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# Does a Calisthenics-Based Exercise Program Applied in School Improve Morphofunctional Parameters in Youth?

Diego de Souza Santos[1], Thiago Eduardo de Oliveira[1], Cássio Adriano Pereira[1], Alexandre Lopes Evangelista[2,3], Danilo Sales Bocalini[3], Roberta Luksevicius Rica[3,4], Matthew R. Rhea[5], Roberto Simão[6], Cauê Vazquez La Scala Teixeira[7,8]

[1]College of Physical Education and Sports, Santa Cecília University, Santos, Brazil, [2]Department of Physical Education, Nove de Julho University, São Paulo, Brazil, [3]Translational Physiology, Postgraduate Program on Physical Education and Aging Science, São Judas Tadeu University, São Paulo, Brazil, [4]Body Perception and Human Movement Laboratory, Postgraduate Program on Physical Education and Aging Science, São Judas Tadeu University, São Paulo, Brazil, [5]A.T. Still University, USA, [6]Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, [7]Department of Biosciences, Federal University of São Paulo, Santos, Brazil, [8]College of Physical Education, Praia Grande College, Praia Grande, Brazil

## ABSTRACT

**Santos DS, Oliveira TE, Pereira CA, Evangelista AL, Danilo Sales Bocalini, Rica RL, Rhea MR, Simão R, Teixeira CV.** Does a Calisthenics-Based Exercise Program Applied in School Improve Morphofunctional Parameters in Youth? **JEPonline** 2015;18(6):52-61. The aim of this study was to investigate the effects of calisthenic strength exercises in Physical Education classes on morphological and functional adaptations in school children. Thirty-nine youth, including both genders, in grades seventh and eighth were assigned to one of two groups: Control (CG = 19) and Calisthenics (CaG = 20). The intervention was performed twice per week, during 12 wks. The measurements were applied at pre- and post-intervention, including body mass index (BMI), push-ups in 1 min (PUS), curl-ups in 1 min (CUR), horizontal jump (HJ), and running speed in 50 m (speed). The PUS and CUR increased for boys and girls in the CaG and decreased in the CG. The HJ did not change in either group, however the % change was significantly higher in the CaG than in the CG. Speed decreased in both groups for boys and girls. Neither group showed significant differences in BMI. The findings indicate that the traditional Physical Education classes are inefficient for improving morpho-functional adaptations after 12 wks and even result in a decrease in strength performance. The addition of calisthenic strength exercises improved strength levels of these school children. For additional benefits on BMI, power, and speed, specific training and additional interventions (e.g., nutritional diet) are necessary and should be included in a well-rounded physical education experience.

**Key Words**: Resistance training, Calisthenics exercises, Performance, Children

## INTRODUCTION

Increasingly, strength training is encouraged among children and adolescents. It is acknowledged as a safe and effective intervention for developing physical and psychological health, improving performance, and preventing injuries in daily activities and sports (12). The benefits of regular strength training during childhood are not restricted to this phase of life, but also contribute to reducing the risk of developing various diseases throughout life (18).

To increase the strength of muscles, it is recommended that moderate intensity resistance training using 1 to 3 sets of 6 to 15 repetitions performed 2 to 3 times·wk$^{-1}$ on a regular basis is applied to the body, preferably through multi-joint exercises (7). If the goal is power, similar work is recommended with high-speed contractions (7). Until recently this and other similar protocols were well accepted by researchers as a reference to optimize both performance results and improvement in the quality of life of children (1). It was believed that practice workouts below these intensities and/or the use of different methods might result in minor positive adaptations in medium and long term (17).

Physical Education classes represent a good venue for implementing a strength training regimen among children. However, the main problem in schools is the unavailability of specific equipment for strength training. Additionally, Dorgo et al. (5) claim that strength training is underexplored in Physical Education classes because the emphasis in these classes is mainly on recreational sports and games with little time given to structured exercise.

Alternative forms of strength training have been proposed by some authors in order to facilitate the application of resistance exercises in school settings where equipment or space is limited. Faigenbaum (6) suggests that body weight exercises are a viable alternative to free weights or resistance machines. Body weight exercises, often called calisthenics, use body weight as resistance with the intent to improve strength through a variety of movements such as pushups, pullups, and situps. Calisthenics may be an useful alternative for resistance exercise among children because the exercises are relatively easy to learn, allow for work in groups, present low risk of injury, and provide a different exercise experience that may be more enjoyable for children (3).

Hence, the purpose of this research study was to investigate the effects of calisthenics strength exercises in Physical Education classes on morphological and functional adaptations in school children in Brazil.

