taking into account changes in the cardiovascular system of athletes during mezzo cycle enables to plan large and significant physical exertion, improve training process as well as functional abilities without prejudice to health.

Keywords: heart rate variability, mezzocycle, middle-distance race, functional abilities.

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INTRODUCTION

Adaptation to physical exertion is one of the urgent issues in sports physiology and medicine. Informative and prognostic criterion that characterizes the effectiveness of adaptation of the cardiovascular system to the training load is heart rateIt reflects changes in the control mechanisms of the autonomic nervous system, and characterizes the activity of the regulatory channels in certain functional states [13].

However, the current understanding of the adaptation is based on regularities established mainly on the study of male body [10].The activity of functional systems, adaptive processes in women bodies differ from those in men's. It is caused by one of the main biological features of the female body associated with reproductive function - cyclical function of the hypothalamic-pituitary-ovarian-adrenal system.

By results of researches [14], the highest functional capabilities are traced in postmenstrual postovulatory phases of the menstrual cycle (MC), the lowest - in ovulatory before menstrual and menstrual phase. Hormonal changes in the - the premenstrual and menstrual phases lead to an increase load on the cardiovascular system [8]; the highest functionality of the respiratory system is in the postovulatory phase [16], and the lowest readiness of the cardiorespiratory system - in the premenstrual phase of MC [8, 17]. So athletic performance depends on the readiness and functioning of all body systems, which, for theirs parts, depend on the hormonal status of the organism, which significantly differs in men and women.

Analysis and synthesis of scientific and methodical literature indicates that the special performance and efficiency of the competitive activity of athletes specializing in the middle distance race is ensured by the level of their preparedness, defined by the cardiorespiratory system state and aerobic-anaerobic capabilities. Cardiovascular system (CAS) at rest and during various loads [7, 11, 17] is an informative indicator of regulatory mechanisms of the human body as a whole, it determines the level of adaptation to training loads [1, 11].

The rational course of adaptation of the aerobic energy system is manifested in the economization reactions in conditions of rest and during standard loads. Adaptation is considered as formation of a new functional system that is aimed at achieving the final result [9]. As a rule, violations of autonomic regulation of CAS is an early sign of the breakdown of adaptation to loads and conducts to decrease in efficiency. Since the heart rate variability (HRV) is an integral indicator of the functional state of the CAS and the organism as a whole [3, 7], its low indicators observed with the dominance of the sympathetic division of the autonomic nervous system, indicating a lack of recovery of athletes after heavy exercise, overtraining, intoxications and other pathological states [2, 4, 6].

Objective: to identify the characteristics of heart rate variability in men and women specializing in the middle distance race during mezocycle.

MATERIAL AND METHODS

To study the cardiac autonomic regulation spectral analysis of heart rate variability indicators were used. When analyzing the short (5 minutes) fragments of kardiorythmgram it was decided to allocate three basic frequency ranges of the spectrum of heart rate fluctuations: Very Low Frequency (VLF) - from 0.003 to 0.04 Hz, Low Frequency (LF) - from 0.04 to 0, 15 Hz and High frequency (HF) - 0.2 to 0.4 Hz frequency. Temporal parameters of heart rate variability as heart rate, maximum duration of NN-intervals for 5 minutes ($R\text{-}R_{max}$), the minimum duration of NN-intervals for 5 minutes ($R\text{-}R_{min}$), the average duration of normal intervals RR (RRNN) were analyzed. We used the following cardiointervalography indicators: the total capacity of the spectrum – TR, Mo (mode - RR-interval meaning that is the most frequent), AMo (amplitude of mode - cardio rate RR, the corresponding value mode). Based on these we are counting indices proposed by R.M.Bayevsky: PAPR - an indicator of the adequacy of regulation processes (PAPR = Amo / Mo), etc. - the index of regulatory systems tension (IN = AMo /2 · BP Mo).

