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# Effect of a multicomponent program on health-related physical fitness in schoolchildren

## *Efeito de um programa multicomponente sobre a aptidão física relacionada à saúde em escolares*

**Rodrigo Machado Sordi[1], André Trevisan[1], Rogério César Fermino[2], Gilcemar Dalmagro de Quadros[1], Ricelli Endrigo Ruppel da Rocha[3*]**

[1] Professional Master's Program in Basic Education, University Alto Vale do Rio do Peixe-(UNIARP), Caçador (SC), Brazil. [2] Doctoral and Master's Program in Physical Education, University Federal of Paraná, Curitiba (PR), Brazil. [3] Professional Master's Program in Basic Education and Master's Program Academic in Development and Society, University Alto Vale do Rio do Peixe (UNIARP), Caçador (SC), Brazil.

***Corresponding author:** Ricelli E. Ruppel da Rocha - E-mail: ricelliendrigo@yahoo.com.br

**ABSTRACT**
This study aimed at assessing the effect of a multicomponent program on health-related physical fitness in schoolchildren. The sample included 120 students of early childhood and elementary education randomized into two groups: an intervention group (IG) that underwent a multicomponent program of physical sport activities along with nutritional education (n=60), and a control group (CG) that did not participate in the program (n=60). Nutritional status, $VO_{2max.}$, muscular strength/endurance and flexibility were evaluated in the beginning and after a 12-week intervention period. The results showed that the IG group changed the nutritional status and increased the $VO_{2max,}$ the muscular strength/endurance and flexibility ($p<0.0001$). The CG group showed no change in the $VO_{2max}$ and the muscular strength/endurance decreased ($p<0.0001$). Flexibility of the CG was lower than in the IG ($p<0.0001$). In conclusion, the multicomponent program improved health-related physical fitness of schoolchildren in basic education.
Keywords: Physical fitness; Sport activities; Nutritional education; Basic education.

**RESUMO**
Este estudo avaliou o efeito de um programa multicomponente sobre a aptidão física relacionada à saúde em escolares. A amostra foi composta por 120 alunos do ensino infantil e fundamental divididos aleatoriamente em dois grupos: grupo intervenção que realizou um programa multicomponente de atividades físico-desportivas e educação nutricional (GI; n=60) e grupo controle que não participou do programa (GC; n=60). Foram avaliados o estado nutricional, $VO_{2máx}$., força/resistência muscular e flexibilidade no início e no final de 12 semanas. Os resultados mostraram que o grupo GI modificou o estado nutricional e aumentou o $VO_{2máx.,}$ a força/resistência muscular e a flexibilidade ($p<0,0001$). No GC o $VO_{2máx.}$, não se alterou, a força/resistência muscular diminuiu ($p<0,0001$). A flexibilidade no GC foi menor, quando comparada ao GI ($p<0,0001$). Em conclusão, o programa multicomponente melhorou a aptidão física relacionada à saúde dos escolares da educação básica.
Palavras-chaves: Aptidão física; Atividades esportivas; Educação nutricional; Educação básica.

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## INTRODUCTION

Childhood and adolescence are considered critical phases, since the lifestyle acquired during this period will go along adulthood[1]. In addition, changes in eating behavior, body composition and physical activity level occur[2]. Research has shown a significant increase in the prevalence of overweight and obesity; moreover it is estimated that 20-30% of young people have this condition worldwide[2]. In Brazil, the prevalence of overweight varies between 15-35%, according to the region[3].

Several factors are attributed to the increased weight gain in childhood and adolescence, among which physical inactivity and inadequate diet[4] are seen. Less than 10% of children and adolescents manage to achieve 60 minutes of daily physical activity with moderate to vigorous intensity to obtain health benefits[5], and the great majority does not consume a sufficient amount of fruits and vegetables according to global recommendations[6].

Therefore, interventions that are capable of impacting health-related behavior, especially during schooling, represent one of the most effective approaches to overcome obesity, prevent physical inactivity, and reduce the risk of chronic diseases[7]. Schools are important places for developing interventions that stimulate changes in the students' lifestyle and eating habits, since they spend a large part of the day in these places. Nevertheless, these institutions have an important role on the students' behavior and attitudes, in addition to providing them with spaces for the practice of physical activities, professionals with different skills and trained teachers[8].

Multicomponent programs have been one of the strategies mainly used by schools to promote body weight control and improve students' eating habits[9-13]. These programs have as purposes to increase the level of physical activities, encourage healthy eating habits and involve family members and the community to improve their lifestyle[14-16]. The majority of these programs are primarily aimed at changing eating habits, nutritional status and the level of physical activity. However, few studies are carried out to assess the effects on health-related physical fitness (HRPF), which is a multifactorial construct that involves 4 components: cardiorespiratory capacity, muscle strength/ endurance, flexibility and body composition[17]. HRPF is considered one of the most important health markers and it is commonly understood as a predictor of morbidity and mortality caused by cardiovascular diseases[18]. The increase in health-related fitness levels is associated with low levels of cholesterol and triglycerides, balanced blood pressure and insulin sensitivity, lower risk of obesity, low prevalence of lower back pain and postural deviations, in addition to reflecting on better academic performance[19]. Consequently, interventions that increase students' physical fitness are important to reduce health risk factors.

