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Original Article

Effect of physical activity with varying duration on adaptation processes of female basketball players

MARIIA SYBIL[1], ROSTYSLAV PERVACHUK[2], ANTON LYTVYNETS[3], YAROSLAV SVYSHCH[4], LILIIA SVYSHCH[5], ULIANA SHEVTSIV[6], YULIA STELMAKH[7]
[1]Department of Biochemistryand Hygiene, Ivan BoberskyStateUniversity of Physical Educationin Lviv, UKRAINE
[2,7]Department of athletic sports, Ivan BoberskyStateUniversity of Physical Educationin Lviv, UKRAINE
[3]Department of Olympic education, Ivan Bobersky State University of Physical Educationin Lviv, UKRAINE
[4]Department of track and field athletic, Ivan Bobersky State University of Physical Educationin Lviv, UKRAINE
[5]Department of foreign languages, Ivan Bobersky State University of Physical Educationin Lviv, UKRAINE
[6]Department of fitness and recreation, Ivan Bobersky State University of Physical Educationin Lviv, UKRAINE

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Abstract.
The article deals with the study of adaptation capabilities of female athletes (by catecholamines concentration in the urine of female basketball players after physical activity) for the purpose of further excellence in sports and increase of functional reserves for maintaining health. The sympatho-adrenal system (SAS) is well known [Megeryan et al, 2015; Romanchuk, 2010; Sybil et al, 1997; Svyshch et al, 2018] to play a central role for homeostasis in the process of body adaptation to work in a stressful environment (emotional stress, long-term or high-intensity physical activity). Playing basketball at a high level suggests the combination of these stress factors. Namely, the excess of adrenaline (A) representative of the hormonal link of the SAS mainly of adrenal origin causes the condition of pre-start fever (“rabbit’s hormone”) [Megeryan et al, 2015; Romanchuk, 2010;Sybil et al, 2002].Simultaneously stimulating creatine phosphokinase and glycolysis, A promotes rapid energy production, i.e. realization of the physical quality of speed. The mediator link of SAS originates from the sympathetic division of the autonomic nervous system and is represented by noradrenaline (NA) – the “lion’s hormone” [Sybil et al, 2002]. Its excessive excretion is characteristic of the aggressive pre-start condition, and in case of unsuccessful realization of the sporting actions can change into a pathy.At the same time, in the process of overcoming long-term muscular efforts, the highest peaks of NA are noted [Megeryan et al, 2015;Romanchuk, 2010;Sybil et al, 1997;Sybil et al, 2002, 2015]. Thus, NA is related tothe physical quality of endurance.Therefore, the SAS-monitoring makes it possible to observe the athletes tolerance and adaptation to physical activity of varying duration. Thecatecholamine indicators (A, NA and DOPA) show both the physical fitness at the start and the specifics of adaption changes during sports activities.Since DOPA is a direct precursor in the synthesis of A and NA, it is considered a criterion for the reserve capabilities of the SAS in its implementation of homeostasis changes.The research involved 12 female basketball players aged 18-19 (candidates for masters of sports and masters of sports).The SAS-monitoringlasted 6 months and comprised the operative control (1 week), current control (1 month) and stage control (4.5 months) from the beginning of the training period. KA was determined in the urine of female athletes by a commonly used fluorescent method
Key Words: female basketball, hormones, catecholamines, adrenaline, noradrenaline, macrocycle.

Introduction.

The present stage of female athletes training necessitates the implementation of a biochemical monitoring system during the macrocycles of their training. This is due to the diverse effects of the environment on the physical condition of athletes, the growing bout and intensity of physical activity at competitions, the increased requirements for a spectacular game, and the specifics of women’s sports. Additionally, the need for targeted multi-stage monitoring of adaptation processes throughout the enduring exercise is preconditioned by the reduced endurance to physical activity of female basketball players[Trach et al, 1997;Bezmylov et al, 2013;Sakharov et al, 2008;Sybil, 1999; Antunes et al, 2017].