13 women (3 - CCM, 5 - I category 5 - II category) and 10 men (2 - CCM 2 - I category 6 - II category) aged 17-24 who specialize in Middle distance race took part in the investigation. The health of all athletes was within the physiological norm. Women were studied in each MC phase, men - similar in each microcycle in the

same terms as women. The menstrual cycle was used as a natural biological model to study the effect of cyclic hormonal changes on autonomic system of the female body.

RESULTS

In modern sport, the use of large physical exertion in combination with other exogenous and endogenous influences is one of the major directions. It is known that women endogenous hormonal changes that take place during the MC, affect the health, functionality, performance, and as a consequence - athletic performance. Spectral analysis, which is widely used as a noninvasive method for studying cardiac autonomic regulation, allowed us to identify significant differences in the functional state CAS athletes during MC (Table. 1).The total capacity of the spectrum (TR), which reflects the level of activity of regulatory systems is the highest at menstrual, ovulatory ($p<0.05$) and postovulatory ($p<0.01$), and lower in postmenstrual and significantly lower - in the premenstrual phases MC. Considering that in the first half of MC the tone of the parasympathetic nervous system prevails and in the second one -sympathetic tone level regulation is enhanced, it is clear that these tone autonomic nervous system changes must influence the mechanisms of regulation of heart rate of athletes. Conducted researches of HF-, LF- and VLF-components contribution into total capacity of fluctuations of heart rate of athletes in different phases of the MC showed the prevalence of HF-component significantly higher at postovulatory phase (1902 (1261-2085) ms^2 ($p<0.01$) at postmenstrual and menstrual phases we observed a gradual decrease (compared with premenstrual).In ovulatory and premenstrual phases MC HF-component influence is reduced greatly.

A very high degree of positive correlation between indicators of TP and HF in menstrual (rs = 0,94), postmenstrual (rs = 0,99), postovulatory (rs = 0,94), premenstrual (rs = 0,93) phases and a high degree of correlation in - ovulatory (rs = 0,88) was proved. This indicates that the TR increase is due to significant increase HF- component at menstrual, and postmenstrual and postovulatory phases, and decrease of these parameters - at premenstrual phase. Reduction of the relationship between these indicators at ovulatory phase, confirms the impact of reducing parasympathetic part of the nervous system in the HRV.

LF-contribution component is much higher in postovulatory phase, compared to menstrual, postmenstrual, ovulatory and premenstrual phases of the MC. Contribution VLF-component gradually increases ranging from menstrual phase, significantly higher in postmenstrual ($p<0.05$) and ovulatory ($p<0.05$), high enough - at postovulatory phase, compared to premenstrual. The possible increase in the contribution of VLF- component in the total power spectrum of heart rate of female athletes in ovulation phase (768 (436-1477) ms^2) compared to other phases of the MC may indicate a high concentration of estrogen in the blood. A high degree of correlation parameters TP and LF in menstrual (rs = 0,91), ovulatory (rs = 0,93), postovulatory (rs = 0,95) and high in postmenstrual (rs = 0,81) and premenstrual (rs = 0,88), as well as a high degree of positive correlation parameters TP and VLF in menstrual (rs = 0,81), postmenstrual (rs = 0,89), postovulatory (rs = 0,84), premenstrual (rs = 0,77) was revealed and a marked degree of interconnection in the ovulatory (rs = 0,67) phases of the MC.

Growth of TP depends on a significant LF increase in menstrual, ovulatory and postovulatory phases, indicating the growing influence of the sympathetic nervous system link to the HRV. VLF-component also affects growth of menstrual TR, postmenstrual, premenstrual and especially in the ovulatory phase, indicating a hyperactive state of the organism of female athletes at this time. Reducing TP and VLF in the premenstrual phase suggests energy shortfall state of their body.

Reduction of the degree of mobilization of the sympathetic ANS links due to the application of regular physical activity can cause poor expressiveness of the contribution of LF- component in the heart rate fluctuations total power of female athletes of different phases of the MC. Such changes in the influence of the sympathetic and parasympathetic ANS divisions displayed in LF/HF balance, indicate that these indexes are the lowest in the menstrual phase, increasing - in postmenstrual and in ovulatory and premenstrual reach the highest rates. However, the ($p<0.05$) indices LF / HF balance in the postovulatory phase are likely to decrease.