Four studies performed with basic education students to evaluate the effects of a multicomponent program in Brazil were found. Such investigations consisted of physical and/or sport activities and nutritional education and/or nutritional guidance[20-22]. However, only one paper evaluated all the components of the students' health-related physical fitness[23]. Due to the lack of studies on the subject and in order to promote health and quality of life in the school environment, the present study aimed at assessing the effects of a multicomponent program on eating habits, nutritional status and health-related physical fitness of students attending basic education. A hypothesis is raised, that is, a multicomponent program with physical sport activities associated with nutritional education shall improve the students' health-related physical fitness.

## METHODOLOGY

### PARTICIPANTS

One hundred and twenty student volunteers enrolled in early childhood and elementary education at a municipal school located in the rural area of Lebon Régis city in the state of Santa Catarina (SC)

participated in the research. This school has a total of 293 students enrolled, 41% of whom participated in the study. As criteria for being included in the study, all participants should have a minimum attendance of 75% in school activities, in addition to not having participated in systematic exercises in the last six months prior to the beginning of the research and not having motor or cardiorespiratory diseases.

PROCEDURES

Initially, the volunteers were randomized into two groups: 1) Intervention Group (IG; n = 60) submitted to a multicomponent program of physical sport activities and lectures on nutritional education; 2) Control Group (CG; n = 60) that did not participate in the program. Figure 1 shows the allocation flowchart of the participants in the different groups.

