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Effect of Different Physical Activities on Neuromuscular System of Sprint Skiers Subject to Bioenergetic Types of Organism

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Abstract: One of the essential preconditions of the performance of athletes is the level of the neuromuscular system functional state. The investigation of the neuromuscular system performances subject to bioenergetic types of an organism ensures deeper analysis of psychophysiological state of the sprint skiers after different physical activities. The study was conducted on the 14-16 year-old sprint skiers of I senior category. The first stage of the study included “D&K-TEST”. This method allowed identifying the profiles of the sprint skiers and divide them into groups according to the energizing type such as anaerobic, aerobic and mixed. The second stage of the study involved psychological diagnostics. Psychological diagnostic tests were carried out up to load, further-after prolonged cyclic aerobic load for 2 h 50 min up to 3 h and then, after round-robin speed exercise on roller skis with variable speed acceleration and strength load for up to 1.5 h. The results of the sprint skier’s psychological diagnostics by bioenergetic type showed that the anaerobic skiers have the most difficulties in enduring the prolonged monotonous exercises than the athletes of aerobic and mixed types. According to psychophysiological studies, one can say that the best type of exercises for anaerobic skiers is speed activities but of limited amount. Both high-speed and long monotonous and strength physical activities are equally suitable for the sprint skiers of mixed type as the psychophysiological studies have shown. According to psychological diagnostics of aerobic skiers, their preference shall be given to low-intensity prolonged physical activities as well as strength loads with a certain influence on the slow muscle fibers.

Key words: Sprint skiers, bioenergetic types of organism, anaerobic type, mixed type, aerobic type, neuromuscular system

INTRODUCTION

The modern ski racing features an increased load on neuromuscular system due to a significant increase in both athletic performance and the volume of physical activities. One of the essential preconditions of the performance of athletes is the level of the neuromuscular system functional state. Numerous studies (Ilyin, 2005; Gibadullin, 2013; Golovachev, 2011; Marinich, 2013) give evidence of the manifestation of highly quick response or speed qualities of the body, depending on the neuromuscular system which is an innate peculiarity defining an individual giftedness which serves in sports as a feature for orientation and selection for various kinds of sports activities. The analysis of the neuromuscular system performances subject to bioenergetic types of an organism could help to analyze deeper the psychophysiological state of athletes after different physical activities. In this regard, the study of the responses of the central nervous system and skeletal system to various physical activities subject to bioenergetic types of athletes is obviously relevant. One of the main ways of solving this problem is to study the dynamics of psychophysiological performances using an integrated portable apparatus for athletes’ psycho diagnosis.

MATERIALS AND METHODS

The study involved male sprint skiers aged 14-16 years (n-18), of I senior category. The first stage of the study included “D&K TEST”, operating on the principle of recording the electrocardiogram in the standard (I, II, III) leads, augmented (aVR, aVL, aVF) leads and chest (V3R, dV3R, V1, V2 , dV2, V4, V5, V6, dV6) leads according to Wilson. This method allows determining a genetically determined bioenergetic type of the athletes’ body by R and S waves in different ECG leads (Gibadullin, 2010; Karlenko, 2013; Kugaevskii, 2009; Petrov, 2014). We classified the bioenergetic profiles into three groups of athletes, namely, anaerobic, mixed and aerobic types. The anaerobic group included 7 athletes, mixed group 6 and aerobic group 5 athletes.

The second stage of the study involved psychological diagnostics with the use of a portable apparatus. The following tests were determined:

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"Tapping" test in 30 sec; Static tremor in 30 sec; "Step-circles" test consisted of 2 circles with a diameter of 20 mm and at a distance of 11 cm from each other. Both circles were quickly touched one by one on command; the number of touches and faults in 30 sec was recorded. "Traffic lights" test identified a complex visual-motor response of the left and the right hands in msec.

Psychological diagnostic tests were carried out up to load, further after prolonged cyclic aerobic activity for 2 h 50 min up to 3 h and then, after round-robin speed exercise on roller skis with variable speed acceleration and strength load for up to 1.5 h (Rusko, 2003).

