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ASSOCIATION BETWEEN EXTRACURRICULAR SPORTS PARTICIPATION, AEROBIC CAPACITY, AND BODY COMPOSITION IN BRAZILIAN ADOLESCENTS FROM A PRIVATE SCHOOL

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Abstract: The aim of this study was to investigate the association between extracurricular sports participation, aerobic capacity, and body composition in school adolescents. This cross-sectional study included 132 adolescents (mean age 12.6 ± 1.2 years; BMI: 20.8 ± 3.7 kg/m^2; 43.2% females) from a private school in Natal, Brazil, of whom 87 participated in extracurricular sports and 45 did not. Sports participation was assessed using the Questionnaire for Physical Activity and Sedentary Behavior Assessment in Adolescents. Aerobic capacity was measured with the 20-meter shuttle run test, while body composition was evaluated through body mass index (BMI) and body fat percentage (%BF). All tests were classified into healthy and unhealthy fitness zones according to the FitnessGram. Poisson regression with robust variance estimated the prevalence ratio (PR) and 95% confidence intervals (CI) for unhealthy fitness levels. The prevalence of inadequate aerobic capacity, BMI, and %BF was 23.5%, 31.8%, and 47.7%, respectively. Adolescents not engaged in extracurricular sports showed a higher prevalence of unhealthy aerobic capacity compared to their sports-active peers, even after adjusting for BMI (PR: 2.59; 95% CI: 1.53–4.40; P<0.001) or %BF (PR: 1.97; 95% CI: 1.14–3.40; P=0.015). No significant association was found between sports participation and BMI or %BF (P>0.05). It can be concluded that participation in extracurricular sports is associated with a lower prevalence of inadequate aerobic capacity among school-aged adolescents, regardless of body composition. These results suggest that promoting extracurricular sports may be a relevant strategy to improve aerobic capacity and promote adolescent health in schools.

Key words: School Health Promotion; Sports; Physical Fitness; Health; Adolescence.

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ASSOCIAÇÃO ENTRE A PARTICIPAÇÃO EM ESPORTES EXTRACURRICULARES, CAPACIDADE AERÓBIA E COMPOSIÇÃO CORPORAL EM ADOLESCENTES BRASILEIROS DE UMA ESCOLA PRIVADA

Resumo: O objetivo deste estudo foi investigar a associação entre a participação em esportes extracurriculares, a capacidade aeróbica e a composição corporal em adolescentes escolares. Este estudo transversal incluiu 132 adolescentes (idade média: 12,6 ± 1,2 anos; IMC: 20,8 ± 3,7 kg/m^2; 43,2% do sexo feminino) de uma escola privada em Natal, Brasil, dos quais 87 participavam de esportes extracurriculares e 45 não. A participação esportiva foi avaliada por meio do Questionário para Avaliação da Atividade Física e Comportamento Sedentário para Adolescentes. A capacidade aeróbica foi avaliada pelo teste de corrida de vai-e-vem de 20 metros, enquanto a composição corporal foi mensurada por meio do índice de massa corporal (IMC) e do percentual de gordura corporal (%GC). Todos os testes foram classificados em zonas de aptidão saudável e não saudável, de acordo com o FitnessGram. A regressão de Poisson com variância robusta foi utilizada para estimar a razão de prevalência (RP) e os intervalos de confiança (IC) de 95% para níveis inadequados de aptidão física. A prevalência de capacidade aeróbica, IMC e %GC não saudável foi de 23,5%, 31,8% e 47,7%, respectivamente. Adolescentes que não participavam de esportes extracurriculares apresentaram maior prevalência de capacidade aeróbica não saudável em comparação aos seus pares que participavam, mesmo após ajuste para IMC (RP: 2,59; IC 95%: 1,53–4,40; P<0,001) ou %GC (RP: 1,97; IC 95%: 1,14–3,40; P=0,015). Nenhuma associação significativa foi encontrada entre a participação esportiva e o IMC ou %GC (P>0,05). Conclui-se que a participação em esportes extracurriculares está associada a uma menor prevalência de capacidade aeróbica inadequada entre adolescentes escolares, independentemente da composição corporal. Esses resultados indicam que a promoção de esportes extracurriculares pode ser uma estratégia relevante para melhorar a capacidade aeróbica e promover a saúde dos adolescentes nas escolas.

