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MUSCLE STRENGTH IN PHYSICALLY ACTIVE AND INACTIVE PRISONERS

Key words: prisoners, activity, strength, flexors.

ABSTRACT

The aim of this study was to assess maximal voluntary contraction (MVC) of the upper limb in active and inactive prisoners as compared with physical education students. The study involved 15 prisoners who were physically active (AP), 15 physically inactive prisoners (IP) and 15 physical education students (ST). Strength measurements were made in static conditions using a handgrip dynamometer and an elbow flexors dynamometer. Maximal voluntary contraction of the dominant hand flexors (MVC_{DH}), non-dominant hand flexors (MVC_{NDH}) and elbow flexors (MVC_{EF}) were analyzed. The results showed that regardless of the tested muscle, the group of physically active prisoners (AP) obtained a significantly higher MVC in comparison with their inactive counterparts. Moreover, the active prisoners achieved significantly higher MVC_{NDH} and MVC_{EF} than the PE students (ST). There were no significant differences in the MVC_{DH}, MVC_{NDH}, MVC_{EF}, between the physically inactive prisoners and physical education students.

INTRODUCTION

The effects of strength training on the human body and the importance of appropriate muscle strength in daily life and sport have been analyzed by numerous researchers and trainers [6, 7, 18, 2, 1, 10, 17, 13, 8]. It has been well-known that regular physical activity allows maintaining a requisite level of muscle strength, whereas inadequate activation of the muscular system leads to detrimental health changes. After several days of physical inactivity (regardless of body position) nitrogen excretion in the urine increases, reflecting the degradation of muscle proteins and muscle atrophy [9]. One's physical activity can be limited for various reasons, for example, imprisonment. Because of specific prison rules, it can be supposed that maximal voluntary contraction (MVC) of inmates is significantly reduced. It should be noted, however, that in the majority of penal institutions strength exercises are allowed. In this situation, it is worth examining whether prisoners who regularly perform strength training differ from physically non-active inmates. Works concerning muscle strength changes in prisoners have not been found in literature.

The aim of the present study was to assess the MVC of the upper limb in physically active and inactive prisoners in comparison with physical education students.

METHODS

Subjects

Thirty inmates from a penal institution in Gorzów Wielkopolski, Poland, who had served at

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least two years, took part in the study. The prisoners were divided into two groups. The first group consisted of physically active prisoners (AP, n = 15), who trained regularly in the prison gym three times a week for 1 hour, in groups of 2 to 6. The second group consisted of physically inactive prisoners (IP, n = 15), who did not perform any strength exercises. All convicts were able to walk around the prison yard five days a week, from Monday to Friday 9.00-13.00. The prisoners were compared with physical education students (ST, n = 15), who were highly physically active (participating in numerous obligatory physical activities), but were not professional athletes.

Before the study, all subjects were informed about the purpose and procedures of the experiment. The study was approved by the Bioethics Committee in Poznań (decision number 1744/03) and all subjects gave their informed consent. Biometric characteristics of the subjects are shown in Table 1.

Table 1. Biometric characteristics of subjects

Group	n	Age (years)	Body height (cm)	Body mass (kg)
AP	15	26.1 ± 2.7	179.9 ± 6.9	82.5 ± 12.4
IP	15	25.5 ± 2.2	176.7 ± 6.2	78.6 ± 12.7
ST	15	24.3 ± 0.8	181.1 ± 6.9	81.1 ± 10.2

