Seasonal changes in functional state of cardiovascular system in female students with different levels of physical activity

UDC 796.01:612

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Abstract

Objective of the study was to assess seasonal changes in the functional capabilities of the circulatory system of female students with different physical activity levels.

Methods and structure of the study. During the study, we assessed the cardiovascular system functionality in two groups of female students. The first group was made of the female skiers studying at sports universities, the second group – of the female students not engaged in sports. The subjects' response to physical loads were assessed based on the indicators reflecting both their adaptive capabilities and cardiovascular system functionality.

The indicators included: heart rate (bpm), systolic and diastolic blood pressure (mmHg), pulse pressure and average dynamic pressure (mmHg), systolic volume (ml) and MBV (l/min). The average daily values of these indicators were used to calculate: Kerdo index, index of functional changes in the circulatory system, or adaptive capacity, type of self-regulation of circulation, circulatory deficiency coefficient, circulatory endurance coefficient, circulatory efficiency coefficient, Robinson index or double product. The resulting digital material was subjected to standard mathematical processing by the method of variation statistics with the calculation of the average value and its error.

Results and Conclusion. Given the correct distribution of physical loads in the long-term prospects, there should be no negative consequences of changes in the central regulatory vector, which determines the predominant distribution of the load among the structural elements of the body, namely sympathicotonia. However, this possibility should be taken into account, otherwise the change in the central regulatory mechanism will lead to the strengthening of the catabolism characteristic of the strenuous functioning and utilization of the bodily reserves and, as a consequence, to the reduction not only of adaptive but also functional capabilities of athletes, which could affect their sports results.

Keywords: *functional capabilities, cardiovascular system, adaptive capabilities, physical loads.*

Background. In characterizing seasonal changes in the structure of the biological rhythms of separate physiological indicators in female university students with different physical activity levels, we have previously identified significant changes in the rhythm [1]. It was not so much their presence in the sporting group that alerted, but the direction and absence of such changes in the non-sporting group. The restructuring of the rhythm, while in itself naturally-determined and manifesting in only one group in the same conditions, may reflect its instability, which is a poor indicator characterizing, in our case, a seasonal decline in adaptive capabilities, which is particularly pronounced in the sporting group [2]. These changes were especially pronounced in the rhythm structure of the cardiovascular system, in particular the daily average of the minute blood volume (hereinafter MBV). In the sporting group, this indicator is seasonally increasing; however, its increase is not accompanied by a rise in the systolic discharge, which for the sporting group would normally be the result of sports trainings, but due to an increase in HR. Consequently, both the adaptive capabilities and functional capacities of female

athletes become very low by spring, as this growth in MBV is typical of untrained people only.

Since the dynamics in the average daily rhythm in the sporting group is accompanied by a decrease in the amplitude of the HR oscillations, it can be assumed that the circulatory system is in a very tense state in spring due to intense physical loads.

Such changes as response to loads, especially physical ones, are, without doubt, inevitable and determined by the local self-regulation mechanisms, in spite of the direction of the rhythm restructuring [3]. The reason for the lack of a rhythmological response, which at first glance is a stable rhythm, may be precisely the absence of expressed physical loads in the non-sporting group. In the long-term prospect, however, the rhythm may reflect not only a shift from self-regulation to the inclusion of the central regulatory mechanisms, but also a shift in the regulatory direction of these mechanisms, which should be taken into account in the organization of the training process by both the athlete and coach.

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The indicators included: HR (bpm), systolic (SBP) and diastolic (DBP) blood pressure (mmHg), pulse pressure (PP) and average dynamic pressure (ADP, mmHg), systolic volume (SV, ml) and MBV (l/min). The average daily values of these indicators were used to calculate: Kerdo vegetative index (KVI), index of functional changes in the circulatory system, or adaptive capacity, type of self-regulation of circulation (TSC), circulatory deficiency coefficient (CDC), circulatory endurance coefficient (CE), circulatory efficiency coefficient (CEC), Robinson index (RI) or double product. The resulting digital material was subjected to standard mathematical processing by the method of variation statistics with the calculation of the average value and its error.

Results and discussion. Given in Table 1 are the results obtained during the study.

While analyzing seasonal changes in the rhythms of the females in both groups, no fundamental differences were found in the average daily hemodynamic indices, which means that the functional state of the circulatory system, taking into account their different physical fitness levels, remain relatively stable throughout the year. The index of functional changes (IFC) is also stable and does not approach the critical value in both groups. Consequently, the

Table 1. Changes in the functional indicators of the cardiovascular system of the female university students with different physical activity levels