RESULTS AND DISCUSSION

Based on the obtained results, we monitored the dynamics of psychophysiological changes in the sprint skiers after different physical activities subject to the bioenergetic types of body.

Psychophysiological findings of the sprint skiers obtained after various types of physical activities revealed the following. The "tapping-test" after prolonged physical activity showed reduction in the performances in all three groups: by 4.7 beats ($p<0.01$) in the anaerobic group by 0.6 beats in the mixed group and by 1.6 beats in the aerobic group. The sprint skiers of anaerobic type showed a significant reduction. The "tapping-test" shows well a quick response of the neuromuscular system, reflecting thereby the speed of impulses along nerve fibers as well as the nature of the excitatory processes. A significant decrease in performances after prolonged physical activity indicates the largest increase in inhibitory processes of the anaerobic-type skiers. As the nature of the applied load was prolonged and monotonous, it indicates a reduced conduction of impulses along nerve fibers. In addition, the neuromuscular system of anaerobic-type skiers is less predisposed to prolonged and monotonous loads which leads to rapid fatigue.

The "tapping-test" findings obtained after speed exercise showed an increase in the performances of the aerobic- and mixed-type groups by 3.3 beats ($p<0.01$) and 13.5 beats ($p<0.05$), respectively while the values of the aerobic-type group remained at the same level. The skiers of anaerobic and mixed types showed a significant increase in their performances. The obtained data showed the highest increase in the skiers of mixed type and more significant increase in the boys of anaerobic type. This test after speed load showed a highly increased lability and, therefore, the force of the neuromuscular system excitation which is reflected by the involvement of fast, large nerve and muscle fibers.

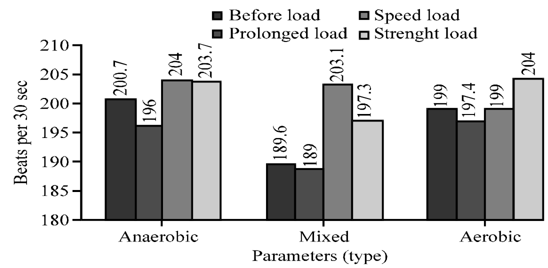

Fig. 1: "Tapping test" performance dynamics after different physical activities subject to the bioenergetic types of body (*$p<0.05$; **$p<0.01$)

The "tapping-test" findings obtained after strength exercise showed an increase in the performances of all three groups: anaerobic-type group by 3 beats, mixed-type group by 7.7 beats and aerobic-type group by 5 beats ($p<0.05$). The skiers of aerobic type showed a significant increase in their performances. The strength load has also resulted in increased excitation and lability of neuromuscular system, but to a lesser extent than the speed load in skiers of anaerobic and mixed types (Fig. 1).

The static tremor test showed the following dynamics. A prolonged physical activity results in the increased tremor indicators in the athletes of all bioenergetic types: anaerobic by 24.7 touches ($p<0,01$), mixed by 20.7 touches ($p<0.01$) and aerobic by 14.6 touches ($p<0.01$). Static tremor reflects largely the small-amplitude oscillation of the distal parts of the limbs resulting from alternating contraction of agonist and antagonist muscles which is connected with the excitation and inhibition processes in these muscles. Tremor is also associated with the time delay in corrective afferent impulses. A significant increase in static tremor can be seen in all skiers after prolonged physical activity and the largest increase in tremor was detected in the anaerobic-type skiers. This test shows that the anaerobic-type skiers had a higher excitation of the neuromuscular system.

The speed load has led to the increased tremor in the athletes of all bioenergetic types: anaerobic by 25 touches ($p<0.01$), mixed by 15 touches ($p<0.05$) and aerobic by 27 touches. The skiers of anaerobic type show larger and significant increase in static tremor after the speed load. The speed load has led to larger excitation and further tremor in sprint skiers of anaerobic type which indicates rapid fatigue of the neuromuscular system.

