REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/04/2026
Vol: 13.05
DOI: 10.66104/z9y4m435
Pages: 1-30

EDUCATIONAL INTERVENTION: PROMOTING PHYSICAL ACTIVITY TO CONTROL AND PREVENT CHILDHOOD OBESITY

INTERVENÇÃO EDUCATIVA: PROMOÇÃO DE ATIVIDADE FÍSICA PARA CONTROLE E PREVENÇÃO DA OBESIDADE INFANTIL

INTERVENCIÓN EDUCATIVA: PROMOCIÓN DE LA ACTIVIDAD FÍSICA PARA CONTROLAR Y PREVENIR LA OBESIDAD INFANTIL

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Abstract

The objective was to measure the effect of an educational intervention on the nutritional status, and cardiorespiratory fitness of children. A total of 709 children enrolled in public schools participated. The participants were organized into two Groups, Control (CG) and Intervention (IG). The study followed three stages, Stage 1 (day 0), the groups were characterized in terms of nutritional status,

REMUNOM
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and cardiorespiratory fitness; Stage 2 (day 1 to 90), with the participation of only IG. This stage consisted of educational activities; Stage 3 (day 91), the groups were reassessed. The majority of the children were eutrophic, but a high number of participants were classified as overweight. There was no change in nutritional status after the educational intervention, but the intervention did increase the distance covered by IG on the running test. The CG reduced this distance ($p < 0.05$) when children were evaluated overall and in relation to sex (male). The actions increased the measures for GI. The eutrophic children in the CG and IG had a higher performance than the overweight children in the cardiorespiratory fitness test in Stage 1. This parameter worsened in Stage 3 for CG, while for IG the intervention increased the measures of fitness for eutrophic and overweight children. It was concluded that the educational intervention did not affect the children's nutritional status, however it increases cardiorespiratory fitness for boys and girls, for eutrophic and overweight children.

Keywords: Interventionist action; Cardiorespiratory fitness; Motor activity; Nutritional status; Health promotion.

Resumo

Objetivou-se mensurar o efeito de uma intervenção educativa sobre o estado nutricional e aptidão cardiorrespiratória de crianças. Participaram 709 crianças matriculadas em escolas públicas. Os participantes foram organizados em dois grupos, Controle (GC) e Intervenção (GI). A pesquisa seguiu em três etapas, Etapa 1 (dia 0), os grupos foram caracterizados em relação ao estado nutricional e aptidão cardiorrespiratória; Etapa 2 (dia 1 a 90), com a participação apenas de GI. Essa etapa foi composta por ações educativas; Etapa 3 (dia 91), os grupos foram reavaliados. A maioria das crianças apresentou eutrofia, entretanto um número elevado de participantes foi classificado com excesso de peso. Não houve alteração no estado nutricional após a intervenção educativa, entretanto a intervenção aumentou a distância percorrida de GI. O GC reduziu essa medida ($p < 0.05$), quando as crianças foram avaliadas no geral e em relação ao sexo (masculino). As ações aumentaram as medidas para GI. As crianças eutróficas de GC e GI apresentaram maior percurso no teste de aptidão cardiorrespiratória na Etapa 1. Houve redução desse parâmetro na Etapa 3 para GC, enquanto para GI a intervenção aumentou as medidas de aptidão para as crianças com eutrofia e excesso de peso. Conclui-se que a intervenção educativa não interfere no estado nutricional, entretanto aumenta a aptidão cardiorrespiratória para meninos e meninas e, para as crianças com eutrofia e excesso de peso.

Palavras-chave: Ação intervencionista; Aptidão cardiorrespiratória; Atividade motora; Estado nutricional; Promoção da saúde.

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Resumen

El objetivo fue medir el efecto de una intervención educativa sobre el estado nutricional y la aptitud cardiorrespiratoria de los niños. Participaron 709 niños matriculados en escuelas públicas. Los participantes se organizaron en dos grupos, Control (CG) e Intervención (IG). La investigación se desarrolló en tres etapas, Etapa 1 (día 0), se caracterizaron los grupos en relación al estado nutricional y aptitud cardiorrespiratoria; Etapa 2 (días 1 a 90), con la participación únicamente de GI. Esta etapa estuvo compuesta por acciones educativas; Paso 3 (día 91), los grupos fueron reevaluados. La mayoría de los niños eran eutróficos, sin embargo, un gran número de participantes fueron clasificados como con sobrepeso. No hubo cambios en el estado nutricional después de la intervención educativa, sin embargo, la intervención aumentó la distancia recorrida en GI. El GC redujo esta medida ($p < 0.05$), cuando los niños fueron evaluados globalmente y en relación al sexo (masculino). Las acciones aumentaron las medidas para GI. Los niños eutróficos del GC y GI mostraron mayor progreso en el test de aptitud cardiorrespiratoria en la Etapa 1. Hubo reducción de este parámetro en la Etapa 3 para el GC, mientras que para GI la intervención incrementó las medidas de aptitud para los niños eutróficos y con sobrepeso. Se concluye que la intervención educativa no interfiere en el estado nutricional, sin embargo aumenta la aptitud cardiorrespiratoria de niños y niñas y de niños con normopeso y exceso de peso.