## METHODS

### Subjects

A total of 40 school children (ages 12.8 ± 0.6 yrs), consisting of 20 boys and 20 girls, were recruited from a public school in Brazil. An institutional ethics committee approved the study. An informed consent was obtained from all participants and their parents. All participants volunteered to participate after receiving verbal explanations of the tests prior to the start of the study. One male student did not reach the minimum attendance requirement (75% of Physical Education classes) and was excluded from the data analysis. The initial sample size of 40 was reduced to 39 subjects.

### Procedures

Each subject underwent anthropometric and functional assessment at pre- and post-intervention. The tests were conducted on a single day, in the sequence explained below:

- Each subject underwent anthropometric and functional assessments at pre- and post-intervention. The tests were conducted on a single day using the following sequence (with a 10-min rest between each test to prevent fatigue).

:

- **Body Mass Index (BMI):** The subjects' body mass and height were measured according to protocols described by World Health Organization (19), and BMI was calculated by dividing body weight (in kilogram) by the square of height (in meters).

- **Horizontal Jump (HJ):** The subjects performed the horizontal jump test according to protocols described by Maulder and Cronin (13). The best distance (in centimeters) of three attempts was recorded.

- **50 M Sprint (SPEED):** The subjects ran a distance of 50 m in the shortest time possible (9). The time was recorded in seconds.

- **Push-Ups (PUS) and Curl-Ups (CUR) in 1 min:** The subjects performed the maximum number of repetitions of PUS and CUR in 1 min (14).

Both interventions were conducted during Physical Education classes over a period of 12 wks. The weekly frequency was twice per week and the duration of each class was 60 min. In order to avoid any embarrassment among students, it was decided to perform each type of intervention in a separate class. All exercises and tests were administered by the same instructor. Thus, the students were randomly divided into one of two groups:

- **Control (CG)** (n = 19)**:** The control group continued in a traditional Physical Education class. The session consisted of 10 min of warm up (running) followed by 40 min of practical skills, motor skills, and sports activities. The cool down involved 10 min of general stretching exercises (1 x 30 sec for the major muscle groups). An introductory session was held two days before the beginning of the study for each participant included in this group. These sessions provided information about the testing, along with opportunities to practice each test to remove potential learning effects.

- **Calisthenics (CaG)** (n = 20)**:** The calisthenics exercise group performed a 10-min warm up (running) followed by five calisthenics strength exercises: (a) wide grip push-ups; (b) squat or lunge; (c) fixed bar inverted row; (d) curl-ups; and (e) narrow grip push-ups). The cool down involved 10 min of general stretching exercises (1 x 30 sec for the major muscle groups). Prior to beginning the intervention, the subjects participated in 2 wks of familiarization with the exercises, because they did not have any previous experience with strength training. The exercise routine followed a linear periodization model in which the volume was gradually increased:

    - **Weeks 1 and 2** (adaptation)**:** One set of 8 to 12 repetitions of each exercise, with a 1-min rest between sets;

    - **Weeks 3 to 5:** Two sets of 8 to 12 repetitions of each exercise, with a 1-min rest between sets; and

    - **Weeks 6 to 12:** Three sets of 8 to 12 repetitions of each exercise, with a 1-min rest between sets.

**Statistical Analyses**

Descriptive statistics (mean ± standard deviation) were conducted to describe the sample. In order to compare inter- and intra-group results, repeated measures ANOVA was employed. The normality of data was verified and confirmed by Mauchly's sphericity test. The significance level adopted was 5% ($P<0.05$).

In order to quantify the magnitude of results, the percentage change (% change) and the effect size (ES) were calculated. The ES classification adopted in this study was the scale proposed by Rhea (16) for untrained subjects: trivial ($ES < 0.50$); small ($0.50 < ES < 1.25$); moderate ($1.25 < ES < 2.0$); and large ($ES > 2.0$). The analysis was made with IBM SPSS Statistics v. 20.

## RESULTS

After 12 wks, only CaG showed significant improvements on CUR and PUS tests between pre- and post-intervention. The significant improvement in CUR and PUS was observed in male (23 and 19%), female (32 and 22%), and among the entire sample (27 and 20%). Significant differences were identified in % change between CaG and CG in the same variables in all subgroups. Speed significantly decreased in CaG and CG for male and female, but not in the group data. In the CG, performance in the CUR, PUS significantly decreased.  HJ did not change in either group, but a significant difference in the % change between groups for male and group data was identified.  No changes were observed in BMI in either group (Tables 1, 2, and 3).