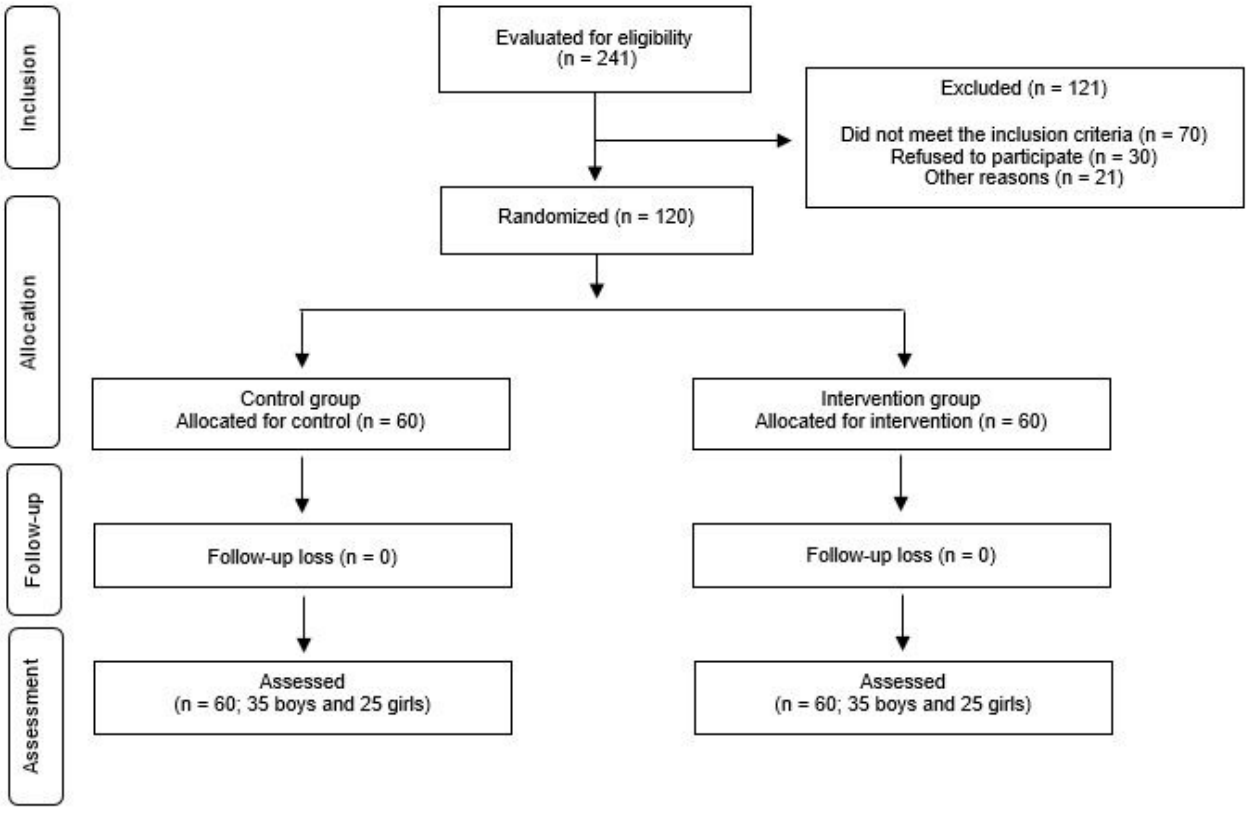


**Figure 1.** Allocation flowchart showing the participants included in the intervention and control groups.

The volunteers were assessed throughout the first week as follows: Day 1: anthropometry and eating habits; Day 2: physical fitness. The evaluations of anthropometric and eating habits were carried out in a room booked by the school management, whereas the physical fitness assessments took place in the school sports hall. In the second week, the IG started the multicomponent program, and the CG maintained normal school activities. At the end of a 12-week intervention period, the groups were re-evaluated.

Body weight was measured by using an anthropometric mechanical scale (Filizola Beyond Technology®, Brazil) with a coupled stadiometer that made it possible to measure the students' height. The Body Mass Index (BMI) was calculated by applying the formula BMI = weight/height² (kg/m²). Sex and age group were considered in order to classify the nutritional status, thus, the following values were established: p≤85 for the students with normal weight, and p≥85 for the overweight ones[24].

The recall questionnaire of the Food and Nutrition Surveillance System (SISVAN) was used for assessing the volunteers' eating habits[25]. This questionnaire evaluates the behavior and eating frequency of daily meals (breakfast, morning snack, lunch, afternoon snack, dinner and supper). In order to describe

the food profile, the types of food consumed were categorized as 'no' and 'yes', and for obtaining the food score, questions on food frequency and types of food were added, ranging from 0 to 17. The closer the overall score was to 17, the better the eating habits.

The Multistage 20-m Shutle Run test proposed by Léger and Lambert[26] was used to assess cardiorespiratory fitness, that is, the Maximal Oxygen Uptake ($VO_{2max}$.). The test was applied to groups of 6 students who performed a shuttle run, rhythmic through a CD recorder that emitted 'beeps' with specific time intervals for each stage. The students moved a distance of 20 meters bounded by two parallel lines. The recorder emitted 'beeps' at specific intervals for each stage, and at each beep the individuals should be crossing one of the two parallel lines with one of the feet, that is, leaving one of the lines they run towards the other, cross it with at least one foot when hearing a 'beep' and return to the opposite direction. The duration of the test depended on the cardiorespiratory fitness of each subject, that is, it was maximal and progressive, less intense at the beginning and more intense at the end, thus, making a possible total of 21 minutes (stages). In order to estimate $VO_{2max}$, the equation suggested by Léger and Lambert[26] was used.

Localized muscle strength/endurance was assessed by applying the one-minute sit-up test and the arm curl test proposed by Pollock and Wilmore[27]. Considering the sit-up test, the students were placed at supine position on a mat with the hips and knees pushed-up and the balls of the feet resting on the ground. The forearms were crossed over the chest, with the palms of the hands facing it; they remained in this position throughout the test. The students performed as many sit-ups as possible, touching the forearms on the thighs, then returning to the starting position, and finishing the test at a new signal from the evaluator, when the chronometer set a minute. During the test the students could stop to rest, but not stop the time counting. Regarding the arm curl test, the students were put in prone position, supported on the tips of the feet and hands, which were positioned on the shoulder line with the elbows extended. At the signal given by the evaluator, students performed elbow push-ups and extensions in the transverse plane until the chest touched the ground, performing maximum repetitions in one minute. If the students needed to rest, they could do it in the initial position of the test with elbows extended.

Flexibility was assessed using the Sit-and--Reach Test originally proposed by Wells and Dillon[28]. This test was performed on a box measuring 30.5cm x 30.5cm x 30.5cm with a 26.0 cm scale in its extension; the zero point was at the end closest to the individual, and the 26°cm coincided with the footrest. The subjects removed their shoes and, in a seated position, touched their feet on the box with their knees extended. With the shoulders pushed-up, extended elbows and overlapped hands, they performed the torso push-up, touching the maximum point of the scale with their hands. Three attempts were made and only the best score was considered. The subjects were submitted to a single evaluation session.

The multicomponent program consisted of physical sport activities that included futsal and karate modalities, in addition to lectures on nutritional education. Physical sport activities were carried out twice a week (on Mondays and Wednesdays) with a length of training (duration) of 120 minutes each for a period of 12 weeks performed in the school sports hall. The lectures on nutritional education took place on Wednesdays on the 4$^{th}$, 8$^{th}$ and 12$^{th}$ weeks of the program, before physical sport activities, in a room booked by the management with audiovisual equipment. All activities occurred during the second shift classes.

Initially, students were divided according to the age group. The activities started with the futsal modality, and soon after they performed karate activities. All classes were divided into 3 parts: 1) Warm--up – it consisted of 15-minute recreational activities; 2) Development - regarding the futsal modality (45 minutes) the basic fundamentals and games were worked, and for the karate modality (45 minutes) the opposition games were developed; 3) Relaxation - stretching exercises for the main muscle groups during 15 minutes. The classes were given by two physical education professionals with experience in futsal and karate, provided by the Secretary of Education of the school municipality.