Palavras-chave: Promoção da Saúde Escolar; Esportes; Aptidão Física; Saúde; Adolescência.

Introduction

Adolescence, defined by the World Health Organization as the age range from 10 to 19 years old[1], represents 16% of the global population[2]. This phase between childhood and adulthood is marked by significant physical, mental, and social transformations[3,4]. Due to the transient nature of this stage, adolescents face challenges such as physical inactivity[5] and excessive screen time[6], which can result in low aerobic capacity and excessive fat accumulation[7].

Among adolescents, the prevalence of low aerobic capacity is 53.3%, while excess body fat affects 40.4%[8,9]. Both conditions are known independent risk factors for hypertension[10]. A study by Lima et al.[11], analyzing data from the Cardiovascular Risk Study in Adolescents (ERICA), found a hypertension prevalence of 8% in this age group. Furthermore, research conducted in India reported that adolescents with overweight or obesity are more likely to develop hypertension than those with normal weight[12]. Low aerobic capacity has also been associated with higher body mass index (BMI)[13–15], elevated body fat percentage[16], increased waist circumference[15,17,18], and a greater risk of cardiovascular issues[19]. Given these risks, health guidelines recommend that adolescents engage in at least 60 minutes of moderate-to-vigorous physical activity daily to promote overall health benefits[20,21]. However, despite these recommendations, the prevalence of physical inactivity among Brazilian adolescents is alarmingly high, reaching approximately 84%[22].

Participation in school-based sports programs, particularly extracurricular activities, represents a valuable opportunity to promote health and meet physical activity recommendations[20]. These activities not only increase energy expenditure[23] and help prevent excess body fat[24], but also extend the time dedicated to physical exercise[25,26], contributing to healthier cardiovascular and metabolic parameters[27,28]. Studies indicate that adolescents involved in extracurricular sports demonstrate better aerobic capacity and a lower prevalence of unfavorable body composition indicators[29–31]. Despite strong evidence supporting these benefits, the association between extracurricular sports participation physical fitness in school adolescents remains incompletely understood. This study provides a novel contribution by examining this relationship in Brazilian adolescents, an area with limited data. The findings may be particularly relevant for health professionals in school settings, providing evidence to support the promotion of physical activity among adolescents. Therefore, this study aims to examine how engagement in extracurricular sports relates to aerobic capacity and body composition in this population. We hypothesize that participation in extracurricular sports is

associated with better aerobic capacity and more favorable body composition among school adolescents.

Materials and Methods

Study Design

This is an observational cross-sectional study based in a school setting. The study was conducted between August and December 2017 at a private school in the city of Natal (Capim Macio neighborhood), Rio Grande do Norte (RN), Brazil. We chose this private school due to its extensive opportunities for extracurricular sports activities during the after-school period, as well as the institution's investment in athlete formation, with students competing in local, regional, and national tournaments. The study was conducted in accordance with the Declaration of Helsinki and Resolution 466/2012 of the Brazilian Health Council, with approval from the Institutional Ethics Committee (Protocol No. 2.198.883/2016). The study followed the STROBE guidelines for observational studies[32].

Participants

Study participants were recruited from a private school in Natal, RN (Facex College). This institution offers various sports modalities in the after-school period. Participants were recruited through the direct dissemination of the study in the classrooms. Adolescents who composed the sample met the following inclusion criteria: enrolled in the 6th to 9th grade of elementary school; aged between 11 and 16 years; no physical disabilities that would prevent participation in physical tests; properly completed and signed assent and consent forms. The exclusion criteria were voluntary withdrawal and failure to complete the physical assessments. During the data collection period, there were 309 students enrolled in the morning shift of elementary school at this institution within the target age range. Of these, only 143 students volunteered, were eligible, and provided assent to participate in the study. A total of 132 participants (43% of the target population) were included in the study analysis (Figure 1).