Palabras clave: Acción intervencionista; Aptitud cardiorrespiratoria; Actividad motora; Estado nutricional; Promoción de la salud.

1. Introduction

Obesity can affect individuals of all age groups and social levels and has increased considerably in recent decades, making it a global public health problem (Moreno *et al*., 2021). Worldwide, it is estimated that 20% of children and adolescents are overweight or obese (Peng *et al*., 2022). This equates to approximately 340 million adolescents and 39 million children (Organização Pan-Americana da Saúde, OPAS, 2022). In Brazil, in 2022, 16.82% of children (5 to 10 years old) were overweight, 11.36% were obese, and 5.73% were severely obese. Thus, it is possible that for every 100 children, 12 have the disease (Brasil, 2022a), and by 2030 obesity could reach 7,664,422 children in the country (*World Obesity Federation*, WOF, 2019).

Genetic and non-genetic conditions can influence the development of obesity (Murphy, 2022). In children, the main non-genetic causes are associated

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with poor diet, low levels of physical activity, and environmental and social changes (*World Health Organization*, WHO, 2021). Specific factors linked to excessive consumption of ultra-processed foods (Brasil, 2022b), together with frequent eating out and eating food without biological need and in front of screens (television, cell phones, etc.) can also contribute to excess weight (Mazur *et al*., 2022). Other causes such as psychosocial ones, binge eating, appetite, stress, bullying, and depression are also related to childhood obesity.

A sedentary lifestyle plays an important role in the development of obesity among children (Dhurandhar *et al*., 2021), especially because they prefer games with little or no movement, such as those that use electronic technology (Gottschalk, 2019). This effect is harmful, as more than 60% of overweight children will remain overweight in early adulthood (Nittari *et al*., 2019). In addition, obesity in childhood can trigger a greater risk of developing other diseases, such as hypertension (Wuhl, 2018), hyperlipidemia, insulin resistance, orthopedic injuries, as well as a greater predisposition to morbidity and mortality (Ramos-Silva *et al*., 2019). Psychological effects can also lead to obesity, especially low self-esteem, social isolation, and poor school performance, among others (Drenowatz *et al*., 2022).

Research has already shown that regular physical activity among children and adolescents is associated with lower adiposity (Ramos-Silva *et al*., 2019; Sztramko *et al*., 2021; Calcaterra *et al*., 2022), improved cardiometabolic health, and physical fitness (Ramos-Silva *et al*., 2019; Sztramko *et al*., 2021), having a positive impact on muscular fitness (Wu *et al*., 2021). Furthermore, children and adolescents who practice 60 minutes of moderate or vigorous physical activity a day are less likely to suffer bullying in the school environment (García *et al*., 2020). Thus, strategies that seek to prevent and control childhood obesity are essential, especially those that address interactive practical methodologies, since they present better results (Swinburn *et al*., 2019).

Educational/behavioral approaches that include daily physical exercise in the school environment, as well as investments in public policies that stimulate and encourage physical activity, are examples of actions that can have positive

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effects on health (Barbosa *et al*., 2020). Other interventions with urban projects, which incorporate the availability and accessibility of spaces linked to nature, parks, recreational environments, cycle paths, and targeted and guided physical exercise, can increase the practice of physical exercise by the community in general (An *et al*., 2019; Rutten *et al*., 2019).

The influence of educational interventions that encourage the practice of physical activity intending to reduce the risk and control excess weight among children has already been confirmed in several studies (Li *et al*., 2014; Li *et al*., 2019; Lima *et al*., 2020; Calcaterra *et al*., 2022). Li *et al*. (2019) developed an intervention with theoretical-practical workshops of physical activity, for 12 months, with 1,641 students in China, verifying a positive effect in the reduction of the children's Body Mass Index (BMI) ($p < 0.05$). Similarly, was observed a 30% reduction in the skin folds of children who took two extra classes (five classes in total) of physical education a week, compared to the Control Group who only took three classes, for a period of 9 months (Lima *et al*., 2020). Multi-component interventions related to physical activity for 10-12 weeks were effective in decreasing BMI levels (Li *et al*., 2014; Duan *et al*., 2025; Nikooyeh *et al*., 2025), skinfolds, and fasting blood glucose, as well as increasing the duration of moderate/vigorous physical activity among children (Li *et al*., 2014). These studies demonstrate that school-based interventions are effective long-term strategies for managing childhood obesity. Despite these findings, regular physical exercise should be associated with healthy eating in childhood (WHO, 2020; Calcaterra *et al*., 2022) since these joint practices can have even better results on the prevention and control of childhood obesity (Seo *et al*., 2019).

The school is an ideal environment for carrying out actions aimed at increasing the practice of physical exercise among children since they spend a long period of the day there (Moreno *et al*., 2021). It is therefore suggested to use different teaching tools, such as recreation and leisure, games, sports, or planned exercises. In addition, it is possible to promote the practice of physical activity among children related to transportation, as preferring active commuting, and to household and community tasks (WHO, 2020). It is also important for the

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introduction of these activities to be carried out in a pleasurable way, avoiding physical and emotional damage to the children. In this context, the research aimed to measure the effect of a theoretical-practical educational intervention on the nutritional status, and cardiorespiratory fitness.

