

# COMPARISON OF A 10 WEEKS RESISTANCE STRENGTH TRAINING PROGRAM ON PREPUBESCENT GIRLS AND BOYS



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## 1. Introduction

Independently of the sex or age, strength it's a preponderant factor associated to other conditioning capacities, as well as performance techniques of the different physical activities.

Nowadays, the effects of strength training in the somatic development during childhood, its effectiveness, its benefits and probable risk associated to it, has been object of interest by the scientific community.

Pre-pubertal boys as well as girls can increase strength, up and beyond their growth and maturation, as long as the volume and intensity of training be accurate. As evidenced in various recent studies: Servodio et al. (1985), Weltman (1986), Sewall and Michel (1986), Pfeiffer and Francis (1986), Docherty et al. (1987), Siegel et al. (1989), Merch and Stoboy (1989), Blimkie et al. (1989), Ramsay et al. (1990), Fukunaga et al. (1992), Ozmun et al. (1993), Faigenbaum et al. (1993, 1997, 1999, 2002), Gregory et al. (1995), Falk and Mor (1996) and Sadres et al. (2001).

We believe that those who didn't evidenced muscular strength increases, were consequence of inadequate magnitude loads, its length, or simply because they didn't follow the progression principle, such as in the studies of Hettinger (1958), Kirsten (1963), Vrijens (1978), Docherty (1987), Siegel (1989).

The mechanisms that are behind the strength gains, in strength training programs, are not still well evidenced. It seems to exist the certainty that strength training produces greater gains, during puberty and after, in virtue, over all, of the increase of serum testosterone, which allows an increase of muscle hypertrophy (Kraemer and Fleck 1993).

Strength gains gotten before puberty, will be resultant of neurological adaptations, such as, the improvement of inter and intra-muscle coordination and order, the synchronization, the amount of motor units recruited, and the frequency of nervous stimulus, and not so much due to hypertrophy (Ramsay et al. 1990; Ozmun et al. 1993; Falk and Mor, 1996).

## 1.1. Purposes

The purpose of this study was to investigate the effects of a 10 weeks resistance training program on the development of the maximal isometric strength, muscle thickness (THICK), contracted brachial perimeters (CBP), relaxed brachial perimeters (RBP), the push-ups (PUSHUP), the pull-ups (PULLUP) and throwing a roller-skate hockey ball (THROW) in prepubescent girls and boys.

## 2. Material and Methods

### 2.1 Sample

The sample was divided into two different groups, the experimental one (EG, n=17) and the control one (CG, n=17) and comprises 20 girls (9,44 ± 0,28 years) and 15 boys (9,34 ± 0,30 years) in the maturation stage I according to Tanner's Scale.

### 2.2 Training program

The EG group was submitted to a training program with calisthenic exercises three times a week (90 minutes each session) during 10 weeks.

The program consisted of training push-ups, modified pull-ups and 2 exercises with elastics (elbows flexion and extension and extension of the arms above the head) until exhaustion.

The training volume was gradually adapted from 3 series between the 1st and 3rd week to 4 series between the 4th and 6th week and to 5 series between 7th and 10th week.



## 2.3 Evaluations

### 2.3.1 Strength

#### Maximal isometric voluntary force (MIVF)

The MIVF was evaluated during the Arm Curl (ARM). The MIVF was measured using a dynamometer (TST 121C from Biopac Systems Inc.)



#### Resistance and power strength

We also evaluated the maximal number of push ups (PUSHUP) and modified pull ups (PULLUP) that each child was able to execute. Finally we measured the distance covered by the roller-skate hockey ball after being thrown (THRW).



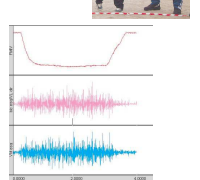
### 2.3.2 Neuromuscular Adaptations (EMG)

During the arm curl exercise, one surface electrode (TSD 150A from Biopac System Inc.) was attached in each biceps (MIVFARM). Ground electrode was attached to the elbow.

The EMG signals were amplified by a differential amplifier with 2Megaohms, a gain of 1000 and a bandwidth between 15-450Hz.

The EMG signals were full-wave rectified and smoothed, allowing to determinate the amplitude of the EMG signal (aEMG) of right bicep (ARMR) and left bicep (ARML).

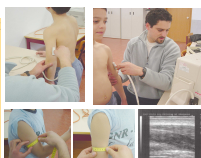
The aEMG was relativized according to the duration of the contraction.



### 2.3.2 Morphological adaptations

The muscle thicknesses of the biceps right arm (THICKBR) and left arm (THICKBL); the muscle thicknesses of triceps right arm (THICKTR) and left arm (THICKTL); the triceps skin folds of right arm (SKINTR) and left arm (SKINTL), were measured by B-mode ultrasonography, using real-time electronic scanner with 7.5MHz scanning head (Eccocamera Aloca SSD-500).

The right relaxed brachial perimeters (RBPR) and left (RBPL) and the right contracted brachial perimeters (CBPR) and left (CBPL) were measured using the usual anthropometric procedures.



### 2.4 Statistical Procedures

We used mean values and standart deviation as descriptive statistic We evaluated the change between the pre-test and the post-test with the test of Wilcoxon (p<0.05).

## 3. Results

Table 1. mean values and standart deviation, W of Wilcoxon value and significance level (p<0.05) in Pre-Test and Post-Test in the difference between the EG and CG in the male and female group, in strength tests.

