

Influence of training loads on psychophysiological indicators of handball players in different phases of the menstrual cycle

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Purpose: to carry out the analysis of results of the research of influence of training loads on psychophysiological indicators of handball players to different phases of the menstrual cycle.

Material & Methods: the researches were conducted on the basis of the Zaporizhia handball women's teams of superleague (16 women of 16–19 years old); research methods: analysis of references, questioning, psychophysiological methods of the research, integrated assessment of functional state and methods of mathematical statistics.

Results: results of own researches of functional and mental states, and also changes of effectiveness ratio of game actions at handball players of high qualification are presented to different phases of the menstrual cycle.

Conclusions: the received results demonstrate that the best conditions for manifestation of functionality of organism of the studied sportswomen are the post-ovulatory phase of the menstrual cycle. The next period, in which handball players can carry out exercise stresses of a little smaller power, is the post-menstrual phase.

Keywords: handball players, phases of menstrual cycle, psychophysiological condition, efficiency of game actions.

Introduction

The problem of training of women-sportswomen acquires the big relevance as features of influence of loadings of different volume and intensity on the woman's organism are not always considered in their training process at the present stage of the development of sport. In particular, such biological feature as the ovarian-menstrual cycle (OMC) is not considered [14].

Most of researchers incline to thought of what the accounting of power of exercise stresses at sportswomen in different phases of the menstrual cycle is necessary [2; 8–10 13; 14; 16], but in practice, especially in game team sports, it becomes seldom.

The search of researches, in which scientists would consider the question of influence of training and competitive activity on features of the course of phases OMC at handball players, allows noting the insignificant number of such works.

So, the attempt is made to find possibilities of improvement of management of women's handball team at the expense of the accounting of specific features the ovarian-menstrual cycle in the research of A. G. Amkhanitskyi [1]. The author considers that completing of teams of handball players with similar length of the ovarian-menstrual will provide to the cycle simplification of management of such team.

L. G. Bukhtyi [3] investigated effectiveness of training activity of handball players depending on feature of the course of the menstrual cycle of sportswomen.

Professor V. Ya. Ignatyeva [4; 5] carried out the deep analysis of features of application of exercise stresses in different phases of the menstrual cycle. The author recommends to ap-

ply exercise stresses with differentiation them on the volume, intensity, and on duration. And she recommends to carry out the greatest intensity of loading in the post-ovulatory phase of the menstrual cycle of handball players.

Thus, it is possible to note that features of realization of integrated preparation in women's teams taking into account specific features of organism demand the additional scientific foundation in the research, which is specially devoted to this problem.

Communication of the research with scientific programs, plans, subjects

The subject of article is developed according to the Built plan of the research work in the sphere of physical culture and sport for 2014–2019 of the Ministry of Ukraine for family, youth and sport 2.4.12.1n, on the subject "Optimization of educational-training and competitive activity in sports", number of the state registration is No. 0114U002659.

The purpose of the research:

to carry out the analysis of results of theresearch of influence of training loads on psychophysiological indicators of handball players to different phases of the menstrual cycle.

Material and Methods of the research

The researches were conducted on the basis of the Zaporizhia handball women's teams of the superleague. 16 women of 16–19 years old participated in the experiment.

Research methods: analysis of references, questioning, psychophysiological methods of theresearch, integrated asses-

ment of functional state and methods of mathematical statistics.

Results of the research and their discussion

The important biological feature of the woman are the existence of menstrual function which is shown the cyclic. This function is the most expressed biological mechanism, and its recurrence is caused by recurrence of fluctuations of the processes in the reproductive system of the woman, which are connected with realization of genital function, important for organism, which involves all other systems of organism in vigorous activity: nervous, cardiovascular, mental, etc. [12].

Experts in clinical gynecology allocate seven phases the ovarian-menstrual cycle [16]. However in sports practice such division is not convenient as each of phases lasts about 3 days that cannot almost be considered during the training or competitive process. In our research we used classification of L. G. Shakhlinoy [16] in which the menstrual cycle is divided into five phases: I phase – menstrual (the 1–6th days); II phase – post-menstrual (the 7–12th days); III phase – ovulatory (the 13–15th days); IV phase – post-ovarian (the 16–24th days); V phase – premenstrual (the 25–28th days). These five phases are available in each cycle irrespective of its duration.