The predominance of HF-contribution component to the total power of fluctuations of heart rate of female athletes, especially during postovulatory, menstrual and postmenstrual MC phases significantly affect heart rate (HR) of female athletes.

It is noted these indicators are much lower at postovulatory 66 (62-69) beats•min^{-1} (rs = - 0,72) ($p<0.05$), postmenstrual 69 (60-71) beats•min^{-1} ($p<0,05$) and menstrual 69 (60-72) beats•min^{-1} compared to the premenstrual phase of MC.

This is reflected also in RR_{min} and RR_{max} indicators - the lowest are in the premenstrual and ovulatory phases ($p<0.05$) compared to menstrual, and postmenstrual and postovulatory ($p<0.05$) MC phases (Table. 1).

A very high degree of positive correlation of RR_{max} and HF in postovulatory (rs = 0,92), a high degree of correlation in menstrual (rs = 0,70), ovulatory (rs = 0,79), premenstrual (rs = 0 85) was determined as well as a marked correlation in postmenstrual (rs = 0,52) phases MC; high degree of positive correlation of RR_{max} and LF in postovulatory (rs = 0,77) and a marked degree of positive correlation in menstrual (rs = 0,50), ovulatory (rs = 0,58) MC phases; high degree of positive correlation of RR_{max} and VLF in menstrual (rs = 0,72) and a marked degree in ovulatory (rs = 0,65), postovulatory (rs = 0,57) MC phases.This shows the positive impact of the SPA, especially parasympathetic link of the performance of the CAS at postovulatory, postmenstrual and menstrual phases. These RRNN indicators are the highest in menstrual, postmenstrual and postovulatory compared to ovulatory and premenstrual phases.

According to many researchers [1-4, 14], who studied sports cardiology, the athletes CAS functional status improvement accompanies decrease in heart rate, AMo increase and decrease of Mo. Thus, the Mo increase is seen in menstrual and ovulatory phases (Table. 1); significant increase - in postmenstrual($p<0.05$) and postovulatory ($p<0.05$) compared to premenstrual phase of MC. The possible AMo reduction - in postmenstrual ($p<0.05$), ovulatory ($p<0.05$) and postovulatory ($p<0.01$) phases, certifies improvement of the functional state of CAS at these phases, compared to the premenstrual phase of MC. Reduction of functional state of CAS was recorded in the premenstrual phase, Mo indicators decreased and AMo-increased.

To determine the degree of adaptation of CAS to various factors and evaluation of its regulation processes we used proposed by R.M. Bayevsky, which indicates the degree of influence of the nervous system on the heart and characterizes activity of sympathetic regulation mechanisms and the state of central contour regulation. It is known that increasing of the indices is observed due to dominant influence of sympathetic and reduction - vagal effects on heart rhythm.

The highest IN is obtained in premenstrual and menstrual, the lowest - in postovulatory ($p<0.05$), postmenstrual and ovulatory phases of MC, indicating a reduction of stress regulatory systems and increase of the functional capabilities of CAS of female athletes during this period.

Thus, the prevalence of the influence of the parasympathetic nervous system indicator shows HF, which has a high negative correlation with others at postmenstrual (rs = - 0,70), postovulatory (rs = - 0,82), premenstrual (rs = - 0,83), and decreases at ovulatory and menstrual phases (rs = - 0,66; rs = - 063, respectively).

Table 1: Dynamics of indicators of heart rate variability of women who specialize in middle race distance, in different phases of MC (background sample)

Indicators	phases of the MC									
	I		II		III		IV		V	
	Median	25-75 percentile	Median	25-75 percentile	Median	25-75 percentile	Median	25-75 percentile	Median	25-75 percentile
Spectral parameters										
TP,ms^2	2517	1689-3527	2194	1967-3958	2418*	1440-4363	3138**	2028-4826	1593	1450-2548
VLF, ms^2	597	312-832	683*	521-756	768*	436-	648	381-1299	503	335-711