The lectures on nutritional education addressed subjects on 'The importance of regular consumption of healthy food' and 'Step by Step for Healthy Eating'[29]. The 60-minute lectures were given by the

nutritionist in charge of the school feeding in the municipality.

Parents or guardians signed the Minor Consent Form (TACMI). This study was approved by the Research Ethics Committee of UNIARP, opinion number 2.757.575.

STATISTICAL ANALYSIS

The data descriptive analysis was carried out and shown as mean, standard deviation (SD), confidence interval (95% CI) and percentages (Δ%). In order to determine the parametric or non-parametric statistics, data normality was verified with Shapiro-Wilk test and Levene's test to assess the homogeneity of the variables. Student's t test for independent samples was used for comparisons between groups. The two-way ANOVA of repeated measures (group and time) was used to evaluate the effect of training from the pre to post intervention period. The level of significance was set at $p < 0.05$ and the analysis were performed by using SPSS (25.0).

**RESULTS**

The characteristics of the groups at the beginning of the research (Table 1) showed that there was no difference between the Control and Intervention Groups with regard to age, body weight and height ($p > 0.05$).

**Table 1.** Characteristics of the participants (Mean and CI 95%)

| | CG (n=60) | IG (n=60) | P value |
|---|---|---|---|
| Age (years) | 11.3(10.5-12.1) | 10.5(9.8-11.1) | 013 |
| Body weight (kg) | 35.2(31.6-38.9) | 33.5(30.4-36.6) | 0.71 |
| Height (m) | 1.35(1.31-1.39) | 1.34(1.30-1.38) | 0.86 |

The scores of eating habits at the beginning of the experiment in the CG were 11.8 ± 1.2, and in the IG it was 11.8 ± 1.3 (Graph 1). After 12 weeks of experiment, the CG did not change the eating habits (11.9 ± 1.7, $p > 0.05$), whereas the IG improved the eating habits (12.3 ± 1.6; $F = 20.82$; $p < 0.001$) (Graph 1). When the groups were compared, there was a significant difference in eating habits after the 12-week intervention period ($F = 16.54$; $p < 0.001$).

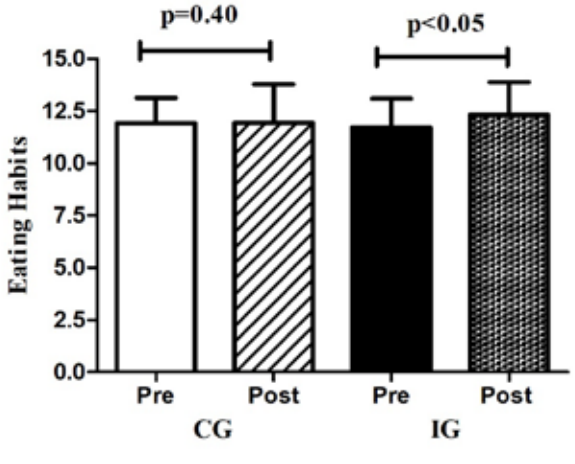


**Figure 1.** Eating habits in the beginning and after the 12-week intervention period in the control group (CG) and intervention group (IG)

Regarding the nutritional status at the beginning of the experiment (Table 2), in the CG 100% had classification up to normal weight. In the IG, 81.7% were up to normal weight and 18.7% were overweight. After 12 weeks of experiment, the group that did not receive the intervention program (CG) showed an increased number of students who were overweight to 30.0% (Table 2). Considering the group that received the intervention (IG), there was no change in the frequency of students who were classified up to normal weight and overweight (Table 2).

**Table 2.** Classification of the nutritional status before and after the 12-week intervention period in the control group (CG) and intervention group (IG)

| Nutritional status | CG | | | | IG | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre | | Post | | Pre | | Post | |
| | N | % | n | % | n | % | n | % |
| Up to normal weight | 60 | 100 | 42 | 70.0 | 49 | 81.7 | 49 | 81.7 |
| Overweigt | - | 0 | 18 | 30.0 | 11 | 18.3 | 11 | 18.3 |

The BMI at the beginning of the experiment in the CG was 12.6 ± 3.7 kg.m$^2$ and in the IG it was 17.8 ± 3.1 kg.m$^2$ (Graph 2). At the end of 12 weeks of experiment, the CG group significantly increased the BMI by 49.9% (18.4 ± 3.7 kg.m$^2$); however, the IG group significantly decreased the BMI by 6.5% (16 , 7 ± 3.5 kg.m$^2$) ($F = 12.14$; $p < 0.01$). When comparing the CG and IG at the end of the 12-week intervention period, there was a significant difference in BMI ($F = 1231.80$; $p < 0.001$).