The individual approach to each sportswoman needs its knowledge not only from positions of its opportunities before the game or transferring of the maximum exercise stresses, knowledge of each pupil and as persons, with features of manifestation of its qualities, traits of character, temperament, emotionally-strong-willed sphere has not the smaller importance. This part of work of the coach has to be carried out in the course of mental conditioning of sportswomen.

We used the technique of G. Ayzenko for studying of mental conditions of female handball players of the super-league [11].

The obtained data allow to be convinced of the essential change of extent of manifestation of mental states at handball players throughout the menstrual cycle (tab. 1).

So, the significant increase in indicators which find mental states is noted in the first phase of cycle (menstrual). Uneasiness (13,7 points) is shown in the greatest measure. The high level of uneasiness is followed by the mental tension, concern, nervousness. It is considered that the considerable uneasiness causes violation of attention, coordination of movements that, certainly, is negative factor for sports activity (see

tab. 1).

Increase in level of manifestation of rigidity (12,6 points) in this phase means that difficulties in implementation of the program of the actions are for this person. In other words, this opposite condition of mobility which is so important in the course of game activity in handball.

Frustration during training also grows in the menstrual phase (12,4 points). Person avoids difficulties, he increases fear of failures, fear to be traumatized in such state during this period.

And, for the end, aggression in this phase is expressed at least (12,1 points). During this period irritability, unevenness increases at sportswomen, but in the following phases of the menstrual cycle the level of aggression exceeds this indicator.

The analysis of change of extent of manifestation of the called mental states in different phases of menstrual cycle of handball players demonstrates that the lowest indicators (except aggression) were observed in the second (post-menstrual) and the fourth (post-ovulatory) phases. And values of mental states, which are studied, is treated as raising of opportunity to performance difficult and considerable by intensity and volume of exercise stresses in the form of activation of psychological functions of sportswomen.

The high level of aggression of sportswomen in these phases can be explained with need of this mental state for effective playing handball. Possibly, this irreplaceable quality of the personality which is formed at players throughout long-term trainings.

The increase in extent of manifestation of mental states, which are defined in ovulatory and premenstrual phases, means that their psychological sphere is overstrained, and high extent of manifestation of mental states leads to decrease in coordination communications in regulation of psychological processes that negatively affects physical efficiency of sportswomen.

Such conclusion can be confirmed with adequate change of effectiveness ratio of game actions.

In table 1 is shown that effectiveness ratio of game actions is the greatest in post-menstrual (0,31 mind. odes.) and post-ovulatory phases (0,45 mind. odes.), that is in what extent of manifestation of mental states which are defined was low. To

Table 1
Indicators of diagnostics of mental conditions of handball players in different phases of the menstrual cycle (n=16)

The measured states	Phases of the menstrual cycle				
	1	2	3	4	5
Uneasiness, points	13,7±1,14	8,1±0,64	15,8±1,08	5,8±0,45	19,3±1,64
Frustration, points	12,4±0,96	9,0±0,83	13,2±0,86	7,7±0,66	15,4±2,36*
Aggression, points	12,1±2,02	15,2±1,84*	13,7±1,17	19,0±0,78	13,2±15,2
Rigidity, points	12,6±1,10	6,6±0,53	11,9±0,88	8,2±0,60	17,9±1,56*
Effectiveness ratio of game actions, mind. odes.	0,24±0,041	0,31±0,052	0,21±0,029	0,45±0,051	0,20±0,037

Notes: 1 – menstrual; 2 – post-menstrual; 3 – ovulatory; 4 – post-ovulatory; 5 – premenstrual; * – $p < 0,05$.

