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Effect of Physical Exercise Within a Multidisciplinary Intervention on Self-Efficacy and Self-Concept in Overweight/Obese Adolescents: A Randomized Clinical Trial

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Abstract

This study examined the effects of 24 weeks of physical exercise performed at a self-selected intensity, as part of a multidisciplinary intervention, on self-efficacy and self-esteem among overweight and obese adolescents. Adolescents were recruited in the city of Petrolina, state of Pernambuco, Brazil, between January and March 2023 via social media, television, and local radio programs. Adolescents of both sexes, aged 13 to 17, with a clinical diagnosis of overweight /obesity, who were pubescent or postpubescent, were eligible for participation. Participants were randomized into an Experimental Group (EG) or a Control Group (CG). The 24-week intervention consisted of nutritional counseling (group sessions, 1 hour/week), psychological counseling (group sessions, 1 hour/week), and supervised physical training (three sessions per week). Outcome variables were assessed using the General Perceived Self-Efficacy Scale and the Rosenberg Self-Esteem Scale. Descriptive statistics (mean ± standard deviation) and analysis of covariance (ANCOVA) were used to examine intervention effects. An intention-to-treat approach was adopted. Effect size was calculated, and a p value < .05 was adopted. A total of 44 adolescents (25 girls) who initiated the intervention were included in the intention-to-treat analysis. The groups were comparable at baseline with respect to outcome measures. After 24 weeks of multidisciplinary intervention, no statistically significant between-group differences were observed for self-efficacy (CG: pre=30.3±4.8, post=44.4±5.4; EG: pre=28.5±5.9, post=46.6±6.1; 95%CI=[-5.63;1.56]; p=0.26; d=0.38) or self-esteem (CG: pre=24.0±5.0, post=25.8±5.4; EG: pre=25.6±7.0, post=28.5±6.9; 95%CI=[-4.54;1.44]; p=0.30; d=0.44). In conclusion, 24 weeks of self-selected intensity physical exercise, as part of a multidisciplinary intervention, was insufficient to produce significant improvements in self-efficacy and self-esteem among overweight and obese adolescents.

Keywords: exercise, adolescent psychology, psychosocial health, pediatric obesity, clinical trial

EFEITO DO EXERCÍCIO FÍSICO, NUMA INTERVENÇÃO MULTIDISCIPLINAR, NA AUTOEFICÁCIA E AUTOESTIMA DE ADOLESCENTES COM SOBREPESO/ OBESIDADE: ENSAIO CLÍNICO ALEATORIZADO

Exercício físico, autoeficácia e autoestima de adolescentes

Resumo

Este estudo verificou os efeitos de 24 semanas de exercício físico, com intensidade autosselecionada e inserido numa intervenção multidisciplinar, sobre a autoeficácia e autoestima de adolescentes com sobrepeso/obesidade. Os adolescentes foram recrutados na cidade de Petrolina-PE, de janeiro a março de 2023 (mídias sociais, TV e programas de rádio local). Foram elegíveis adolescentes (ambos os sexos) com diagnóstico de sobrepeso/obesidade, de 13 a 17 anos, púbere ou pós-púbere. Os participantes foram aleatorizados em Grupo Experimental (GE) e Grupo Controle (GC). A intervenção de 24 semanas consistiu em aconselhamento nutricional (em grupo, 1h/semana), psicológico (1h/semana, em grupo) e treinamento físico supervisionado (3x/semana). As variáveis desfechos foram avaliadas pela Escala de Autoeficácia Geral Percebida e pela Escala de Autoestima de Rosenberg. Utilizou-se a estatística descritiva (média ± desvio padrão) e a análise de covariância para identificar os efeitos da intervenção. A análise por intenção de tratar foi empregada. Calculou-se o tamanho do efeito. Adotou-se valor de p<0,05. Os 44 adolescentes (25 meninas) que iniciaram a intervenção foram incluídos na intenção de tratar. Os grupos foram semelhantes para os desfechos avaliados na linha de base. Após 24 semanas de intervenção multidisciplinar não foram encontradas diferenças significativas para a autoeficácia (GC: pré=30,3±4,8; pós=44,4±5,4; GE: pré=28,5±5,9; pós=46,6±6,1; IC95%=[-5,63;1,56]; p=0,26; d=0,38) e autoestima (GC: pré=24,0±5,0; pós=25,8±5,4; GE: pré=25,6±7,0; pós=28,5±6,9; IC95%=[-4,54;1,44]; p=0,30; d=0,44) dos adolescentes com sobrepeso/obesidade. Conclui-se que 24 semanas de exercício físico, com intensidade autosselecionada e inserido em uma intervenção multidisciplinar, não foram capazes de melhorar a autoeficácia e a autoestima de adolescentes com sobrepeso/obesidade.

Palavras-chave: exercício, psicologia do adolescente, saúde psicossocial, obesidade pediátrica, ensaio clínico

EFECTO DEL EJERCICIO FÍSICO, EN UNA INTERVENCIÓN MULTIDISCIPLINARIA, SOBRE LA AUTOEFICACIA Y LA AUTOESTIMA DE ADOLESCENTES CON SOBREPESO/OBESIDAD: ENSAYO CLÍNICO ALEATORIZADO