2. Materials and Methods

2.1 Ethical issues

This work was approved by the UNICENTRO Research Ethics Committee, opinion number 4.872.901/2021. To participate in the research, the children's parents or guardians signed the Free and Informed Consent Form and the children signed the Free and Informed Assent Form.

2.2 Target population

A total of 709 school-age children (8-10 years old) enrolled between the 3rd and 5th grades in seven urban public schools in Guarapuava, PR, Brazil, took part in the study. Of this group, 50.4% (357) were male and 49.6% (352) female.

2.3 Sample determination

The children were chosen using simple random sampling. A post hoc power analysis was performed considering a total sample size of 709 participants (286 in the control group and 423 in the intervention group, chosen by lottery). A significance level of 5%, and an effect size of d = 0.3, which is commonly adopted in intervention studies. Parametric equivalents were used for the tests applied. The results indicated a statistical power of 0.97, which demonstrates that the study had sufficient sensitivity to detect differences between groups and across time.

The inclusion criteria for participation were: school age, regular enrollment in the 3rd, 4th, and 5th grades of urban municipal schools in Guarapuava, PR; participation in all stages of the research and signature of the Free and Informed Consent Form and Free and Informed Assent Form by those responsible. Children who did not meet these criteria were excluded from the study. The intervention was implemented taking into account the schools and individuals who met the

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inclusion criteria.

2.4 Study design

The participants were organized into two Groups, Control (CG) and Intervention (IG). The study followed three stages: a) Stage 1 (day 0), children were characterized in terms of nutritional status, and cardiorespiratory fitness; b) Stage 2 (day 1 to 90), with only IG taking part. This stage consisted of theoretical and practical educational activities, which included: 1) theoretical interventions, which emphasized the practice of physical activity; 2) practical interventions, using games, especially those related to popular culture and required bodily movement, such as walking, running, jumping, among others. The CG children did not take part in any intervention; c) Stage 3 (day 91), both groups were reassessed concerning nutritional status, and cardiorespiratory fitness.

2.5 Research stages

2.5.1 Stage 1

This stage was considered day 0 of the research. Both Control (CG) and Intervention (IG) groups were evaluated in relation to nutritional status (anthropometry) and cardiorespiratory fitness.

2.5.1.1 Assessment of nutritional status

The children's nutritional status was assessed using the anthropometric method, taking their weight and height. To measure weight (kg), a portable digital scale (PowerPack®, model BLD-G210, China), with an accuracy of 100 g was used. Height (m) was checked using an inelastic tape measure (100 cm, precision 0.1 cm) fixed to the wall (without a plinth) (Brasil, 2011). Nutritional status was analyzed by BMI, using the formula weight/height², according to the child's age.

The results were expressed as a z-score in relation to the median of the reference population, using the Growth Curves for ages 5 to 19 recommended by the WHO (Brasil, 2006; 2007). The diagnosis of nutritional status was classified as

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follows: "marked thinness"; "thinness"; "eutrophy"; "overweight"; "obese"; and"severely obese". For statistical comparison purposes, nutritional status was also categorized as follows: a) "underweight" (thinness and marked thinness); b) "eutrophy" (adequate nutritional status) and; c) "overweight" (overweight, obesity, and severe obesity) (Brasil, 2006; 2007). The category "eutrophy" was adopted as the reference group. Nutritional status was assessed using the WHO AnthroPlus program version 1.0.4 (WHO, 2009).

2.5.1.2 Assessment of cardiorespiratory fitness

In this phase of the study, the students' cardiorespiratory fitness was assessed using the 6-Minute Walk test (6MWT). 6MWT was carried out on a flat site with white chalk marking the perimeter of the track and the use of cones, from meter to meter. We also used a measuring tape, whistle, stopwatch, and a record sheet. The students were organized into groups suited to the size of the track and instructed on how to perform the test, emphasizing that they should run for as long as possible, avoiding speed bumps interspersed with long walks. During the test, the participants were told that 2, 4, and 5 minutes had passed. At the last minute, they were warned that there was 1 minute left to end the test ("Attention: 1 minute to go"). At the end of the practice, the whistle was blown, and the children had to stop running and remain in place until the researcher had recorded the distance covered (Gaya *et al*., 2021). To assess the results of the 6MWT, the values from Stage 1 were compared with those from Stage 3, to verify a possible improvement in the participants' cardiorespiratory fitness.

2.5.2 Stage 2

2.5.2.1 Intervention

Only IG took part in the theoretical-practical interventions. Each action/activity was considered to be one lesson, lasting 30 minutes. The activities were carried out for 3 months (days 1 to 90), with 1 lesson per week, totaling 12 lessons per grade class (4 meetings per month per school). It should be noted that

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both the CG and IG children continued to attend the regular weekly physical education class included in the school curriculum (Brasil, 1997), which has 60 minutes.

The actions were based on the methodology adapted from Freitas and Amaral (1988). Each action was organized into 4 periods: 1) Interaction, in the first 2 minutes, the students were arranged in a circle to receive theoretical explanations about the activity; 2) Preparatory session (warm-up), in which 8 minutes of exercises were applied in the form of games and activities; 3) Main activity, in which the children performed age-specific exercises for 18 minutes and; 4) Body restoration (final part), known as "returning to calm", lasting 2 minutes. Slower, resting, or relaxing activities were applied. The children were told to sit in a circle, and a conversation was held about the activities.

