STRESS REACTIVITY OF CENTRAL HEMODYNAMICS IN POWERLIFTERS

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Introduction. Stress tolerance is an important quality that helps protect both human physical and mental health [1]. In most studies the level of stress is determined using psychological tests. But their common drawback is subjectivity when subjects estimate their abilities [3]. Among the recently used objective methods is the reaction of individual hemodynamic parameters and heart rate variability [2, 4]. This paper describes the results of the study of central hemodynamics in powerlifters under the influence of graduated stress load.

The purpose of the study was to examine the reaction of central hemodynamics of powerlifters to graduated stress loads.

Materials and methods. To initiate the state of stress, we used the designed computer-aided choice task, which helps reproduce the state of psychoemotional stress in the examined individuals of any age. The task was to most quickly extinguish the green square image that appears on the monitor screen by pressing a certain key. The computer program automatically displayed a green or red square of specified sizes (1 x 1 cm) in a random sequence in different parts of the screen. The speed of presentation of squares increased with each stage of the test, which followed one another non-stop, and the duration of stages was similar (2 min) and the number of presentations increased from 70 (at the 1st stage) to 120 (on the 5th). Thus, the subject had to work under the conditions of increasing time pressure. Pressing the key when a red square image appeared was regarded as an error. When an error occurred, there was a sound signal and the screen displayed a flash of red. Blood pressure (BP) and heart rate (HR) were measured in the initial state and during the 1st, 5th and 10th minute of the test as well as after 2 minutes of rest. Stroke volume (SV), minute blood volume (MBV), total peripheral vascular resistance (TPVR) and specific peripheral vascular resistance (SPVR) were calculated by generally accepted formulas. Indexed hemodynamic parameter - the cardiac index (CI, l/min/m^2) was calculated using the following formula: CI = SI x HR, where SI (ml/m^2) is stroke index calculated as follows: SI = SV/ABSA, where ABSA (m^2) is the absolute body surface area defined using the Dubois formula. The results were processed by the methods of nonparametric statistics using the license application program package “Excel” and “Statistic for Windows 6.0”. The mean (M) and the error of mean (m) were calculated and a correlation analysis was carried out. Correlations between changes in various parameters were assessed by the Spearman’s non-parametric test. The results were presented as M±m. Differences were considered reliable at the significance level of $p<0.05$.

Results and discussion. ***1. Stress reactivity of central hemodynamics in powerlifters.*** The mean age of the athletes was 21.7±3.6 years (n=18). Body weight indices ranged widely (from 68 kg to 150 kg) and averaged at 91.8±4.9 kg with height being 180.6±1.7 cm. Systolic blood pressure (SBP) of powerlifters in the initial state was proved to be significantly higher compared with that in the control group of non-athletes (125.8±2.87 vs 114.5±1.9 mm Hg; p=0.007). Diastolic blood pressure (DBP in groups) did not differ significantly. Heart rate of powerlifters was higher, but there were no significant differences. Average hemodynamic pressure of powerlifters was also higher (p=0.012), as well as MBV (5758.6±163,3 ml vs 5233.0±167.2 ml; p=0.036). At the same time SI of athletes was lower than in the control group (38.9±1.2 ml/m^2 vs 48.5±1.8 ml/m^2; p=0.000). Specific peripheral vascular resistance of powerlifters was higher in comparison with the control group (30.6±1.39 dyn*s*cm^{-5}/m^2 vs 25.2±1.3 dyn*s*cm^{-5}/m^2; p=0.018). Adaptive capacity of the cardiovascular system of athletes proved to be lower than that of the control group members (2.4±0.10 and 1.9±0.04 points, respectively; p=0.000).

During the ***1st minute*** of the SBP test increased by 3.7% indices in the group of powerlifters (by 5.3%; p=0.02 - in the control group). DBP changed by 1.4% only. In contrast to the control group heart rate of the powerlifters remained almost the same. Average hemodynamic blood pressure of athletes remained higher (p=0.011). MBV increased by 3.0% (and by 9.5% in the control group). Specific peripheral vascular resistance remained practically higher than in the control group (p=0.003). Stoke index remained lower in the group of athletes (39.5±1.2 ml/m^2 vs 49.2±1.9 ml/m^2; p=0.000). Activation of the sympathetic nervous system of athletes was also lower compared to the control group. Vegetation index (Kerdo index) of powerlifters even decreased by 7.2% in contrast to the increase in the control group (by 84.3%). Adaptive capacity of the athletes remained virtually unchanged compared to the control group, but remained lower (2.44±0.09 vs 2.04±0.04 points, respectively; p=0.000).

During the ***5th minute*** of the test no significant changes in SBP, DBP and heart rate took place in the group of powerlifters compared with the initial state. MBV of athletes increased by 5.9% only (and by 12.8% in the control group). The increase of MBV was due to a moderate increase of heart rate (by 4.0%) as well as due to a decrease of specific peripheral vascular resistance (by 3.3%). It is characteristic that the sympathetic nervous system became active. Vegetation index in the group of athletes started to increase compared to the first minute of observation (by 43.06%). Differences in the stroke index values persisted (p=0.000). Adaptive capacity also remained lower (2.43±0.09 points vs 1.99±0.04 points in the control group; p=0.000).