Table 2

Indicator of complex express assessment of functional condition of handball players in different phases of the menstrual cycle (n=16)

Indicators	Phases of the menstrual cycle				
	1	2	3	4	5
HR, bpm ⁻¹	90,5±3,45	82,7±2,17	88,4±4,03	81,2±3,14*	92,8±3,21
SAP, mil.mer.col.	118,6±12,07	116,0±11,12	118,4±12,14	115,3±10,32	120,1±9,96
DAP, mil.mer.col.	74,4±4,16	72,8±4,07	73,6±3,73	70,6±3,86	73,9±3,14
TBHbr, s	56,2±5,03	61,0±3,17	55,8±3,21	62,5±3,32	54,7±3,08
TBHex, s	37,9±3,16	44,0±5,79	40,1±1,68	45,3±3,18*	36,0±2,77
SVB, ml	70,44±4,45	72,7±4,38	73,12±5,08	75,38±7,18	70,3±3,64
MVB, l·min ⁻¹	6,32±6,07	6,62±4,44	6,16±3,39	6,85±6,08	6,07±4,03
CI, l·min ⁻¹ ·m ²	3,02±0,77	3,44±0,84	3,11±0,37	3,90±0,40	3,01±0,31
GPR, dyn·s·sm ²	1101,1±20,11	1130,5±18,43	1112,7±17,41	1145,8±16,02	1106,6±15,86
HV, ml	800,3±11,01	807,6±10,76	803,1±10,31	809,2±10,46	800,1±10,79
IRob, m. od.	110,2±4,83	97,8±4,08	106,8±5,17	96,9±3,88	112,2±4,22
CPB, m. od.	4120,5±23,16	4078,5±22,06	4129,8±20,74*	4037,6±21,33	4020,0±22,38
DSAP, mil.mer.col.	2,3±0,17	2,0±0,29	2,4±0,16	2,0±0,18*	2,6±0,11
DDAP, mil.mer.col.	-3,1±0,20	-3,0±0,16	-3,4±0,13	-3,0±0,17*	-3,6±0,16
IH, m. od.	0,27±0,06	0,33±0,03**	0,30±0,04	0,44±0,04*	0,26±0,04
ISK, m. od.	1455,6±10,72*	1645,7±12,34**^	1443,6±12,41*	1732,4±11,72*	1333,7±11,80
LFS, m. od.	51,92±3,45	58,32±4,38	52,20±4,76	61,23±7,33	50,06±5,02
LFCe, m. od.	26,32±2,18	29,24±2,33	26,11±2,46	34,47±2,36*	25,83±2,28

Notes: reliable differences between cycle phases: * – 1–2; ^ – 2–3; ■ – 3–4; • – 4–5; ** – 2–4; HR – heart rate; SAP – systolic arterial pressure; DAP – diastolic arterial pressure; TBHbr – time of breath holding on breath; TBHex – time of breath holding on exhalation; SVB – systolic volume of blood; MVB – minute volume of blood; CI – cardiac index; GPR – the general peripheral resilience; HV – heart volume; IRob – Robinson's index; CPB – coefficient of profitability of blood circulation; DSAP – deviation of systolic arterial pressure; DDAP – deviation of diastolic arterial pressure; IH – index of hypoxia; ISk – Skibinsky's index; LFS – the level of functional state of CVS; LFCe – the level of functional condition of system of external breath.

the contrary, the growth of extent of manifestation of negative mental states (except aggression) was followed by the decrease to effectiveness ratio of game actions: in menstrual (0,21 mind. odes.), ovulatory (0,24 mind. odes.) and premenstrual (0,20 mind. odes.) phases.

In the subsequent research we carried out the integrated assessment of functional condition of handball players [15] who trained taking into account features of physiologic changes in their organism in different phases of the menstrual cycle. The obtained data are presented in tab. 2.

As testify the data of this table, the measured indicators change depending on phases of the menstrual cycle of handball players.

Indicators of cardiovascular system and blood circulation changed in the greatest measure. So, for example, such indicators as minute volume of blood and cardiac index, the smallest in premenstrual phase, and the greatest – in post-ovulatory. At the same time the change of indicator on 0,78 mm·min⁻¹, and in the second – on 0,89 mm·min⁻¹ is observed in the first case.