The topics covered between lessons 1 and 11 were different, except for lesson 12, in which the 2 actions most voted for by the children among those carried out previously were reapplied. In the interventions, the topics covered focused on the importance and benefits of the child's health and well-being. Also, the need for constant physical activity, both inside and outside the school, was reinforced. The actions were designed to promote interactive activities among the children, strengthening socialization. In addition, to show the importance of practicing daily physical activity/exercise and discuss problems caused by physical inactivity and sedentary lifestyle, especially childhood obesity. Throughout the process, the possible harm caused by prolonged use of electronic devices (e.g. television, computer, and video game) was emphasized. The children were also encouraged to play games that reflect popular culture and that require body movements, such as walking, running, and jumping. It is noteworthy that 100% of the participating children adhered to the activities. Although the exercises proposed in the activities were of moderate intensity, it is not possible to know with certainty whether they were capable of producing relevant physiological changes in the target audience, considering that no analysis in this regard was carried out. Chart 1 describes the activities carried out in each intervention (class).

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Chart 1 - Activities carried out in Stage 2 - Intervention.

Class	**Preparatory session**[a] (8 minutes)	**Main activity**[a] (18 minutes)
1	Tail Taker (Arranca Rabo) (Vieira, 2019)	Stand-up Sit-down (Morto-Vivo and a variation) (Vieira, 2019)
2	Human Target (Alvo Humano) (Vieira, 2019)	The Four Elements (Os Quatro Elementos) (Vieira, 2019)
3	Bull (Boi) (Vieira, 2019)	Glue (Cola) (Vieira, 2019)
4	Lifting in Duos (Levantamento em Duplas) (Cavallari, 2003)	Cross the Road (Travessia) (Paraná, 2022)
5	Crouch (Abaixar-se) (Vieira, 2019)	Pula-Sapo (Paraná, 2022)
6	Simon Says (Mestre Mandou) (Cavallari, 2003)	Jump-frog (Queimada) (Cavallari, 2003)
7	Five (Cinco) (Vieira, 2019)	Freeze Dodgeball (Queimada-Congelada) (Paraná, 2022)
8	Ball Tag (Pique está com a Bola) (Ferreira, 2003)	Spider Tag (Gruda Aranha) (Ferreira, 2003)
9	Ship and Plane (Avião e Navio) (Ferreira, 2003)	Human Tic-Tac-Toe (Jogo da Velha Humano) (Brasil, 2010).
10	Vehicle Run (Corrida dos Transportes) (Equipe BNL, 2009)	Curupira (Curupira) (Brasil, 2019)
11	Hawk (Gavião) (Costa, 2017)	Cleaning the Garden (Limpando seu Jardim) (Ferreira, 2003)
12	Ball Tag* (Pique está com a Bola)* (Ferreira, 2003)	Cross the Road (Travessia) (Paraná, 2022)

Note: [a]Activity name in English (Activity name in native language - Portuguese) *In class 12, the 2 games most voted by the children, among the previous ones, were reapplied.

2.5.3 Stage 3

This stage was carried out 90 days after the intervention period (day 91). The children were reassessed regarding their nutritional status, and cardiorespiratory fitness, according to the methodology described in Stage 1.

2.6 Statistical analysis

The post hoc power analysis was performed using the G*Power software, version 3.1.9.7. The normality of the data was assessed using the Shapiro-Wilk test and the homogeneity of variances using the Levene test. The sample did not present a normal distribution or homogeneity, therefore the following nonparametric tests were used for the analyses: Mann-Whitney, and Wilcoxon

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Tests. The results were expressed as absolute numbers, mean, median, standard deviation, and frequency. The data was analyzed in RStudio (version 4.0.3), using the R language, considering a 5% significance level.

3. Results and Discussion

Took part in the research, 357 boys (50.3%) and 352 girls (49.7%), aged between 8 years (41.5%), 9 years (41.6%), and 10 years (16.9%). The average age was 8.8±0.72 years (8.7±0.70 years for girls and 8.8±0.75 years for boys). The children's average weight was 34.2±9.53 kg (33.9±9.10 kg for girls and 34.6±9.94 kg for boys), and their height was 1.4±0.07 m (1.4±0.07 m girls and boys). The children had an average BMI of 18.3±3.83 kg/m², which was lower for girls (17.9±3.54 kg/m², overweight) compared to boys (18.4±3.94 kg/m², eutrophy). The CG group included 286 children, 137 boys (47.9%) and 149 girls (52.1%), aged between 8 years (30.4%), 9 years (45.1%), and 10 years (24.5%). The average age was 8.9±0.73 years (8.9±0.74 years for girls and 8.7±0.74 years for boys). The children's average weight was 35.0±9.50 kg (35.0±9.52 kg for girls and 35.0±9.51 kg for boys) and height was 1.3±0.07 m (1.3±0.07 m girls and boys). The children had an average BMI of 18.2±3.7 kg/m² (18.2±3.7 kg/m² for girls and boys). The IG group had 423 children, 220 boys (52.1%) and 203 girls (47.9%), aged between 8 years (49.0%), 9 years (39.0%) and 10 years. (12.0%). The average age was 8.6±0.68 years for both boys and girls. The children's average weight was 33.9±9.52 kg (33.6±9.50 kg for girls and 33.7±9.52 kg for boys) and height was 1.3±0.06 m (1.3±0.06 m girls and boys). The children had an average BMI of 18.1±3.8 kg/m² (18.1±3.8 kg/m² for girls and boys).