Measurements

The measurements were approved by prison warders, who were responsible for security of the experiment. A Takei A5402 Digital Hand Grip Dynamometer was used to measure the maximal voluntary contraction of dominant (MVC_{DH}) and non-dominant hand flexors (MVC_{NDH}). Results in kilograms were converted into newtons. The subjects' performance was measured in a standing position with straightened arms, abducted by about 20 cm from the body. At a signal a subject had to squeeze the dynamometer with the greatest possible force. All subjects performed the test three times with each hand. The intervals between consecutive attempts were 10 minutes each; the mean value of three measurements was analyzed. Beside the MVC of hand flexors, the maximal voluntary contraction of elbow flexor muscles (MVC_{EF}) was measured. An original device with a PUE C/31 weighing indicator and LCD display connected with a tensometer (measurement error < 0.02%) was used (Figure 1). Results were expressed in newtons. Repeatability of measurements was high (ICC = 0.978). The seated subjects were to curl and hold a mini barbell (2 kg) in hands. The barbell was connected to the measuring device with a wire rope. The length of the rope was adjustable and just before the measurement the rope was slightly stretched to eliminate a jerk. The angle at the elbow was 90°. At a signal a subject attempted to lift the barbell with the greatest possible force. The test was performed three times with 12 min breaks between repetitions; data from the three measurements were averaged.

Figure 1.

Statistical methods

The following statistical methods were used in the analysis:

– Shapiro-Wilk test to check the normal distribution of strength test results and Bartlet test to check the homogeneity of variance;
– Mean values and standard deviations;
– One-way Anova test and Tukey test to calculate the significance of differences between groups.

The differences were identified as statistically significant at $p \leq 0.05$.

RESULTS

The results showed that regardless of the study group the mean muscle MVC was always the highest in the AP group. The force level obtained by the AP during the isometric contraction of the dominant hand was significantly higher than that obtained by the IP. Also in comparison with the PE students the physically active prisoners achieved a higher MVC_{DH}, but the difference was non-significant (Figure 2). Furthermore, the level of this parameter obtained by the inactive prisoners and students also did not differ significantly.

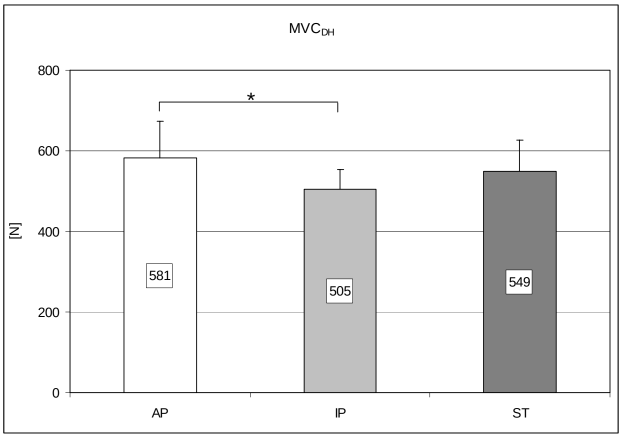

Figure 2.

The MVC of the non-dominant hand obtained by the AP was also significantly higher than the one achieved by the IP. Moreover, between the AP and ST a significant difference in this parameter was also observed. However, the MVC_{NDH} achieved by IP and ST was not significantly different (Figure 3).

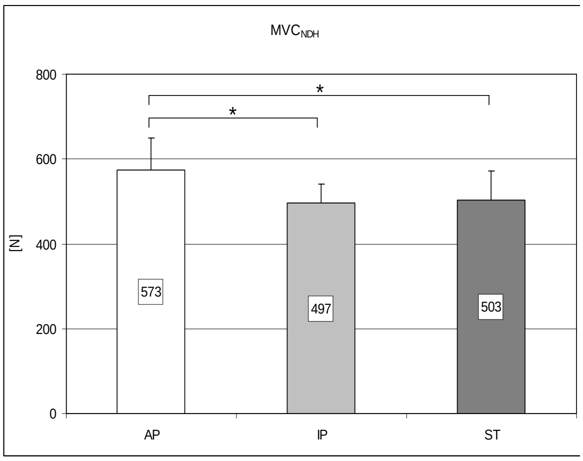

Figure 3.

The MVC level obtained by active prisoners during the isometric voluntary contraction of the elbow flexor muscles was significantly higher as compared to the IP and ST. However, the MVC_{EF} achieved by IP and ST did not differ significantly (Figure 4).

