Strength and Power in Wheelchair Athletes

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ABSTRACTS

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Welcome

On behalf of all three organizers Faculty of Physical Education and Sport Comenius University, Slovak Society of Sports Medicine, and Slovak Olympic Committee we have the pleasure to welcome you to the 7th International Conference on Strength Training.

Traditionally this multidisciplinary meeting brings together scientists, coaches, medical doctors and other health professionals from all over the world to share the most up to date research related to strength training.

Format of the conference is based on key note lectures presented by invited recognized scientists complemented by reviewed submitted contribution in form of oral podium presentations, defended and non-defended posters.

Also this edition of the conference series brings not only deeper insight into mechanisms of muscle response to mechanical loading, but also practice relevant information related to enhancement of the effects of strength training for both performance and health.

We sincerely hope you will enjoy the 7th International Conference on Strength Training.

Prof. Dušan Hamar, MD, PhD
Conference Chairman

STRENGTH AND POWER IN WHEELCHAIR ATHLETES

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INTRODUCTION

Studies dealing with spinal cord injury (SCI) patients and athletes have focused on analyzing endurance training, metabolic and cardiorespiratory fitness. Several studies found impaired performance in these subjects due to "unique changes in metabolic, cardiorespiratory, neuromuscular and thermoregulatory systems, which reduce their overall physiological capacity" [1, p. 26]. In contrast, little is known about strength and power in SCI subjects, especially in athletes performing competitive wheelchair sports.

Although some wheelchair sports are of growing popularity as recreational and competitive sports there is also a lack of knowledge regarding guidelines for specific training designs, especially in strength training. Most wheelchair sports depend on strength and power of upper extremities and these abilities should be developed explicitly by heavy resistance training. It is questioned if training regimes of high performance athletes could be transferred to training in wheelchair sports. In this context we performed two studies. In the first study (I) we evaluated strength and power properties in upper extremities in wheelchair athletes comprehensively. In the second study (II), we investigated effects of an eight-week program consisting of heavy-resistance exercises.

METHODS

(**I**) Twenty-five male subjects participated in the first study - thirteen with SCI and twelve healthy physical education students conversant with strength training. First, established measurements were modified for analyses with SCI-subjects. Second, several power and strength parameters were evaluated in upper extremities in all subjects in standardized positions and conditions. Subjects' performances were tested in isometric as well as in dynamic actions: Movement speed was analyzed in a Smith machine by measuring maximal velocity and maximal acceleration of the barbell. Maximal strength and maximal rate of force development (MRFD) were evaluated by measuring force-time curves in isometric condition. Moreover, we evaluated one repetition maximum (1RM) and strength endurance (repetitions with a weight representing 60% of the individual 1RM). Moreover, we recorded EMG-activity of upper extremities muscles (Triceps brachii, Biceps brachii, and Pectoralis major).

(**II**) Sixteen male subjects participated in the second study - eight with SCI and eight healthy physical education students. The subjects participated in an eight-week program consisting of heavy-resistance exercise performed twice per week. Each training session consisted of 10 to 12 repetitions in 5 sets. Training exercise was bench press. All exercise sessions were individually surveyed and supervised as SCI subjects have often difficulties during exercises in stabilizing their upper part of the body because of lack of muscle strength and coordination deficits. Subjects' performances were tested three times: before starting the eight-week program, after finishing the training program and one week afterwards. We measured the same parameters in isometric and in dynamic actions as in the first study. Additionally, we tested 10m-sprinting performance in wheelchair athletes.

In both studies athletes with SCI were wheelchair basketball or wheelchair rugby players in the first national leagues or in the national team.

RESULTS

(I) Overall, analyses of group differences showed no significant differences between wheelchair athletes and physical education students, both for strength and power properties in the isometric condition (p-values between 0.483 and 0.914) as well as in the dynamic condition (p-values between 0.156 and 0.421). But in static condition wheelchair athletes showed a tendency to advantage in maximal strength and in rate of force development. And physical education students show a tendency to advantage in maximal movement velocity in dynamic condition.

(II) Overall, both groups showed again similar results: In all parameters we measured an improved performance in post-testing – in wheelchair athletes as well as in physical education students. Increases ranged between 4.2% and 31.6%. But the level of significance ($p \leq 0.05$) was not reached in pre-post comparisons. In most strength and power parameters wheelchair athletes showed a tendency to a higher profit from the strength training used in this study. But using analyses of group differences only the comparison of effects on MRFD showed a significant advantage for wheelchair athletes ($p=0.01$). In 10 m-sprinting performances we found no improvement due to strength training.

DISCUSSION

Data from our first study demonstrate that there is overall no group difference of strength and power properties between wheelchair athletes and physical education students conversant with strength training. But in interindividual analyses SCI-subjects showed a much stronger variation of results. Furthermore, in interindividual comparisons of EMG data we found different coordination patterns depending on the classification of motor ability. A reason for this lies in the fact that wheelchair athletes have a spectrum of functional abilities depending on the level of spinal cord injury. Most wheelchair basketball players have the lesion at the level of the lumbal vertebrae (called Paraplegia) leading to no impairment of upper extremities. Wheelchair rugby players, on the other hand, are tetraplegic with a spinal cord injury at the level of the cervical vertebrae leading to impairment affecting functional abilities of upper extremities as well.

Our data from the second study indicate that wheelchair athletes and physical education students show similar effects of heavy resistance-training on strength and power properties in upper extremities. In contrast to hitherto assumptions about minor adaptation capacities to training exercises in SCI-patients, our study showed clear effects of strength training. Some wheelchair athletes participating in this study were tetraplegic. Nevertheless, they showed strong improvements in nearly all strength and power parameters due to heavy resistance-training lasting eight weeks. In MRFD we demonstrated a prominent and significant difference between wheelchair athletes and control subjects. Besides real effects of strength training and despite of habituation sessions before pre-tests, we speculate about stronger learning and habituation influences on testing situation in these subjects. It is difficult to compare these results with data from the literature as we are unaware of any reports showing effects of comparable training regimes on power and strength parameters in wheelchair athletes [2]. Most studies cope with strain of daily activities and rehabilitation of patients to maintain a certain level of physical activity and promoting functional independence. Accordingly, they used merely moderate intensities in exercises like wheelchair ergometer, kayak ergometer, hand cycling, arm cranking, and circuit training but not heavy resistance training.

CONCLUSION

In conclusion, the present studies proved that strength training with heavy resistance may provide functional value to optimize performance in competition in individual sports such as wheelchair athletics (e. g. sprinting and throwing) and in team sports such as wheelchair basketball.

REFERENCES

[1] Bhambhani, *Sports Med* 32, 23-51, 2002
[2] Turbanski et al., *J Strength Cond Res*, 24(1), 8-16, 2010