In general, the children weighed above the values (median z-score) informed for their age and sex, which is 26.8 kg for girls and 27.2 kg for boys (WHO, 2007). The participants' height contemplated the median reported for this audience of 1.30 m for both sexes (WHO, 2007). However, the children's BMI results were higher than indication for the median (z-score) for their age, which is 15.9 kg/m² for boys and girls (WHO, 2007). Table 1 shows the results regarding the nutritional status of the children (CG and IG), considering Stages 1 and 3.

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Table 1 - Nutritional status of the children (general assessment, Control Group, and Intervention Group) in Stages 1 and 3

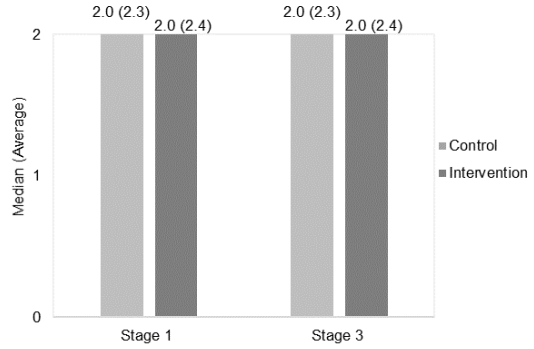
Variable	Stage 1		Stage 3	
	n	%	n	%
General assessment				
Low weight	16	2.2	25	3.5
Eutrophy	430	60.7	426	60.1
Overweight	130	18.3	152	21.4
Obesity	95	13.4	80	11.3
Severe obesity	38	5.4	26	3.7
Control Group (CG)				
Low weight	9	3.2	13	4.5
Eutrophy	174	60.8	174	60.8
Overweight	46	16.1	54	19.0
Obesity	43	15.0	36	12.5
Severe obesity	14	4.9	9	3.2
Intervention Group (IG)				
Low weight	6	1.4	12	2.8
Eutrophy	259	61.2	252	59.6
Overweight	82	19.5	98	23.2
Obesity	52	12.2	44	10.4
Severe obesity	24	5.7	17	4.0

n = 709 (n = 357, boys; n = 352, girls); CG: n = 286 (n = 137, boys; n = 149, girls); IG: n = 423 (n = 220, boys; n = 203, girls).

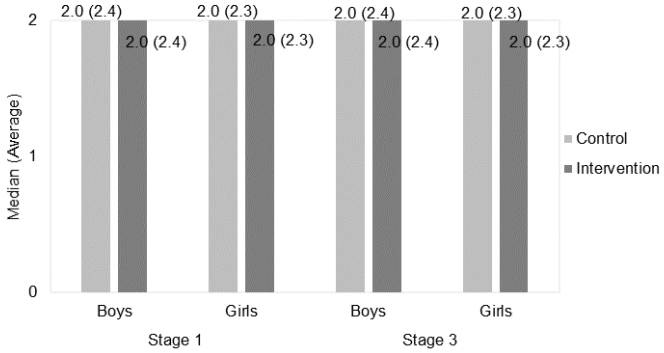
Most children presented eutrophy in Stages 1 and 3. However, a high number of participants were classified as overweight (general assessment, 37.1% in Stage 1 and 36.4% in Stage 3; CG, 36.0% in Stage 1 and 34.7% in Stage 3; IG, 37.4% in Stage 1 and 37.6% in Stage 3) for their age and sex (WHO, 2007). These results corroborate with assessments carried out in other Brazilian states (Pitanga *et al*., 2022). This high level of overweight is due to non-genetic causes, which are associated with poor diet, low levels of physical activity, and environmental and social changes (WHO, 2021). Added to this, there is the insufficient number of meals, consumption of sugary drinks, eating out, eating without hunger, and in front of screens (television, cell phone, etc.) (Mazur *et al*., 2022). Figure 1 shows the comparison of results between the same stage and the effect of the educational intervention on the children's nutritional status, considering CG and IG groups in Stages 1 and 3.

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a) Assessed overall



b) Sex

a) n = 709 (n = 357, boys; n = 352, girls); CG: n = 286 (n = 137, boys n = 149, girls); IG: n = 423 (n = 220, boys; n = 203, girls); Mann-Whitney test applied between CG and IG groups for individual Stages 1 (p = 0.523) and 3 (p = 0.297); Wilcoxon test comparing the effect of the intervention between Stages 1 and 3 (CG: p = 0.217; GI: p = 0.423); Nutritional status classification values: 1, Underweight; 2, Eutrophy; and 3, Overweight. b) n = 709 (n = 357, boys; n = 352, girls); CG: n = 286 (n = 137, boys; n = 149, girls); IG: n = 423 (n = 220, boys; n = 203, girls); Mann-Whitney test applied between sexes considering CG and IG and individual Stages 1 (CG: boys, p = 0.677; girls, p = 0.222) and 3 (IG: boys, p = 0.831; girls, p = 0.233); Wilcoxon test comparing the effect of the intervention on the same group and the same sex between Stages 1 and 3 (CG: boys, p = 0.144; girls, p = 0.819; IG: boys, p = 0.549; girls, p = 0.593).