The obtained data on static tremor after strength load showed the following changes. Static tremor increased in all study groups: anaerobic by 33.8 touches ($p<0.05$), mixed by 19.4 touches ($p<0.06$) and aerobic by 18.2 touches. The skiers of anaerobic type also show larger and significant increase in static tremor after the strength load (Fig. 2).

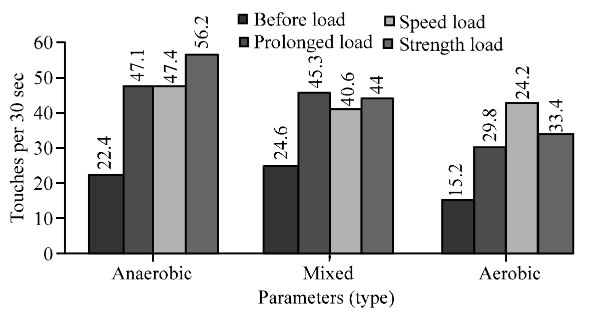

Fig. 2: Static tremor performance dynamics after different physical activities subject to the bioenergetic types of body (*p<0.05; **p<0.01)

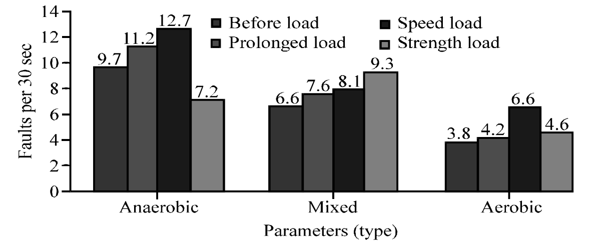

Fig. 3: "Step-circles" test performance dynamics in the number of faults after different physical activities subject to the bioenergetic types of body

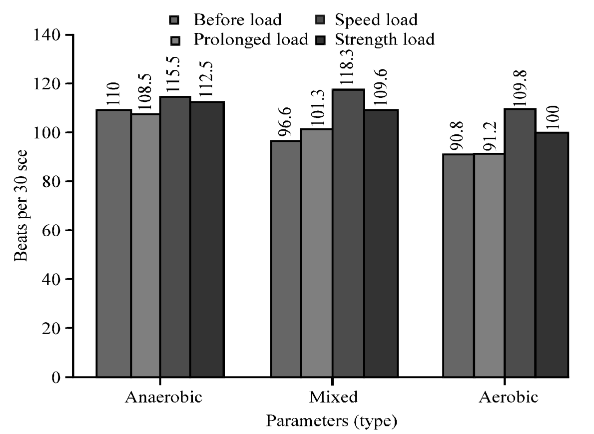

Fig. 4: "Step-circles" test performance dynamics after different physical activities subject to the bioenergetic types of body (*p <0.05; **p <0.01)

The "step-circles" test showed the following results. The group of anaerobic-type skiers showed decrease in average values after prolonged physical activity by 1.5 beats as well as increase in the number of faults made by 1.5 beats. The group of mixed and aerobic-type skiers showed increase in average values by 4.7 and 0.4 beats as well as increase in the number of faults made by 1 and 0.4 beats. This test reflects largely the mobility (switching speed of excitation and inhibition processes) and lability of the neuromuscular system and the speed of refocusing of the visual-motor response. The prolonged physical activity has not led to significant changes, however, the average values show an increase in inhibition processes and decrease in attention level of the anaerobic-type sprint skiers.

Speed physical activity resulted in the increased average values in the athletes of all bioenergetic types: anaerobic by 5.5 beats mixed by 21.7 beats ($p<0.01$) and aerobic by 19.8 beats ($p<0.05$). In this test, all groups of athletes made greater number of faults: anaerobic by 3 touches, mixed by 1.5 touches and aerobic by 2.8 touches. There are significant changes in the performances of the athletes of mixed and aerobic types. This indicates a positive impact of the load on the neuromuscular system mobility. This test for a number of faults made has revealed no significant changes; however, the overall trend can be seen as a slight decrease in the level of attention and accuracy that is likely due to a larger excitation of the neuromuscular system after speed load. Findings of the "step-circles" test obtained after strength load have shown the following dynamics. The sprint skiers of all bioenergetic types showed the increased average values: anaerobic by 2.5 beats, mixed by 13 beats and aerobic by 9.2 beats ($p<0.05$).