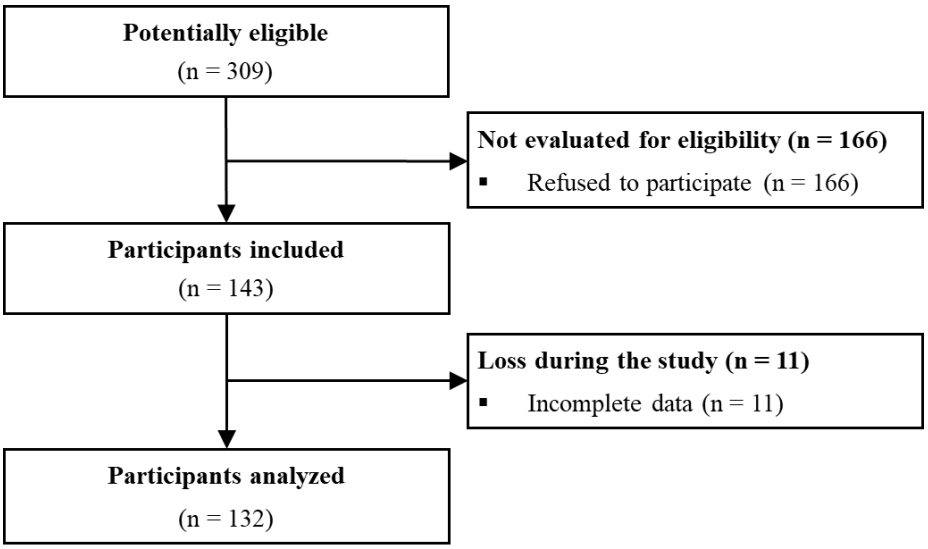

Figure 1 - Flowchart of the study sample.

Procedures

The data were collected on the school premises, which have a space for physical assessment and a covered sports court. Data collection took place in the morning, from 8:00 a.m. to 12:00 p.m. All data collection was performed by a team of properly trained researchers, following ethical considerations and methodological protocols recommended for observational studies. After team training and recruitment, the volunteers underwent a data collection process divided into different stages. Initially, participants completed the questionnaires in person and face-to-face with the evaluator, providing information about age, gender, and school year through the Anamnesis questionnaire, in addition to filling out the Physical Activity Readiness Questionnaire (PAR-Q)[33]. Next, they completed the Physical Activity Level and Sedentary Behavior Questionnaire for Adolescents[34]. Subsequently, participants underwent an anthropometric examination, which measured body mass, height, trunk-cephalic height, and skinfold thickness. Finally, participants performed the progressive maximum effort run test (20-meter shuttle run, as per the protocol of Léger and Lambert[35]).

Extracurricular Sports Participation

Extracurricular sports participation was assessed using the Physical Activity Level and Sedentary Behavior Questionnaire for Adolescents, a validated and reliable instrument for Brazilian adolescents[34]. The questionnaire includes a list of physical activities related to sports and leisure, represented by pictures, divided into four categories: sports activities supervised by a professional; active and sedentary leisure activities, separated by weekdays and weekends; school commuting activities (e.g., walking to school); and activities performed at school,

divided into physical education classes and free time/recess. Extracurricular sports participation was considered when the participant had been practicing for at least 3 months, as estimated by the question: “How long have you been practicing sports?”. Participants were categorized as “extracurricular sports participants” if they engaged in any individual and/or team sport activity after school hours at least twice a week. Individuals who did not participate in any sports or did not meet the required duration of practice were classified as “non-sports participants”.

Body Composition

Body mass and height were measured using a mechanical scale with an integrated stadiometer (Welmy®, W300, Brazil). Body mass index (BMI) was calculated as the ratio of body mass (in kg) to height (in meters) squared (kg/m2). The BMI z-score for each participant was classified according to age and sex into healthy weight, overweight, or obesity[36]. The age- and sex-specific reference criteria from FitnessGram® were used to classify BMI into the healthy and unhealthy fitness zones[37]. Body fat percentage (BF%) was estimated using the skinfold technique, with the use of a scientific caliper (Cescorf®, Porto Alegre, Brazil). Skinfold measurements for the triceps and calf were taken following the procedures described earlier[38]. The BF% estimate was calculated by summing the skinfolds (ΣSF = triceps + calf) and applying the equations from Slaughter et al.[39]. Boys: BF% = 0.735 (ΣSF) + 1.0. Girls: BF% = 0.610 (ΣSF) + 5.1. Where Σ2SF = the sum of the skinfolds. The age- and sex-specific reference criteria from FitnessGram® were used to classify BF% into the healthy and unhealthy fitness zones[37].