Figure 1. Comparison of results between the same stage and effect of the educational intervention on the nutritional status (Body Mass Index/age) of the children, assessed overall (a) and by sex (b), considering the Control (CG) and Intervention Groups (IG) and Stages 1 and 3.

The children showed no significant difference ($p > 0.05$) in the BMI/age classification between the groups, either in Stage 1 or 3, being considered eutrophic in general. Also, there was no significant difference ($p > 0.05$) in the nutritional status between boys and girls in the CG and IG groups, considering the

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ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/04/2026
Vol: 13.05
DOI: 10.66104/z9y4m435
Pages: 1-30

individual Stages 1 and 3, endorsing other studies (Machado *et al*., 2020; Barnes *et al*., 2021). This occurs because, at this stage of childhood (pre-puberty), the organism's development is mainly centered on cognitive functions. Therefore, physical differences and changes, such as the growth peak in height, along with biological maturation of sexual organs and muscular functions, and other changes in body composition between the sexes occur more decidedly in the later phase, classified as puberty (Papalia *et al*., 2013). However, some factors can influence changes in adiposity in childhood and adolescence (Janssen *et al*., 2019), such as stressors related to physical and mental conditions (Rawal *et al*., 2023), low physical activity (WHO, 2020), and inadequate nutrition (Li *et al*., 2019).

Recent evidence indicates that anthropometric changes in childhood should be understood as dynamic and heterogeneous trajectories, and not merely as point measurements between stages. BMI and other adiposity indicators follow different growth patterns from the first years of life, with distinct trajectories, such as stable or accelerated gain, which can be identified early and are associated with future health outcomes (Xie *et al*., 2023; Zhu *et al*., 2026). In this context, early factors, such as intrauterine conditions, gestational weight gain, and environmental exposures, contribute to the formation of these trajectories, reinforcing the idea that subtle differences in childhood can be amplified over time (Xie *et al*., 2023). Thus, even in the absence of significant differences between groups at specific times, as observed in the present study, continuous monitoring is fundamental, as it allows the identification of divergent growth patterns that may not be detected in cross-sectional analyses, but which have a relevant clinical and epidemiological impact throughout the life cycle.

The educational intervention did not influence the children's nutritional status, in the general assessment and by sex ($p > 0.05$), corroborating other similar studies (Habib-Mourad *et al*., 2020; Barnes *et al*., 2021). Some aspects may justify these results, especially those related to the short time taken to carry out the actions, as well as the lack of interventions to change eating habits, among others. In this context, studies that used a longer period of educational actions, between 4 months and 5 years, found significant improvements in the nutritional

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/04/2026
Vol: 13.05
DOI: 10.66104/z9y4m435
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status of children (Seo *et al*., 2019; Obita; Alkhatib, 2023). According to Jakicic *et al*. (2020), physical activity should always be associated with other lifestyle changes. Some examples are the inclusion of activities with family involvement (Habib-Mourad *et al*., 2020), behaviors aimed at improving long-term sustainability (Zeldman *et al*., 2023), nutritional programs (Habib-Mourad *et al*., 2020) and the availability of environments favorable to physical activity (leisure centers, parks, playgrounds, community safety) (Mason *et al*., 2023). Long-term cohort studies demonstrate that changes in BMI and adiposity result from cumulative exposures and behavioral modifications maintained over several years (Cleland e*t al*., 2022; Brasileiro *et al*., 2025). Furthermore, evidence indicates that interventions initiated in childhood and followed for extended periods, including transitions to adolescence, are more effective in modifying growth trajectories and preventing overweight, especially when they combine health education, a supportive environment, and family involvement (Berger *al et al*., 2024; Vilela *et al*., 2025).

Table 2 shows the results of the children's cardiorespiratory fitness, comparing the CG and IG groups in the individual stages. Also, the results of the educational intervention on this parameter between the CG and IG groups.

Table 2 - Comparison of the cardiorespiratory fitness of the children (general assessment), of the Control (CG) and Intervention (IG) Groups, concerning Individual Stages 1 and 3*; and the results of the educational intervention between the groups, considering the children in general and by sex**

Variable	**Stage 1**		**Stage 3**		**p****
	Median (meters)	Mean±SD (meters)	Median (meters)	Mean±SD (meters)	
Overall assessment					
CG (n = 286)	783.5	797.1±176.68	763.0	776.6±147.59	*0.002*
IG (n = 423)	719.0	765.7±170.35	776.0	820.4±169.86	*<0.001*
p*		*0.004*		*0.005*	
Boys assessment					
CG (n = 137)	808.0	827.0±181.60	789.0	804.1±156.84	*0.018*
IG (n = 220)	750.0	795.4±180.59	804.0	852.4±176.56	*<0.001*

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Received: 13/01/2026 - **Accepted:** 01/04/2026
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p*		*0.033*		*0.035*	
Girls assessment					
CG (n = 149)	743.0	769.7±167.99	732.0	751.2±134.14	0.062
IG (n = 203)	702.0	733.4±152.51	743.0	785.6±155.40	*<0.001*
p*		*0.024*		0.124	

n = 709 (n = 357, boys; n = 352, girls); CG: n = 286 (n = 137, boys; n = 149, girls); IG: n = 423 (n = 220, boys, n = 203, girls); *Mann-Whitney test comparing the GC and GI column in individual, 1, and 3 Stages; **Wilcoxon test comparing the effect of the intervention considering the same group between Stages 1 and 3.