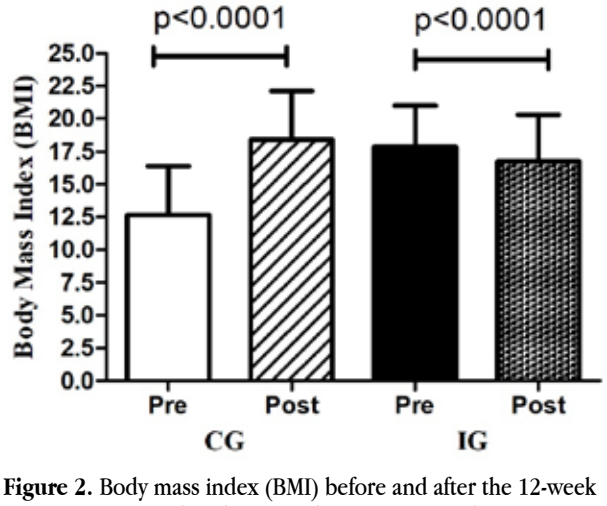


**Figure 2.** Body mass index (BMI) before and after the 12-week intervention period in the control group (CG) and intervention group (IG).

The CG showed no change in $VO_{2max}$. at the end of 12 weeks of experiment ($p > 0.05$); however, regarding strength and endurance in the arm curl ($p < 0.001$) and sit-up tests ($p < 0.001$), there was a significant reduction of 7.9% and 9.2%, respectively, whereas flexibility increased 4.6% ($p < 0.001$) (Table 3).

The $VO_{2max}$. in the IG increased strength and endurance at 3.5% in arm curl; 26% and 16.1% in the sit-up test, respectively, and the flexibility increased 8.5% ($p < 0.0001$) at the end of the 12-week intervention period. When comparing the groups, there was a significant difference in $VO_{2max}$. ($F = 55.87$; 0.001) regarding strength and endurance in arm curls ($F = 210.94$; $p < 0.001$), sit-up test ($F = 233.56$; $p < 0.001$), and flexibility ($F = 36.63$, $p < 0.001$) after the 12 weeks of experiment.

**Table 3.** Comparison of physical fitness before and after the 12-week intervention period in the control group (CG) and intervention group (IG). (Mean ± SD)

| Variables | CG | | | IG | | |
|---|---|---|---|---|---|---|
| | Pre | Post | Δ% | Pre | Post | Δ% |
| $VO_{2max.}$ (ml.kg.min.) | 40,3±4,8 | 40,2±4,9 | -1,0 | 44,1±4,8 | 45,6±4,3*[a] | 3,5 |
| Arm curl (rep.) | 14,3±8,7 | 13,3±8,7* | -7,9 | 19,1±8,8 | 22,9±8,6*[a] | 26,0 |
| Sit-ups (rep.) | 20,3±9,6 | 18,7±9,4* | -9,2 | 27,3±8,5 | 31,2±8,4*[a] | 16,1 |
| Flexibility (cm) | 21,5±2,5 | 22,4±1,9* | 4,6 | 25,6±4,8 | 27,6±4,7*[a] | 8,5 |

**P.S.** *p<0,0001- Pre and post intervention intragroup comparison; [a]p <0.0001 - Pre and post intervention comparison between groups.

## DISCUSSION

The present study showed that the IG changed eating habits after attending the program for 12 weeks (Graph 1). These results are similar to the ones obtained by other investigations that assessed the eating habits of schoolchildren in multicomponent programs with nutritional education and/or nutritional guidance. A study carried out in China included 1.641 schoolchildren aged 6 to7 years attending basic education to participate in a multicomponent program for 12 months, which consisted of physical activities, lectures and practical activities on healthy eating. The results showed that the eating habits improved, since there was an increase in fruit consumption, in addition to a reduction of sugars and unhealthy snacks in their diets[9]. Another study assessed 1.175 students from Denmark with an average age of 13 years who participated in a 9-month program that included 3 components: a) school - during the school period the students were provided with a piece of fruit or vegetable in the classroom and curricular activities on computer about healthy eating; b) local community - sport activities in the community and; c) parental participation - increased knowledge about the consumption of fruits and vegetables in adolescence. The results also showed that students acquired healthier eating habits by consuming more fruits and vegetables in their diets[6]. Peterson et al.[30] assessed 5.665 students attending the 7th grade in Massachusetts schools in the United States for 3 years. The authors showed the effects of a multicomponent program that consisted of a daily increase of 5 to 9 portions of fruits and vegetables, reduced hours watching television and an hour of daily physical activity. There was a significant difference in the students' eating habits at the end of this period.

Regarding nutritional status, the IG decreased the BMI, whereas the CG increased it (Graph 2) after 12 weeks of experiment. The BMI decrease in the IG is likely to be related to both, changes in eating habits and an increase in the practice of weekly physical activity. According to Gasparotto et al.[31] the increased consumption of fruits, vegetables and salads, in addition to a diet based on reduced fatty and sugary foods, associated with the increase in daily energy expenditure due to physical activities, results in a negative daily energy balance that influences body weight loss and, consequently, the BMI.