Ejercicio físico, autoeficacia y autoestima de adolescentes

Resumen

Este estudio examinó los efectos de 24 semanas de ejercicio físico, con intensidad autoseleccionada y dentro de una intervención multidisciplinaria, sobre la autoeficacia y la autoestima de adolescentes con sobrepeso/obesidad. Los adolescentes fueron reclutados en Petrolina-PE, a través de redes sociales, televisión y programas de radio locales. Fueron elegibles adolescentes con diagnóstico de sobrepeso/obesidad, de 13 a 17 años, pubescentes o postpubescentes. Los participantes fueron aleatorizados en Grupo Experimental (GE) y Grupo Control (GC). La intervención de 24 semanas consistió en asesoramiento en grupo nutricional (1 hora/semana), psicológico (1 hora/semana) y entrenamiento físico supervisado (3 veces/semana). Se utilizó la Escala de Autoeficacia General Percibida y la Escala de Autoestima de Rosenberg. Se utilizó estadística descriptiva y análisis de covarianza para identificar los efectos de la intervención. Se empleó un análisis por intención de tratar. Se calculó el tamaño del efecto. Se adoptó un valor de $p<0,05$. Los 44 adolescentes (25 niñas) que iniciaron la intervención fueron incluidos en el análisis por intención de tratar. Los grupos fueron similares en cuanto a los resultados evaluados en la línea base. Tras 24 semanas de intervención multidisciplinaria, no se encontraron diferencias significativas en la autoeficacia (GC: pre=30,3±4,8; post=44,4±5,4; GE: pre=28,5±5,9; post=46,6±6,1; IC95%=[-5,63;1,56]; p=0,26; d=0,38) y la autoestima (GC: pre=24,0±5,0; post=25,8±5,4; GE: pre=25,6±7,0; post=28,5±6,9; IC95%=[-4,54;1,44]; p=0,30; d=0,44) de los adolescentes con sobrepeso/obesidad. Se concluye que 24 semanas de ejercicio físico, con intensidad autoseleccionada y dentro de una intervención multidisciplinaria, no fueron suficientes para mejorar la autoeficacia y la autoestima de los adolescentes con sobrepeso/obesidad.

Palabras clave: ejercicio palabra, psicología del adolescente, salud psicossocial, obesidad pediátrica, ensayo clínico

In 2019, in Brazil, the prevalence of overweight among adolescents aged 15–17 years was 19.4% (approximately 1.8 million individuals), with a higher prevalence among girls (22.9%) compared to boys (16.0%). A high prevalence of obesity (8.5%–9.9%) was also observed in this age group (Pelegrini et al., 2021). Estimates suggest that by 2030, 15.71% of adolescents aged 10–19 years will be obese (Lobstein et al., 2022), and that in Brazil the prevalence of overweight may reach 50% by 2035 (Lobstein et al., 2024).

In recent decades, research has increasingly emphasized the adverse effects of obesity on adolescents' psychological health and well-being (Kiviruusu et al., 2016; Morrison et al., 2015). Adolescents with overweight or obesity are more vulnerable to mental health problems than their eutrophic peers (Nigatu et al., 2016). Self-efficacy and self-esteem, for example, are considered core components of mental health (Ribeiro et al., 2019; Sbicigo et al., 2012). Lower levels of self-efficacy may contribute to reduced self-esteem (Bleidorn et al., 2016), and the inverse relationship has also been reported (Montes-Hidalgo & Tomás-Sábado, 2016).

The literature suggests that regular physical exercise may be a promising strategy for both obesity management and the promotion of mental health. Several studies have incorporated physical exercise into multidisciplinary interventions (De Miguel-Etayo et al., 2015; Fidelix et al., 2019; Goldfield et al., 2017) aimed at the treatment and/or control of obesity (Goldfield et al., 2018), as well as at improving self-esteem and body image among adolescents (Gow et al., 2020). A clinical trial similar in design to the present study, which combined nutritional counseling with physical exercise, demonstrated significant improvements in global self-esteem, selected mood indicators, and perceived strength, in addition to positive changes in physical self-perception among adolescents with overweight or obesity (Goldfield et al., 2015). In contrast, another multidisciplinary intervention reported reductions in depressive symptoms, but no significant effects on anxiety or self-esteem among adolescents with obesity (Fidelix et al., 2019). Furthermore, a meta-analysis of 49 studies (N = 10,471) indicated that obesity treatment in adolescents based on multidisciplinary interventions was associated with increased post-intervention self-esteem (effect size = 0.34, $p < .0001$); however, no Brazilian studies were included in this analysis (Gow et al., 2020). Another meta-analysis reported a small effect size of exercise on self-esteem among children and adolescents with both normal weight and obesity (Liu et al., 2015). Multidisciplinary interventions have also been associated with improvements in other outcomes, including quality of life (Chen et al., 2022; Garcia et al., 2019), physical fitness, obstructive sleep apnea and sleep quality (Roche et al., 2020), anthropometric indicators (e.g., BMI z score, waist circumference) (Lambertucci et al., 2022), and insulin sensitivity (Bocca et al., 2014).

Despite these findings, multidisciplinary interventions with a primary focus on mental health outcomes in adolescents remain limited (Fidelix et al., 2019; Goldfield et al., 2015; Tulloch et al., 2020). Moreover, several methodological limitations have been identified in the existing literature, including low to moderate quality of evidence in studies assessing anthropometric outcomes among adolescents with obesity (Al-Khudairy et al., 2017; Bahia et al., 2019;

Pardos-Mainer et al., 2021), high risk of bias (Al-Khudairy et al., 2017; Hasanpour et al., 2014), insufficient reporting of physical exercise protocols (Ibáñez & Heredia, 2019; Kelley & Kelley, 2013), substantial heterogeneity of intervention formats (e.g., school-based, extended reality, web-based interventions) (De Souza Filho et al., 2021; Ibáñez & Heredia, 2019; Malik et al., 2022; Manzanarez et al., 2020; Pablos et al., 2018), and absence of participant randomization (Nyberg et al., 2015).