						1477				
LF, ms^2	564	307-861	687	413-1229	476	270-1384	757	432-1243	491	340-911
HF, ms^2	1320	867-1916	1324	811-2116	1145	698-1954	1902**	1261-2085	926	492-1367
LF/HF	0,427	0,353-0,613	0,581	0,449-0,783	0,532	0,402-1,090	0,433*	0,341-0,606	0,769	0,527-0,925
Temporary indicators										
HR, beats•min^{-1}	69	60-72	69	60-71	71	65-73	66	62-69	69	67-84
R-R_{min}, *ms*	764	734-847	764*	731-787	745♦	685-760	802*	745-834	726	657-802
R-R_{max}, *ms*	1019	975-1108	1024*	983-1194	989	901-1116	1072*	973-1134	947	843-1064
RRNN, *ms*	875	836-998	877*	847-1008	843	824-924	921*	879-974	877	714-905
Cardointervalography										
Mo, *c*	0,871	0,827-0,972	0,869*	0,847-0,960	0,864	0,810-0,918	0,883*	0,870-0,963	0,869	0,732-0,898
AMo, *%*	38,1	29,0-44,5	38,8*	30,0-43,2	36,4*	30,6-41,6	34,2**	30,3-37,3	47,4	39,5-55,0
PAPR, *s.u.*	39,3	32,9-59,0	39,6**	32,3-45,9	39,1*	30,4-52,5	39,4**	30,3-43,9	59,7	41,8-75,1
IN, *s.u.*	91,4	63,7-129	90,6	53,1-105	68,1	48,3-119	66,5*	52,4-107	110	74-216

Notes: *- (P <0.05) **- (P <0.01) - significant changes in results compared to premenstrual phase of MC; - (P <0.05) - significant changes in results compared to postovulatory phase of MC.

Men who specialize in a middle distance race HRV research was performed during five microcycles of the basic mezzo cycle that in terms corresponded to the research of women. The results of spectral analysis of men who specialize in a middle distance race, it was established that high TP, which reflects the level of activity of regulatory systems is the highest - in the third, lower - in the first (p<0.01), the second (p<0 01) and fifth microcycles, and the lowest - in the fourth (p <0.01) one.

High TP is achieved by increasing of the contribution of VLF-component, indicating the involvement of predominantly humor-metabolic system and the parasympathetic nervous regulation of the heart rhythm, as evidenced by a significant contribution HF-component (Table. 2).

The highest contribution of VLF-component is set in the third microcycle and lower - in the first and fifth (p<0.05) and significantly lower - in the second (p <0.01) and fourth (878.5 (625-1756) ms^2 (p<0.05) 20,1 (8,4-48,6) % (p<0.01)) microcycle (compared to the third microcycle). High levels of VLF-component in the third micro cycle reflects hyper adoptive state of the body of men which may be the result of excessive response of the adaptive system to stress, and is significantly lower (p<0.05) - in the second micro cycle, indicating energy deficit state of their body. A very high degree of correlation relationship between TP and VLF was determined in the first microcycle (rs = 0,93) and visible - in the second (rs = 0,66) and third (rs = 0,65) ones.

LF-component contribution is much higher in the third microcycle, slightly lower - in the first and fifth microcycles and it is significantly reduced - in the second and fourth (p<0.01) ones. A very high degree of interconnection between TP and LF is defined in the first micro cycle (rs = 0,95), the second one (rs = 0,94), the fourth one (rs = 0,98) and rather noticeable - in the third (rs= 0,65) micro cycle.

The high indicators of HF-component, indicating a significant effect of the parasympathetic ANS link on the heart rhythm were proved. The highest HF-component was observed in the first, third and fourth micro cycles and significantly lower ones were in the second and fifth. A high degree of correlation interconnection of the TP and HF indicator was revealed in the second (rs = 0,91), fourth (rs = 0,94), fifth (rs = 0,95) microcycles and a high one - in the first (rs = 0.75) and third (rs = 0,77).