Aerobic Capacity

Aerobic capacity was assessed through the 20-meter shuttle run test[35]. This test was conducted on the school’s covered sports court. The protocol consisted of individual 20-meter round-trip runs, during which the speed was controlled by the audio of a metronome. The initial speed was 8.5 km/h, with an increase of 0.5 km/h every 1 minute. The test was performed until voluntary exhaustion or if the participant failed to maintain the speed set by the metronome, falling behind the 20-meter line twice consecutively. Participants were verbally encouraged to continue exercising for as long as possible. The test was administered in groups of five participants per class, with one evaluator for each participant. The number of laps, total distance (m), and maximum speed (km/h) were recorded at the end of the test. Maximal oxygen consumption (VO_2max) was estimated using the equation from Mahar et al.[40], which includes data on the number of laps completed, age, sex, and BMI. The FitnessGram® reference criteria

were used to classify VO2max into healthy or unhealthy fitness zones according to sex and age[37].

Other Variables

Other variables, such as age, sex, school grade, and pubertal stage, were used to characterize the sample or as confounding variables (covariates). These data were obtained through the anamnesis questionnaire and standardized measurements. Pubertal stage was assessed through the peak height velocity (PHV), using anthropometric data[41]. Each participant was classified as prepubertal, pubertal, or postpubertal.

Statistical Analysis

The normal distribution of the data was assessed using the Shapiro-Wilk test and scatter plots. Continuous data were presented as mean ± standard deviation (SD), and categorical data as absolute frequency (n) and relative frequency (%). One-way ANOVA and Fisher's exact test were used for bivariate analyses. Poisson regression with robust variance was used to analyze the prevalence ratio (PR) and its 95% confidence intervals (CI), both crude and adjusted, for each fitness outcome (aerobic capacity, BMI, and BF%) in the unhealthy zone between extracurricular sports participants and non-participants. For the adjusted analysis, independent variables associated with each dependent variable in the bivariate analysis ($P<0.10$) were included as covariates. The independent variables tested as confounding factors were age, sex, and pubertal stage. The inclusion of the covariate in the model was based on the Wald test and model fit. Since an association was observed only with the aerobic capacity outcome, multiple models were created, adjusting the analysis for body composition outcomes. Due to multicollinearity between BMI and BF%, two distinct models were established with different predictors of aerobic capacity: Model 1: age, sex, pubertal stage, and BMI. Model 2: age, sex, pubertal stage, and BF%. The model fit quality was assessed using the Omnibus test. A P-value < 0.05 was considered statistically significant. The analyses were performed using IBM SPSS Statistics for Windows/v.27.0 (IBM Corp., Armonk, NY).

Results

The characteristics of the participants are described in Table 1. A total of 65.9% of adolescents engage in extracurricular sports, while 34.1% do not participate. Among those involved in sports, 66 (75.9%) practice team sports, 11 (12.6%) participate in individual sports, 29 (33.3%) engage in martial arts, and 29 (33.3%) take part in two or more sports modalities.

Most participants are male (56.8%), with 29.5% in the prepubertal stage, 60.6% in the pubertal stage, and 9.8% in the postpubertal stage. Regarding body composition, 58.3% have normal weight, while 26.5% are overweight and 15.2% are classified as obese. Comparing adolescents who participate in extracurricular sports with non-participants, those engaged in sports exhibit higher VO_2max levels and lower BF% ($P < 0.05$).

Table 1 – Characteristics of study participants.

