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Relationship among Height Weight and Motor Nerve Transmission Velocity in Aerobic Trained Athletes

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Abstract

The purpose of this study was to investigate the relationship among height, weight and motor nerve conduction velocity (MNCV) in upper and lower extremities (radial & sural nerve of bilateral side) in aerobic trained athletes (long distance runners & cyclists). A total of 50 male long distance runners & cyclists with an average age, height and weight of 23±2 years, 172.8±5.8 cm and 70.05±4.2 Kg respectively, volunteered to participate in this study selected from Tamilnadu. Each subject's MNCV was measured with the help of computerized equipment called "NEUROPERFECT" (Medicaid Systems, India) and the data was analyzed using Mean ±SD and Pearson correlation. Results shows that MNCV of radial nerve of right and left side was not significantly different (p < .05) but MNCV of sural nerve of bilateral side significantly different (p < .05). The sural nerve had significantly faster MNCV than the radial nerve. The body height was positively and significantly related with MNCV of left radial nerve (r=.41) but negatively with MNCV of right sural nerve (r= -.30).The body weight was also positively and significantly related with MNCV of right radial nerve (r=.29) and left radial nerve (r=.33) respectively. Thus, it is concluded that the faster MNCV of sural nerve in long distance runners and cyclists may be the result of their long term training adaptations which may be further related to their pattern of movement requirement.

Keywords: Motor Nerve Conduction Velocity, Long Distance Runners, Cyclists.

Introduction

Theorists have pointed to the contribution of neurological system to the performance of the athletes of different sports due to the requirement of different motor actions (Payne & Morrow 1993). Some studies suggest strength and power athletes have faster MNCV than endurance athletes (Kamen et al.,1984). However, it has also been reported that no differences were evident between power and endurance groups (Sleivert et al., 1995). Other researchers have shown that trained individuals have faster MNCV than untrained ones (Hoyle & Holt 1983).The findings of nerve conduction velocity may give explanations for poor performance of the athletes due to poor muscle coordination and/or weakness of muscle actions (Wilbourn 1990). It is more meaningful and interesting to measure the motor nerve conduction velocity in upper and lower extremities of aerobic trained athlete like long distance runners & cyclists who need to control their movement patterns accurately and maintained pace or speed during the performance and this requires neural adaptation in them. In theory, changes in MNCV may be an indicator of improved neural adaptations in athletes due to their exercise training program. The nervous system is divided into the central nervous system (CNS) that includes the brain and spinal cord, and the peripheral nervous system (PNS) comprising cranial nerves and spinal nerves. The brain comprises of two regions:

- Cerebellum - coordinates muscles to allow precise movements
- Diencephalon - contains two structures:
    - Thalamus - acts as a relay station for incoming sensory nerve impulses, sending them on to the relevant areas of the brain for processing
    - Hypothalamus - keeps conditions inside your body constant e.g. regulating your body temperature

Receptor organs, which include the ears, eyes and muscles, collect information (stimuli). The CNS then interprets this information and sends it back to 'effector' organs which carry out the body's response to the stimuli. Some actions are largely automatic, such as the stretch/reflex involved in the leg muscles when jumping but others appear to be more interpreted by the brain, like fatigue signals. Research indicates that prolonged sports involvement influences the way the CNS 'controls' muscular recruitment and patterning. Researchers from Finland (Eloranta 2003) investigated the influence of sports background on leg muscle coordination during concentric and drop vertical jumps. They discovered that the CNS influenced the firing and recruitment patterns of

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the sports participants' muscles and they attributed these differences to the specifics of the individuals' sport and the effect years of training had on the CNS. They went on to conclude that, "Prolonged training in a specific sport will cause the central nervous system to program muscle coordination according to the demands of that sport" *and also added,* "the learned skill-reflex of the CNS seems to interfere in the performance of another task".

