Original Article

Vegetative status of sportsmen depending on the level of their sensorimotor reaction

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Published online: June 30, 2017

(Accepted for publication June 17, 2017)

DOI:10.7752/jpes.2017.02113

Abstract:

The researchers studied the influence of sensorimotor reactivity on vegetative status of sportsmen. Among the examined sportsmen, the majority of individuals with medium level of sensorimotor reactivity possess vegetative tonus, characterized by background emphotony, while sympathicotonia was supposedly prevalent in a group of sportsmen with high level of sensorimotor reactivity, in comparison with those with medium and low level of sensorimotor reactivity ($p < 0,05-0,001$). Hypersympatycotonic vegetative reactivity was estimated among sportsmen with high and medium level of sensorimotor reactivity, which indicates tension in functioning of cardio-vascular system and lowering of body's adaptive abilities. High speed of sensorimotor reactivity facilitates increasing the tension of the mechanisms of heart rhythm vegetative regulation, which is accompanied by parasympathetic influences of vegetative system.

Key words: sensorimotor reactivity, vegetative status, vegetative reactivity, cardiointervalography, sports activity.

Introduction

Perception and processing of visual information is one of the principal capacities of human nervous system. It is a generally known fact that effectiveness of people's professional activity under the influence of nervous processes speed characteristics (speed of information perception, analysis, decision making, its translation on the effector) and time of aftereffect, restoration of reflector unit readiness to new reaction, ability to perceive the rhythm etc. [3, 12, 17].

Sport activity is categorized as an extreme human activity characterized by constant variability of factors of training process, decision-making in the context of uncertainty and time deficit, which influences formation of regulatory mechanisms and adaptive abilities of child's body [18, 21]. The character and extent of influence is determined by combination of exogenous (specifics of physical exercise stress, peculiarities of training process) and endogenous factors, connected with individual features of morphofunctional and psychofunctional status of adolescent sportsmen. [19, 22, 23]

As evidenced by the analysis of recent research and publications, development and formation of neurodynamic properties and sensorimotor functions depend not only on morphofunctional cortical and subcortical brain structures but also on functional state of sportsmen's body, the level of motor activity, sport specialization and qualification [2, 6, 7, 9, 10].

Higher centers of nervous system facilitate mobilization and regulation of body's vegetative functions, while the character of vegetative regulation mechanisms, level of physiological reserves and physiological cost of adaptation of body's principal functional systems determine sport results and sportsmen's health state as a whole [3, 13, 20].

Moreover, mobilization of functional reserves of organs and systems of organism in response to impact of extreme factors, which is accompanied by explicit hypoxia leads to activation of lipids peroxidation. It is generally known that a state of hypoxia may be both an etiologic factor of many disorders and a factor in forming long-term adaptation to physical exercise stress [8].

Secondary vegetative disorders may be an early indicator of health disorders in sportsmen, connected both with physical and psycho-emotional stress which are common in sports [16, 24].

For this reason prevention takes a special role in the process of managing sportsmen's training process, as part of the healthcare system and activities should be aimed at detection of pre-nosological state in sportsmen and its correction [11].

The aim of the study is to determine specifics of vegetative regulation of heart rhythm in sportsmen with different level of sensorimotor reactivity.

Material and methods

The researchers examined 27 sportsmen of high qualification, Masters of Sports of Ukraine in pankration, aged 18-20.

Specifics of sensorimotor reactivity in sportsmen were determined based on indicators of sensorimotor reactivity using program application "Diagnost-1" [14].

Sensorimotor reactivity was evaluated based on the latent period of simple visual-motor response time (LP VMRT), latent period of selection response in three-stimuli oddball tasks (LP SR1-3) and choice of two out of three stimuli (LP SR2-3). Latent periods of motor-visual response of different complexity were determined in "optimal rhythm" mode, which is the most convenient for each individual. Performing the task in a set mode allowed to register medium time of latent period and complex motor-visual response (M), standard deviation (σ) and error of the mean (m).

The level of sensorimotor response (low, medium, high) was determined using sigma deviation method ($M \pm 1\sigma$) by simple motor-visual response indicator.

Depending on the level of sensorimotor response, sportsmen were divided in three groups:

First group – sportsmen possessing low level of sensorimotor response ($n=8$);

Second group – sportsmen possessing with medium level of sensorimotor response ($n=10$);

Third group – sportsmen possessing with high level of sensorimotor response ($n=9$).

To assess vegetative regulation examination of variable heart rhythm (VHR) was conducted using for short recordings hardware and software complex "CardioSpectr" LC Solveig according to international standard (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996).

