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INFLUENCE OF HEAVY WEIGHT TRAINING ON PHOSPHAGENIC-ANAEROBIC CAPACITY IN PROMINENT DISABLED WEIGHTLIFTERS

Key words: disabled weightlifters, anaerobic efficiency, strength.

ABSTRACT

The aim of this study was to estimate the influence of strength training on anaerobic-phosphagenic power and its components in prominent disabled weightlifters. Ten disabled weightlifters, members of the Polish National Team took part in the study. The athletes were tested twice using the Monark cycle ergometer adapted for upper body work. Anaerobic power was estimated using the method of Vandewalle et al. The subjects performed weightlifting bench tests two times. The first tests were executed at the start of the preparatory period, and the second ones after six months before the competition period. The study revealed non-significant differences between P_{\max} and its components: F_0 and V_0 attained by disabled weightlifters during the first ergometric test and after six months of heavy weight training. However, the strength level after six months of weight training increased significantly. It most likely results from the specific prolonged training of our subjects and their high anaerobic capacity before the tests.

INTRODUCTION

Weightlifting is one of the most popular sports for the disabled. It is also a sports event, where the disabled achieve similar sports results to their able-bodied counterparts. Athletes with amputations, paraplegia and cerebral palsy practice weightlifting very often. Various studies have discussed the influence of different kinds of training on muscle pain (mostly shoulder muscles), imbalance, performance of daily chores, etc. [2, 3]. Furthermore, many authors emphasize the positive influence of training on the aerobic and anaerobic capacity in disabled people [11, 15, 16, 21]. In Donachy's research [3] strength training performed by subjects with a left glenohumeral disarticulation and transtibial amputation (three times per week over a two-month period, followed by exercises twice a week for an additional two months using

variable resistance machines) caused 36.8% of strength increase in the trained limb. Moreover Jacobs et al. [11] investigated ten men with chronic neurologically complete paraplegia at the T5-L1 levels. Their research revealed that a 12-week circuit resistance training brought about an improvement in the isoinertial strength (between 1.9% and 30%), maximal oxygen consumption (29.7%) and peak power output during an arm cranking test ($p < 0.05$). However, there has been no data concerning disabled weightlifters' training and the effects of this training on their anaerobic-phosphagenic capacity. The question remains whether changes of weightlifting bench test results are connected with changes in the anaerobic-phosphagenic capacity.

It has been attested that strength training improves the maximal anaerobic power in able-bodied people. It is possible that strength training might have a similar influence on the maximal anaerobic power in disabled people. The aim of this study was to estimate the influence of strength training on the anaerobic-phosphagenic power and its components in prominent disabled weightlifters after amputation and paraplegia. Moreover, the study also attempted to estimate the maximal anaerobic power level in disabled weightlifters in comparison with other disabled athletes.

METHODS

Ten disabled weightlifters (DW), members of the Polish National Team, took part in the study. The subjects were tested twice. During the first test their mean age was 33 years old and their average weight was 78 kg; during the second test they were 34 years old and their average weight was 77 kg.

The subjects had trained weightlifting for 5.5 years on the average and they represented an advanced sports level. They competed in different weight and disability categories. The disabilities in the sample were varied: amputation of lower limbs (after car accidents) (5 subjects); spine fracture (2), infantile cerebral palsy (2) and infantile paralysis (1). The tests were carried out by the same researchers using the same procedures. The participation in the tests was voluntary and each subject had obtained a doctor's consent. The tests were granted approval of the Local Committee for Ethics and Scientific Research in Poznań (Poland), decision number: 1744/03.

The athletes were tested twice on the Monark cycle ergometer coupled with a PC adapted for upper body work. The first tests were performed at the start of the preparatory period (October), and the second tests after six months (April), before the competition period. Anaerobic power was estimated using the correlation between force and velocity ($F - V$) at work on the Monark 814 E ergometer for upper body work, according to the method of Vandewalle et al. [19]. To calculate the maximal power (P_{\max}), V_0 and F_0 were estimated. V_0 is the intercept of the force-velocity regression line with the velocity axis; F_0 is the intercept of the regression line with the force axis. After a standard warm-up each subject performed five or six exercises on the arm ergometer. Subjects were motivated to reach the maximal velocity of pedal revolu-

tions during each trial. Different loads were applied and trials were performed within the velocity range between 100-200 rpm. During the test the athletes sat on their own wheelchairs and their shoulders line was consistent with the axis of crank revolution. For the purpose of better standardization and elimination of undesirable muscle work a special stabilization was used. Each weightlifter was immobilized in the pelvic girdle and thighs; with the aid of a special system of belts.

To assess the maximal strength (F_{\max}) in October and April, the subjects performed weightlifting bench tests. P_{\max} was expressed in watts, F_{\max} in kilograms and these results were also calculated into kilograms of body mass.

Between October and April the weightlifters trained with heavy loads: 80-100% RM, and they tried to improve their weightlifting technique; they also played basketball (as a supplementary sport).

The results were presented as mean values with standard deviations. The paired t – test was used to calculate the differences between the groups, and the Pearson coefficient of correlation was also used to determine the correlation between selected parameters; the level of statistical significance was set at $p < 0.05$.

RESULTS

Differences between the maximal anaerobic power reached by the weightlifters during the first and the second test were non-significant. P_{\max} reached during the first test was even a little higher compared to the second test; $p > 0.05$ (Table 1). Similar trends were observed in the P_{\max} components: V_0 and F_0 (Table 1). However, regardless of the lack of differences in P_{\max} and its components: V_0 and F_0 , the maximal strength achieved during the second weightlifting bench test was significantly higher in comparison with the first test (Table 1).