Bompa (2005) identifies two CNS processes as it relates to sports performance - 'excitation' and 'inhibition'. The speed at which signals are sent from the receptors to effectors, and back again, results in levels of excitation or inhibition. For example, to move the body as fast as possible when sprinting, the speed of signal transference through the CNS needs to also to be as fast as possible. An athlete's receptors and effectors therefore need to be optimally excited and uninhibited in order to result in the optimum recruitment of fast-twitch muscle fibre. However, CNS fatigue will slow the speed of excitation, particularly within fast-twitch fibres, which fatigue much more rapidly than slow-twitch fibres. Consequently, Bompa believes exercises should only be performed as long as 'quickness' is possible. There is some evidence that physical activity has some influence on nerve conduction velocity. Halar *et al*., (1985) showed in 20 subjects that the nerve conduction velocity of the sural nerve increased from 36.1±3.1 m/sec to 39.0±3.2 m/sec during 30 minutes of walking. However, Halar *et al*., (1985) pointed out that the influence of physical activity is not the same for all types of exercise and that not all nerves may be affected in the same way. Campbell et al., (1981) reported that the motor nerve conduction velocity is also influenced by other variables like body height and segment lengths. Thus, the purpose of this study was to investigate the relationship among height, weight and motor nerve conduction velocity (MNCV) in upper and lower extremities (radial & sural nerve of bilateral side) in aerobic trained athletes (long distance runners & cyclists) and to understand whether their neural specification would change from long term training.

Methodology

The fifty aerobic trained athletes (25 long distance runners & 25 cyclists) in the age range of 18-25 years were voluntarily recruited as subjects in the present study on the basis of their predominant energy system i.e. aerobic. The subject's physical characteristics are shown in Table 1. Informed consent was obtained from all subjects. The data was collected in Exercise Neurophysiology Laboratory. Motor Nerve Conduction Velocity was assessed with the help of computerized equipment called "Neuroperfect" (Medicaid Systems, India) by using the standard technique (Smorto & Basmajian 1979).The subject lay on a wooden table with the straight arm and leg as radial and sural nerve motor nerve conduction velocity was tested. The differences in the mean values and relationship among age, height, weight and MNCV was identified using Pearson correlation with a significance level of $p < 0.05$ by statistical software 'SPSS' version 10.

Results

The mean age, body height and body weight of the subjects were 23±2 years, 172.8±5.8 cm and 70.5±4.2 kg respectively (Table I).

Table I. Mean ±SD of physical characteristics of aerobic trained athletes

Group	N	Age (yrs)	Height (cm)	Weight (kg)
Aerobic	50	23 ±2	172.8±5.8	70.5±4.2

The mean of motor nerve conduction velocity of right and left radial nerve and sural nerve was 42.4 m/s, 42.6 m/s, 51.1 m/s and 53.3 m/s respectively (Table 2). It was found that the mean values of bilateral MNCV of sural nerve were greater than radial nerve. Further, the mean MNCV of left sural was more than the right sural nerve.

Table II. Mean ±SD of motor nerve conduction velocity of radial & sural nerve of aerobic trained athletes

	Radial Nerve (m/s)	Sural Nerve (m/s)
Right	42.4± 6.9	51.1± 8.3*
Left	42.6± 7.3	53.3± 7.2*

* significant at the 0.05 level

The results of correlation showed (Table 3) that age was positively and significantly related body height (r= .46) and body weight (r= .34). The body height was positively and significantly related with body weight (r= .31) and MNCV of left radial nerve (r=.41) but negatively related with MNCV of right sural nerve (r= -.30).The body weight was also positively and significantly related with MNCV of right radial nerve (r=.29) and left radial nerve (r=.33) respectively. Further, MNCV of right radial and MNCV of right sural was positively and significantly related with MNCV of left radial (r=.65) and MNCV of left sural (r=.64) respectively.

