

**ANALYSIS OF VEGETATIVE HOMEOSTASIS STATE OF ELITE HANDBALL PLAYERS**

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**Abstract.** *Purpose:* to study characteristics and dynamic of elite handball players' physiological indicators. *Material:* In experiment elite handball players (n=112, age 18–35 years) participated. For determination of vegetative homeostasis state we analyzed variability of heart rhythm. The researches were conducted in laboratory conditions in rest state, in lying position during 5 minutes. *Results:* it was found that organism's adaptation reactions to training loads go with different tension of regulation systems. At the end of competition period there appears hyper-kinetic syndrome. It witnessed insufficiency of means, which permit to maintain optimal regulation of cardio-vascular system and increase its functional potentials. *Conclusions:* indicators of cardio-vascular system and their dynamic witnessed maintaining of high level of handball players' organism hemodynamic provisioning. High level of vegetative homeostasis pointed at certain degree of sportsmen's fitness. Such state is sufficient for preservation of high potential of sympathetic –adrenaline system and overcoming of fatigue processes.

**Key words:** handball, stage, hemodynamic, variability, heart rhythm, fatigue.

**Introduction**

Extreme training-competition loads of modern sports result in disordering of organism's homeostasis and in substantial adaptation changes [3]. Considering it, it is important to conduct constant control of sportsman organism's functional state in training process [1]. The problem of its assessment is rather difficult and requires comprehensive examination of all organs and systems [4]. Min functional systems of work provisioning in training-competition process are central and periphery nervous systems, muscular skeletal apparatus. Demand in researches of psycho-physiological, vegetative and physical qualities of handball players and team is rather high. Its realization permits to rationally form and optimize it at different stages [7,11]. At the same time fragmentary character of such researches do not permit to assess dynamic of changes of sportsmen's functional state to the fullest extent and to correct training process [5,14,20].

Medical biological provisioning of sport functioning is rather important in modern conditions. For assessment of physiological functions' vegetative regulation a number of specialists used method of heart rhythm variability (HRV), which is based on analysis of consequent RR-interval [3, 9]. This method permits to register disorders of neurohumoral balance; participation of sympathetic and para-sympathetic, nervous and humoral links in regulation of heart beats rhythm, degree of centralization of its control [19].

HRV was studied in different game kinds of sports: football [8,11], hockey [15], handball [10], and basketball [16]. All they include recording of telemetry data [18,20], which gives information about heart's response to physical loads. Such loads express great variability of intensity [17]. At the same time it points at energy value of fulfilled exercise [12]. It was found that at the end of competition stage, sportsmen had improvement of vegetative regulation of heart rhythm [13]. It witnesses about accumulation of significant portion of not corrected fatigue, which increases up the end of the mentioned period. All above said served pre-condition for our researches.

**Purpose, tasks of the work, material and methods**

*The purpose of the research* was to study characteristics and dynamic of elite handball players' vegetative homeostasis during year macro-cycle. In compliance with this purpose we solved the following *tasks*:

1. Studying of peculiar features and dynamic of cardio vascular system indicators in elite handball players during year macro-cycle.
2. Studying of characteristics and dynamic of elite handball players' vegetative homeostasis during year macro-cycle.

*Materials and methods of the research:* the research was conducted during year macro-cycle – at the beginning and at the end of preparatory stages; at the beginning and at the end of competition stages. In the research 112 elite handball players – participants of Ukrainian Supreme league (age – 18035 years) took part. For determination

of vegetative homeostasis we analyzed variability of heart rhythm. The following indicators were calculated: mode (Mo, sec.), mode amplitude (AMo,%), variation range (dRR, m.sec.), standard deviation of full massive of cardio intervals (SDNN, m.sec.), index of regulatory systems' tension (IT, conv.un.). The research was conducted in laboratory conditions, in rest state, in lying position during 5 minutes.