Especially indicative changes of regulatory components. So, index of Robinson, which characterizes quality of regulation of work of cardiovascular system in menstrual and premenstrual phases is the greatest, – 110,2 and 112,2 mind. odes., and

the smallest in p post-ovulatory and post-menstrual phases, respectively equals 96,9 and 97,8 mind. odes. Interpretation of the results, which are received by index of Robinson, which we applied in the research, allows to note that the less this indicator is, the more perfect the mechanism of functional regulation of the cardiovascular system of the person is. That is, it functions best of all in these two phases. Similarly, the coefficient of profitability of blood circulation changes also by phases of the menstrual cycle: profitability of blood circulation is the best in post-ovulatory and post-menstrual phases.

The objective confirmation of positive changes in organism of handball players in these phases of the menstrual cycle are changes of index of Skibinsky, which is used for assessment of functional condition of cardio-respiratory system. In this case, on the contrary, the more the indicator is, the more effectively functions of cardio-respiratory system is. The obtained data demonstrate that the smallest indicators in premenstrual, ovulatory and menstrual cycle phases (1333,7; 1443,6 and 1455,6 $\frac{ml \cdot s}{b \cdot min}$). The best indicators of index of Skibinsky are again in post-ovulatory 1732,4 $\frac{ml \cdot s}{b \cdot min}$ and post-menstrual 1645,7 $\frac{ml \cdot s}{b \cdot min}$ phases.

It should be noted that Skibinsky's index, except the noted, allows estimating also thde resistance of organism to hypoxia and strong-willed qualities of the person. In other words, the cardio-respiratory system best of all adapts to exercise

Table 3

Indicators of endurance, working capacity and power supply of organism of handball players in different phases of the menstrual cycle (n=16)

Indicators	Phases of the menstrual cycle				
	1	2	3	4	5
PLB1, kgm·min ⁻¹	78,4±4,75	83,1±3,30	78,6±3,24	88,4±4,07*	75,1±3,44
PLB2, kgm·min ⁻¹	108,5±6,30	115,7±6,43	101,2±5,86 [■]	119,8±6,84*	100,0±5,33
NumA ₁ , times	25	25	25	25	25
NumA ₂ , times	35	35	35	35	35
HR1, bpm ⁻¹	166,3±9,17	160,1±8,86	168,4±9,02	158,6±8,45	170,1±7,86
HR2, bpm ⁻¹	177,4±7,16	170,6±7,42	178,2±7,33	169,6±7,07	179,8±7,30
aPWC170, kgm·min ⁻¹	628,7±20,3	636,8±21,1	625,8±20,5 [■]	641,7±21,6*	625,0±22,0
rPWC170, kgm·min ⁻¹ kg ⁻¹	8,64±0,78	10,28±0,96	9,02±0,57	11,55±0,83	8,52±0,70
aMCO, l·min ⁻¹	2458,8±103,4	2510,07±107,2	2403,02±108,0	2620,2±111,2	2400,1±105,3
rMCO, ml·kg·min ⁻¹	34,22±5,03	38,45±4,86	35,12±5,47	39,78±6,42	34,01±4,88
ALACp, w·kg	4,28±0,58	5,96±0,60	4,73±0,61 [■]	6,37±0,52*	4,01±0,49
ALACc, %	19,33,5±5,03	23,07±5,77	18,96±4,91	24,48±4,37	17,46±3,34
LACp, w·kg	1,75±0,31	1,89±0,27	1,68±0,32	2,34±0,28	1,70±0,17
LACc, s. u.	10,35±0,64	11,56±0,70	10,61±0,63 [■]	13,50±0,82*	10,07±0,77
PANO, %	45,88±3,45	48,87±4,57	46,13±6,20	49,43±5,33	45,10±6,11
HR _{PANO} , bpm ⁻¹	93,2±6,08	88,6±6,18	94,4±9,02	87,2±8,76	95,3±8,81
GMC, s. u.	104,41±11,04	116,53±12,02	105,13±12,14	119,06±12,32	104,22±11,55
LFP, s. u.	10,24±1,15	12,38±1,03	10,88±0,95	13,27±1,07	10,01±2,03
GE, points	7,45±1,01	9,58±0,75	7,92±0,84 [■]	11,46±0,85*	7,00±0,50
HE, points	9,30±0,51*	14,40±0,60 [▲]	10,01±0,65 [■]	16,25±0,71*	8,96±0,58
HPE, points	3,25±0,24	3,61±0,30	3,48±0,22 [■]	4,33±0,31*	3,10±0,20
PSP, s. u.	19,85±3,04	21,47±2,66	20,11±2,55	23,60±2,49	19,02±1,88
RO, points	8,82±0,86	9,41±0,76	9,0±0,90	9,83±0,94	8,52±0,62