The process of the athlete's body adaptation to the increased training loads activates the hypothalamic-pituitary-adrenocortical and sympathoadrenal systems – the hormonal (A) and mediator (NA) links that control the development of adaptation processes [Aleksandrova et al, 2013;Megeryan et al, 2015;Skybaet al, 2017; Korobeynikov et al, 2020].Hormonal changes reflect the degree of training and competitive stress of the athletes. The imbalance of hormones affects the functioning characteristics of various body systems and the fitness obtainability [Sybil et al, 1997;Sybil et al, 2002;Pervachuk, 2013;Pedersen et al, 2000].

Corresponding Author: ROSTYSLAV PERVACHUK, E-mail: r.pervachuk@gmail.com

The response of SAS to training load of different types and objectives, its dependence on the loading capacities and the body conditioning, is manifested by increased concentrations of catecholamines, their precursors and metabolites in blood and tissues, as well asintensified urinary excretion [Megeryan et al, 2015;Sybil et al, 1997;Sybil et al, 2002;Sybil et al, 2004].

The results of our previous research indicate the dependence of training loads of different kinds and objectives upon the training intensity and fitness of the body conditioning of female athletes (Sybil et al, 1997, 2002). This issue has already been covered in various sources:Sybil et al., (1996, 2004, 2018); Sakharov et al, (2008); Bezmylov et al, (2013); Megeryan et al, (2015); Tyshchenko et al, (2020)etc.The problem, however, remains relevant and needs further research,pertaining specifically to the game sports and the women's sportsin particular.

Material and methods.

Purpose: exploring the impact of physical activity with varying duration on catecholamine concentration in female basketball players,with the aim of revealingthe peculiarities of adaptation processes during the macrocycles of their training.

Objectives: 1. to examine the changes in excretion of female basketball players before and after the match at the beginning of training macrocycle; 2. to investigate the changes in CA excretion of female basketball players before and after the match at the end of training macrocycle; 3. to explore the changes in adrenaline, noradrenaline and DOPA concentration in the urine of female basketball players before and after the workout throughout the training period; 4. to distinguish the impact ratio of physical activity duration on the concentration of A, NA and DOPA in the urine of female basketball players at the beginning and at the end of training macrocycle.

Research methodology and procedure. The study involved 12 highly qualified female basketball players aged 18-19. Monitoring was performed by determining the concentration of adrenaline, noradrenaline and DOPA in the urine of the athletes with a commonly used fluorescent method. The study material was collected 30 minutes before and 30 minutes after the match. The studies were performed at the beginning and at the end of the training macrocycle –for 6 months. Additionally, during 6 months, the operative control (1 week after the beginning of training sessions), current control (1 month after the beginning of training sessions) and stage control (4.5 months after the beginning of trainingsessions during the competitive period) were carried out. To detect the impact of physical activity duration on the CA concentration by the method of a one-way analysis of variance, the court time of the athletes during the game was monitored, and hence they were divided into groups (I – 5-10 minutes, II – 11-17 minutes, III – 18-24 minutes).

Results.

The monitoring results on catecholamine concentration in the urine of female basketball players during the training macrocycle are shown in Fig. 1-5.

The results of comparative analysis of catecholamine concentration in the urine of female basketball players at the beginning of training macrocycle

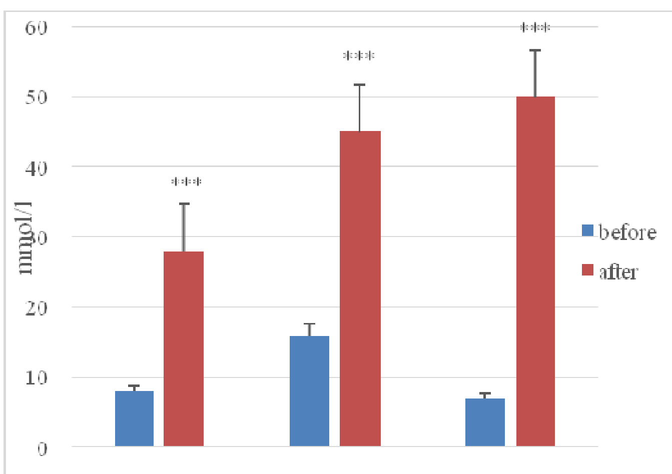

Fig. 1 Catecholamine concentration in the urine of female basketball players before and after the match at the beginning of training macrocycle(****p* ≤ *0,999)*