### Results of the research

Results of the research at the beginning of preparatory period witness about low and below average indicators of general physical workability and energy supply of organism. Chronotropic function of heart confidently reduced to the end of preparatory period (by 9%,  $P < 0.05$ ). Up to the beginning of competition period it passed to mode of functional sport bradycardia – reduction of heart beats rate (HBR) in comparison with beginning of preparatory period by 17% ( $P < 0.01$ ). Further stabilization was observed up to the end of competition period.

We registered 50% handball players, who have high level of myocardium functional activity, 35% – average, 15% – low. Be y level of heart muscle's metabolic reserve we did not receive any indicators. Relative indicator of myocardium's metabolic provisioning was normal in 97% of handball players. Electric cardiographic parameters of heart's functional state (assessed in 4 points by 5-points' scale) pointed at absence of maximal value. We registered single cases of arrhythmia, resulted from disorder of function of automaticity. They prevailed in preparatory period.

Recent time analysis of heart rhythm variability, owing to which we receive information about influence of vegetative nervous system and some humoral and reflex factors on work of heart, has been becoming more and more popular [5,10]. In the conducted research we registered single reduction of handball players' indicators. It pointed at disordering of vegetative nervous and cardio-vascular systems' interactions. The highest indicators of heart rhythm variability were received in most of sportsmen and it characterized higher para-sympathetic tonus. Analysis of heart rhythm variability at the beginning of preparatory period showed at balanced regulatory, vegetative mechanisms and reflects high centralization of heart rhythm regulation processes (see table 1).

Table 1. Indicators of vegetative regulation of elite handball players at different stages of the research ( $X \pm m$ )

Indicators	STAGES								
	BPP	EPP	T bpp- epp, P	BCP	ECP	T bcp - ecp, P	T bpp - bcp, P	T epp- bcp, P	T epp - ecp, P
Mo, m.sec	968,67± 165,84	1052,34± 177,76	0,34 P>0,05	1140,85± 182,45	1080,79± 166,92	0,24 P>0,05	0,70 P>0,05	0,35 P>0,05	0,12 P>0,05
AMo,%	34,45± 3,16	30,18± 2,45	1,07 P>0,05	28,42± 2,28	32,44± 3,26	1,01 P>0,05	1,55 P>0,05	0,53 P>0,05	0,55 P>0,05
SDNN, m.sec	82± 5,55	80±4,63	0,28 P>0,05	78± 5,12	80± 5,67	0,26 P>0,05	0,53 P>0,05	0,29 P>0,05	0,00 P>0,05
dRR, m.sec	348,36± 86,14	336,22± 112,24	0,09 P>0,05	324,64± 106,44	332,47± 128,54	0,05 P>0,05	0,17 P>0,05	0,07 P>0,05	0,02 P>0,05
IT, conv.un.	55,12± 34,86	58,34± 52,92	0,05 P>0,05	64,97± 46,72	60,86± 28,46	0,08 P>0,05	0,17 P>0,05	0,09 P>0,05	0,04 P>0,05

Notes: BPP – beginning of preparatory period; EPP – end of preparatory period; BCP- beginning of competition period; ECP – end of competition period; \* –  $P < 0,05$ ; \*\*\* –  $P < 0,001$

The most probable level (in physiological sense of cardio-vascular system's functioning) of handball players' Mo permitted to assess actual state of regulation systems. Minimal value of indicator was observed at the beginning of preparatory period and maximal – at the end.

Mode amplitude (AMo) reflects stabilizing effect of centralization of heart rhythm control, which is conditioned by degree of activation of vegetative nervous systems's sympathetic sector. It reflects level of rhythm's rigidity. Single increase of AMo witnessed prevalence of sympathetic influences on sinus node and significant rigidity of rhythm.

SDNN is an integral indicator, which characterizes variability of heart rhythm. It depends on influence of vegetative nervous system's sympathetic and para-sympathetic sectors on sinus node. We registered separate cases of maximal upper indicators of norm that pointed at increase of para-sympathetic activity of vegetative nervous system.