In the overall assessment of the children and by sex, the CG showed a greater distance covered ($p < 0.05$) before the intervention (Stage 1) compared to the IG. However, in Stage 3 (post-intervention), the IG had the highest result in the cardiorespiratory test, considering the children in general and for the boys, with no significant difference between the groups ($p > 0.05$) for the girls. Studies have shown that school-age children do not show many differences between the sexes regarding motor skills, but girls may show lower levels of physical activity compared to boys (Sturm *et al*., 2021).

The intervention (Stage 2) increased the distance covered by the IG children. The Control Group, which did not take part in any activity, reduced this measure ($p < 0.05$), both in the overall assessment and for the boys. In the case of the CG girls, there was no effect for the 6MWT ($p > 0.05$), but the intervention significantly increased the test measures for the IG. These results corroborate other similar studies (Fochesatto *et al*., 2022; Quist *et al*., 2022). When children realize their abilities and challenge themselves, can develop self-efficacy in their own fitness skills state (Flynn *et al*., 2018), which was also proven in this study. Furthermore, presenting adequate levels of cardiorespiratory fitness from childhood is fundamental for maintaining health over time, which can reduce the incidence of metabolic syndrome in adulthood (Haapala *et al*., 2022). Thus, intervention programs aimed at physical activity in schools are essential to promote health and prevent diseases in childhood (Fredriksen *et al*., 2017).

Beyond the physiological stimulus provided by the activities, the improvement in cardiorespiratory fitness may also be explained by behavioral mechanisms activated by the intervention. Because the program used playful and

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ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/04/2026
Vol: 13.05
DOI: 10.66104/z9y4m435
Pages: 1-30

culturally familiar games, repeated weekly exposure, peer interaction, and a final class based on children's preferred activities, it likely increased enjoyment, perceived competence, relatedness, and autonomous motivation to be active. Recent evidence shows that game-based physical education significantly improves enjoyment in children and adolescents, particularly in those younger than 12 years, and that self-determination theory-informed interventions are more effective when they support autonomy, competence, and relatedness, with effects often mediated by autonomous motivation and need satisfaction. In addition, school-based physical activity interventions can positively influence children's social and emotional learning, suggesting that social interaction and group participation are not merely contextual features, but active ingredients that may increase engagement and willingness to sustain effort during practice (Mo *et al*., 2024; Moon *et al*., 2024; Ntoumanis; Moller, 2025).

From a practical standpoint, behavioral pathways may help explain additionally why the intervention improved 6MWT performance without producing significant changes in BMI over 90 days. In school settings, proximal effects often emerge first in participation, adherence, enjoyment, and exercise tolerance, whereas anthropometric changes are more likely when programs are longer, theory-driven, and combined with broader behavior-change strategies. Recent reviews indicate that action planning, social support, feedback, self-monitoring, and goal setting are among the most promising techniques for increasing physical activity in children with overweight/obesity, while umbrella evidence suggests that long-term and theory-based school programs are more likely to sustain changes in activity and influence weight-related outcomes (Alalawi *et al*., 2024; Peng *et al*., 2024).

For children between 8 and 10 years old it is recommended that the 6MWT distance covered is 782.3 m (healthy zone) as a cut-off point indicating an increased chance of the child/adolescent presenting some cardiovascular risk factor (hypercholesterolemia and hypertension). For boys, the recommendation is 814.7 m, and for girls 750.0 m (Gaya *et al*., 2021). Values below these ratings can be considered a cardiovascular risk zone. The children assessed in this study

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ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/04/2026
Vol: 13.05
DOI: 10.66104/z9y4m435
Pages: 1-30

performed an average distance (Stages 1 and 3) for the 6MWT of 790.0 m (819.7 m for boys and 759.9 m for girls), classifying them in the healthy zone.

The children's rating in the general and by sex assessment was considered positive in the joint stages. However, in Stage 1, the CG children were classified in the healthy zone, while in Stage 3 they moved into the at-risk zone. Contrary, the IG (general assessment) was at risk before the intervention and moved into the healthy zone after the actions. A similar result was observed only for the IG boys. The CG boys were in the risk zone in both Stages 1 and 3. As for the girls, those in the CG were classified in the healthy zone in both Stages 1 and 3. The ones in IG moved from the risk zone (in Stage 1) to the healthy zone (in Stage 3). Table 3 shows the comparison between the CG and IG children's cardiorespiratory fitness, considering their nutritional status (Individual Stages 1 and 3). Table 3 shows the effect of the intervention on cardiorespiratory fitness.