Carried out researches on the contribution of HF-, LF- and VLF-components in the total power of fluctuations of heart rate indicate that in the third microcycle tone of the parasympathetic nervous system prevails and high VLF-component reflects the hyperadaptive state of the body of men, and in the first, second, fourth and fifth microcycles enhanced sympathetic tone link regulation.

LF/HF balance is shifted toward the influence of the parasympathetic ANS link. Much lower indicators are in the third micro cycle get increased in the first, fourth and somewhat gets reduced in the second and significantly gets higher in the fifth ($p<0.05$) micro cycle, indicating the prevalence of the influence of sympathetic link of the ANS on heart rate.

The low spectrum (TP) total capacity, especially in the fourth micro cycle and increase of contribution of LF-component into total capacity of fluctuations of heart rate of athletes in the fourth and fifth micro cycles significantly effects heart rate. It is noted significantly higher heart rate in the fourth and fifth micro cycles, compared to the first, second and third ones, in which we observed the increase of the contribution of HF-component and high range of the total capacity of (TP) spectrum. (Table. 2).

This distribution of HF-, LF- and VLF-components in the total capacity of fluctuations of heart rate is displayed on indicators: $R\text{-}R_{min}$ - the lowest are in the first, fourth and fifth micro cycles, compared to the second and third; significantly lower rates $R\text{-}R_{max}$ are in the second ($p<0.01$), fourth ($p<0.01$) and fifth ($p <0.01$) micro cycles, compared to the third one (1244 (1145-1338) ms) (Table. 2). RRNN highest indicators are in the second, third and fourth micro cycles, indicating the effectiveness and efficiency of CAS, compared to the first and fifth micro cycles.

The highest values of Mo are observed in the third and probably less in the second ($p<0.05$), fourth ($p <0.01$) and fifth ($p <0.05$) micro cycles (tab. 2).

Table 2: Dynamics of indicators of heart rate variability of men who specialize in the middle distance race during mezzocycle (background sample)

indicators	Microcycle									
	I		II		III		IV		V	
	Median	25-75 percentile	Median	25-75 percentile	Median	25-75 percentile	Median	25-75 percentile	Median	25-75 percentile
Spectral parameters										
TP, ms^2	3886**	1075-6023	2632,5**	1012-4650	6709,5	1960-10330	1906,5**	195-4560	2388	326-6239
VLF, ms^2	1030,5	363-3768	602**	525-1348	2679	561-3631	878,5*	625-1756	1383	664-2164
LF, ms^2	864	490-1719	713,5	225-1295	1103	576-2058	779	464-2102	1080,5	530-1379
HF, ms^2	1194	403-2060	888,5	177-1998	1572	697-2284	1051,5	337-2538	636,5	321-1510
LF/HF	0,946	0,409-1,31	0,827	0,458-1,27	0,773	0,650-1,01	0,949	0,517-2,51	1,715*	0,718-2,23
Temporary indicators										
HR, *beats•min*$^{-1}$	64	55-78	61,5	56-78	60,5	54-62	69,5	58-76,3	71,1	63,0-76,3
$R\text{-}R_{min}$, *ms*	781,5	655-881	826	672-949	810	723-923	712,5	622-854	701	622-761
$R\text{-}R_{max}$, *ms*	1053	879-1289	1096**	884-1274	1244	1145-1338	1041**	805-1179	1064**	950-1162

RRNN, *ms*	947	767-1095	974	768-1065	995	966-1107	1006	848-1057	954	797-1070
Cardointervalography										
Mo, *c*	0,950	0,778-1,08	0,957*	0,747-1,09	1,045	0,952-1,12	0,838**	0,697-1,03	0,840*	0,711-1,00
AMo, *%*	30,0	23,5-51,1	38,4	25,6-48,6	28,45	26,5-36,4	31,0	18,9-53,7	29,35	17,4-52,7
PAPR, *s.u.*	32,55	21,9-50,5	33,85	25,3-79,3	33,55	22,40-78,20	45,95*	30,30-83,90	55,15	23,40-74,10
IN, *s.u.*	55,2	35,1-255	80,4**	37,6-336	22,8	12,3-92,0	51,4	18,4-266	43,6	19,2-233