Regarding physical exercise training protocols, some studies demonstrate high internal validity (Alves et al., 2022; Barros et al., 2019; Fidelix et al., 2019; Goldfield et al., 2015; Lyra et al., 2022), but limited external validity. This limitation may hinder the replicability of interventions in real-world settings, such as schools, community programs, and Primary Health Care (PHC) units, particularly due to equipment requirements and cost constraints (Panca et al., 2018). Consequently, the assessment of low-cost and feasible exercise protocols is essential for broader implementation.

Although the benefits of regular physical exercise are well established, up to 60% of adolescents with obesity may discontinue participation in supervised physical training programs (Fidelix et al., 2019). Adolescents are known to have lower adherence rates to multidisciplinary weight loss interventions, particularly when activities are perceived as imposed or lack enjoyment. The perception of physical exercise as unpleasant represents a significant barrier to the initiation and maintenance of long-term programs among sedentary and obese individuals (Ekkekakis et al., 2016). In this context, allowing adolescents to self-select exercise intensity may enhance autonomy, intrinsic motivation, and enjoyment, supporting engagement in the weight management process (Parfitt et al., 2012). Therefore, the aim of the present study was to examine the effects of 24 weeks of self-selected intensity physical exercise, incorporated into a multidisciplinary intervention, on self-efficacy and self-esteem of overweight and/or obese adolescents.

Method

Study design, ethics, randomization, and sample size calculation

This study was a single-blind randomized clinical trial with a parallel-group design. The trial is part of an umbrella project entitled "Acute and Chronic Effects of Different Types and Intensities of Physical Training on Psychosocial and Motor Aspects of Adolescents With Obesity" (CAAE: 54262721.3.0000.8052; approval no. 5,332,194). Eligible adolescents were randomized in a 1:1 allocation ratio into either an Experimental Group (EG) or a Control Group (CG) using an online randomization tool (https://www.randomizer.org/). Randomization was performed after completion of baseline assessments, stratified by sex, and conducted by an independent researcher who was blinded to participant assessments. Allocation concealment was ensured. Two *a priori* sample size calculations were conducted based on the primary outcomes (self-efficacy and self-esteem). The sample size calculation for self-efficacy was based on data from a clinical trial involving adolescents with obesity (Schranz et al., 2014). The calculation for self-esteem was based on effect size estimates derived from interventions similar to the present

study, as reported in a meta-analysis study (Gow et al., 2020). Sample size estimation assumed 80% statistical power, a 5% significance level, and effect sizes of 0.34 for self-esteem and 0.50 for self-efficacy. Based on these parameters, a sample of 34 adolescents per group was required for the self-esteem outcome and 16 adolescents per group for self-efficacy. To account for an anticipated 20% attrition rate, the final estimated sample sizes were 43 adolescents for self-esteem and 20 adolescents for self-efficacy.

Participants and eligibility criteria

Adolescents with overweight or obesity were recruited from the city of Petrolina, state of Pernambuco (PE), Brazil, and surrounding areas between January and March 2023 through social media, television, local radio programs, and school visits. Eligibility criteria included: a clinical diagnosis of overweight or obesity; age between 13 and 17 years; pubertal or postpubertal maturation stage; both sexes; absence of genetic, psychiatric, metabolic, or endocrine disorders; absence of musculoskeletal conditions contraindicating physical exercise; no participation in structured physical exercise programs within the previous three months; and preserved visual and auditory abilities. Exclusion criteria comprised: severe illnesses or clinical conditions that prevented continuation of physical exercise, use of medications capable of influencing the analyzed outcomes, and pregnancy during the intervention period.

Multidisciplinary intervention

The multidisciplinary intervention for the EG consisted of nutritional counseling, psychological support, and supervised physical exercise over a 24-week period. Adolescents allocated to the CG participated in the nutritional and psychological counseling sessions and received theoretical guidance on physical exercise and lifestyle modification at baseline. Detailed descriptions of each intervention component are provided below.

Nutritional counseling

Group-based nutritional education sessions (approximately 10 adolescents per group) were conducted once a week, with each session lasting approximately one hour, for a total of 24 sessions. All sessions were delivered by a registered nutritionist. Throughout the intervention, participants were encouraged to reduce overall caloric intake. The sessions focused on promoting reduced consumption of ultra-processed foods, increased intake of natural and minimally processed foods, education on food labeling and nutritional composition, critical discussion of fad diets, and guidance on macronutrient selection (proteins, carbohydrates, and lipids), among other topics (Ladeia et al., 2019). No individualized dietary prescriptions were provided. The nutritionist was blinded to group allocation.

Psychological counseling

Psychological counseling consisted of weekly group sessions (approximately 10 adolescents per group), each lasting one hour, for a total of 24 sessions, conducted by two licensed clinical psychologists. The sessions addressed topics related to obesity, including anxiety and depressive symptoms, body image distortion, dysfunctional eating behavior patterns, and psychological factors that may be associated with low adherence and motivation for physical activity. These topics were delivered using a psychoeducational approach, aimed at enhancing adolescents' understanding of obesity and the overall treatment process. Psychoeducation is based on the premise that greater knowledge about one's physical and mental health, cognitive-emotional functioning, and treatment strategies enhances active engagement in behavioral change (Lukens & McFarlane, 2006). Both psychologists were blinded to group allocation.

Supervised physical exercise

Adolescents in the EG participated in three weekly group-based physical exercise sessions throughout the 24-week intervention period. The exercise program was supervised by three physical education professionals. Sessions emphasized the development of physical capacities and motor skills, including proprioception, muscular strength and endurance, flexibility, motor coordination, balance, and cardiorespiratory fitness (Netto & Aptekmann, 2016). The exercises consisted primarily of integrated, multi-joint movements designed to mimic functional movements and postures commonly encountered in daily activities (De Oliveira et al., 2013).

