COMPARISON OF A 10 WEEK RESISTANCE STRENGTH TRAINING PROGRAME, IN MUSCLE MORPHOLOGY, ELECTROMYOGRAPHY ACTIVITY AND STRENGTH GAINS 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: Servedio et al.(1985), Weltman (1986), Sewall and Micheli (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 neuromuscular adaptations and not so much due to hypertrophy (Falk and Mor, 1996).

1.1. Purposes

The purpose of this research was to compare the maximal voluntary isometric force (MVIF), the electromyography activity (EMG) and the muscle thickness between pre-pubertal boys and girls.

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 ± 30 years) in the maturation stage I according to Tanner's Scale.

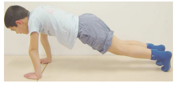
2.2. Training program

The EG group was submitted to a training program with callisthenic 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 Triceps Press (TPA). 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)

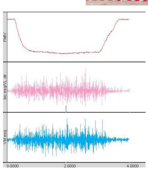
During the Triceps Press exercise, one surface electrode (TSD 150A from Biopac System Inc.) were attached in each vastus lateralis (TPAEMVL) and each vastus medialis (TPAEMVM) of both arms.

Ground electrode was attached to the elbow.

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

The EMG signals were full-wave rectified and smoothed, allowing to determinate the integral of the EMG signal (iEMG) of both vastus lateralis (TPAEMVL) and both vastus medialis (TPAEMVM).

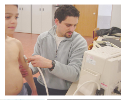
The iEMG was relativizated according to the duration of the contraction.

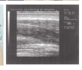


2.3.2 Morphological adaptations

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 (Ecocamera 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 desviation 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 desviation, W of Wilcoxon value and sigificance 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			
	Pre-test	Post-test	W	p	Pre-test	Post-test	W	p
PUSHUP (rep)	8,17±8,73	20,17±10,32	2,207	0,027'	6,13±3,68	5,86±3,24	0,213	0,832
PULLUP (rep)	4,33±2,42	9,50±1,64	2,207	0,027'	6,00±2,45	4,86±2,67	1,089	0,276
THRW (m)	13,37±2,63	16,33±1,96	2,201	0,028'	16,29±3,42	15,33±3,12	0,676	0,499
MIVFTRP (Kg)	38,97±6,69	43,19±10,41	1,521	0,128	37,97±6,69	42,19±10,41	1,521	0,128

TEST	EG Female				CG Female			
	Pre-test	Post-test	W	p	Pre-test	Post-test	W	p
PUSHUP (rep)	2,45±3,47	23,09±25,93	2,938	0,003'	4,33±5,59	5,57±3,74	1,913	0,056
PULLUP (rep)	2,18±1,99	9,55±8,68	2,941	0,003'	4,00±1,50	4,14±2,12	0,276	0,783
THRW (m)	8,04±2,59	9,06±1,96	2,401	0,016'	9,01±2,12	10,28±2,72	1,690	0,091
MIVFTRP (Kg)	32,02±8,39	32,54±8,36	0,089	0,929	32,43±8,10	36,44±10,92	0,338	0,735

Table 2. mean values and standart desviation, W of Wilcoxon value and sigificance 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			
	Pre-test	Post-test	W	p	Pre-test	Post-test	W	p
TPAEMVLR	0,37±0,14	0,31±0,12	0,944	0,345	0,29±0,17	0,27±0,09	0,676	0,499
TPAEMVMR	0,22±0,08	0,17±0,11	1,214	0,225	0,18±0,12	0,23±0,19	0,845	0,398
TPAEMVLL	0,66±0,96	0,28±0,12	0,674	0,500	0,30±0,12	0,24±0,20	0,676	0,499
TPAEMVML	0,34±0,14	0,27±0,07	1,753	0,080	0,43±0,20	0,32±0,13	1,521	0,128

TEST	EG Female				CG Female			
	Pre-test	Post-test	W	p	Pre-test	Post-test	W	p
TPAEMVLR	0,33±0,10	0,23±0,10	1,778	0,075	0,36±0,16	0,26±0,11	1,352	0,176
TPAEMVMR	0,16±0,06	0,14±0,07	0,711	0,477	0,26±0,15	0,27±0,19	0,169	0,866
TPAEMVLL	0,28±0,09	0,26±0,13	0,889	0,374	0,43±0,19	0,24±0,16	1,183	0,237
TPAEMVML	0,36±0,18	0,24±0,14	2,401	0,016'	0,39±0,21	0,27±0,04	1,352	0,176