The researchers performed two types of analysis: time-domain analysis and frequency-domain analysis. In the process of time-domain analysis the following elements were assessed: NN normal series of R-R intervals excluding extrasystoles; SDNN – standard deviation of NN intervals; RMSSD – Root Mean Square of the Successive Differences R-R; pNN50 – the fraction of consecutive NN intervals that differ by more than 50 ms; SI – index of tension.

In frequency-domain analysis the absolute magnitude of (TF) total frequency; (HF) the power of high frequency fluctuations, which is specific of respiration component of heart rate variability, connected with parasympathetic regulation; LF – powers of low frequency fluctuations of specter, which reflect the activity of subcortex vasomotor center and are connected with sympathetic chain of regulation; VLF – the powers of very low frequency, which reflects activity of suprasegmental divisions of autonomic nervous systems and neurohumoral component of regulation, LF/HF – coefficient, which reflects the balance of vegetative influences.

Computer analysis included determining initial vegetative tonus; the prevalence of parasympathetic (vagotonia) or sympathetic (sympathicotonia) division of higher nervous system, balance (eutony).

Registering by cardiointervalogramm was conducted in horizontal position (lying on the back), in the state of relative calm during the first half of the day for a total of five minutes.

Determining of higher nervous system reactivity was performed using active orthostatic test [4, 24].

After background recording by intervalogramm, an examined sportsman without any abrupt movements took vertical position in which a repeat recording was done.

Assessment of vegetative reactivity was determined in correlation SI2 (index of tension in orthostasis) to SI1 (index of tension in the state of relative calm) and normal, hypersympathicotonic and asympaticotonic types were singled out [12].

Mathematical and statistical processing of the data was performed by an application "STATISTICA 8.0" with determining the mean (M) and standard error (m).

For nominal variables the interconnection according to the conjugation table and Pearson (χ^2) criterion was applied. Using dispersion analysis the contribution to sanitary and hygiene factors of examined youth sport schools to measures of functional state of young sportsmen's bodies was calculated.

Differences between samplings in cases of comparison of their mean, distributed by normal law, were assessed by Stuart's parasympathetic criterion (t). Probability of differences was assessed by the level of significance (p) at the $p < 0,05$ level.

The research is carried out according to the plan of scientific and research work of the Chair of medical and biological fundamentals of physical culture Sumy Makarenko State Pedagogical University on the topic "Physiological and hygienic support of health-promotion activity of educational establishments" state registration 0113U004662.

Results

The assessment of structure of initial vegetative tonus allowed to establish prevalence of background emphotony ($52,94 \pm 9,61\%$), which guaranties optimal adaptation to factors of external environment. Vegetative balance, defined among the majority of the examined individuals, is allegedly connected to completing of adaptive transformations and formation of optimal regulation on the given stage of ontogenesis.

Vagus-cholinergic type of vegetative regulation, manifested through parasympathicotonia among $41,18 \pm 9,47\%$ sportsmen, which is appropriate to morphologic maturity of organism and ensures stabilization of hearth rhythm regulation due to improvement of self-regulation mechanisms.

As evidenced by the results of analysis of initial vegetative tonus of sportsmen depending of the level of their sensorimotor response, background emphotomy prevailed among individuals with medium level of sensorimotor response ($83,33 \pm 7,17\%$), compared to representatives who had high ($50,0 \pm 9,62\%$, $p < 0,01$) or low level ($20,0 \pm 7,70\%$ $p < 0,001$) of sensorimotor response.

Parasympathictonia occurred only among sportsmen with low level of sensorimotor response, while the percentage of individuals with sympathictonic vegetative tonus was allegedly higher among people with high sensorimotor response ($57,14 \pm 9,52\%$), compared to sportsmen with medium ($28,57 \pm 8,69\%$, $p < 0,05$) and low level of sensorimotor response ($14,29 \pm 6,37\%$, $p < 0,001$).

Assessment of vegetative reactivity of sportsmen demonstrated that vegetative imbalance among the majority of examined sportsmen, manifested through asympaticotonic ($40,0 \pm 9,43\%$) and hypersympaticotonic reactivity ($33,33 \pm 9,14\%$), which is the evidence of unsatisfactory adaptation as a result of decline of defense and adaptation mechanisms of their bodies.

Analysis of variables of vegetative reactivity of sportsmen enabled to define their dependence on the level of sensorimotor reactivity ($\chi^2 = 17,84$, $p < 0,01$).