In this test, the number of faults made increased in mixed-type groups by 2.7 beats, anaerobic by 0.8 beats while aerobic-type athletes made fewer faults by 2.5 beats. This test has revealed a significant increase in the performances of the aerobic-type sprint skiers after strength load which indicates the strength of neuromuscular system excitation. No significant changes in the number of faults made were observed (Fig. 3 and 4).

The "traffic light" test has shown a performance dynamics in the time of complex visual-motor left-hand response as follows. A prolonged physical activity resulted in the increased time in the sprint skiers of all bioenergetic types: anaerobic by 100.3 msec, mixed by 206.8 msec and aerobic by 58.4 msec. This test determines the complex visual-motor response associated with the speed of excitation and signal processing in the brain cortex. After the prolonged physical activity, the time of left-hand reaction showed increase in time of all sprint skiers, however, without any significant changes. The worsened reaction time after prolonged physical activity indicates central delay and slight fatigue in the right part of the brain.

Speed physical activity resulted in the increased time of the left-hand reaction in the sprint skiers of all

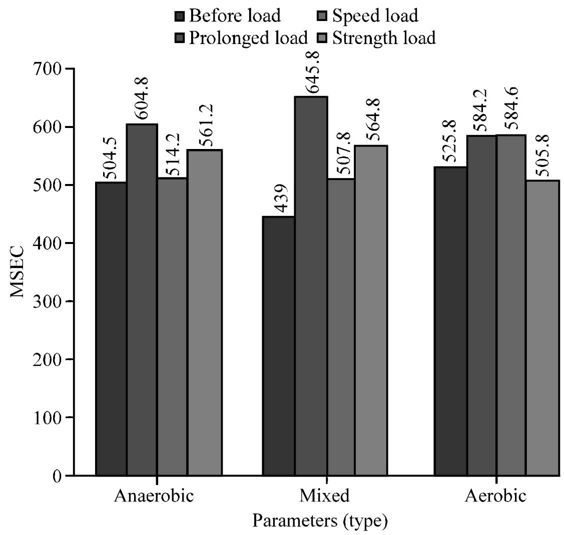

Fig. 5: Visual-motor left-hand response performance dynamics after different physical activities subject to the bioenergetic types of body (*p<0.05; **p<0.01)

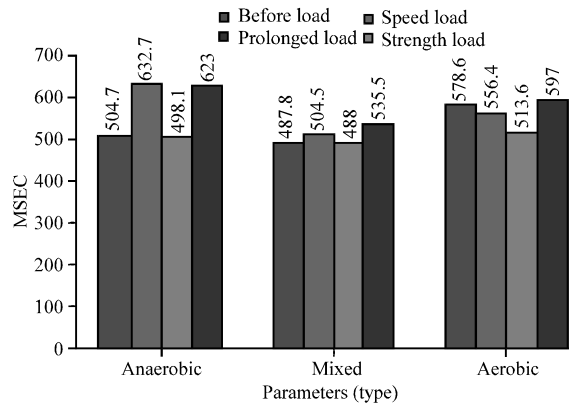

Fig. 6: Visual-motor right-hand response performance dynamics after different physical activities subject to the bioenergetic types of body (*p<0.05; **p<0.01)

bioenergetic types: anaerobic by 9.7 msec, mixed by 68.8 msec and aerobic by 58.4 msec. No significant changes were determined; however, the general trend of increase in time of response to speed load is lower than in other types of physical activity.