The changes related to the BMI in the IG corroborate with others found by surveys carried out with basic education students. A study with 1.641 elementary schoolchildren from Guangzhou district in China was divided into an intervention group (n = 832), which attended a 12-month multicomponent program consisting of physical exercises and practical activities on healthy eating, and a control group (n = 809) that did not undergo the program. The results showed that the BMI in the intervention group was lower compared to the control group at the end of the period[9]. Another study with 1.150 basic education students from the state of New South Wales in Australia also showed a lower BMI after a 24-month program of physical sport activities for students, parents and the community[2]. An investigation that followed 2.292 basic education students in the United States for 3

years developed a program that included 4 components, that is, nutritional education, incentive to physical activity and reduction of sedentary behavior, in addition to information about healthy choices for life. The results showed that the BMI of the intervention group was lower than the group that did not attend the multicomponent program[32].

Interestingly, all parameters of physical fitness in the present study improved with the multicomponent program in the IG (Table 3). This result is likely to be related to the increase in the weekly volume (minutes) of physical activity practiced by students during the multicomponent program. Such a program prioritized physical sport activities with a frequency of 2 times a week, duration of 120 minutes for each session with a total increase of 240 minutes of physical activity per week. According to Coledam et al.[33] the increase in weekly physical activity is associated with greater cardiorespiratory fitness, muscle strength/endurance, flexibility and reduced body fat.

It should also be emphasized that improving the components of health-related physical fitness during the growth and development phase may decrease health problems in adulthood, since the cardiorespiratory capacity ($VO_{2máx.}$) when found in adequate values, reduces the risk of cardiovascular diseases, diabetes and cancer[17]. Muscle strength and endurance are important to reduce the incidence of musculoskeletal disorders and generate disabilities in students[34]. Maintaining good levels of flexibility prevents postural problems, in addition to reducing the incidence of injuries and helping to maintain functional capacities so that daily life activities can be performed[35].

The results in health-related physical fitness shown in the present study with the implementation of an intervention that included physical sport activities and nutritional education were similar to the ones obtained in other national and international surveys with basic education students. The results of an investigation with 33 female adolescents who underwent a 12-week multicomponent intervention program, 3 times a week, consisting of concurrent training, theoretical and practical classes on nutrition and cognitive behavioral therapy, showed that aerobic capacity ($VO_{2máx.}$) and the maximum isometric muscle strength significantly increased after 12 weeks[36]. Another study with 18 adolescents divided into a weight training group (Group 1; n = 9) and a functional training group (Group 2; n = 9), in which both groups performed a multicomponent program for 12 weeks, 3 times a week, with nutritional education, physical therapy and cognitive behavioral therapy activities, showed that cardiorespiratory capacity ($VO_{2max}$), muscle strength/endurance, and flexibility significantly increased after the program[37]. An investigation carried out with 34 students from public schools aged 9 to 11 years, divided into an intervention group (n = 17) and a control group (n = 17), aimed at assessing the effects of an intervention with physical activities and guidance on healthy eating habits for 10 weeks. It was seen that aerobic capacity increased after the intervention[20]. Another study carried out with 238 students from three schools in the municipality of Criciúma, Brazil, also found that all components of physical fitness increased in the intervention group compared to the control group after a 28-week multicomponent program that consisted of physical activities and nutritional education[23].

It is worth mentioning that the present study has some limitations. The variations in macronutrients and micronutrients that occurred with the aim of changing the eating habits of the participants were not discriminated. Regarding the physical sport activities performed by the students, there was no control over the intensity of the exercises. However, it is understood the importance of assessing the effects on physical fitness obtained with interventions that use the practice of physical activities and nutritional education in different performance periods in the school environment. Considering the literature, it is seen that interventions vary from a few weeks to several months, and the components of the programs also change, which makes it difficult to understand which strategies are more efficient to improve health-related physical fitness of schoolchildren.

## CONCLUSIONS

In conclusion, a 12-week multicomponent program consisted of physical sport activities and nutritional education was effective in the sense of changing the eating habits and nutritional status of basic education students. In addition, all components of health-related physical fitness improved with the multicomponent program.

Extracurricular programs with a focus on the practice of physical activities and guidelines on healthy eating for students who attend the municipal and state education systems should be implemented in order to reduce possible health problems throughout life. Further research should also be carried out to investigate the effects of different intervention programs in schools to assess the impacts on schoolchildren's health and quality of life.

As a practical application of this study, increasing the amount of physical sport activities by 120 minutes per week during second shift classes and giving lectures on good eating habits would be a good strategy to reduce physical inactivity and overweight-related problems in the school population.

