Effect of the muscular strength detraining in prepubertal boys

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ABSTRACT

The strength trainability in children has been widely explored, however, there is still a questioning with regard to how strength decreases when they stop training. The objective of this study was to evaluate the effect of 12 weeks of muscular strength detraining of boys trained for 12 weeks. Seven prepubertal boys (EX 9.4 ± 1.6 years of age) trained three series of 15 repetitions, three times a week for 12 weeks. The training, supervised and developed in equipments, consisted of eight exercises including knee extension (KE) and elbow flexion (EF). The 1-RM test of NE and EF was performed before and after training and 12 weeks after detraining. A similar group of boys (n = 7, 9.7 ± 1.7 years), who did not train served as control (CO). After training, the group EX increased ($p < 0.05$) 1-RM from 14.6 ± 9.8 to 26.2 ± 12.9 kg in KE, and 4.7 ± 2 to 7.9 ± 4.1 kg in FC. After 12 weeks of detraining, the 1-RM was 19.6 ± 11.2 in NE and 6.5 ± 3 kg in FC. The decrease on strength was not statistically significant ($p > 0,05$). When corrected by the body weight and by the lean body mass (LBM), the 1-RM of NE decreased significantly ($p > 0,05$) from 0.64 ± 0.1 to 0.45 ± 0.1 and from 0.83 ± 0.2 to 0.61 ± 0.2 of the body weight and LBM, respectively. The EF strength did not decrease significantly when corrected by the body weight and LBM. The strength levels did not change in the first 12 weeks for group CO, however, after 24 weeks, it presented an increase of 41% in the 1-RM of KE and 53% in EF. One concludes that, after detraining, the muscular strength presented no significant reduction in absolute values; the results are significant only when corrected by weight and LBM and it is only evidenced for the lower limbs.

Key words: Strength training. Strength decrease. Prepubertal.

INTRODUCTION

The muscular strength trainability is observed in children as well as in adults. In previous studies, increases on the muscular power in boys were observed when adequately trained[1-3]. The strength training may bring benefits to the physical performance and to the health of children such as the improvement on the motive coordination and sportive performance, the improvement on the body composition, in other words, increases on muscular mass in pubertal boys, decreases on body fat[4] and the decrease and prevention of lesions in recreative and competitive sports as well as the improvement on the competitive performance[5].

There is a lack of information with regard to the detraining period; however, a study of Hakkinen and Komi[6] reports that during a period of eight weeks without the training stimulus, the strength decrease in adults is initially due to the neural disadaptation caused by inactivity. Other studies[7,8] also followed the detraining period in adults.

Following the detraining period for at least the same period of training in adults, it is expected that the loss would be equivalent to gains obtained with training. In children this can be less evident, once they are in the developing and maturation phase, what leads to an unavoidable increase on size and muscular strength[9].

Faigenbaum *et al.*[10] observed a significant drop in the strength of children after 8 weeks of detraining; now Blimkie *et al.*[11] verified a slight drop, however, not significant in strength of 1-RM after eight weeks of detraining in prepubertal children.

On the other hand, in sportive modalities in which strength is determinant for the performance, the training interruption phase could affect strength in the competition phase[12].

Studies that evaluate the detraining period in children are scarce, and many times present diverging results with regard to the alterations occurred in this period at the different maturational stages.

The objective of this study was to evaluate the effect of 12 weeks of detraining on the muscular strength of boys who trained for 12 weeks.

METHODS

Subjects

The sample of this study was composed of two groups, an experimental group (EX) and a control group (CO); the groups were selected from two different schools. In both groups (EX and CO), the responsible for the boys, after being aware of the procedures and activities developed in the research, signed a consent form with the agreement from the participant. This study and the consent form were approved by the Ethics Committee of the Porto Alegre General Hospital.

The group EX was composed of seven prepubertal boys[13] with the average age of 9.4 ± 1.6 years. The averages (± SD) of weight, height, body fat percentage and lean body mass (LBM) were of 39.9 ± 11.8 kg; 142.0 ± 11.4 cm; 20.1 ± 10.7% and 29.1 ± 5.9 kg, respectively. This group trained for 12 weeks.