Notes: *- (P <0.05) **- (P <0.01) – significant changes in results compared with the third of the microcycle

The AMo indicators are much lower in the first, third, fourth and fifth micro cycles and this indicates functional status of CAS improvement at these micro cycles, compared to the second one. Reduction of functional state of CAS is recorded in the fourth and fifth microcycles: significantly decreased indicators of Mo and increased - HR and AMo. The lower PAPR indicators are defined in the first, second and third micro cycle: 32.55 PAPR (21,9-50,5), 33,85 (25,3-79,3), 33.55 (22,40-78,20) (respectively) high rates are defined in fifth (55.15 (23,40-74,10) and significantly higher - in the fourth (45.95 (30,30-83,90) (p<0.05) microcycle, compared to the third.

It was determined that the lower IN indicators are in the third and fifth micro cycles. A slight increase in these parameters was observed in the first and fourth micro cycles and significant increase - 80.4 in the second (37,6-33,6) s.u. (P<0.01)), indicating a higher degree of tension of regulatory systems and reduction of functional capacity of CAS of athletes in these micro cycles compared to the third one.

DISCUSSION

Considering that the middle-distance running is a cyclical sport that develops mainly aerobic-anaerobic endurance and due to the formation of structural track of the long-term adaptation to physical exercise. That is why sportswomen have the regulatory effects of the vagus nerve on the heart. We marked a pronounced dominance of the contribution for MC HF-component confirming the predominance of parasympathetic tone of the nervous system, especially in postovulatory, menstrual and postmenstrual MC phases.

It is known that the higher TP, HF, Mo, the more active is the parasympathetic regulation link and consequently lower the VLF, LF HR, AMo, PAPR, etc., and hence a lower degree of tension of regulatory systems. A high degree of negative correlation between these indicators was established.

So, during the postovulatory and postmenstrual MC phases high connected activity of central governance structures and parasympathetic ANS link of women athletes show that the control system of the body is in optimum condition and reflects the high energy and reserved capabilities of the organism.

The results of the study show that probable increase in the contribution of VLF-component in total capacity spectrum of heart rate of female athletes ovulation phase (768 (436-1477) ms^2) compared to other phases of the MC may indicate a high concentration of estrogen in the blood. Reduced values of TP, HF, Mo, and thus the parasympathetic link of regulation and increasing the values of VLF, heart rate, AMo, PAPR, IN indicates a slight increase in the degree of tension of regulatory systems in the ovulatory phase, compared to postovulatory and postmenstrual ones.

A significant decline in the TP, HF and, consequently, lower level of parasympathetic regulation and increase of the values of LF, heart rate, AMo, PAPR, etc., and high and noticeable degree of negative relationships between these indicators shows a significant increase in the degree of tension of regulatory systems and reduction of functional capability of CAS of female athletes during menstrual and especially in premenstrual phases of MC (p<0.05) compared to postovulatory one.

Hence, the changes in the functional state of the CAS of female athletes who specialize in middle distance race, allow to plan rationally during MC the use of large and significant physical exertion in mezzo cycles, improve the training process and save their health.

Our work shows that the adaptive capacity of the female body to specific loads of the female athletes specializing in a middle distance racedepend on hormonal status during the MC.It is established that optimal for manifestation - development of endurance quality is postovulatory and postmenstrual phases of the cycle, as confirmed by differences in functional features of the organism of female athletes in each MC phase. Redistribution of training loadings in scope and intensity considering features of the organism of the female athletes in different phases of the MC will give coach to fulfill the planned load for 100%, and safe the health of female athletes and thus create conditions to achieve of high sports results, keep their sports longevity.

Men in the first and third microcycles demonstrate high functional condition of the CAS, it was proved by the HRV indices: the level of activity of the autonomic regulation was gradually increasing due to the predominance of parasympathetic link of regulation over the sympathetic one. During these special microcycles physical performance increased, indicating effective adaptation to physical loading.

In the second and fourth microcycles a slight decrease in the functional state of CAS was identified, which was reflected in lower levels of autonomic regulation and increased level of sympathetic regulation,in tension of regulatory systems that reduced special performance and occurred some fatigue.