During the ***10th minute*** of the test no significant hemodynamics changes occured in the group of powerlifters. SBP, DBP and heart rate values remain at the level of the 5th minute. A moderate decrease of SV took place (by 1.9%). SI remained practically unchanged. Significant differences in comparison with the control group remain in the values of SBP (p=0.001), pulse pressure (p=0.004), average hemodynamic pressure (p=0.016), SI (p=0.002) and specific peripheral vascular resistance (p=0.025). Adaptive capacity also remains lower (2.46±0.09 points vs 2.00±0.04 points in the control group; p=0.000).

SBP and DBP of athletes returned to their initial values after 2 minutes of ***rest***. At the same time adaptive capacity was over 2.0 points (2.30±0.09).

2. Stress reactivity of central hemodynamics in the control group. Average age of the tested persons was 18.6±1.2 years (n=15), body weight averaged at the level of 64.4±6.7 kg with the height being 171.9±6.6 cm. SBP in the initial state ranged from 105 to 131 mm Hg (114.5±7.5 mm Hg), and DBP - from 52 to 75 mm Hg (63.6±6.66 mm Hg). Average SV in the group was 77.1±7.8 ml, and heart rate was 68.3±2.2 bpm (planned heart rate = 66.7±0.5 bpm). Average hemodynamic blood pressure was within the age norm (80.5±1.3 mm Hg). CI (3.3±0.15 $l*min/m^2$) indicated the hyperkinetic type of blood circulation. SI reached 48.5±1.8 ml/m^2. TPVR averaged at the level of 1255.3±54.4 $dyn*cm^{-5}$. No testees had TPVR values higher than 2500 $dyn*s*cm^{-5.}$ Adaptive capacity (AC) of the cardiovascular system averaged at no more than 2.0 points within the group (1.9±0.04).

During the ***1st minute*** of the test the following reaction of central hemodynamics was observed. SBP increased by 5.3% from initial values (120.2±2.6 mm Hg), and DBP - by 1.6% (65.2±1.7 mm Hg). CI increased by 9.7% from initial values, but SI changed by 1.4% only. Thus, the increase of MBV was mainly due to the increase in HR. Indeed, HR increased by 8.8% from the initial value. Increase of MBV (from 5233.0±167.2 to 5728.7±196.6 ml) occurred also due to a slight decrease in vascular resistance from 25.2±1.3 $dyn*s*cm^{-5}/m^2$ to 24.0±1.4 $dyn*s*cm^{-5}/m^2$, which is associated with the activation of the sympathetic nervous system. Vegetation index increased from 5.6±3.6 to 10.3±3.4 c.u. AC was 2.4±0.04 points, that indicating the moderate tension of regulatory systems.

During the ***5th minute*** of the test the following changes of central hemodynamics took place. SBP started to decrease (to 115.6±2.2 mm Hg), and DBP values approach those of the initial state (63.5±1.6 mm Hg). At the same time MBV kept growing (to 5903.1±225.7 ml). The deviation from the initial state was 12.8%. MBV increase took place mainly due to an increase in HR, SV changed a little. Activation of the sympathetic nervous system continued, as indicated by the increase of the vegetation index (to 15.2±3.5 c.u.). Some contribution to the increase of MBV was made by a continuing decrease of SPVR (from 25.2±1.3 $dyn*s*cm^{-5}/m^2$ in the initial state to 22.7±1.4 $dyn*s*cm^{-5}/m^2$). Although CI kept growing (3.74±0.21 l/m^2 vs 3.62±0.17 l/m^2 during the 1st minute), SI remained practically unchanged compared to the 1st minute. AC of the cardiovascular system returned to the normal limits (not more than 2.0 points).

During the ***10th minute*** of the test SBP continued to decline, although insignificantly, while DBP was growing (by 3.1% of the initial value). Heart rate started to decrease compared to the previous observation period. Decrease of SV compared to the 5th minute of observation was also characteristic (from 77.7±2.1 to 74.4±1.9 ml). This was followed by a decrease of MBV (5573.6±160.0 ml) due to increasing SPVR compared with the previous observation period (from 22.7±1.4 to 24.3±1.2 dyn*s*cm^{-5}/m^2). It should be noted that the activity of the sympathetic nervous system decreased at this stage of the study (vegetation index was 10.9±2.8 c.u.). AC did not change significantly.

After 2 minutes of ***rest*** SBP and DBP returned to their initial state, but heart rate still exceeded the initial values by 5.9%, and SV and SI returned to their initial values. The constantly increased value of MBV was stipulated by continuing increased HR, as SPVR became even lower (24.3±1.4 dyn*s*cm^{-5}/m^2) than such in the initial state (25.2±1.3 dyn*s*cm^{-5}/m^2).

Conclusions

1. Differences in the indicators of central hemodynamics between powerlifters and the control group can be traced already in the initial state. Athletes are characterized by higher values of systolic blood pressure, total peripheral vascular resistance and lower adaptive capacity of the cardiovascular system.

2. Powerlifters are characterized by reduced reactivity of the cardiovascular system in the initial period of reaction to graduated stress. Active change in hemodynamics (increase of heart rate, decrease in peripheral vascular resistance) starts only from the 5th minute. However, the final stage is defined by the loss of efficiency of hemodynamics (decrease of stroke volume, minute volume and increase of peripheral resistance), which is not observed in the control group.

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