Table III. Correlation among age, height, weight & motor nerve conduction Velocity in aerobic trained athletes

	Body Height	Body Weight	MNCV of right radial	MNCV of left radial	MNCV of right sural	MNCV of left sural
Age	.46**	.34*	-.14	-.23	.15	.21
Body Height	-	.31*	.26	.41**	-.30*	-.15
Body Weight		-	.29*	.33*	.14	-.04
MNCV of right radial			-	.65**	.13	.10
MNCV of left radial				-	.10	.28
MNCV of right sural					-	.64**

**significant at the 0.01 level ; *significant at the 0.05 level; MNCV-motor nerve conduction velocity

Discussion on Findings

In the presented study, the results showed that aerobic trained athletes had faster motor conduction velocity in sural nerve than the radial nerve. The results seem reasonable, since, the goals of long distance runners and cyclists training program are more rapid and coordinated movements in the lower extremity. It may cause physiological adaptations in nerve structure. Gerchman et al., (1975) indicated that ventral motoneurons following long term exercise had histochemical changes. The changes in nerve conduction velocity may be indicative of adaptations in the nerve structure such as increased axon diameter and myelination (Ross et al., 2001). It was also observed in the present study that motor nerve conduction velocity of sural nerve was significantly and negatively related with body height. Similar results were also reported by Falck and Stalberg (1995). Based on a good correlation between the height of the individual and the length of the nerve, the motor nerve conduction velocity in lower limbs decreases by 2- 3 m/s for 10 cm increase in height (Falck and Stalberg 1995). Gilliatt and Thomas (1960) reported that nerve impulses propagate faster in the proximal than in the distal nerve segments. It is presumed that the neural adaptation of muscles in the trained athletes is due to a more active recruitment of motor units and an increase of their firing rates upon maximum voluntary contraction. The recruitments of slow- (type I) and fast twitch (type IIa,b) muscle fibers are in relation to the intensity of effort. For rapid, powerful movements, the fast-twitch fibers are activated (Edgerton 1976). Further, it is also assumed that the improvement of strength performance to be due to the fact that the athletes can recruit more of type IIa, and especially type IIb, motor units during maximum contraction of the measured muscles, and that they can express their true strength capacity by increasing their capacity to recruit more type II motor units during rapid, powerful movements. This means that trained athletes can more fully activate their prime moving muscles in maximal voluntary contractions. However, there is inter subject variability in this ability, and some muscles are more difficult to activate than others. Untrained subjects may have difficulty both in recruiting all motor units and in gaining optimal firing rates of the activated units in certain muscles (Sale 1987). Apart from the increased activation of the agonist muscle (prime movers in a task), neural adaptation may cause changes in the activation of synergist and antagonist muscles, which can be manifested as improved skill and coordination (Rutherford & Jones 1986). The contraction of antagonist muscles may provide a stabilization factor during rapid contractions of agonist muscles.

These findings lead to the conclusion that it is possible to increase strength without adaptation in the muscle, but, not without adaptation in the nervous system (Clarke 1973). In a competitive run, athlete would be able to move along at higher rates of speed. Finally, the nervous system can also learn to activate motor units in a way which will produce not only the desired level of strength and power for a particular sport, but, also the most energy-efficient production of strength and power. By dialling up' just the right motor units for a particular activity and 'calling' them at the correct time, the nervous system enhances coordination (skill and efficiency of movement), thus conserving energy and allowing competitive levels of effort to be carried out at a lower (and thus easier) percentage of 'max'. It matters not whether the 'max' refers to maximal aerobic capacity (VO2max), maximal running speed, max cycling speed, max rowing speed, top swimming speed, etc. - if the nervous system allows any effort to be carried out at a lower percentage of maximal that effort will be easier to tolerate and sustain during workouts and competitions. All of these positive changes within the nervous system can be called 'neural adaptations' to training (Honet *et al.*, 1968).Thus, the nervous system plays a critically important role in the development of greater strength, and the nervous system can even learn patterns of muscle coordination and activation which can be utilized by the trained athletes to boost their performance in the sport competitions.

Conclusion

The results of the present study indicate that long term training is important for increasing motor nerve conduction velocity in athletes. But, the types of training may have different levels of adaptation in them. Thus, it is concluded that the faster motor nerve conduction velocity in sural nerve of long distance runners and cyclists may be the result of their long term training adaptations which may be further related to their pattern of movement requirement.

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