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PSYCHOPHYSIOLOGICAL STATE OF AMATEUR ATHLETES REGULARLY ENGAGED IN MOUNTAIN RUNNING

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Annotation. In the performed study, the psychophysiological state was identified and its gender features were revealed in amateur athletes regularly engaged in mountain running in the conditions of the Caucasian Mineral Waters region. The study's results demonstrated a satisfactory functional state of central hemodynamics and parameters of the heart rate autonomic regulation, reduced indicators of sensorimotor reaction time and good mental capacity and endurance in male and female amateur runners aged 35-40 years. Gender differences in hemodynamic and motor performance indices in mature men and women regularly engaged in mountain running were also found. Differences in hemodynamics are manifested by greater peripheral vascular resistance and lower systolic blood pressure in women compared to men. Differences in motor skills are associated with shorter motor reaction time and its variation in men compared to women.

Keywords: amateur athletes, mountain running, long-distance running, hemodynamics, psychomotorics, reaction time, heart rate variability.

Introduction. The role of physical culture and sports as an integral part of preventing and treating diseases is growing each year [1-3]. Majority of the population is actively engaged in physical culture as part of amateur sports [4]. The studies show that physical activities have a favorable effect on delaying development of various diseases such as obesity [5], diabetes [6-7], atherosclerosis, coronary heart disease and many others [8].

There is a large number of sports and physical activities associated with mountains [9-11]. Recently, mountain running is gaining popularity. However, amateur sport and independent workouts may be followed by a high risk of violating the main principles of the training process [12], difficult environmental conditions of the middle altitude have a significant effect on the functional state of the body of those engaged, which requires a special approach [9-11]. For this reason, observation of the functional state of amateur athletes aged over 35 years is of relevance.

The study's objective – to identify the psychophysiological state and reveal its gender-based features in amateur athletes regularly engaged in mountain running.

Methods and organization. The study included amateur athletes regularly engaged in mountain running, who work out 3-6 times per week, residents in the Caucasian Mineral Waters region (Mineralnye vody, Pyatigorsk, Essentuki, Kislovodsk), age – 39.98 ± 6.12 years.

Study of heart rate variability (HRV) and central hemodynamics was made with the ESTECK System Complex (LD Technology, USA). The complex includes bioimpedance sensor, photoplethysmography sensors (pulse oximeter) and oscillometric sensor.

Following indices were also measured with the ESTECK System Complex: SpO₂ – blood oxygen saturation; Stiffness Index, associated with blood pressure in major arteries; Reflection Index, associated with blood pressure in small and medium arteries; PVR – peripheral vascular resistance; CO – cardiac output; CI – cardiac index.

To evaluate the influence of biologically active substances on the psychophysiological state, we examined simple (the RT S1 test variant) and complex visual-motor reactions (the RT S4 test variant).

The reaction time study was conducted with the Vienna Test System (SCHUHFRIED GmbH, Austria). Main variables were: average reaction time, average motor reaction time. When the rest button is used, reaction time is defined as the time between the occurrence of a relevant stimulus and the moment when the finger is removed from the button. Additional variables are: reaction time dispersion – standard deviation of the reaction time after the Box-Cox transformation; motor reaction time dispersion – standard deviation of the motor reaction time after the Box-Cox transformation.

The Schulte test was conducted with the “Sports psychophysiology” complex. This test allows estimating time characteristics of attention (selectivity, stability, switchability), mental capacity when performing activities that require attention [13].

All the participants gave an informed consent to take part in the study. The study was approved by the Biological Ethics Committee of the North Caucasian Federal Scientific and Clinical Center.

The Statistica 13.0 software was used for the statistical data processing. We calculated the standard indices of descriptive statistics (median, first and third quartiles). All data were summarized in tables. The distribution normalcy was identified with the Shapiro-Wilk test. The comparison of indices was made with the Mann-Whitney test (for analyzing data dynamics in independent groups). The statistical significance was deemed valid if $p < 0.05$.

Results and discussion. The study of HRV and hemodynamic parameters has shown that almost all indices were within the physiological norm limits (table 1). There were some slightly reduced values of systolic blood pressure in women engaged in mountain running, which can be explained by sports hypotension resulting from long-term adaptation to endurance loads. The comparative index analysis between men and women demonstrated statistically significant differences in a form of higher indices of the peripheral vascular resistance ($p < 0.0007$) and reduced systolic blood pressure ($p < 0.001$) in women compared to men.