## REFERENCES

1. Sutherland R, Campbell E, Nathan N, Wolfenden L, Lubans DR, Morgan PJ, et al. A cluster randomised trial of an intervention to increase the implementation of physical activity practices in secondary schools: study protocol for scaling up the Physical Activity 4 Everyone (PA4E1) program. BMC Public Health. 2019; 19(1):883.

2. Hollis JL, Sutherland R, Campbell L, Morgan PJ, Lubans DR, Nathan N, et al. Effects of a 'school-based' physical activity intervention on adiposity in adolescents from economically disadvantaged communities: secondary outcomes of the 'Physical Activity 4 Everyone' RCT. Int J Obes. 2016; 40(10):1486-93.

3. Rossi CE, Costa LCF, Machado MS, Andrade DF, Vasconcelos FAG. Fatores associados ao consumo alimentar na escola e ao sobrepeso/obesidade de escolares de 7-10 anos de Santa Catarina, Brasil. Ciênc Saúde Coletiva. 2019; 24:443-54.

4. Afshin A, Forouzanfar MH, Reitsma MB, Sur P, Estep K, Lee A, et al. Health effects of overweight and obesity in 195 countries over 25 years. N Engl J Med. 2017; 377(1):13-27.

5. Cooper AR, Goodman A, Page AS, Sherar LB, Esliger DW, van Sluijs EM, et al. Objectively measured physical activity and sedentary time in youth: the International children's accelerometry database (ICAD). Int J Behav Nutr Phys Act. 2015; 12:113.

6. Jørgensen SE, Jørgensen TS, Aarestrup AK, Due P, Krølner R. Parental involvement and association with adolescents' fruit and vegetable intake at follow-up: Process evaluation results from the multi-component school-based Boost intervention. Int J Behav Nutr Phys Act. 2016; 13(1):112

7. Fernandez-Jimenez R, Santos-Beneit G, Tresserra-Rimbau A, Bodega P, de Miguel M, de Cos-Gandoy A, et al. Rationale and design of the school-based SI! Program to face obesity and promote health among Spanish adolescents: A cluster-randomized controlled trial. Am Heart J. 2019; 215:27-40.

8. Kobel S, Wirt T, Schreiber A, Kesztyus D, Kettner S, Erkelenz N, et al. Intervention effects of a school-based health promotion programme on obesity related behavioural outcomes. J Obes. 2014; 476230; 1-8.

9. Li B, Pallan M, Liu WJ, Hemming K, Frew E, Lin R, et al. The CHIRPY DRAGON intervention in preventing obesity in Chinese primary-school--aged children: A cluster-randomised controlled trial. PLoS Med. 2019; 16(11):e1002971.

10. Telford RM, Olive LS, Cochrane T, Davey R, Telford RD. Outcomes of a four-year specialist-taught physical education program on physical activity: a cluster randomized controlled trial, the LOOK study. Int J Behav Nutr Phys Act. 2016; 13:64.

11. Evans A, Ranjit N, Hoelscher D, Jovanovic C, Lopez M, McIntosh A, et al. Impact of school-based vegetable garden and physical activity coordinated health interventions on weight status and weight-related behaviors of ethnically diverse, low-income students: Study design and base-

line data of the Texas, Grow! Eat! Go! (TGEG) cluster-randomized controlled trial. BMC Public Health. 2016;16(1):973.

12. Habib-Mourad C, Ghandour LA, Moore HJ, Nabhani-Zeidan M, Adetayo K, Hwalla N, et al. Promoting healthy eating and physical activity among school children: findings from Health-E--PALS, the first pilot intervention from Lebanon. BMC Public Health. 2014; 14:940.

13. Eather N, Morgan PJ, Lubans DR. Improving health-related fitness in children: the Fit-4-Fun randomized controlled trial study protocol. BMC Public Health. 2011; 11:902.

14. Bansilal S, Vedanthan R, Kovacic JC, Soto AV, Latina J, Bjorkegren JLM, et al. Rationale and Design of Family-Based Approach in a Minority Community Integrating Systems-Biology for Promotion of Health (FAMILIA). Am Heart J. 2017; 187:170-81.

15. Peñalvo JL, Santos-Beneit G, Sotos-Prieto M, Bodega P, Oliva B, Orrit X, et al. The SI! Program for Cardiovascular Health Promotion in Early Childhood: A Cluster-Randomized Trial. J Am Coll Cardiol. 2015;66(14):1525-34.

16. Santos-Beneit G, Bodega P, de Miguel M, Rodríguez C, Carral V, Orrit X, et al. Rationale and design of the SI! Program for health promotion in elementary students aged 6 to 11 years: A cluster randomized trial. Am Heart J. 2019; 210:9-17.

17. Venckunas T, Mieziene B, Emeljanovas A. Aerobic Capacity Is Related to Multiple Other Aspects of Physical Fitness: A Study in a Large Sample of Lithuanian Schoolchildren. Front Physiol. 2018; 9:1797.