Indicators	Sporting group		Non-sporting group	
	Autumn	Spring	Autumn	Spring
HR	62.2 ± 1.6	65.2 ± 1.1	80.09 ± 2.9	80.91 ± 3.2
SV	67.52 ± 1.4	67.67 ± 0.9	65.88 ± 2.14	65 ± 1.5
MBV	4.20 ± 0.16	4.42 ± 0.12	5.34 ± 0.12	5.18 ± 0.12
SBP	112 ± 1.8	107.4 ± 1.6	111.27 ± 2.6	110.9 ± 1.6
DBP	69.3 ± 1.9	67.1 ± 1.8	71.5 ± 2.1	71.6 ± 1.85
PP	42.6 ± 0.7	40.3 ± 0.4	40.32 ± 1.9	39.38 ± 1.4
ADP	87.26 ± 1.9	84.02 ± 1.5	88.35 ± 2.13	80.05 ± 1.5
KVI	-11 ±0.9	-3 ± 0.2	10 ± 1.1	10 ± 0.9
TSC	111 ± 3.31	103 ± 2.78	90 ± 2.11	88 ± 2.19
CDC	1.81 ± 0.04	1.65 ± 0.03	1.39 ± 0.03	1.37 ± 0.03
CEC	14.4 ± 1.29	16.2 ± 1.31	20.0 ± 1.41	20.7 ± 1.34
CEC	2666 ± 116	2600 ± 112	3200 ± 123	3159 ± 119
RI	69.4 ± 2.86	69.6 ± 2.17	88.8 ± 2.67	89.1 ± 2.77

total adaptive reserve (AR) of the subjects in both groups remains at a quite acceptable level.

The physiologically standard and predictable picture is confirmed by other hemodynamic indices. The excellent state of the cardiovascular system reserves in the sporting group reflects the cardiac index (Robinson index). It is normal in the non-sporting group. The circulatory deficiency coefficient, which does not increase in any of the groups, is not a cause for concern. This is crucial for the sporting group, as the reduction of this indicator at all training stages reflects the normalization of the cardiovascular system functionality.

The circulatory endurance coefficient, which is virtually stable and reflects the abnormally low cardiac training level of the non-sporting female students, grows seasonally in the sporting group, which indicates at least the restoration of the working capacity that reduces, for example, due to fatigue. It should also be noted that it is the presence of fatigue in the sporting group that indirectly confirms the changes in the other indices. Although slight, the increase in the circulatory efficiency coefficient indicates a decrease in the economical efficiency of hemodynamics, which is due to their fatigue. The seasonal shift in the hemodynamic load towards the heart, and therefore the increased utilization of the functional reserves, is evidenced by the changes in the type of self-regulation of circulation. The type of self-regulation of circulation changes, though slightly.

The group deflections are not critical and this confirms the change in the Kerdo index, which, while reflecting the change of the type of central regulation and decreasing seasonally, remains within the vagotonic zone, which is more acceptable for athletes. These shifts do exist, as opposed to the non-sporting group, where these indicators and the biological rhythm values remain almost unchanged, while being functionally low to reflect the poor training level of cardiovascular system.

Conclusion. The rhythm stability in the non-sporting group may indicate to insignificant loads that require tension in the cardiovascular system in particular, and the cardiorespiratory system in general. The absence of physical loads, other than ecological-climatic, allows the rhythm to remain more stable and ultimately creates the illusion of sustainable adaptive reserves. There is such a reserve, of course, as evidenced by the quite acceptable index of functional changes, which scope is limited by the low functional capabilities, which in the long-term prospects will undoubtedly lead to a further shift in the regulatory mechanisms towards sympathicotonia and reduced economization.

The body of the female students of the sporting group, while reacting to additional, regular and intense physical loads in the same environmental-climatic conditions, utilizes adaptive reserves more actively, and therefore, a high economisation level is not at issue here either. However, the instability of the rhythm in this case reflects not so much the decrease of the adaptive capabilities of the female athletes but the tension in the cardiovascular system itself, reflecting the possibilities of urgent adaptation. The analysis of the hemodynamic indices shows that there are no changes or shifts in the central regulation mechanisms, and that is what counts.

This means that, given the correct distribution of physical loads in the long-term prospects, there should be no negative consequences of changes in the central regulatory vector, which determines the predominant distribution of the load among the structural elements of the body, namely sympathicotonia. However, this possibility should be taken into account, otherwise the change in the central regulatory mechanism will lead to the strengthening of the catabolism characteristic of the strenuous functioning and utilization of the bodily reserves and, as a consequence, to the reduction not only of adaptive but also functional capabilities of athletes, which could affect their sports results.

References

1. Povzun A.A., Grigoryev V.A., Apokin V.V. et al. Comparative analysis of seasonal changes in body adaptive capacities of female skiers based on biorhythm indices. Teoriya i praktika fiz. kultury. 2010. No. 8. p. 95-98.
2. Povzun A.A., Apokin V.V., Povzun V.D., Usaeva N.R. Active sporting female students' biorhythmic structure: seasonal variations. Teoriya i praktika fiz. kultury. 2017. no. 1. pp. 83-85.
3. Pogodina S.V., Globenko R.R., Lukavenko A.V. Systematization of chronobiological observations in rating and modeling of functional capabilities of professional athletes of different ages. Nauka i sport: sovremennye tendentsii. 2018. No. 4. pp. 44-49.