Normal vegetative reactivity occurred among $75,0 \pm 8,33\%$ sportsmen with low level of sensorimotor response, while the percentage of individuals with high level of sensorimotor response with normal reactivity was supposedly lower and constituted $25,0 \pm 8,33\%$ of examined individuals ($p < 0,001$) (Fig. 1).

Fig. 1. Structure of vegetative reactivity of sportsmen depending on their sensorimotor response, (%), (n=27)

Vegetative balance, which manifested through hypersympaticotonic reactivity occurred in $60,0 \pm 9,42\%$ of sportsmen with high level of sensorimotor reactivity and $40,0 \pm 9,42\%$ of sportsmen with medium level of sensorimotor response (lacking among the individuals with low level), which is the evidence of stress of cardiovascular system, decline of adaptive capacity of organism in estimated individuals.

Results of analysis of variables of heart rate variability indicate hyperactivity of sympathoadrenal system in sportsmen with high level of sensorimotor response (Table 1). The value of SDNN which reflects standard heart rate variability and RMSSD, which indicated high frequency components of heart rhythm in sportsmen with high level of sensorimotor response were allegedly lower, compared to sportsmen with low level of sensorimotor response ($p < 0,01$). The received data signifies enforcement of sympatic influence, which suppresses activity of autonomous contour of regulation in sportsmen with high level of sensorimotor response.

The SI variable was higher among the individuals with high level of sensorimotor reactivity, which indicates the stress of regulatory mechanisms of their body ($p < 0,01$).

Table 1. Indicators of heart rate variability of sportsmen depending on their level of sensorimotor response, (M $\pm$ m)

Indicators	sportsmen possessing low level of sensorimotor response, $n=8$	sportsmen possessing medium level of sensorimotor response, $n=10$	sportsmen possessing high level of sensorimotor response, $n=9$
NN, ms	710,33±11,41	713,25±23,43	699,80±18,87
SDNN, ms	163,0±37,39**	77,0±23,58	51,40±6,95
RMSSD, ms	209,5±53,79**	83,50±40,61	45,60±6,03
pNN50, %	43,67±9,04	21,0±7,45	19,60±4,91
SI	24,33±7,79**	63,5±20,80	101,0±23,06
triangular index	10,17±1,08**	7,25±0,75	6,40±0,75
Mo	641,0±25,30	701,0±38,30	657,0±16,0
Amo	21,50±2,64**	30,75±3,73	33,40±2,68
TP, ms ²	28256,0±11454,61	6429,75±3613,90	2737,6±742,99
VLF, ms ²	4549,83±1781,72*	1350,0±570,54	619,40±305,36
LF, ms ²	8929,5±4152,68	1847,25±677,68	1298,2±363,66
HF, ms ²	14776,67±5606,53*	3210,25±2438,18	820,40±204,38
LF/HF	0,68±0,19*	1,98±0,99	2,10±0,66

* - $p<0,05$, probable difference, compared to a group of high level of sensorimotor response;

** - $p<0,01$, probable difference, compared to a group of high level of sensorimotor response.

Analysis of specter characteristics of heart rate variability of sportsmen with different levels of sensorimotor response indicates probable differences in groups of estimated individuals with very low frequency (VLF) heart rate, high frequency (HF) specter of fluctuations and vegetative balance (LF/HF).

Allegedly lower variables of HF combined with hyperactivity of suprasegmental division of vegetative nervous system (VLF) in sportsmen with high frequency of sensorimotor response indicate activation of sympatic chain of vegetative regulation of heart rhythm. The stated fact is confirmed by supposedly higher variable of LF/HF in sportsmen with high level of sensorimotor response, ($p<0,05$), which indicates stressing of regulatory mechanisms in the estimated individuals.

Discussion

In the study, it was determined a significantly higher proportion of persons with sympathicotonia among athletes with a high level of sensorimotor response in comparison with athletes with low-and middle-level sensorimotor response ($p<0,05-0,001$), which coincides with the data of other authors [10, 20].

Analysis of autonomic reactivity suggests, that hypersympaticotonic type was determined in athletes with high and medium level sensorimotor response that indicates the tension they have of the functioning of the cardiovascular system, reducing the adaptive capacity of the organism[1, 5, 6, 13].

The high level of sensorimotor response connected with stressing of vegetative regulation of heart rate, which is accompanied by decline in parasympatic influences of vegetative nervous system [10, 20].

Conclusions

We came to conclusion that high level of sensorimotor response connected with stressing of vegetative regulation of heart rate, which is accompanied by decline in parasympatic influences of vegetative nervous system.

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