Table 3. mean values and standart desviation, W of Wilcoxon value and sigificance 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			
	Pre-test	Post-test	W	p	Pre-test	Post-test	W	p
RBPR (cm)	21,25±3,56	22,42±2,87	2,041	0,041'	20,69±2,90	21,01±2,62	0,378	0,705
RBPL (cm)	21,17±2,40	22,42±2,87	2,041	0,041'	20,59±2,94	20,93±2,68	0,333	0,739
CBPR (cm)	22,70±2,50	23,67±2,58	2,201	0,028'	23,20±4,04	22,90±2,49	0,135	0,893
CBPL (cm)	22,55±2,26	23,50±2,53	2,060	0,039'	21,76±2,80	22,21±2,75	0,552	0,581
SKINTR (mm)	9,17±2,71	9,33±3,20	0,687	0,492	6,36±2,69	8,09±3,74	1,753	0,080
SKINTL (mm)	8,83±2,79	9,50±2,74	1,414	0,157	6,83±2,42	6,66±2,87	0,272	0,785
THICKBL (cm)	2,52±0,37	2,12±0,55	1,633	0,102	2,14±0,59	2,21±0,46	0,412	0,680
THICKBL (cm)	2,48±0,33	2,12±0,57	1,787	0,074	2,10±0,54	2,19±0,35	0,601	0,496
THICKTR (cm)	1,88±0,20	1,95±0,38	0,677	0,498	1,96±0,42	2,04±0,30	0,256	0,798
THICKTL (cm)	1,90±0,20	1,88±0,22	0,000	1,000	1,93±0,38	2,06±0,47	1,476	0,140

TEST	EG Female				CG Female			
	Pre-test	Post-test	W	p	Pre-test	Post-test	W	p
RBPR (cm)	21,75±2,45	22,32±1,98	2,070	0,005'	21,20±2,30	21,81±3,40	1,604	0,109
RBPL (cm)	21,34±2,27	22,23±2,02	2,051	0,040'	21,21±3,30	21,89±3,74	1,841	0,066
CBPR (cm)	22,75±2,01	23,45±2,08	2,941	0,003'	21,99±3,00	22,74±3,37	2,264	0,024'
CBPL (cm)	22,31±1,91	23,32±2,21	2,603	0,009'	22,09±3,47	22,78±3,50	1,826	0,068
SKINTR (mm)	10,82±2,44	10,64±2,06	0,359	0,719	11,00±3,84	11,00±4,51	0,318	0,750
SKINTL (mm)	10,72±2,45	10,00±1,61	0,722	0,470	9,89±3,27	10,66±3,48	1,500	0,134
THICKBL (cm)	2,31±0,30	2,45±0,48	0,870	0,384	1,86±0,27	1,96±0,15	2,226	0,026'
THICKBL (cm)	2,35±0,45	2,14±0,31	1,471	0,141	1,94±0,24	2,04±0,24	2,050	0,040'
THICKTR (cm)	1,89±0,29	1,78±0,34	0,445	0,398	2,12±0,36	2,26±0,42	0,516	0,606
THICKTL (cm)	1,95±0,39	1,89±0,31	0,354	0,723	2,21±0,56	2,23±0,47	0,170	0,865

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 diferent strength test. This improvement reached the value of 146% in the PUSHUP test, of 119% in the PULLUP test, and of 22% in THWR, concerning the boys; while 842% in PUSHUP test, 338% in PULLUP test and 12% THWR concerning the girls.

In the FIMVTRP there weren't significant alterations between pre and post-test in both sexes.

In the table 2 is presented the neuromuscular adaptations. The comparisons revealed statistically significant decrease in the TPAEMVML, in the female EG. In the female EG there weren't any statistically significant values.

Finally, in the table 3, concening to the morphological 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.

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 Mersh 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 callisthenic exercises. There were no significant differences on the MVIF between boys and girls doing the triceps press exercise. The strength gains were not followed by an increase of muscle mass.

In the same way, there were no significant differences according to gender on the thickness of the triceps of the both arm of the triceps. It seems that the elements underlying the increase and strength gains can be related to the increase of the coordination of the movement.

The coordination seems to be an element that highly contributes to the increase of strength for more complex exercises.

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