	Total	Non-sports participants	Sports participants	*P value*
N	132	45 (34.1)	87 (65.9)	
Sex				
Female	57 (43.2)	24 (53.3)	33 (37.9)	0.099
Male	75 (56.8)	21 (46.7)	54 (62.1)	
Age, years	12.6 ± 1.2	12.7 ± 1.3	12.5 ± 1.2	0.362
Grade				
6th grade	34 (25.8)	11 (24.4)	23 (26.4)	0.485
7th grade	44 (33.3)	12 (26.7)	32 (36.8)	
8th grade	29 (22.0)	13 (28.9)	16 (18.4)	
9th grade	25 (18.9)	9 (20.0)	16 (18.4)	
Pubertal stage				
Prepubertal	39 (29.5)	11 (24.4)	28 (32.2)	0.091
Pubertal	80 (60.6)	26 (57.8)	54 (62.1)	
Postpubertal	13 (9.8)	8 (17.8)	5 (5.7)	
BMI, kg/m^2	20.8 ± 3.7	21.1 ± 4.4	20.7 ± 3.2	0.620
BMI				
Normal	77 (58.3)	28 (62.2)	49 (56.3)	0.453
Overweight	35 (26.5)	9 (20.0)	26 (29.9)	
Obesity	20 (15.2)	8 (17.8)	12 (13.8)	
Body fat, %	25.0 ± 8.8	27.4 ± 9.1	23.8 ± 8.5	0.027
Shuttle run test, laps	40.9 ± 20.4	29.4 ± 15.2	46.8 ± 20.2	<0.001
Shuttle run test, km/h	10.8 ± 1.2	10.1 ± 0.9	11.2 ± 1.1	<0.001
Shuttle run test, m	818 ± 407	588 ± 303	937 ± 404	<0.001
VO_2max, ml/kg/min	45.5 ± 6.6	42.2 ± 6.3	47.2 ± 6.0	<0.001

The values are expressed as mean ± standard deviation (SD) for continuous variables and absolute (n) and relative (%) frequency for categorical variables. BMI, body mass index; VO2max, maximal oxygen consumption.

The prevalence of unhealthy aerobic capacity, BMI, and BF% in the total sample was 23.5% (n = 31), 31.8% (n = 42), and 47.7% (n = 63), respectively. Figure 2 illustrates the prevalence of these indicators among extracurricular sports participants and non-participants. Adolescents who participated in sports had a significantly lower prevalence of unhealthy aerobic capacity compared to non-participants (14.9% vs. 40.0%, $P < 0.05$). However, no significant differences were found in BMI and BF% between groups ($P > 0.05$).

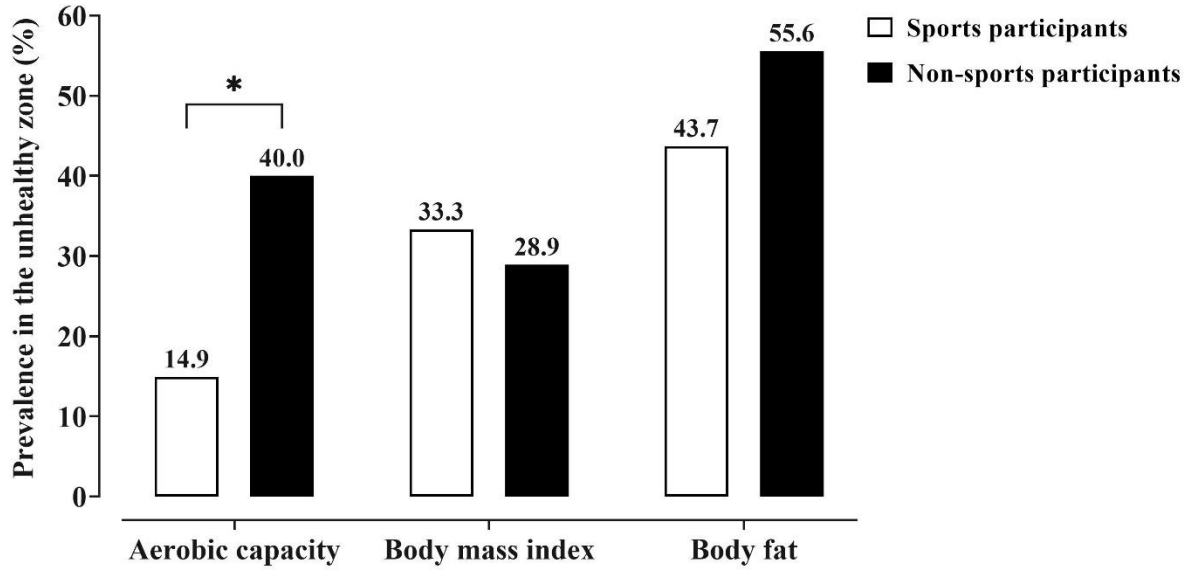

Figure 2 – Prevalence of unhealthy aerobic capacity, body mass index, and body fat percentage among adolescents participating in extracurricular sports (n = 87) and non-participants (n = 45). Significant difference between groups at $P < 0.05$.