18. Zhang M, Schumann M, Huang T, Törmäkangas T, Cheng S. Normal weight obesity and physical fitness in Chinese university students: an overlooked association. BMC Public Health. 2018;18(1):1334.

19. Milanovic I, Radisavljevic-Janic S, Zivkovic MZ, Mirkov DM. Health-related physical fitness levels and prevalence of obesity in Serbian elementary schoolchildren. Nutr Hosp. 2019;36(2):253-60.

20. Militão AG, Karnikowski MGO, Silva FR, Militão ESG, Pereira RMS, Campbell CSG. Effects of a recreational physical activity and healthy habits orientation program, using an illustrated diary, on the cardiovascular risk profile of overweight and obese schoolchildren: a pilot study in a public school in Brasilia, Federal District, Brazil. Diabetes Metab Syndr Obes. 2013; 6:445-51.

21. Guimarães RF, Silva MP, Martini MCS, Guerra-Júnior G, Gonçalves EM. The effects of an after-school intervention program on physical activity level, sedentary time, and cardiovascular risk factors in adolescents. Motriz: rev educ fis. 2017; 23(spe2): e101769.

22. Farias ES, Paula F, Carvalho WRG, Gonçalves EM, Baldin AD, Guerra-Júnior G. Efeito da atividade física programada sobre a composição corporal em escolares adolescentes. J Pediatr. 2009;91(2):122-129.

23. Silva LS, Fisberg M, de Souza Pires MM, Nassar SM, Sottovia CB. The effectiveness of a physical activity and nutrition education program in the prevention of overweight in schoolchildren in Criciúma, Brazil. Eur J Clin Nutr. 2013;67(11):1200-4.

24. WHO. Growth reference data for 5-19 years. Geneva: World Health Organization 2007.

25. Arguelhes BP, Nilson EAF, Bortolini GA, Costa JC, Costa MLS, Azevedo RR, et al. Orientações para Avaliação de Marcadores de Consumo Alimentar na Atenção Básica. Brasília – DF: Ministério da Saúde 2015. 33 p.

26. Léger LA, Lambert J. A maximal multistage 20-m shuttle run test to predict VO2 max. Eur J Appl Physiol Occup Physiol. 1982;49(1):1-12.

27. Pollock ML, Wilmore JH. Exercícios na saúde e na doença: avaliação e prescrição para prevenção e reabilitação. Rio de Janeiro: Medsi; 1993.

28. Wells KF, Dillon EK. The Sit and Reach—A Test of Back and Leg Flexibility. Res Q. 1952;23(1):115-8.

29. Brasil. Guia Alimentar para a População Brasileira. 2 ed. Brasília — DF: Ministério da Saúde,

Secretaria de Atenção à Saúde, Departamento de Atenção Básica; 2014. 158 p.

30. Peterson KE, Spadano-Gasbarro JL, Greaney ML, Austin SB, Mezgebu S, Hunt AT, et al. Three-Year Improvements in Weight Status and Weight--Related Behaviors in Middle School Students: The Healthy Choices Study. PLoS One. 2015; 10(8):e0134470-e.

31. Silva Gasparotto G, Pereira da Silva M, Miranda Medeiros Cruz R, de Campos W. Overweight and physical activity practice associated with eating behavior of brazilian college students. Nutr Hosp. 2015;32(2):616-21.

32. DeBar LL, Schneider M, Drews KL, Ford EG, Stadler DD, Moe EL, et al. Student public commitment in a school-based diabetes prevention project: impact on physical health and health behavior. BMC Public Health. 2011; 11:711.

33. Coledam DHC, Ferraiol PF, Greca JPA, Teixeira M, Oliveira AR. Aulas de educação física e desfechos relacionados à saúde em estudantes brasileiros. Rev Paul Pediatr. 2018; 36:192-8.

34. Davoli GBQ, Lima LRA, Silva DAS. Abdominal muscular endurance in Brazilian children and adolescents: systematic review of cross-sectional studies. Rev Bras Cineantropom Desempenho Hum. 2018; 20:483-96.

35. Batista KRdO, Couto JdO, Oliveira MGDd, Silva RJdS. Flexibility in Brazilian children and adolescents: a systematic review. Rev Bras Cineantropom Desempenho Hum. 2018; 20:472-82.

36. Branco BHM, Valladares D, de Oliveira FM, Carvalho IZ, Marques DC, Coelho AA, et al. Effects of the Order of Physical Exercises on Body Composition, Physical Fitness, and Cardiometabolic Risk in Adolescents Participating in an Interdisciplinary Program Focusing on the Treatment of Obesity. Front Physiol. 2019;10;1013.

37. Branco BHM, Carvalho IZ, Oliveira HG, Fanhani AP, Santos MCM, Oliveira LP, et al. Effects of 2 Types of Resistance Training Models on Obese Adolescents' Body Composition, Cardiometabolic Risk, and Physical Fitness. J Strength Cond Res. 2020;34(9):2672-82.