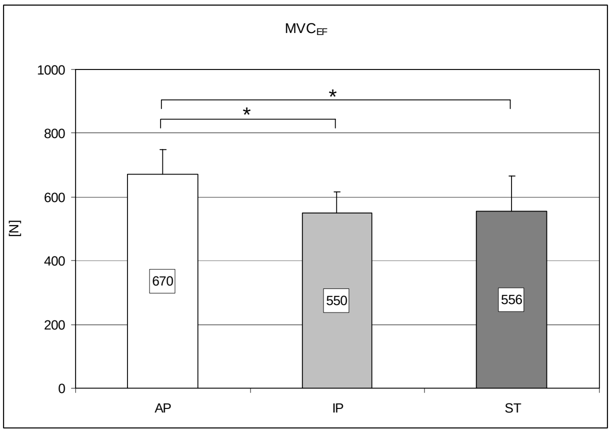

Figure 4.

DISCUSSION

Literature lacks data concerning changes in the level of muscle strength in prison inmates. The reduction of physical activity has been known to induce muscle atrophy [3, 5], which results mainly from atrophy of type II fibers recruited during very intensive efforts [11]. The rate of atrophy is not uniform in all muscles, and for the lower limb it can be 2-12% after 5 weeks of bed rest [4]. In many muscles, but not in all, atrophy can be reduced by resistance training alone and by resistance training combined with vibration stimulation (during 60-day immobilization in bed) [14]. The prisoners' activity is obviously higher than people lying in bed. However, fewer opportunities to undertake physical activity and small prison cell areas are factors which may affect muscle atrophy and reduce the MVC level. Nevertheless, our study revealed the highest MVC values in the group of physically active prisoners, which may indicate that the relatively low physical activity of active prisoners (strength exercises 3x1 hour/week) was sufficient to maintain or increase muscle strength in these subjects (unfortunately, the initial MVC level was unknown). The higher MVC displayed by physically active inmates as compared with non-active ones is not surprising, but significant differences in MVC between the AP and ST groups are interesting. On the one hand, we realized that strength training performed by AP could positively affect muscle strength, but on the other hand, we had expected that the lack of normal activity had a negative influence on health [16] and on MVC. Active prisoners also obtained higher MVC values of the dominant and non-dominant hand than young men studied by Mathiowetz et al. [12] (about 43 and 108 N higher, respectively). Moreover, the MVC achieved by the AP using the dominant hand was only about 8 N higher than the one achieved by the non-dominant hand (in Mathiowetz et al. the difference was 73 N). It may indicate that strength exercises performed by the AP could affect the reduction of strength deficit between hands.

The results of our study also showed that the MVC in physically inactive prisoners did not differ significantly from the MVC in students, irrespective of the tested muscles. It was interesting because we had assumed lower values of maximal voluntary contraction in the convicts due to their lower physical activity (students exercised regularly for 4-5 years) and a negative impact of a long-term imprisonment. Because the initial level of MVC in the IP is not known we can only assume two causes of this fact. The first one is that a relatively high strength level in the IP group is genetically determined, and the other one is that low physical activity declared by the inactive inmates did not have to be consistent with the truth (data was obtained from inmates during the interview). But even if we assume that the initial level of MVC of these inmates was higher than that of physical education students, imprisonment and lack of physical activity should have a significant impact on MVC reduction. One of the factors which could affect strength capacity of prisoners could be a rational, balanced diet of 2800 kcal/24h [15].

The obtained results allowed us to draw the following conclusions:

1. Maximal voluntary contraction of dominant and non-dominant hand flexors and elbow flexor muscles achieved by physically active prisoners is significantly higher than MVC of physically inactive prisoners.
2. Maximal voluntary contraction of the non-dominant hand flexors and elbow flexor muscles achieved by physically active prisoners is significantly higher than MVC of physical education students.
3. Maximal voluntary contraction of the dominant and non-dominant hand flexors and elbow flexor muscles of physically inactive prisoners and physical education students did not differ significantly.

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