**Table 1. General Parameters.**

| Parameters | Group | Before | After | % Change | ES | Interaction | P |
|---|---|---|---|---|---|---|---|
| **Body Weight** (kg) | CG | 54 ± 11 | 54 ± 11 | 0 ± 4 | -0.02 | 1.00 | >0.05 |
| | CaG | 53 ± 9 | 53 ± 8 | 0 ± 4 | -0.02 | | |
| **Height** (m) | CG | 1.57 ± 0.06 | 1.57 ± 0.06 | 0 ± 0.20 | 0.02 | 1.00 | >0.05 |
| | CaG | 1.59 ± 0.06 | 1.59 ± 0.06 | 0 ± 021 | 0.00 | | |
| **Body Mass Index** ($kg \cdot m^{-2}$) | CG | 22 ± 4 | 22 ± 4 | -1 ± 4 | -0.05 | 0.06 | >0.05 |
| | CaG | 21 ± 3 | 21 ± 3 | -0.49 ± 4 | -0.04 | | |
| **Push Ups** (rep) | CG | 20 ± 6 | 19 ± 5 | -6 ± 11 | -0.18 | 44.26 | <0.01 |
| | CaG | 22 ± 7 | 27 ± 8 | 20 ± 12† | 0.73 | | |
| **Abdominal Strength** (rep) | CG | 23 ± 4 | 21 ± 4 | -10 ± 11 | -0.45 | 34.76 | <0.001 |
| | CaG | 21 ± 4 | 30 ± 10 | 27 ± 15† | 2.06 | | |
| **Horizontal Jump** (cm) | CG | 140 ± 18 | 139 ± 17 | -1 ± 2 | -0.08 | 11.39 | >0.05 |
| | CaG | 125 ± 25 | 128 ± 25 | 3 ± 3† | 0.13 | | |
| **Speed** (sec) | CG | 13 ± 1 | 14 ± 1 | 3 ± 5 | 0.26 | 6.21 | >0.05 |
| | CaG | 14 ± 2 | 15 ± 2 | 8 ± 7* | 0.69 | | |

Values expressed in mean ± SD.
*0.01, †0.001 indicate statistical differences between control (CG) group.

**Table 2. Male Parameters.**

| Parameters | Group | Before | After | % Change | ES | Interaction | P |
|---|---|---|---|---|---|---|---|
| **Body Weight** (kg) | CG | 54 ± 10 | 53 ± 11 | -1 ± 4 | -0.06 | 2.13 | >0.05 |
| | CaG | 52 ± 9 | 53 ± 8 | 1 ± 3 | 0.06 | | |
| **Height** (m) | CG | 1.57 ± 0.7 | 1.57 ± 0.7 | 0.14 ± 0.27 | 0.00 | 0.48 | >0.05 |
| | CaG | 1.60 ± 0.8 | 1.60 ± 0.8 | 0.06 ± 0.20 | 0.00 | | |
| **Body Mass Index** ($kg \cdot m^{-2}$) | CG | 22 ± 3 | 21 ± 3 | -2 ± 4 | -0.15 | 0.87 | >0.05 |
| | CaG | 20 ± 2 | 20 ± 2 | 1 ± 3 | 0.13 | | |
| **Push Ups** (rep) | CG | 18 ± 6 | 18 ± 5 | -3 ± 11 | -0.09 | 18.93 | <0.001 |
| | CaG | 25 ± 8 | 30 ± 9 | 19 ± 10$^{\dagger}$ | 0.77 | | |
| **Abdominal Strength** (rep) | CG | 25 ± 4 | 22 ± 4 | -11 ± 7 | -0.60 | 13.23 | <0.01 |
| | CaG | 23 ± 3 | 32 ± 10 | 23 ± 13$^{\dagger}$ | 2.71 | | |
| **Horizontal Jump** (cm) | CG | 146 ± 16 | 145 ± 16 | -1 ± 1 | -0.06 | 8.32 | >0.05 |
| | CaG | 130 ± 23 | 133 ± 23 | 3 ± 4* | 0.16 | | |
| **Speed** (sec) | CG | 12 ± 1 | 13 ± 1 | 3 ± 6 | 0.62 | 5.45 | <0.01 |
| | CaG | 13 ± 1 | 14 ± 1 | 11 ± 9* | 1.45 | | |

Values expressed in mean ± SD.
*0.01, $^{\dagger}$0.001 indicate statistical differences between control (CG) group.