Notes: reliable differences between cycle phases: * – 1–2; ▲ – 2–3; ■ – 3–4; * – 4–5; PLB1 – the power of the 1st loading on the bicycle ergometer No. 1; PLB2 – the power of the 2nd loading on the bicycle ergometer No. 2; NumA₁ – the number of ascensions on step at the first loading No. 1; NumA₂ – the number of ascensions on step at the second loading No. 2; HR1 – heart rate after the first loading; HR2 – heart rate after the second loading; aPWC170 – absolute power; rPWC170 – relative power; aMCO – absolute maximum consumption of oxygen; rMCO – relative maximum consumption of oxygen; ALACp – alactate power; ALACc – alactate capacity; LACp – lactate power; LACc – lactate capacity; PANO – threshold of anaerobic exchange; HR_{PANO} – heart rate at threshold of anaerobic exchange; GMC – the general metabolic capacity; LFP – the level of functional preparedness; GE – the general endurance; HE – high-speed endurance; HPE – high-speed and power endurance; PSP – profitability of system of power supply; RO – reserve opportunities.

stresses in post-ovulatory and post-menstrual phases of the menstrual cycle.

Direct confirmation of the best opportunities of sportswomen in these phases is definition of endurance, working capacity and power supply which results are presented in tab. 3.

These of tables 3 give the chance to be convinced available accurate dependence of functional condition of handball players on phase of their menstrual cycle. So, for example, had power of the first and second loadings on the bicycle ergometer was the greatest post-ovulatory – 88,4 kgm·min⁻¹ and 119,8 kgm·min⁻¹ and in post-menstrual phases 83,1 kgm·min⁻¹ and 115 kgm·min⁻¹.

It is important that the heart rate was the smallest at the bigger power of loadings in these phases of cycle, that is heart worked economically.

The analysis of absolute and relative power also convinces available dependences of their level on phase of the menstrual cycle of sportswomen.

Essential changes in different phases of the menstrual cycle happen at handball players with lactat and alactat power and capacity. Both at enrichment by blood oxygen, and at impoverishment by its oxygen the power and capacity the best in post-ovulatory phase, slightly worst they in post-menstrual cycle phase.

Important is also the level of functional preparedness of sportswomen in different phases of cycle. Definition of these indicators has given the chance to be convinced, as they are the best in the mentioned phases of the menstrual cycle and the worst in premenstrual and menstrual phases. The same regularity in manifestation of functional indicators of sportswomen can be observed also after diagnostics of high-speed

and power and general endurance.

Profitability of system of power supply has low indicators in menstrual and premenstrual phases of cycle. It means that the organism of handball players in these phases of cycle is much worse provided with energy and profitability of this process in these phases is low. At the same time these indicators are the best in post-ovulatory and post-menstrual phases.

Significant indicator is also the level of reserve opportunities of sportswomen: the bigger it is, increasingly they have ability to manifestation of the maximum opportunities, especially in extreme conditions of competitions. As the obtained data testify, reserve opportunities of handball players have the largest level in post-ovulatory (9,83 mind. odes.), and after it – in

post-menstrual (9,41 mind. odes.) cycle phases.

Conclusions

The received results convince available the best conditions of manifestation of functionality of organism of the studied sportswomen in post-ovulatory phase of the menstrual cycle. The next period, in which handball players owe the objective opportunity to carry out exercise stresses of a little smaller power, is post-menstrual phase.

Prospects of the subsequent researches. The perspective direction of implementation of the obtained data is the creation of training process with programming of individual load of handball players in different phases of the menstrual cycle.

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