Due to the analysis of the results presented in Fig. 1, after the match a significant increase was observed by all indicators of catecholamine concentration in the urine of female basketball players at the beginning of the training macrocycle. The concentration of adrenaline increased by 3 times, noradrenaline –by 3.5 times. The increase in DOPA concentration was the highest (by 4.2 times), indicating the involvement of all parts of the sympatho-adrenal system to overcome the physical activity loads.

The higher concentration of adrenaline points out the athletes using the speed qualities of their body, and the significant growth of noradrenaline concentration showstheir applying a variety of endurance qualities to overcome the physical loading.The concentration of DOPA testifies a high reserve capacity for organizing the adaptation responses to the physical activity loads. The literary sources [Megeryan et al, 2015;Romanchuk, 2010;Sybil et al, 1997;Sybil et al, 2002] provide evidence for the fact that CA excretion increase by 2-4 times indicates an adequate response of the athlete's body to the loading.It is essential to note anincrease balance in the rate of both the hormonal link (responsible for speed) and the noradrenaline link (responsible for different types of endurance) of SAS.

The results of comparative analysis of catecholamine concentration in the urine of female basketball players at the end of training macrocycle

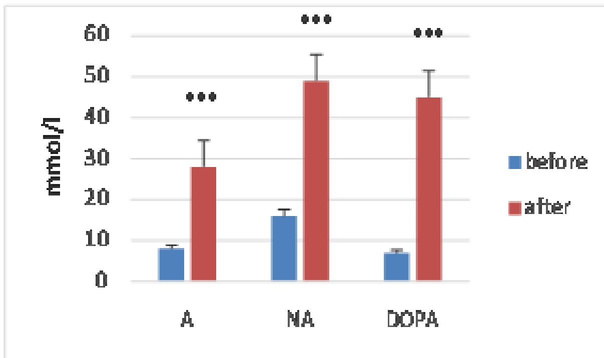

Fig. 2 Catecholamine concentration in the urine of female basketball players before and after the match at the end of training macrocycle (****p* ≤ *0,999*)

The comparative analysis of catecholamine concentration in the urine of female basketball players at the end of training macrocycle (after 6 months), revealed a similar increase by indicators of adrenaline, noradrenaline and DOPA. This proves the athletes' fitness throughout the training period. The growth of DOPA concentrationconfirms maintaining of the athletes' potential to overcome the physical activity loads, thus suggesting an appropriate physical condition and adequate preparation during the training macrocycle. The concentration of DOPA after the game increased by5.7 times, representinga reserve capacity for the synthesis of both A and NA. I.e. the indicators that, through α- and β- adrenoceptors, involve the successive inclusion of different energy sources: first – anaerobic (creatine phosphate and glycolysis), and then– aerobic,oxidative phosphorylation. The increase by all indicators after the physical loading is reliable (*p* ≤ *0,999).*

The results of comparative analysis of adrenaline, noradrenaline and DOPA concentration before and after the workout throughout training macrocycle