Each session lasted between 40 and 60 minutes, being structured into three phases: warm-up (5–10 minutes, including mobility exercises and abdominal muscle activation), main phase (20–30 minutes, consisting of circuit training with 3–5 exercises performed at different stations), and cool-down (5–10 minutes, including stretching and relaxation exercises) (Netto & Aptekmann, 2016; Santos et al., 2017). During the main phase, adolescents engaged in three types of circuit training, performed with or without equipment: Training A (e.g., squats, agility ladder drills, stationary running, airplane exercise, and overhead press for the upper limbs); Training B (e.g., sumo squats, high row, burpees, single-leg instability exercises, and ball-bounce walking); and Training C (e.g., front plank, lunges, lower abdominal exercises, jogging, and single-leg support). The first 12 weeks were dedicated to exercise familiarization.

Training volume was progressively increased by extending active intervals, shortening recovery periods, and increasing the number and complexity of exercises (Santos et al., 2017). Progression occurred every four weeks. During the familiarization phase, participants progressed from 30 seconds of activity and 30 seconds of rest (two circuit rounds) to 50 seconds of activity and 40 seconds of rest (three circuit rounds). From Weeks 13 to 24, training progressed from 40 seconds of activity and 30 seconds of rest (two rounds) to 60 seconds of activity and 40 seconds of rest (three rounds). Exercise intensity was self-selected by the adolescents and monitored during each session using the Rating of Perceived Exertion (RPE) scale (Borg, 1982), which has

been widely applied in physical exercise research (Bom et al., 2016; Cardoso et al., 2019; Ladeia et al., 2019). The scale was displayed in a visible location, and instructors guided participants to maintain effort levels within the target intensity range.

Descriptive measures

General participant characteristics were collected, including age, sex, maximum lifetime body weight, and previous attempts to lose weight. Anthropometric measurements, including body mass, height, body mass index (BMI), skinfold thickness, and body circumferences, were obtained by a researcher with extensive experience in anthropometric assessment procedures.

Outcomes

All outcomes were assessed at three time points—baseline, 12 weeks, and 24 weeks—following participant randomization and were conducted by the same evaluators at all assessment points.

Psychosocial variables

All questionnaires were administered in a quiet, private room. The instruments used in the present study were previously translated and validated for the Brazilian population.

Self-Efficacy

Self-efficacy was assessed using the General Self-Efficacy Scale (GSES) (Schwarzer & Jerusalem, 1995). The scale consists of 10 items assessing individuals' perceived personal competence and is rated on a 4-point Likert scale (1 = not at all true to 4 = exactly true). Total scores range from 10 (low self-efficacy) to 40 (high self-efficacy). The GSES has demonstrated strong evidence of validity and reliability, and its use is recommended in studies involving Brazilian adolescents (Sbicigo et al., 2012).

Self-Esteem

Self-esteem was assessed using the Rosenberg Self-Esteem Scale (RSES) (Rosenberg et al., 1965). Responses to the 10 items are provided on a 4-point Likert scale, ranging from "strongly agree" to "strongly disagree". Five items are positively worded and five are negatively worded (Items 3, 5, 8, 9, and 10). Scores for negatively worded items are reverse-coded, and a total score ranging from 10 to 40 is calculated, with higher scores indicating greater self-esteem. The RSES has been validated for use among Brazilian adolescents, demonstrating satisfactory psychometric properties (Sbicigo et al., 2010).

Statistical analysis

All statistical analyses were conducted using R software (Version 4.2.2; R Core Team, 2022) by an independent researcher blinded to group allocation. The study followed the intention-to-treat (ITT) principle, whereby all randomized participants were included in the analyses, regardless of protocol deviations (e.g., loss to follow-up or non-adherence to intervention components).

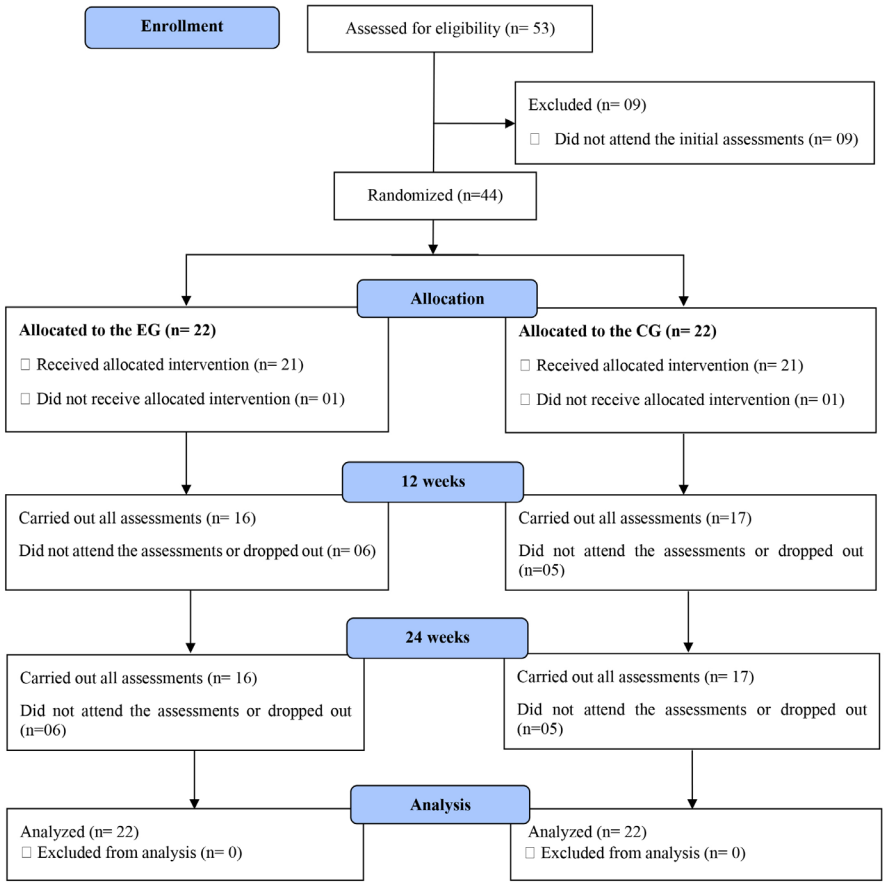
Data normality was assessed using the Shapiro–Wilk test and visual inspection of histograms and Q–Q plots. Between-group intervention effects (EG vs. CG) were examined using analysis of covariance (ANCOVA). For each outcome, the baseline score was included as a covariate in all ANCOVA models. Estimated marginal means and between-group mean differences were calculated at 12 and 24 weeks. Additionally, the moderating effect of sex on intervention-related changes was examined using ANCOVA models for each outcome. The statistical significance level was set at $p < .05$ for all analyses, and effect sizes were calculated. The R script detailing the primary statistical analyses is available online[1].