In 15% of handball players we registered substantial increase of SDNN that witnessed about increased activity of autonomous regulation circuit. Total effect of vegetative regulation of SDNN blood circulation (reflecting all periodical components of variability of total BCP indicators) also reduced from 82m.sec. to 78 m.sec. Indicator SDNN showed trend to reduction in process of training micro-cycle. For example, at the beginning of preparatory period we received  $82 \pm 5.55$  m.sec.; at the beginning of competition period it was  $78 \pm 5.12$  m.sec.; by the end of competition period we observed insignificant increase of SDNN up to  $80 \pm 5.67$  m.sec.

The same changes at the stages of the research were observed in indicator dRR. At the beginning of preparatory period it was  $348.36 \pm 86.14$  m.sec., at the beginning of competition period –  $324.64 \pm 106.44$  m.sec; at the end of competition period numerical value of dRR was  $332.47 \pm 128.54$  m.sec. Index of tension (IT) gives the fullest picture of tension of central mechanisms of regulation in adaptation to varying influences. It reflects degree of centralization of heart rhythm control. Index of tension showed increasing from stage to stage of macro-cycle up to 65 conv.un.

### Discussion

In our researches we confirmed the data, which were analyzed in works by Barbero-Alvarez, Buchheit [8,10]. At first stages of preparatory-competition processes we observed optimization of cardio-vascular system's work. It is reflected in hypotonic orientation of blood pressure dynamic that, partially, is considered in works [1, 6]. Transition to less energy consuming functional sport bradycardia and dynamic of indicators of central blood circulation volume reduced "loading heart by volume", though Kayacan Y. pointed at sympathetic balance with short term load [14]. At the end of competition period there occurs transition to hyper kinetic type of regulation and it was, to some extent, increase of heart chronotropic function's activity and overcoming of fatigue processes [3]. These effects confirmed rather high degree of elite handball players' fitness.

### Conclusions:

1. Indicators of cardio-vascular system and their dynamic during all process of the research witnessed maintaining of high level of hemo-dynamic provisioning of elite handball players' organism.
2. High level of vegetative homeostasis pointed at certain level of sportsmen's fitness. Such state is sufficient for preservation of high potential of sympathetic adrenaline system and for overcoming of fatigue processes. The received data witness about demand in seeking of methods and means, which could correct and optimize sportsmen's functional potentials more successfully at competition stage.

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### Conflict of interests

The authors declare that there is no conflict of interests.

### References:

1. Arishnova NG, Vikulov AD, Bocharov MV. Ispol'zovanie pokazatelej central'noj gemodinamiki i serdechnogo ritma dlja ocenki funkcional'nogo sostoianija sportsmenov vysokoj kvalifikacii [Application of central hemo-dynamics and heart rhythm indicators for assessment of elite sportsmen's functional state], *Iaroslavskij pedagogicheskij vestnik* 2010;4;53–60. (in Russian)
2. Ivanova NI. *Funkcional'noe sostoianie kardiorespiratornoj sistemy sportsmenov s razlichnoj specifikoju myshechnoj deiatel'nosti v podgotovitel'nom i sorevnovatel'nom periodakh podgotovki*. Cand. Diss. [Functional state of cardio-vascular system of sportsmen with different specificity of muscular functioning in preparatory and competition periods. Cand. Diss.], Moscow; 2010. (in Russian)
3. Malikov MV, Svat'iev AV, Bogdanovs'ka NV. *Funkcional'na diagnostika u fizichnomu vikhovanni i sporti* [Functional diagnostic in physical education and sports], Zaporizhzhia: ZNU Publ.; 2006. (in Ukrainian)
4. Pavlov SE, Pavlova TN. *Tekhnologija podgotovki sportsmenov* [Technology of sportsmen's training], Moscow: Schjol'kovo; 2011. (in Russian)
5. Sidorenko TA, Kalashnikov AV, Iur'ev IuN, Shurmanov EG. Analiz gendernykh razlichij pokazatelej serdechnogo ritma u sportsmenov, zanimajushchikhsia ciklicheskimy vidami sporta [Analysis of gender