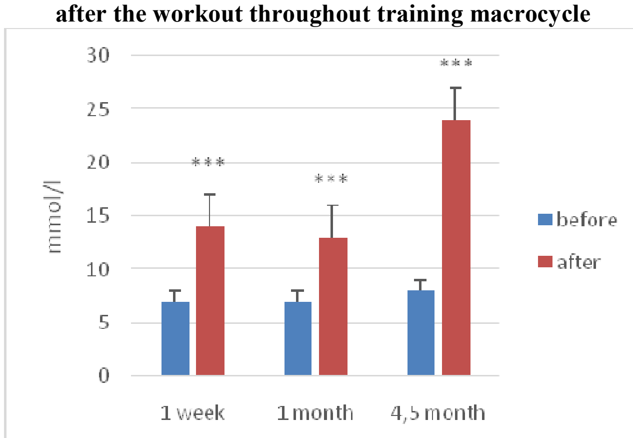

Fig. 3 Changes of adrenaline concentration in the urine of female basketball players before and after the workout throughout the training period (*** *p* ≤ *0,999*)
1 week –Operative control, 1 month – Current control
4.5 months – Competitive period

During the training macrocycle, changes in catecholamine concentration were monitored before and after the training sessions for 2 hours. The data presented in Fig. 3 show the increase of adrenaline concentration in the urine of female basketball players after the physical loads throughout the observation period.

1 week after the beginning of training macrocycle, adrenaline concentration in the urine of female basketball players after the loading increased by 2 times. Similarly, after 1 month of the training sessions, adrenaline concentration after the physical loads increased by approximately 2 times. During the competitive period (after 4.5 months of training sessions),adrenaline concentration in the urine of female basketball players after the loading increased by 3 times.The growth of adrenaline concentration within all control periods is reliable (– *p ≤ 0,999).*

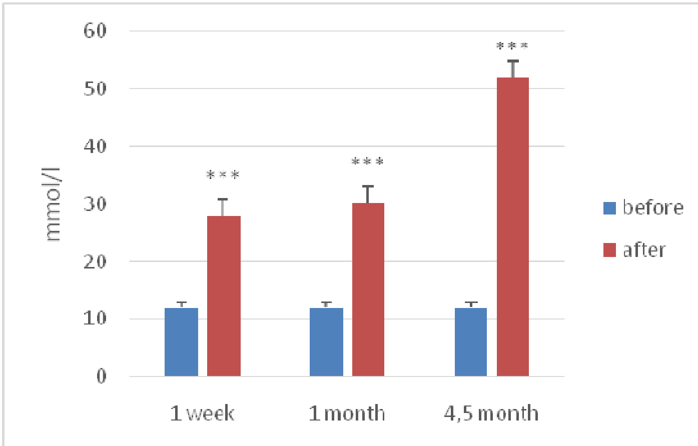

Fig. 4 Changes of noradrenaline concentration in the urine of female basketball players before and after the workout throughout the training period (*** *p ≤ 0,999*)
1 week – Operative control, 1 month – Current control
4.5 months – Competitive period

The data presented in Fig. 4 indicate the growth of noradrenaline concentration after a two-hour training session throughout the observation period. The operative control (1 week after the beginning of training sessions) proved the increase of noradrenaline indicator by 1.8 times. The current control (1 month after the beginning of training sessions) showed the increase of noradrenaline concentration after the physical loads by 2 times. After 4.5 months (during the competitive period), the highest growth of noradrenaline concentration in the urine of female basketball players was recorded after a two-hour training session– by 3.5 times. The increase of noradrenaline concentration within all control periods is reliable (– *p ≤ 0,999).*The results shown in Fig. 3 and 4 suggest the appropriate levels of both the speed qualities (according to the changes in A excretion) and different types of endurance qualities (according to the changes in NA excretion) during all the control points.