Table 3 - Effect of the educational intervention on cardiorespiratory fitness (6MWT), considering the nutritional status of the children (general assessment) and by sex, in the Control (CG) and Intervention (IG) Groups, in Stages 1 and 3

Variable	**Stage 1** Median (meters)	**Stage 3** Median (meters)	**p**
Overall assessment			
CG (n = 286)			
Underweight (n = 9)	757.0	737.0	0.678
Eutrophy (n = 174)	813.0	792.0	*0.003*
Overweight (n = 103)	722.0	721.0	0.227
IG (n = 423)			
Underweight (n = 6)	844.5	888.0	0.752
Eutrophic (n = 259)	740.0	804.0	*<0.001*
Overweight (n = 158)	694.5	730.0	*<0.001*
Evaluation of the boys			
CG (n = 137)			
Underweight (n = 3)	882.0	737.0	0.593
Eutrophic (n = 76)	869.0	837.0	*0.036*
Overweight (n = 58)	754.0	741.5	0.296
IG (n = 220)			
Underweight (n = 3)	1007.0	1014.0	1,000

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ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/04/2026
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Eutrophic (n = 130)	776.5	853.5	*<0.001*
Overweight (n = 87)	716.0	748.0	*<0.001*
Evaluation of the girls			
CG (n = 149)			
Underweight (n = 6)	754.5	757.5	0.917
Eutrophic (n = 98)	777.5	766.5	*0.041*
Overweight (n = 45)	683.0	667.0	0.538
IG (n = 203)			
Underweight (n = 3)	783.0	786.0	0.593
Eutrophic (n = 129)	714.0	763.0	*<0.001*
Overweight (n = 71)	671.0	704.0	*<0.001*

n = 709 (n = 357, boys; n = 352, girls); Wilcoxon Test comparing in line the effect of the intervention, considering the same group.

There was a positive result from the intervention on the children's cardiorespiratory aptitude, considering their nutritional status. In the CG, there was a reduction in the distance covered ($p < 0.05$) for children with eutrophy comparing Stage 1 with Stage 3, even when separated by sex. As for the IG, the intervention increased this parameter for children with eutrophy and overweight, which was also verified for boys and girls. Similar results were found in other similar research (Zhu *et al*., 2019; Mijalkovic *et al*., 2022). There was no significant difference ($p > 0.05$) between stages for overweight and underweight children CG and low IG weight. Children with low body weight can trigger deficits in their growth and physical development, which results in neurological, cognitive, motor, functional, and behavioral complications (Galler *et al*., 2021). Furthermore, they may present an increase in energy expenditure and tissue catabolism (Kumar *et al*., 2002), impairing performance and cardiorespiratory fitness (Peralta *et al*., 2020).

4. Conclusion

The majority of school-age children have a normal nutritional status, but a large number are overweight. The educational intervention does not interfere with the nutritional status and physical activity habits of children. However, it increases the cardiorespiratory aptitude (measured by the distance covered) for boys and girls, and for the children with eutrophy and overweight, contrary to what was

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/04/2026
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DOI: 10.66104/z9y4m435
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observed for those that did not participate in this type of intervention. It is worth mentioning that the children also showed good acceptance of physical activity and were classified as active in terms of the overall intensity of the exercises. However, the main way in which children go to school is passive.

5. Study Limitations

This study presents some limitations that should be considered. Although the sample size was significant, participants were recruited exclusively from public schools in a single municipality, which may limit the generalizability of the findings to other contexts. The intervention period (90 days) may have been insufficient to promote measurable changes in nutritional status, especially considering that anthropometric outcomes generally require follow-up over longer periods. Furthermore, the intervention focused mainly on promoting physical activity, without including structured components related to diet, which may have limited its impact on weight indicators.

Another limitation refers to the absence of objective measures of exercise intensity and physiological responses, making it difficult to determine whether the activities were sufficient to induce relevant metabolic adaptations. Moreover, BMI was used as the sole indicator of nutritional status, not allowing differentiation between fat mass and lean mass. Finally, potential confounding factors, such as food intake, family environment, and physical activity outside the school environment, were not controlled. The lack of long-term follow-up also limits the assessment of the sustainability of the improvements observed in cardiorespiratory fitness.

6. Acknowledgements

The authors thank the funders of the research, the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Fundação Araucária de Apoio ao Desenvolvimento Científico e Tecnológico do Estado do Paraná (FUNDAÇÃO

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/04/2026
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ARAUCÁRIA), Governo do Estado do Paraná, through the Secretaria da Ciência, Tecnologia e Ensino Superior do Estado do Paraná (SETI-PR), Unidade Gestora do Fundo Paraná (UGF), Programa Universidade sem Fronteiras (USF), Ministério da Saúde (MS), Departamento de Ciência e Tecnologia da Secretaria de Ciência, Tecnologia, Inovação e Insumos Estratégicos em Saúde do Ministério da Saúde (Decit/SCTIE/MS), Secretaria de Saúde do Estado do Paraná (SESA-PR) and Universidade Estadual do Centro-Oeste (UNICENTRO), Paraná, Brazil. The authors would also like to thank the Writing Center (CERTA – Centro de Escrita, Revisão e Tradução Acadêmica – www3.unicentro.br/centrodeescritaacademica) of the UNICENTRO for assistance with English language translation and developmental editing.

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