Strength physical activity resulted in the increased time of the left-hand reaction in the sprint skiers of anaerobic type by 56.7 msec and mixed by 125.8 msec ($p<0.05$) while the aerobic-type group showed decrease in their reaction time by 20 msec. A significant increase in the reaction time can be observed in the sprint skiers of mixed type (Fig. 5).

The "traffic light" test has shown a performance dynamics in the time of complex visual-motor right-hand response as follows. Prolonged physical activity resulted in the increased time of the right-hand reaction in the sprint skiers of anaerobic and mixed types by 128 msec ($p<0.01$) and 16.7 msec, respectively while the aerobic-type group showed decrease in their reaction time by 22.2 msec. A large significant increase in reaction time of anaerobic-type sprint skiers after prolonged physical activity expresses clearly the central delay and significant fatigue of visual-motor response and left cortex of the brain.

Speed physical activity resulted in the decreased time of the right-hand reaction in the sprint skiers of anaerobic and aerobic types by 6.6 msec and 65 msec, respectively, while the mixed-type group showed increase in their reaction time by 0,2 msec. This physical activity has not led to any noticeable changes. Strength physical activity resulted in the increased time of the right-hand reaction in the sprint skiers of all bioenergetic types: anaerobic by 118.3 msec ($p<0.05$) mixed by 47.7 msec and aerobic by 18.4 msec. A large significant increase in reaction time of anaerobic-type sprint skiers after strength load indicates the growing fatigue processes (Fig. 6).

Summary: Our psychophysiological study revealed the performance of the neuromuscular system of sprint skiers subject to their bioenergetic types after various physical activities. According to the results of psychodiagnostics, the aerobic-type athletes have highly labile and mobile nervous system. While the neuromuscular performance is lower than in the aerobic- and mixed-type which is especially noticeable in the most test results obtained after prolonged physical activities. Speed training loads showed high level of excitation of the neuromuscular system in athletes of these types. However, there was a significant increase in static tremor, indicating decreased performance of anaerobic-type skiers after speed load; nevertheless, a decline in performance of the neuromuscular system was still less pronounced as compared to the results obtained after prolonged physical activities. Strength trainings affected the growth of the neuromuscular excitation in athletes of this type but they were less pronounced as compared to the results obtained after speed physical activities.

The mixed-type sprint skiers showed high mobility and performance of the neuromuscular system as compared to the anaerobic-type skiers. It reflects most clearly the results of prolonged physical activity where a decline in the neuromuscular performance is less pronounced. A significant increase in most test results after speed load in the mixed-type skiers indicates high level of performance of the neuromuscular system at this type of activity. High neuromuscular performance can be seen also after strength load which shows highly significant values of the obtained results.

The sprint skiers of aerobic type showed higher neuromuscular performance after prolonged physical activity than the anaerobic-type skiers but less pronounced than the mixed-type athletes. Speed physical activity has led to less pronounced performance of the neuromuscular system in the athletes of this type as compared to the skiers of other bioenergetic types. Strength physical activity indicates a higher increase in the performance of the neuromuscular system as compared to the sprint skiers of anaerobic type.

CONCLUSION

The results of the sprint skiers psychological diagnostics by bioenergetic type showed that the anaerobic skiers have the most difficulties in enduring the prolonged monotonous exercises (Sandbakk, 2010; Oyono-Enguelle, 1990) than the athletes of aerobic and mixed types. The study has shown that physical activity in most of the tests show a significantly higher increase in the fatigue process of the neuromuscular system than in other study groups. Therefore, the sprint skiers of anaerobic type should choose physical activity more carefully. According to psychophysiological studies, one can say that the best type of exercises for anaerobic skiers is speed activities but of limited amount. The study has revealed the highest performance of the neuromuscular system in the mixed-type sprint skiers after all physical activities studied. Both high-speed and long monotonous and strength physical activities are equally suitable for this group of sprint skiers. According to psychological diagnostics of aerobic skiers, their preference shall be given to low-intensity prolonged training loads as well as strength loads with a certain influence on the slow muscle fibers (Mahood, 2001).

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