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 does 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. By level of heart muscle’s metabolic reserve we did not receive any indicators. Relative indicator of intervals (SDNN, m.sec.), index of regulatory systems’ tension (IT, conv.un.). The research was conducted in myocardium’s metabolic provisioning was normal in 97% of handball players. Electric cardiographic parameters of 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±m)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>STAGES</th>
<th>BPP</th>
<th>EPP</th>
<th>Tbpp-ecp, P</th>
<th>BCP</th>
<th>ECP</th>
<th>T bcp-ecp, P</th>
<th>T bcpp- bcp, P</th>
<th>T ecp- bcp, P</th>
<th>T ecpp, P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mo, m.sec</td>
<td>968,67±1052,34±</td>
<td>0.34</td>
<td>1140,85±</td>
<td>1080,79±</td>
<td>0.24</td>
<td>0.70</td>
<td>0.35</td>
<td>0.12</td>
<td></td>
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</tr>
<tr>
<td>AMo,%</td>
<td>165,84 177,76</td>
<td>P&gt;0,05</td>
<td>182,45</td>
<td>166,92</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td></td>
<td></td>
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<tr>
<td>SDNN, m.sec</td>
<td>34,45± 30,18±</td>
<td>1,07</td>
<td>28,42±</td>
<td>32,44±</td>
<td>1,01</td>
<td>1,55</td>
<td>0,53</td>
<td>0,55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPP</td>
<td>3,16 2,45</td>
<td>P&gt;0,05</td>
<td>2,28</td>
<td>3,26</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td></td>
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<tr>
<td>BCP</td>
<td>82± 80±4±63</td>
<td>0,28</td>
<td>78± 80±</td>
<td>0,26</td>
<td>0,53</td>
<td>0,29</td>
<td>0,00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECP</td>
<td>5,55</td>
<td>P&gt;0,05</td>
<td>5,12</td>
<td>5,67</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
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<tr>
<td>dRR, m.sec</td>
<td>348,36± 336,22±</td>
<td>0,09</td>
<td>324,64±</td>
<td>332,47±</td>
<td>0,05</td>
<td>0,17</td>
<td>0,07</td>
<td>0,02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCP</td>
<td>86,14 112,24</td>
<td>P&gt;0,05</td>
<td>106,44</td>
<td>128,54</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECP</td>
<td>55,12± 58,34±</td>
<td>0,05</td>
<td>64,97±</td>
<td>60,86±</td>
<td>0,08</td>
<td>0,17</td>
<td>0,09</td>
<td>0,04</td>
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<tr>
<td>conv.un.</td>
<td>34,86 52,92</td>
<td>P&gt;0,05</td>
<td>46,72</td>
<td>28,46</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
<td>P&gt;0,05</td>
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</tbody>
</table>

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’ sympathetic sector. It reflects level of rhythm’s rigidness. Single increase of AMo witnessed prevalence of sympathetic influences on sinus node and significant rigidness 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±5.55 m.sec.; at the beginning of competition period it was 78±5.12 m.sec.; by the end of competition period we observed insignificant increase of SDNN up to 80±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±86.14 m.sec., at the beginning of competition period – 324.64±106.44 m.sec; at the end of competition period numerical value of dRR was 332.47±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 sportmen’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 sportmen’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.

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