**Table 3. Female Parameters.**

| Parameters | Group | Before | After | % Change | ES | Interaction | P |
|---|---|---|---|---|---|---|---|
| **Body Weight** (kg) | CG | 55 ± 12 | 55 ± 12 | 0 ± 3 | 0.01 | 0.92 | > 0.05 |
| | CaG | 54 ± 10 | 53 ± 9 | -1.30 ± 5 | -0.08 | | |
| **Height** (m) | CG | 1.57 ± 0.05 | 1.58 ± 0.05 | 0 ± 0.26 | 0.08 | 0.36 | > 0.05 |
| | CaG | 1.58 ± 0.05 | 1.58 ± 0.05 | 0 ± 0.27 | 0.04 | | |
| **Body Mass Index** ($kg \cdot m^{-2}$) | CG | 22 ± 5 | 22 ± 5 | 2 ± 4 | 0.01 | 1.83 | > 0.05 |
| | CaG | 22 ± 5 | 21 ± 4 | 0 ± 3 | -0.11 | | |
| **Push Ups** (rep) | CG | 23 ± 6 | 21 ± 6 | -8 ± 11 | -0.26 | 30.06 | < 0.01 |
| | CaG | 20 ± 7 | 25 ± 4 | 22 ± 14$^{\dagger}$ | 0.74 | | |
| **Abdominal Strength** (rep) | CG | 22 ± 4 | 20 ± 4 | -8 ± 13 | -0.36 | 19.74 | < 0.01 |
| | CaG | 19 ± 5 | 29 ± 10 | 32 ± 16$^{\dagger}$ | 2.21 | | |
| **Horizontal Jump** (cm) | CG | 135 ± 18 | 133 ± 16 | -1 ± 5 | -0.10 | 4.00 | > 0.05 |
| | CaG | 121 ± 28 | 123 ± 27 | 2 ± 4 | 0.10 | | |
| **Speed** (sec) | CG | 14 ± 1 | 15 ± 2 | 2 ± 5 | 0.23 | 3.14 | < 0.01 |
| | CaG | 15 ± 1 | 16 ± 2 | 5 ± 3 | 0.55 | | |

Values expressed in mean ± SD.
$^{\dagger}$0.001 indicate statistical differences between control (CG) group.

## DISCUSSION

The main motivation for this study was the observation of the need to incorporate forms of physical training that address the current needs of the school children without the need for incorporating resistance equipment. These needs are related to the development of physical fitness components for health and performance. They address the fitness limitations caused by the current inactive leisure activities of children in the modern world (1).

Strength training programs for children and adolescents have been shown to be effective. They contribute to improvements related to physical and mental health (8), improvements in physical performance and the prevention of injuries in sports, and the prevention of diseases in adulthood (12). At school, alternative forms of strength training have been proposed to minimize the problem of not having sufficient resistance training equipment (5). Calisthenics strength exercises have been identified as the alternative strength training exercises due to practicality and value (3).

However, in the present study, the callisthenic intervention was inefficient in promoting changes in the subjects' BMI, as was the general Physical Education program. This result may relate to the fact that morphological changes are highly dependent on other factors such as dietary intake (11), which was not controlled in this study. Additionally, the frequency of twice a week and the short duration of intervention may not be sufficient to promote changes in BMI (10).

The performance of CUR and PUS improved in the CaG group in boys (23 and 19%, respectively), in girls (32 and 22%, respectively), and in the combined sample (27 and 20%, respectively), but decreased in the CG. This finding can be attributed not only to the specificity of the tests applied to evaluate the progress of the training program, but also to increased muscle strength developed by various body weight exercises (2). Interestingly, the observation of a decrease in CUR and PUS performance in the CG highlights the inefficiency of the conventional Physical Education intervention model in promoting increased muscular strength levels. As strength is one of the most relevant physical capabilities for sports performance, health, quality of life, and functional independence, the results of this study emphasizes the need to include specific programs for muscle strengthening in school children that are designed to complement the traditional curricular activities in Physical Education classes (7).

In the HJ, neither group showed significantly changes after intervention. Although there are reports in the literature that the increase in muscle strength in untrained subjects contributes to an increase in power output (20), the results of this study do not confirm this hypothesis. Thus, specific power training (e.g., plyometrics) is necessary to provide better improvements in lower body power (4).

Also, the speed performance was not change in both groups for general sample, but decreased in the separate analysis for boys and girls. Similarly to that observed in HJ, specific speed training seems necessary to improve this variable and children seem to be more sensitive to detraining this capacity in the absence of specific stimuli (15). This study highlights the need for specific training methods employed for developing well-rounded physical capacity among children.

Finally, despite limitations in the current study (i.e., the lack of control on food intake and short intervention time), this study demonstrates the value of including strength exercises in the Physical Education curriculum. The protocol employed in this study is simple to implement and teach, can be altered based on space and time limitations, and is very cost effective.

## CONCLUSIONS

The traditional Physical Education class involving recreations sports activities is inefficient for improving morphofunctional adaptations after 12 wks, thus resulting in a decrease in strength performance. The addition of calisthenics strength exercises improved the strength levels of school children. For additional benefits on BMI, power, and speed, specific training and additional interventions (e.g., nutritional diet) are necessary.

**Address for correspondence:** Cauê Vazquez La Scala Teixeira, Pça. Eng. José Rebouças, S/N, Ponta da Praia, Santos, SP, Brasil, 11030-000, contato@caueteixeira.com.br

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