Table 1
Heart rate variability and central hemodynamics indices of amateur athletes regularly engaged in mountain running, Me [Q1; Q3]

Indices	Women	Men	P<	Standard
HR	77.8 [67.4; 89.1]	71.0 [62.1; 74.1]	-	60-80
HF	30.9 [23.9; 42.3]	30.7 [24.7; 38.6]	-	22-34
LF	34.6 [27.6; 40.1]	37.9 [26.4; 51.4]	-	22-46
LF/HF	0.9 [0.8; 1.5]	1.0 [0.8; 2.1]	-	0.5-2
SI	85.2 [71.3; 194.3]	85.2 [58.7; 117.5]	-	50-200
SDNN	50.8 [39.5; 64.4]	52.9 [45.9; 69.5]	-	40-80
SpO ₂	97.0 [96.0; 97.0]	96.0 [95.0; 97.0]	-	95-100
Stiffness Index	7.2 [6.7; 7.5]	7.6 [7.3; 8.4]	-	7-9
Reflexion Index	30.0 [25.0; 30.0]	30.0 [25.0; 30.0]	-	30-45
Augmentation Index	1.1 [1.0; 1.1]	1.0 [1.0; 1.1]	-	0.89-1.33
PVR	1416.8 [1333.8; 1555.8]	1121.7 [1034.6; 1295.7]	0.0007	900-1500
sBP	106.0 [99.0; 123.0]	131.0 [122.0; 135.0]	0.001	110-140
dBp	75.0 [71.0; 86.0]	79.0 [70.0; 86.0]	-	75-90

Note: HF – power of high-frequency waves; LF – power of low-frequency waves; SI – stress index; SDNN – standard deviation of the NN intervals; SpO₂ – blood oxygen saturation; PVR – peripheral vascular resistance; sBP – systolic blood pressure; dBp – diastolic blood pressure; data are presented in a form of medians and quartiles; p – according to the Wilcoxon’s test

The sensorimotor reaction time study revealed low values in amateur runners, which may be related to age as well as specifics of sports activity (long running). There are statistically significant gender differences as well:

reduced motor time of simple and complex sensorimotor reactions in men compared to women, as well as reduced values of the motor reaction time dispersion (table 2). All participants had acceptable values of mental capacity and stability.

Table 2

Indices of sensorimotor reactions' time and mental capacity of amateur athletes regularly engaged in mountain running, Me [Q1; Q3]

Indices	Women	Men	P<
SSRT	288.0 [280.0; 307.0]	262.0 [248.0; 282.0]	-
Motor SSRT	159.0 [149.0; 196.0]	115.0 [94.0; 143.0]	0.0008
SSRT dispersion	44.0 [32.0; 46.0]	32.0 [26.0; 45.0]	-
Motor SSRT dispersion	22.0 [20.0; 29.0]	18.0 [14.0; 22.0]	0.03
CRT	425.0 [344.0; 500.0]	412.0 [345.0; 476.0]	-
Motor CRT	211.0 [155.0; 219.0]	132.0 [109.0; 149.0]	0.02
CRT dispersion	59.0 [45.0; 71.0]	64.0 [47.0; 86.0]	-
Motor CRT dispersion	30.0 [18.0; 42.0]	16.0 [14.0; 22.0]	0.03
Work efficiency	35.0 [34.2; 36.3]	37.9 [33.6; 43.7]	-
Mental capacity	1.0 [0.9; 1.0]	1.0 [0.9; 1.1]	-
Mental stability	0.9 [0.9; 1.1]	1.0 [0.9; 1.1]	-

Note: SSRT – simple sensorimotor reaction time; the data are presented in a form of median and quartiles; CRT – choice reaction time; p – according to the Wilcoxon's test

Identification of connections of psychophysiological indices of HRV, reaction time and mental capacity revealed a negative correlation of the degree of choice reaction time dispersion with the HR index ($r=0.86$, $p<0.05$) and positive correlation of the degree of choice reaction time dispersion with HF ($r=0.89$, $p<0.05$), mental stability with LF ($r=0.89$, $p<0.05$). The data received reflect an increase in stability of sensorimotor reactions and mental capacity with increased tone of the sympathetic division of the autonomic nervous system.

Conclusion. The conducted study has identified the physiological state and found its gender features in amateur athletes regularly engaged in mountain running in the conditions of the Caucasian Mineral Waters region. The study's data show a satisfactory functional state

of central hemodynamics and heart rate autonomic regulation, reduced indices of the sensorimotor reaction time and desirable indices of mental capacity and endurance. We have found a connection between the autonomic nervous system and mental capacity: increased stability of sensorimotor reactions and mental capacity with increased tone of the sympathetic division of the autonomic nervous system.

We have also discovered gender differences in hemodynamic and motor indices of mature mountain runners. The differences in hemodynamics are shown in higher peripheral vascular resistance and lower systolic blood pressure in women compared to men. The differences in motor skills are associated with shorter motor reaction time and its dispersion in men compared to women.

Conflict of interest. The authors declare no conflict of interest.

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