The group CO was composed of seven prepubertal boys with the average age of 9.7 ± 1.7 years, who presented the following averages (± SD) for weight, height, body fat percentage and lean body mass (LBM): 36.6 ± 3.9 kg; 142.2 ± 6.4 cm; 15.9 ± 7.7% and 29.0 ± 2.9 kg, respectively. This group participated in no oriented physical activity or specific training program during the 24 weeks of the study.

Stages of the study

The study had duration of 24 weeks and the strength evaluations were performed before training (pre) and after training (post) and after 12 weeks of training, detraining (D3) for group EX; for group CO, the evaluations followed the same standard and period.

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Anthropometric evaluations

Weight and height were verified in a balance (resolution of 100 g) and stadiometer label Filizola. The body fat percentage was estimated through the equation of Slaughter *et al.*(14), which uses the sum of the subscapular and triceps skinfolds. This equation considers gender and maturational degree. The skinfolds measure was performed using the Lange compasses, following the Lohman *et al.*(15) standards, performed in order to characterize the sample adiposity and to obtain the lean body mass fat used for the adjustment of the strength values (relative strength).

Maximal isotonic dynamic strength – 1-RM

All strength tests were evaluated in the knee extension and elbow flexion movements.

For this evaluation, the 1 maximal repetition test (1-RM)(16), which consists of the performance of the movement in all articular amplitude with execution time of 5 seconds was used.

The test loads were progressively applied with interval of 1 minute between attempts until the boy could no longer perform a full repetition. The load of the previous attempt was considered. The loads variation used was of 250 g, calibrated in electronic balance label Urano model PS – 180 A, resolution of 100 g. During the performance of the test, the appraiser verified the segment speed and the articular amplitude.

In order to find the relative strength, the absolute strength was divided (corrected) by the body weight and also by the lean body mass fat (LBM). Through the body fat percentage calculation, using equation of Slaugther *et al.*(14), the LBM was obtained for the adjustment of the strength values.

Strength training

The strength training had duration of 12 weeks with three weekly sessions of 60 minutes. Each session was divided as follows: 10 minutes of warm up in horizontal cycle ergometer Taurus without load; 40 minutes of strength exercises (described below) and 10 minutes of flexibility exercises (passive) performed by the professors responsible for the training. The program included main and secondary exercises.

The main exercises were: knees extension and elbow flexion respectively developed in extensor chair Taurus and "Pulley" of the same label, adapted with "Scott" seat.

The secondary exercises were hip adduction and abduction (adductor and abductor chair), pectoral (bench press with dumbbells or in bench press machine, Taurus equipment), dorsal (ear deltoid), sit up and lumbar.

The boys performed an adaptation session in the week prior to the beginning of training, which intensity was of 40% of the 1-RM test. The training intensity ranged from 60 to 80%(17) of the 1-RM test.

Statistical analysis

In order to verify differences between all periods analyzed for each group, the non-parametrical analysis was performed using the Friedman test. The difference between the evaluation periods was verified through the method of Multiple Comparisons for the Friedman test.

A non-parametrical test was selected, once data were not homogeneous and the sampling number did not admit a parametrical analysis.

For the inter-groups analysis, the T-Test for Independent Samples was used for each period, for all variables evaluated.

A parametrical analysis was selected, once when methods (T-Test and Mann-Whitney Test) were compared, no differences statistically significant were verified, thus the parametrical method was selected.

The statistical package used for all analysis was the SPSS 8.0.

The significance level adopted was $p < 0,05$.

RESULTS

For the 1-RM strength values of Knee Extension (KE) and Elbow Flexion (EF), the groups presented no difference statistically significant when compared to each other during the periods of study, thus becoming the similar groups (table 1).

After 12 weeks of training, group EX increased significantly ($p < 0,05$) the 1-RM strength of knee extension and elbow flexion in 78 and 67% respectively (from 14.6 ± 9.8 to 26.2 ± 12.9 kg in knee extension and from 4.7 ± 2 to 7.9 ± 4.1 kg in elbow flexion). The group CO did not change statistically the strength values at the first 12 weeks, however, after 24 weeks (from pre to D3), the group CO increased 41% in knee extension and 53% in elbow flexion (table 1).