In the fifth microcycle we observed a slight improvement of the CAS functional state: increase in autonomic regulation at the expense of the predominance of parasympathetic regulation over the sympathetic link, which lead to increase of the efficiency.

Thus, in the third and fifth micro cycles high interconnected activity of central governance structures of the parasympathetic ANS link of athletes shows that the control system of the body stays in optimum condition and reflects the high energy and reserved capabilities of the organism. High values of TP, HF, Mo were established, indicating the increased activity of the parasympathetic link of regulation and lower values VLF, LF HR, AMo, PAPR, etc., and, consequently, a lower degree of tension of regulatory systems.

Reduction of values of TP, HF, Mo, and thus the parasympathetic link of regulation, and increase of values of VLF, heart rate, AMo, PAPR, etc., indicates a slight increase in the degree of tension of regulatory systems of athletes in the first and fourth microcycles, compared to the third and fifth ones.

A significant decline in the TP, HF indicators and as a result - parasympathetic regulation link and increasing of values of LF, heart rate, AMo, PAPR evidences of a significant increase in the degree of tension of regulatory systems and reduction of functional capability of CAS of athletes in the second microcycle, compared to the third and fifth ones.

Thus, the results of changes of functional state of the CAS of athletes who specialize in the middle distance race during mezzo cycle allow to plan the use of large and significant physical exertion, improve the training process and functional capabilities.

Our research confirmed the important role of the development and planning of the training process of athletes [12], depending on the functional capabilities and level of fitness of the organism to physical exercise [5]. Our results of spectral analysis of heart rate of female athletes confirm the data [2, 10, 13-15], which showed that the functional state of the cardiovascular system depends on the hormonal status of their body during MC, which enable planning of large and significant physical exertion in accordance to the training mezzocycles of the functional state in different phases of the MC.

CONCLUSION

It is established that women who specialize in the middle distance race proved that functional status of CAS according to the results of tension index (IN) increases during postmenstrual, postovulatory and ovulatory phases and decreases - in the menstrual and premenstrual ones.

It is determined that during postovulatory phase of high connected activity of central governance structures and of the parasympathetic ANS link of female athletes shows that the control system of the body stays in optimum condition and reflects the high energy and reserved capabilities of the organism.

A significant increase of the contribution of VLF-component in total capacity of spectrum of heart rate of female athletes in the ovulation phase compared to other phases of the MC may indicate a high concentration of estrogen in the blood and a change of secretory activity of female gonads in the ovulation phase. The decrease in the parasympathetic link of regulation and increase of the indicators of humoral regulation confirms a slight increase in the degree of tension of regulatory systems in the ovulatory phase compared to postovulatory one.

The decrease in the parasympathetic link of regulation and increase the degree of tension of regulatory systems indicates the reduction functional capabilities in SSA of female athletes during menstrual, postmenstrual and especially premenstrual phases ($p<0.05$) compared to postovulatory. Functional state of men during the first and second micro cycles increases, and decreases in the third and fourth ones and during the fifth microcycle it increases again.

In the first, second and fourth micro cycles the influence of the sympathetic division and central contour of regulation increases, leading to a decline in TP, HF, Mo, SDNN, and raise of the VLF, LF HR, AMo, PAPR, etc., and therefore the degree of tension of regulatory systems and CAS functional capabilities athletes raises too.

It is determined that in the third micro cycle there is high interrelated activity of central structures of governance and parasympathetic ANS division of athletes which shows that the regulatory system of the body is in optimum condition and reflects the high energetic and reserved capacity of the organism. Thus, in the third microcycle combination of high activity of central structures of governance and parasympathetic ANS division of athletes shows that the regulatory system of the body is in optimum condition and reflects the high energetic and reserved capacity of the organism. It is noted the increase of indicators TP, HF, Mo, and the decrease of VLF, LF, heart rate, AMo, PAPR, IN, and consequently - the degree of tension of regulatory systems, especially in the third microcycle decreases too.

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