TEST	EG Male				CG Male				EG Female				CG Female			
	Pre-Test	Post-Test	W	p	Pre-Test	Post-Test	W	p	Pre-Test	Post-Test	W	p	Pre-Test	Post-Test	W	p
PUSHUP (n=)	6175.2	11711.8	2287	0.001	6114.0	8161.9	9218	0.001	6125.0	7109.0	2218	0.001	6125.0	6722.4	1231	0.001
PULLUP (n=)	6325.4	10914.4	2287	0.001	6491.4	8165.7	1889	0.276	5745.0	6555.0	2249	0.001	6465.0	6742.7	629	0.281
THRW (m)	14322.8	16312.9	1245	0.001	16293.8	16312.0	626	0.895	14825.0	14825.0	2495	0.001	14825.0	16762.7	1689	0.001
MIVF (kg)	11015.1	11663.7	1512	0.011	11701.0	12010.0	630	0.001	11035.0	11635.0	1412	0.001	11520.0	11951.0	650	0.001

Table 2. mean values and standart deviation, W of Wilcoxon value and significance level (p<0.05) in Pre-Test and Post-Test in the difference between the EG and CG in the male and female group, in neuromuscular adaptations.

TEST	EG Male				CG Male				EG Female				CG Female			
	Pre-Test	Post-Test	W	p	Pre-Test	Post-Test	W	p	Pre-Test	Post-Test	W	p	Pre-Test	Post-Test	W	p
ARMR (n=)	6150.8	6270.8	1261	0.001	6276.1	6290.7	626	0.370	6100.0	6225.1	1261	0.001	6254.1	6270.1	610	0.371
ARML (n=)	6100.0	6100.0	626	0.370	6100.0	6100.0	626	0.370	6100.0	6100.0	626	0.370	6100.0	6100.0	626	0.370

Table 3. mean values and standart deviation, W of Wilcoxon value and significance level (p<0.05) in Pre-Test and Post-Test in the difference between the EG and CG in the male and female group, in morphologic adaptations.

TEST	EG Male				CG Male				EG Female				CG Female			
	Pre-Test	Post-Test	W	p	Pre-Test	Post-Test	W	p	Pre-Test	Post-Test	W	p	Pre-Test	Post-Test	W	p
THICKBR (n=)	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001
THICKBL (n=)	11752.0	11752.0	1249	0.001	11752.0	11752.0	1249	0.001	11752.0	11752.0	1249	0.001	11752.0	11752.0	1249	0.001
SKINTR (n=)	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001
SKINTL (n=)	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001
SKINTR (n=)	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001
SKINTL (n=)	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001
THICKTR (n=)	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001
THICKTL (n=)	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001
SKINTR (n=)	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001
SKINTL (n=)	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001	12252.0	12252.0	1249	0.001

## 4. Discussion and Conclusions

In Vrijens (1978), Sewall and Michel (1986), Siegel et al. (1989) studies, where they used a dynamic strength training program, there weren't significant strength increases in the MIVF evaluation.

Following the example of Sailors and Berg (1987), McGovern (1984), Weltman et al (1986), Siegel et al (1989), Blimkie et al (1989), Ramsay et al (1990), Ozmun et al (1994), there weren't evidences of significant improvement relating to strength performance associated to muscular hypertrophy. In fact this results are in agreement with the present study. Further more, the morphological adaptations, resulted of strength training with children of both sexes, as been less consistent, even those registered by Merch and Stoboy (1989) and by Fukunaga et al (1992).

Not having registered statistically significant improvements in aEMG, as result of the specific training, such results lead us to think that the applied training must have focused its effects accordingly to specifically executed movements during different weeks of training, and that it had, probably, promoted a specifically motor coordination and developed a self executing velocity (Weineck, 1980).

The results suggested that prepubescent children can increase strength following a strength training program that includes calisthenic exercises.

In conclusion, it seems that children can improve strength without any increase of hypertrophy or neuromuscular adaptations, but due to an improvement of the motor coordination.

## 5. References

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In the Table 1., is presented the strength evaluation. As we can see, in both EG there were significant alterations between pre-test and post-test; while in the CG there weren't any significant differences. The alterations noticed in both sexes of EG were in a positive sense, in other words, the performance increased in the different strength test. This improvement reached the value of 146% in the PUSHUP test, of 119% in the PULLUP test, and of 22% in THRW, concerning the boys; while 842% in PUSHUP test, 338% in PULLUP test and 12% THRW concerning the girls. In the FIMVARM there were only significant alterations between pre and post-test, in the female group, where there was a significant decrease of the performance.

In the table 2 is presented the neuromuscular adaptations. The comparisons revealed statistically significant results in the ARMAEMR, in the male EG.

In the female EG there weren't any statistically significant values.

Finally, in the table 3, concerning to the morphologic adaptations, there were statistically significant differences, in the EG, both in girls as in boys, in RBPR, RBPL, CBPR and CBPL between the pre-test and the post-test. In the female CG, there were also significant differences in the CBPR. As to the triceps skin folds, it's essential to enlighten that the average values referring to the EG are also bigger in this case, except, as illustrated, in the female CG, in the SKINTR during pre-test and SKINTR and SKINTL during post-test. The results of the muscular thickness of the biceps presented, during the post-test, two statistically significant values, in the THICKBR and THICKBL, in the female CG.