TABLE 1
1-RM of Knee Extension (NE) and Elbow Flexion (EF) of experimental (EX n = 7) and control (CO n = 7) groups in the 24 weeks of study (average and SD)

Strength	Group	Pre	Post	D3
1-RM NE (kg)	EX	14.6 ± 9.8	26.2 ± 12.9*	19.6 ± 11.2
	CO	13.0 ± 4.1	14.7 ± 4.1	18.3 ± 4.7#
1-RM EF (kg)	EX	4.7 ± 2.0	7.9 ± 4.1*	6.5 ± 3.0
	CO	3.4 ± 1.0	4.2 ± 1.1	5.2 ± 1.1#

(*) difference statistically significant ($p < 0.05$) from pre to post.
(#) difference statistically significant ($p < 0.05$) from pre to D3.

After 12 weeks of detraining, despite presenting a tendency, the absolute values of 1-RM strength in group EX presented no statistically significant drop ($p > 0.05$), from 26.2 ± 12.9 to 19.6 ± 11.2 kg for KE and from 7.9 ± 4.1 to 6.5 ± 3.0 kg for EF. The results also show that the tendency is more evident in the lower limbs than in the upper limbs (table 2).

TABLE 2
1-RM of Knee Extension (NE) and Elbow Flexion (EF) of experimental group (EX n = 7) after 12 weeks of training and detraining (average and SD)

Strength	Post	D3
1-RM NE (kg)	26.2 ± 12.9	19.6 ± 11.2
1-RM EF (kg)	7.9 ± 4.1	6.5 ± 3.0

When the results were corrected by body weight and LBM, the strength drop from Post to D3 was significant in the knee extension.

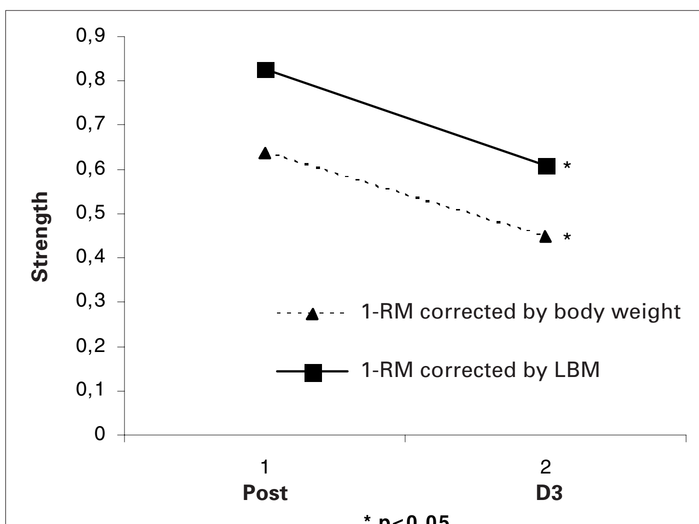

***Fig. 1** – Averages and Standard deviation of 1-RM strength of knee extension corrected by body weight and LBM during detraining of group EX*

The 1-RM strength of knee extension corrected by the body weight presented reduction of 41% ($p > 0.05$), from 0.64 ± 0.15 to 0.45 ± 0.15, and of 36% (from 0.83 ± 0.29 to 0.61 ± 0.26), when corrected by the LBM (figure 1).

During the 12 weeks of detraining, even corrected by the LBM, the 1-RM strength of elbow flexion of group EX presented no significant reduction (figure 2).