Correlation coefficients between P_{\max} and F_0 during the first and second tests were significant (0.95 and 0.98, respectively). Similarly, a significant correlation was noted between P_{\max} and F_{\max} (0.84 and 0.71, respectively) as well as between F_0 and F_{\max} (0.88 and 0.73, respectively).

Table 1. Results of ergometric and weightlifting bench tests

Group n=10		P _{max} [W]	P _{max} [W/kg b.m.]	V ₀ [obr/min]	F ₀ [N]	F ₀ /kg [N/kg]	F _{max} [kg]	F _{max} [kg/kg b.m.]
DW I	x	530	6.71	207	102	1.31	166	2.24
	SD	219	1.15	25	41	0.22	33	0.43
DW II	x	507	6.65	211	95	1.25	176*	2.37*
	SD	176	1.34	20	28	0.22	0.44	0.44

* – significant difference ($p < 0.05$) between results from the first and second test

DISCUSSION

Improvement of anaerobic capacity has an impact not only on the sport result, but also on the quality of life of disabled people. Systematic, well-conducted strength training improves the ability of people with spinal cord injuries to perform daily tasks and affects their overall activity level [3, 10]. In paraplegic patients, shoulder complaints attributable to muscle dysbalance arising from the particular daily form of exercise are often observed. Strength training leads to lower muscular fatigue and higher maximum strength [15]. Disabled people after rehabilitation, who experience beneficial changes inside their bodies, start to train weightlifting. Requirements are similar in sports for the disabled and able-bodied. Sport results in weightlifting depend directly on the maximal strength of arm and chest muscles. Some authors suggest that the maximal strength achieved by the able-bodied and the disabled alike is significantly correlated with the maximal anaerobic-phosphagenic power [12, 13].

The present study confirms this fact as P_{max}, F₀ and F_{max}, both during the first and second tests were significantly correlated with each other ($p < 0.05$). These correlations support the usefulness of Vandevallé's test for evaluation of the sport level of disabled weightlifters. Furthermore, studies by Jacobs et al. and Vanlandewijck et al. also confirm the reliability of ergometric tests for anaerobic capacity evaluation in paraplegics and wheelchair basketball players, respectively [9, 20]. Trop's results revealed a significant correlation between P_{max} reached by disabled basketball players in the ergometer test and wheelchair driving on a treadmill [17]. Therefore, we expected that with along the F_{max} changes, P_{max}, and perhaps its components: F₀ or V₀, would also change simultaneously. However, our study failed to reveal

significant changes in P_{max} and its components: F₀ and V₀, after six months of heavy weight training, regardless of the significant increase of the maximal level of strength achieved during the weightlifting test. It probably results from differences in specific movement coordination during strength training performed at a slow rate, which is the form of strength training used in the present study, and very dynamic ergometer exercises. According to Hakkinen, heavy weight training with large loads (70-120% RM) significantly enhances the maximum strength, but does not improve the rate of strength development [6]. Additionally, the same author holds that this kind of training can decrease the ability of rapid muscle strength development and achievement of high maximal power [6]. Moreover, the weightlifters tested in our study performed exercises aimed at improvement of the weightlifting technique. It is possible that the higher weightlifting test result was caused by improved neuro-muscular coordination. The lack of improvement in the anaerobic-phosphagenic capacity after six months of heavy weight training can also be explained by the high sports level represented by the subjects under study. The six-month period between the first and the second tests might have been too short to observe significant changes in the maximal power in that specific sample. Additionally, Kanda and Hashizume's study showed that the MVC level can decrease in able-bodied persons over 30 years of age [14], but a higher decrease is observed in people over 50 years of age [1]. However, Ecker claims that the most significant drop in anaerobic capacity appears in the third decade of life [4]. It is possible that the lack of changes in the anaerobic phosphagenic capacity can be caused by the factor of our subjects' age. Moreover, Grassi et al. [5] stated that the P_{max} level in able-bodied people who trained different sports decreased linearly between

40 and 75 years of age. We can thus expect that an increase in the anaerobic efficiency and maximal strength of our subjects can be rather difficult to achieve in the future.

The anaerobic-phosphagenic power obtained by the weightlifters was definitely higher than by athletes tested by others authors. Japanese disabled basketball players in Tsukagoshi et al. [18] achieved $351 \pm 104\text{W}$; whereas Israeli disabled basketball players in Hutzler et al. [7] reached $393 \pm 69\text{W}$. This may prove that heavy weight training improves the anaerobic-phosphagenic power to a greater extent than basketball training. Certainly, the P_{\max} values achieved by disabled people strongly depend on the level and type of disability. Hutzler's study showed that subjects with amputated lower limbs reached higher P_{\max} than people with polio and paraplegics [8]. Five from the ten weightlifters tested in our study were after lower limbs amputations, so to some extent this could also have an influence on the high P_{\max} achieved by the entire sample.

It can be concluded that six-month heavy weight training does not affect the anaerobic-phosphagenic capacity in prominent disabled weightlifters, regardless of the increase of their strength level. It probably results from the subjects' specific (performed at a slow rate) prolonged weight training and their high anaerobic capacity achieved before the tests. It has also been observed that the level of anaerobic-phosphagenic capacity in disabled weightlifters is higher in comparison with other athletes.

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