Results

All adolescents included in the sample (n = 44) completed the 24-week assessment and were included in the intention-to-treat analysis (Figure 1). Adherence to psychological counseling sessions was 41.22% in the EG and 33.24% in the CG. Regarding nutritional counseling, adherence rates were 41.81% in the EG and 27.68% in the CG. Adherence to the supervised physical exercise protocol among adolescents in the EG (n = 22) was 43.2%. On average, participants reported a Rating of Perceived Exertion (RPE) score of 5.3, corresponding to an intense level of effort.

Figure 1

Flowchart of the study



At baseline, no significant between-group differences were observed for any of the investigated variables (Table 1). Participants had a mean age of 14.25 ± 1.42 years, a mean body mass of 98.83 ± 21.41 kg, and girls comprised 56.82% (n = 25) of the total sample. The maximum lifetime body mass reported by adolescents averaged 95.6 kg (n = 42), whereas 4.6% (n = 2) of participants were unable to recall their highest recorded body mass. The maximum body mass reported among all participants was 147 kg. In addition, 90.9% (n = 40) of adolescents reported having attempted weight loss at least once during their lifetime (data not shown in the table).

Table 1

Baseline characteristics of participants according to group allocation (n=44). Petrolina (PE), Brazil, 2023.

Variables	EG (n=22)	CG (n=22)	All (n=44)
Age (years)	13.59±1.14	14.91±1.38	14.25±1.42
Height (cm)	164.18±7.93	167.05±9.64	165.61±8.85
Body mass (kg)	97.83±21.30	99.83±21.97	98.83±21.41
BMI (kg/m^2)	36.01±5.97	35.53±5.53	35.77±5.69
Sum of skinfolds (mm)	277.65±31.0	272.35±34.89	275.0±32.73
Waist circumference (cm)	103.91±14.72	101.39±12.38	102.65±13.50
Hip circumference (cm)	117.75±11.51	120.59±18.24	119.17±15.14
Self-efficacy (score)	28.50±5.89	30.27±4.78	29.39±5.38
Self-esteem (score)	25.59±7.07	24.05±5.04	24.82±6.12

Note: Experimental Group = GE; Control Group = GC; Centimeters = cm; Kilograms = kg; Body Mass Index = BMI; Millimeters = mm. Values expressed as mean and standard deviation.

After 24 weeks of intervention, incorporating self-selected intensity physical exercise into a multidisciplinary approach, no statistically significant between-group differences were observed for self-efficacy or self-esteem (Table 2). A reduction in body mass was observed in the EG compared to the CG after 12 weeks of intervention (EG: pre = 97.83 ± 21.30, post = 97.88 ± 23.30; CG: pre = 99.83 ± 21.97, post = 100.23 ± 24.71; 95% CI [-5.04, -0.51]; p = .02). However, this between-group difference in body mass was not sustained at the 24-week follow-up (p = .15). No significant between-group differences were identified for BMI, sum of skinfolds, waist circumference, or hip circumference after 24 weeks of intervention. Effect sizes for the intervention across the investigated outcomes ranged from small (d = 0.05) to moderate (d = 0.43).

Table 2

Effects of a multidisciplinary intervention including self-selected–intensity physical exercise on anthropometric and psychosocial indicators in overweight/obese adolescents.