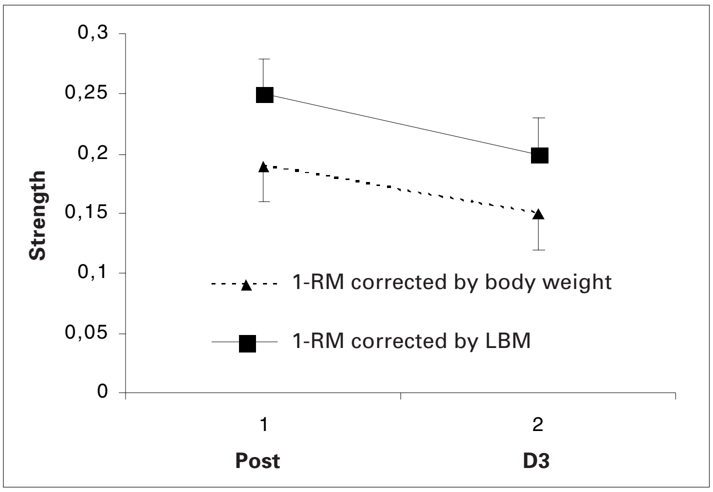

Fig. 2 *– Averages and Standard deviation of 1-RM strength of elbow flexion corrected by body weight and LBM during detraining of group EX*

DISCUSSION

The results of the present study demonstrated that, after 12 weeks of strength training, an increase on the 1-RM strength of 78% occurred for the knee extension and of 67% for the elbow flexion in prepubertal boys. After 12 weeks of detraining, a significant knee extension decrease strength of 41% corrected by the body weight and of 36% corrected by the LBM occurred. In the control group, a progressive and biological increase on 1-RM strength occurred, being significant only at the end of the 24 weeks.

Two studies[10,11] observed the detraining period in children. Blimkie *et al.*[11], after 8 weeks of detraining preceded of 8 weeks of dynamic training, observed a non-significant decrease in the 1-RM absolute strength of prepubertal boys in bench press and leg press. These results of Blimkie *et al.* are similar to results of the present study, once presented a decrease tendency of absolute strength, but statistically not significant.

Faigenbaum *et al.*[10], recorded a 28.1% decrease on the 6-RM strength in the knee extension of a group of 11 prepubertal boys and 4 girls after 8 weeks of detraining preceded of 8 weeks of dynamic training.

Faigenbaum *et al.*[10], found significant reduction on the 6-RM absolute values (submaximal) after eight weeks of detraining, now Blimkie *et al.*[3] evaluated that same detraining duration and found no reduction statistically significant evaluating the maximal strength using the 1-RM test. Maybe if tests were similar, the results presented different behavior.

In another study, Blimkie *et al.*[4] verified no reduction on strength in the detraining period for the upper limbs; these results are similar to results of this study, where no reduction statistically significant on the 1-RM strength of elbow flexors was verified as well.

The non-reduction of strength in elbow flexors could be associated to the trainability difference between upper and lower segments[11].

Intense gains of strength in prepubertal children are observed in the first four to eight training weeks due to neuromotor adaptations and, after this period, strength remains increasing, but in lower degree[18]. It is possible that, when the detraining period is evaluated for eight weeks, preceded of eight weeks of training, we find significant reduction on strength because in the period in which a relevant gain of strength occurs, the stimulus is removed, thus the drop may be more intense as observed in the study of Faigenbaum *et al.*[10].

Only a few studies compared results of group EX to group CO. In the present study we observed that, at the end of the 24 weeks, both groups presented values with no difference statistically significant in the several 1-RM strength measures. Thus, the strength training in prepubertal children did not influence the strength gain due to the growth and development process.

In the detraining period, the strength reduction in adults is always evident, between 12%[19], some times reaching up to 68%[20].

Considering that the strength gain in adults and prepubertal children is different, in other words, a neural and morphological adaptation occurs to adults or the increase on the muscular mass, it is expected that the strength loss behavior is also different.

In prepubertal children, the maturational process makes the strength reduction in the detraining period less evident[11].

This study had as limitation the reduced sampling number, and a larger number of individuals is desired in further studies. More studies evaluating this period will contribute for the knowledge about variables that may influence the strength detraining in children.

CONCLUSION

Although the strength reduction was not statistically significant, one should consider that this reduction indeed occurred after training interruption and it may be relevant in children who participate in competitive sports. Thus, the maintenance of the strength training should be considered, especially in preparation periods in the several sportive modalities.

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