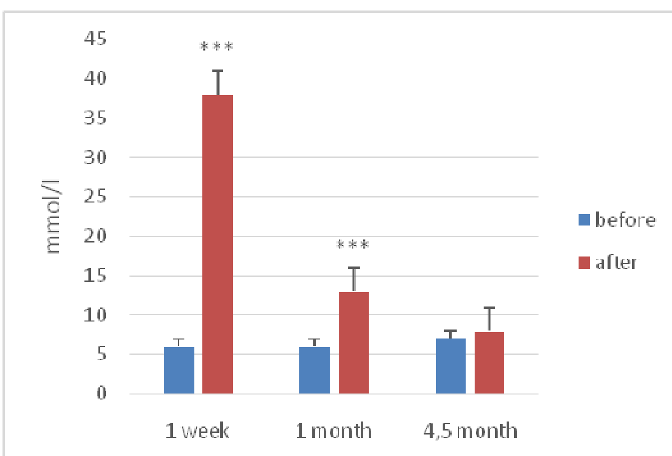

Fig. 5 Changes of DOPA concentration in the urine of female basketball players before and after the workout throughout the training period (*** *p ≤ 0,999*)
1 week – operative control, 1 month – current control
4.5 months – competitive period

The results of the comparative analysis of DOPA concentration in the urine of female basketball players presented in Fig. 5 reveal stabilization of this indicator throughout the training macrocycle.

1 week after the beginning of training sessions,DOPA concentration after a two-hour workout increased by 5 times, consequently the body needed large reserve capacity to overcome the physical activity loads. The changes of DOPA concentration in the urine of female athletes before and after training are reliable (*$p \leq 0{,}999$)*.

The current control of this indicator (1 month after the beginning of training sessions) showed the decrease of DOPA level in the urine of female athletes.

4.5 months after the beginning of training sessions (during the competitive period),neither increase nor decrease of this indicator was observedafter a two-hour workout, suggesting an appropriate physical condition of the female basketball players and their preparedness for the competitions.

The results of one-way analysis of variance for the impact of physical activity duration on the concentration of adrenaline, noradrenaline and DOPA in the urine of female basketball players

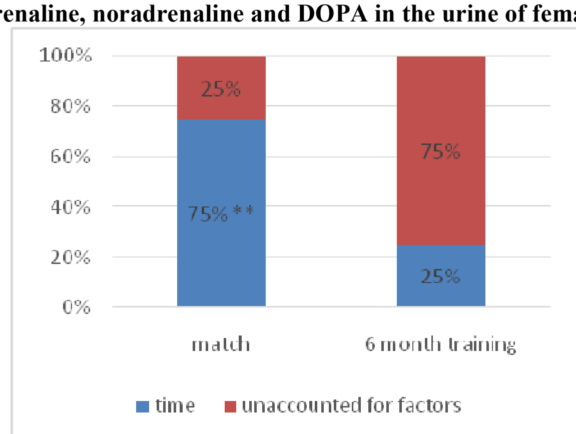

Fig. 6 The impact ratio of physical activity duration on adrenaline concentration in the urine of female basketball players at the beginning and at the end of training macrocycle (** $p \leq 0{,}99$)

Due to the results of one-way analysis of variance presented in Fig. 6, there are some differences in the impact ratio of physical activity durationat the beginning and at the end of training macrocycle.

At the beginning of a 6-month training, the court time of a female basketball player impacts significantly on the adrenaline concentration in the athlete's urine, and thus on her speed capabilities.The impact ratio of physical activity duration at the beginning of training macrocycle makes up 75% and is reliable ($p \leq 0{,}99$).These data may indicate a substantialloss of the body speed capabilities with increasing physical loads.

At the end of training macrocycle, the impact ratio of time factor on adrenaline concentration in the urine of female basketball players reduced to 25%, consequently the loss of speed capabilities depending on physical activity duration decreased considerably.The 6-month training allowed improving the physical qualities of female athletes, developing their emotional stability, and overcoming the “rabbit syndrome”.