Variables	EG (n = 22)			CG (n = 22)			Δ (CI 95%) Baseline and 12 weeks		Δ (CI 95%) Baseline and 24 weeks		Cohen's d
	Baseline	12 weeks	24 weeks	Baseline	12 weeks	24 weeks		p-value		p-value	
Body mass (kg)	97.83± 21.30	97.88± 23.30	95.84± 19.92	99.83± 21.97	100.23± 24.71	101.49± 25.27	-2.78 (-5.04; -0.51)	0.02*	-2.58 (-6.14; 0.98)	0.15	0.25
BMI (kg/m²)	36.01± 5.97	36.45± 6.23	35.09± 5.10	35.53± 5.53	36.80± 6.19	36.22± 6.33	-0.69 (-1.60; 0.20)	0.12	-0.77 (-2.04; 0.49)	0.22	0.20
Sum of skinfolds (mm)	277.65± 31.0	262.55± 35.71	256.25± 39.21	272.35± 34.89	261.21± 36.99	254.25± 44.07	-3.78 (-14.6; 7.0)	0.48	-8.65 (-24.3; 7.0)	0.27	0.05
Waist circumference (cm)	103.91± 14.72	101.53± 14.77	98.50± 12.56	101.39± 12.38	99.89± 13.27	101.23± 15.16	-1.32 (-4.6; 1.9)	0.42	0.78 (-3.13; 4.70)	0.68	0.20
Hip circumference (cm)	117.75± 11.51	116.75± 12.29	116.27± 11.42	120.59± 18.24	119.11± 12.52	119.04± 12.52	-1.64 (-6.55; 3.27)	0.50	-1.87 (-7.09; 3.35)	0.47	0.22
Self-efficacy (score)	28.50± 5.89	28.0± 6.26	46.06± 6.14	30.27± 4.78	28.42± 5.44	44.45± 5.41	-0.19 (-3.31; 2.92)	0.90	-2.04 (-5.63; 1.56)	0.26	0.30
Self-esteem (score)	25.59± 7.07	27.42± 7.60	28.47± 6.94	24.05± 5.04	25.21± 5.86	25.85± 5.45	-1.35 (-4.27; 1.58)	0.36	-1.55 (-4.54; 1.44)	0.30	0.43

Note: Δ: Difference between groups; Confidence Interval = CI; Experimental Group = EG; Control Group = CG; Centimeters = cm; Kilograms = kg; Body Mass Index = BMI; Millimeters = mm. ANCOVA. Values are presented as mean ± SD. ANCOVA adjusted for baseline values.

Table 3 presents the group- and sex-stratified analyses of changes in anthropometric and psychosocial indicators. Compared with girls, boys demonstrated a significant reduction in body mass after 12 weeks of physical exercise intervention (-3.96 [-7.37, -0.56] vs. -1.62 [-4.70, 1.46]; p = .02). However, this sex-specific difference was not maintained at the 24-week follow-up. Furthermore, no significant group-by-sex interactions were observed for anthropometric or psychosocial outcomes after 24 weeks of self-selected intensity physical exercise within the multidisciplinary intervention context.

Table 3

Group- and sex-specific analyses of anthropometric and psychosocial indicators in overweight/obese adolescents.

Variables	EG (n=22)		CG (n= 22)		Δ (CI 95%)			
	Boys (n=10)	Girls (n=12)	Boys (n=9)	Girls (n=13)	Boys	p-value	Girls	p-value
Body mass (kg)								
Baseline	101.86±24.89	94.47±18.22	112.74±26.87	90.88±12.33				
12 weeks	102.93±27.40	92.83±18.58	111.03±32.52	92.12±14.27	-3.96 (-7.37; -0.56)	0.02*	-1.62 (-4.70; 1.46)	0.29
24 weeks	99.07±25.49	93.69±16.60	114.97±28.97	91.39±17.73	-1.85 (-7.36; 3.66)	0.49	-2.94 (-7.40; 1.51)	0.18
BMI (kg/m²)								
Baseline	36.5±6.14	35.6±6.06	36.62±6.33	34.78±5.04				
12 weeks	37.28±7.06	35.62±5.57	37.13±7.81	36.55±5.23	-1.13 (-2.49; 0.22)	0.10	-0.36 (-1.62; 0.88)	0.55
24 weeks	34.47±5.99	35.5±4.75	38.38±6.44	34.87±6.29	-0.51 (-2.67; 1.64)	0.63	-0.93 (-2.61; 0.73)	0.26
Sum of skinfolds (mm)								
Baseline	285.03±37.36	271.51±24.53	292.64±36.87	258.29±26.48				
12 weeks	270.2±45.71	254.9±22.09	275.03±38.84	250.84±34.30	-5.73 (-22.3; 10.8)	0.48	-2.55 (-17.7; 12.6)	0.73
24 weeks	263.4±59.07	251.49±21.12	276.78±31.51	237.35±46.21	-12.67 (-38.6; 13.2)	0.32	-5.94 (-27.2; 15.3)	0.57
Waist circumference (cm)								
Baseline	110.7±13.96	98.25±13.32	107.61±12.88	97.08±10.41				
12 weeks	109.72±13.41	93.33±11.53	104.75±14.75	96.25±11.66	-2.86 (-7.75; 2.02)	0.24	0.21 (-4.30; 4.73)	0.92
24 weeks	102.0±16.32	96.17±9.71	106.28±14.38	97.44±15.53	2.93 (-2.85; 8.72)	0.30	-0.76 (-5.65; 4.11)	0.75
Hip circumference (cm)								
Baseline	117.05±13.72	118.33±9.90	127.11±26.23	116.08±8.35				
12 weeks	115.39±14.16	118.11±10.79	121.25±16.52	117.5±9.46	-3.17 (-10.71; 4.36)	0.39	-0.88 (-7.55; 5.78)	0.79
24 weeks	113.08±12.83	118.39±10.61	122.25±13.14	116.62±12.34	-2.10 (-10.81; 6.60)	0.62	-1.72 (-8.56; 5.11)	0.61
Self-efficacy (score)								
Baseline	32.5±3.1	25.17±5.64	30.22±6.48	30.31±3.47				
12 weeks	31.1 ± 4.7	25.2±6.3	27.4±6.9	29.0±4.6	-1.47 (-6.58; 3.63)	0.56	0.83 (-3.70; 5.37)	0.71
24 weeks	49.4 ± 4.1	43.1±6.3	45.7±5.1	43.4±5.7	-2.93 (-8.25; 2.37)	0.27	-0.92 (-6.0; 4.1)	0.71
Self-esteem (score)								
Baseline	30.4 ± 5.78	21.58±5.43	24.56±4.28	23.69±5.65				
12 weeks	31.11 ± 6.11	24.1±7.5	25.86±6.12	24.83±5.95	-0.16 (-5.07; 4.74)	0.94	-2.31 (-6.36; 1.72)	0.25
24 weeks	30.88 ± 6.49	26.33±6.96	27.0±4.06	24.91±6.41	1.14 (-3.58; 5.85)	0.62	-3.58 (-7.68; 0.52)	0.08