- distinctions of heart rhythm of sportsmen, practicing cyclic kinds of sports], *Uchenye zapiski universiteta im. P.F. Lesgafta* 2015;5(123):164–168. (in Russian)
6. Sysoev AV, Popova IE. Funkcional'nye osobennosti serdca sportsmenov razlichnoj specializacij v dinamike godichnogo cikla trenirovok [Functional characteristics of sportsmen's hearts (of different specializations in dynamic of annual training cycle)], *Teoriia i praktika fizicheskoi kul'tury* 2012;5:31–34. (in Russian)
  7. Tkachuk VG, Rovnyj AS, Leus LI. Funkcional'noe sostoianie razlichnykh sensornykh sistem pri reprodukcii sportsmenami tochnostnykh dvizhenij [Functional state of different sensor systems in sportsmen's reproduction of accurate movements]. *Pedagogics, psychology, medical-biological problems of physical training and sports* 2010;10:77–81. (in Ukrainian)
  8. Barbero-Alvarez J, Soto VM, Barbero-Alvarez V, & Granda-Vera J. Match analysis and heart rate of futsal players during competition. *Journal of sports sciences* 2008;26(1):63–73.
  9. Buchheit M, Lepretre PM, Behaegel AL, Millet GP, Cuvelier G, & Ahmaidi S. Cardiorespiratory responses during running and sport-specific exercises in handball players. *Journal of science and medicine in sport: Sports Medicine Australia* 2009;12(3):399–405.
  10. Buchheit M. Sensitivity of heart rate and psychometric measures to monitor physical performance in handball. *Int J Sports Med.* 2014;1:164–172.
  11. Hamdy AA. A comparative study between players of football and handball in Egyptian national team in Heart Rate Variability. *Weight Loss and Fitness Expo: International Conference*, July 13–15, 2015. Pennsylvania, Philadelphia, USA; 2015. P 100–105.
  12. Fudge BW, Wilson J, Easton C, Irwin L, Clark J, Haddow O. Estimation of oxygen uptake during fast running using accelerometry and heart rate. *Medicine and science in sports and exercise* 2007;39(1):192–198.
  13. Kayacan Y. Time-domain heart rate variability in professional handball players. *Acta Physiologica* 2011;203:686–690.
  14. Kayacan Y, Yildiz S. Resting and post-exercise heart rate variability in professional handball players. *J Sports Med Phys Fitness* 2015;15:100–105.
  15. Konarski J, Matuszyński M, & Strzelczyk R. Different Team Defense Tactics and Heart Rate during a Field Hockey Match. *Studies in Physical Culture & Tourism* 2006;13:145–147.
  16. Matthew D, & Delextrat A. Heart rate, blood lactate concentration, and timemotion analysis of female basketball players during competition. *Journal of sports sciences* 2009;27(8):813–821
  17. Moore AD, Lee SM, Greenisen MC, & Bishop P. Validity of a heart rate monitor during work in the laboratory and on the Space Shuttle. *American Industrial Hygiene Association Journal* 1997;58(4):299–301.
  18. Terbizan DJ, Dolezal BA, & Albano C. Validity of seven commercially available heart rate monitors. *Measurement in Physical Education & Exercise Science* 2002;6(4):243–247.
  19. Terhardt J, Lederbogen F, Feuerhack A, Hamann-Weber B, Gilles M, Schilling C. Heart Rate Variability During Antidepressant Treatment With Venlafaxine and Mirtazapine. *Clinical Neuropharmacology* 2013;36(6):198–202.
  20. Vesterinen V. Heart rate variability in prediction of individual adaptation to endurance training in recreational endurance runners. *Scand J Med Sci Sports.* 2013;23(2):171–178.

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