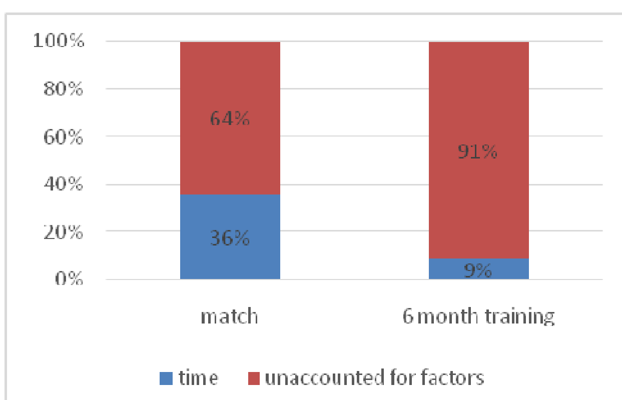

Fig. 7 The impact ratio of physical activity duration on noradrenaline concentration in the urine of female basketball players at the beginning and at the end of training macrocycle

The one-way analysis of variance forthe impact ratio of female athletes' game time on noradrenaline concentration in their urine after the match at the beginning of training macrocycle revealedthe dependence of this catecholamineupon physical activity duration.The impact ratio of time factor makes up 36%. Thus, there is a loss of the body endurance depending on the physical activity duration.

After a 6-month training period, i.e. at the end of training macrocycle, the female basketball players became more capable of enduring the physical loads.The training process was aimed at strengthening physical endurance, which gave the results.

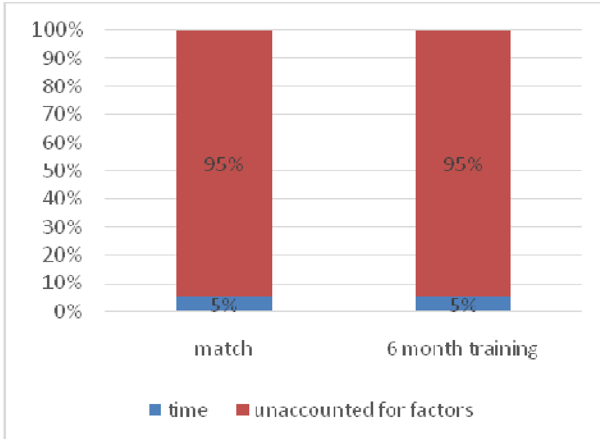

Fig. 8 The impact ratio of physical activity duration on DOPA concentration in the urine of female basketball players at the beginning and at the end of training macrocycle

Discussion.

The one-way analysis of variance for the impact ratio of female athletes' court time on DOPA concentration in their urine testified the absence of such impact. Regardless of the court time of female basketball players during the game, their DOPA concentration did not change (the impact ratio made up only 5%). These results suggest an appropriate physical condition of the female basketball players and large reserve of energy capacity to overcome the physical activity loads. The impact ratio of time factor was unchanged at the beginning and at the end of training macrocycle, thus the training process was arranged in accordance with the requirements for coaches to improve the physical qualities of athletes.

Conclusions.

The studies on the impact of physical activity with varying duration upon catecholamine excretion of female basketball playersdefined an adequate growth of adrenaline, noradrenaline and DOPA rates:

After the match at the beginning of training macrocycle, concentration of all the examined catecholamines increases significantly– by 3-4 times; after the match at the end of training macrocycle (6 months), concentration ofadrenaline and noradrenaline in the urine of female basketball players increases by 3 times, and DOPA concentration – by 5.7 times.

The operative control (1 week of training sessions) after physical loads reveals the concentration increase of adrenaline by 2 times, noradrenaline – by 1.8 times, and DOPA – by 5 times.

The current control testifies the growth of all catecholamines concentration in the urine of female basketball players by 2 times.

After 4.5 months of the training period, the concentration of adrenaline increases by 3 times, noradrenaline – by 3.5 times, and the level of DOPA remained unchanged.

The one-way analysis of variance shows the impact of physical activity duration on adrenaline and noradrenaline concentration at the beginning of training macrocycle (75% and 36% respectively), while at the end – the impact ratio is insignificant (25% and 9% respectively).

Physical activity duration has no impact on the concentration of DOPA in the urine of female basketball players.

The SAS-monitoring is a highly informative method and can be recommended for the control of adaptation changes of female basketball players throughout the training macrocycle.

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