Note: Δ: Difference between sexes; Confidence Interval = CI; Experimental Group = EG; Control Group = CG; Centimeters = cm; Kilograms = kg; Body Mass Index = BMI; Millimeters = mm. ANCOVA

Adverse events

Adverse events were monitored weekly and collected via in-person interviews for the EG and via telephone or WhatsApp contact for the CG. Participants were instructed to report any changes in daily routines, medical consultations, occurrences of acute and/or chronic illnesses, or the emergence of new symptoms. Additionally, self-reported engagement in physical exercise and/or physical activities outside the supervised intervention was documented. Over the 24-week intervention period, the most frequently reported adverse events in the EG included dizziness (n = 7), calf pain (n = 4), back discomfort (n = 3), headache (n = 3), shortness of breath (n = 3), inner thigh pain (n = 3), knee pain (n = 3), ankle pain (n = 1), foot pain (n = 1), ankle sprain (n = 1), groin pain (n = 1), and nausea (n = 1). In the CG, reported adverse events during follow-up included ankle sprain (n = 2), flu-like illness (n = 2), cholelithiasis (n = 1), and anxiety (n = 1).

Throughout the 24-week period, adolescents were also queried regarding participation in physical exercises/activities outside the intervention protocol. The EG reported engagement in futsal (approximately 3 times/week, ~120 min; n = 1), cycling (5 times/week, ~90 min; n = 1), jiu-jitsu (2 times/week, ~90 min; n = 1), soccer (3–5 times/week, ~60 min; n = 2), active commuting to school (walking) (4 times/week, ~20 min; n = 1), dog walking (2 times/week, ~120 min; n = 1), neighborhood volleyball (2–3 times/week, ~120 min; n = 1), swimming (1 time/week, ~90 min; n = 2), judo (2 times/week, ~120 min; n = 1), school handball (2 times/week, ~60 min; n = 1), resistance training (5 times/week, ~90 min; n = 1), and dance (3 times/week, ~60 min; n = 1). The CG reported activities such as walking (3–5 times/week, ~30 min; n = 2), weight lifting (3–6 times/week, ~90 min; n = 2), other sports (1–4 times/week, ~60 min; n = 3), cycling (4 times/week, ~20 min; n = 1), and martial arts (5 times/week, ~90 min; n = 1).

Discussion

The main findings of this study indicate that 24 weeks of self-selected intensity physical exercise, implemented as part of a multidisciplinary intervention, did not result in statistically significant improvements in self-efficacy or self-esteem among adolescents with overweight/obesity. Nonetheless, when considering the magnitude of the observed effect sizes, particularly for psychosocial outcomes, the findings may still be considered clinically meaningful, given the well-documented negative impact of excess weight on self-efficacy and self-esteem (Sanders et al., 2015). Moreover, effect sizes comparable to those observed in the present study have been reported in previous investigations (Gow et al., 2020; Liu et al., 2015).

Observational studies have demonstrated significant associations between physical exercise and self-esteem (Guddal et al., 2019; Rodriguez-Ayllon et al., 2019), and some experimental studies suggest that physical exercise may contribute to short- and medium-term improvements in self-esteem (Gow et al., 2020; Hasanpour et al., 2014). Importantly, such improvements appear to occur regardless of weight loss and/or hypertrophy (King et al., 2020; Schranz et al., 2014). A meta-analysis involving 49 studies (n = 10,471) reported that

multidisciplinary obesity treatment in adolescents was associated with increased post-intervention self-esteem (effect size = 0.34; p < .001) (Gow et al., 2020), although no Brazilian studies were included. Similarly, another meta-analysis identified a small but positive effect of physical exercise on self-esteem in both eutrophic and obese children and adolescents (Liu et al., 2015).

Despite these findings, the literature investigating the effects of physical exercise interventions on psychosocial outcomes such as self-efficacy and self-esteem remains heterogeneous (Fidelix et al., 2019; Kim et al., 2020). Goldfield et al. (2012) reported that 10 weeks of moderate-intensity exercise performed twice weekly did not improve self-esteem in adolescents with obesity. In addition, most studies examining self-efficacy in this population are observational in nature (Utley et al., 2016; Wurz & Brunet, 2020), which limits causal inference. One of the few randomized interventions, conducted by Bagherniya et al. (2018), demonstrated significant improvements in nutritional behaviors and self-efficacy among adolescents with obesity compared with a control group.

The absence of statistically significant psychosocial effects in the present study—and in several previous investigations—may be partially explained by the fact that both adolescence and obesity are developmental conditions marked by profound physiological, emotional, and psychosocial changes (Farhat, 2015; Silva et al., 2016), which may affect self-efficacy and self-esteem. Furthermore, it is noteworthy that the few studies investigating the role of physical exercise in adolescents with obesity have been conducted exclusively in female samples (Bagherniya et al., 2018; Liu et al., 2015) and have primarily focused on increasing physical activity levels (Lee et al., 2012). These gaps underscore the need for additional research addressing psychosocial health outcomes in mixed-sex samples of adolescents with overweight/obesity.

Consistent with prior evidence, multidisciplinary interventions that include physical exercise have been shown to promote weight loss in adolescents with obesity (Al-Khudairy et al., 2017). In the present study, however, differences in body mass were observed only by sex, with boys demonstrating greater short-term reductions in body mass than girls. Preliminary investigations have reported that boys may be more likely to experience weight loss due to a combination of biological, physiological, and behavioral factors, including higher basal metabolic rates, greater lean muscle mass (Tsai et al., 2016), and higher engagement in vigorous physical activity (Guddal et al., 2019; Tsai et al., 2016). Nevertheless, sex differences in weight loss responses remain insufficiently explored, particularly given that the male sex has been underrepresented in weight loss interventions (Pagoto et al., 2012; Susanto et al., 2022), which may limit the generalizability of existing findings. Notably, early weight loss has been identified as a key predictor of long-term treatment success (Unick et al., 2015), suggesting that boys may be more likely to achieve sustained weight management benefits.

Adolescents frequently report low self-efficacy and self-esteem, and these vulnerabilities may be further exacerbated by obesity (Greydanus et al., 2018; Ribeiro et al., 2019; Thedinga et al., 2021). However, in the present study, baseline levels of self-efficacy and self-esteem were

relatively high, which may have attenuated the potential impact of the intervention. It is possible that physical exercise exerts smaller psychosocial effects among individuals who already demonstrate adequate self-efficacy and self-esteem. This hypothesis is supported by prior studies in which adolescents with obesity and low baseline self-esteem or body image did not exhibit significant psychosocial improvements following intervention (Fidelix et al., 2019; Goldfield et al., 2015). Similarly, Tulloch et al. (2020) reported that baseline self-efficacy did not mediate changes in outcome expectations or physical fitness among adolescents with obesity. Moreover, these studies employed different instruments to assess self-efficacy, self-esteem, and body image, which may further contribute to inconsistencies across findings.

Although the broader literature supports the positive effects of physical exercise in promoting psychosocial health among children and adolescents (Bagherniya et al., 2018; Fidelix et al., 2019; Gow et al., 2020), evidence regarding the specific contribution of self-selected exercise intensity within multidisciplinary interventions remains limited, particularly among adolescents with overweight or obesity. In this regard, while not statistically significant, the findings of the present study suggest that incorporating self-selected exercise intensity may help maintain psychosocial outcomes and anthropometric indicators over a 24-week period. This observation is particularly relevant given that progressive increases in body weight during adolescence are generally expected (Freedman et al., 2018).

Strengths and Limitations of the Study

The present study has several limitations that should be considered. First, sleep patterns and dietary habits — variables that may influence the outcomes — were not controlled. Additionally, the use of self-report questionnaires to assess the primary variables, although validated, represents a limitation because it may increase susceptibility to recall bias. Moreover, the exercise sessions were conducted at different times of day (afternoon and evening), which may have influenced participants' motivation to exercise and potentially led to physiological and performance variability. The lack of blinding of the professionals administering the exercise sessions may also have introduced bias in activity monitoring. Another relevant factor is the small sample size, which reduces the statistical power of the analyses and limits the generalizability of the findings. It is important to note that, despite the availability of 100 slots for the study, the number of adolescents who sought participation was low. Furthermore, participants' low adherence to the intervention requires caution when interpreting the results. Among the most frequently reported reasons for missed sessions were ankle sprains, flu-like symptoms, medical appointments, school obligations, and transportation difficulties. Thus, low adherence may have attenuated the observed effects of the intervention.

On the other hand, several strengths of the study deserve emphasis. This study aimed to address limitations identified in prior research by including both boys and girls and by ensuring blinding of all therapists responsible for nutritional and psychological interventions, outcome assessors, and the statistician. Additionally, the duration of the intervention (24 weeks) and the

exercise protocol, characterized as sustainable, low-cost, and easily transferable to other professional and contextual settings, represent key strengths of the study.

Practical Implications and Directions for Future Research

From a practical perspective, the findings suggest several relevant implications for professionals involved in the prevention and/or treatment of obesity. First, incorporating discussions related to psychosocial health with adolescents may represent a useful strategy to mitigate the negative effects associated with obesity. For physical education professionals, this study provides evidence that self-selected exercise intensity can be safely incorporated into adolescents' routines, particularly given that the reported adverse effects were minor. Health professionals may apply these findings within clinical management strategies, including multidisciplinary approaches that integrate different areas of expertise, considering the multifactorial etiology of obesity. In terms of public policies, the data from this study underscore the importance of intersectoral strategies aimed at preventing and treating adolescent obesity, thereby contributing to the development of evidence-based actions aligned with health promotion principles.

Considering the limitations and findings of this study, future research should prioritize larger and more representative samples to enhance statistical power and improve the generalizability of results. Controlling external variables with substantial potential influence, such as sleep and dietary habits, as well as standardizing intervention schedules, may reduce potential biases and improve outcome consistency. Moreover, studies that incorporate enhanced engagement strategies aimed at improving participant adherence may provide additional insight into the observed effects. Additionally, the findings raise several unanswered questions, including: Does intervention timing influence adolescents' physiological responses and performance? Is exercise motivation affected by the time of day? Would innovative strategies increase adherence to interventions? Which approaches are most effective in engaging parents/caregivers in adolescent-focused programs? Addressing these questions in future studies may contribute to the development of more effective, evidence-based interventions and advance knowledge in this field.

Final Considerations

The inclusion of self-selected physical exercise intensity in a 24-week multidisciplinary intervention did not result in improvements in self-efficacy or self-esteem among adolescents with overweight or obesity.

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