Table 2 presents the prevalence and crude PR for unhealthy aerobic capacity, BMI, and BF% among extracurricular sports participants and non-participants. Adolescents who did not participate in sports had a significantly higher PR for unhealthy aerobic capacity (PR = 2.68; P = 0.002). However, no significant associations were found between sports participation and BMI or BF% (P > 0.05).

Table 2 – Prevalence and crude prevalence ratio of unhealthy aerobic capacity, body mass index, and body fat percentage among adolescents participating in extracurricular sports (n = 87) and non-participants (n = 45).

	Healthy	Unhealthy			
	n (%)	*n* (%)	*P value*	PR	(95% CI)
	Aerobic capacity				
Non-sports participants	27 (60.0)	18 (40.0)	0.002	2.68	(1.45; 4.96)
Sports participants	74 (85.1)	13 (14.9)			
	Body mass index				
Non-sports participants	32 (71.1)	13 (28.9)	0.608	0.87	(0.50; 1.50)
Sports participants	58 (66.7)	29 (33.3)			
	Body fat percentage				
Non-sports participants	20 (44.4)	25 (55.6)	0.183	1.27	(0.89; 1.81)
Sports participants	49 (56.3)	38 (43.7)			

The values are expressed as absolute frequency (n), relative frequency (%), prevalence ratio (PR), and 95% confidence interval (CI).

Table 3 presents the adjusted PR for unhealthy aerobic capacity among extracurricular sports participants and non-participants. In Model 1, sports participation remained significantly associated with aerobic capacity even after adjusting for BMI and other known confounders (PR = 2.59; P < 0.001). Similarly, in Model 2, this association persisted after adjusting for BF% and additional covariates (PR = 1.97; P = 0.015). All multiple models showed good fit, with P < 0.001 in the Omnibus test.

Table 3 – Adjusted prevalence ratio for unhealthy aerobic capacity among adolescents participating in extracurricular sports (n = 87) and non-participants (n = 45).

	Model 1			Model 2		
	PR	(95% CI)	*P value*	PR	95% CI	*P value*
Non-sports participants	2.59	(1.53; 4.40)	<0.001	1.97	(1.14; 3.40)	0.015
Sports participants	1.00	Reference		1.00	Reference	

The data are presented as prevalence ratio (PR) and 95% confidence interval (CI). Model 1: Adjusted for age, sex, pubertal stage, and body mass index. Model 2: Adjusted for age, sex, pubertal stage, and body fat percentage.

Discussion

This study aimed to analyze the association between engagement in extracurricular sports, aerobic capacity, and body composition in school adolescents. The main findings were: (i) a high prevalence of inadequate aerobic capacity (23.5%), unhealthy BMI (31.8%), and excessive body fat (47.7%) was observed; (ii) 65.9% of adolescents participated in extracurricular sports, while 34.1% did not; (iii) non-participants exhibited a higher prevalence of inadequate aerobic capacity compared to their peers, regardless of body composition; and (iv) extracurricular sports participation was not associated with excess weight or body fat in this population.

Regarding the high proportion of adolescents participating in extracurricular sports observed in our sample, this finding may be explained by the fact that they study in a private educational institution. In Brazil, private schools generally offer a wider range of sports activities and greater structural support for physical exercise, which can facilitate students' engagement in extracurricular sports. This is consistent with studies indicating that adolescents in higher socioeconomic contexts tend to have greater access to structured physical activities[42]. Additionally, research suggests that socioeconomic conditions influence sports participation, with young individuals from more affluent areas engaging in sports more frequently[43]. A Brazilian study involving a cohort of 4,350 youths reinforces this scenario, showing that boys from private schools are 38% more likely to participate in individual sports than those from other educational settings[44]. Access to sports activities plays a crucial role in increasing physical

activity levels among adolescents, helping them meet the daily recommended amount of physical activity for this age group[20]. Therefore, it is essential for both public and private policies to encourage and promote sports participation in schools and communities, ensuring that adolescents have access to these opportunities and foster a physically active and healthy lifestyle.

Adolescents who did not engage in extracurricular sports exhibited a higher prevalence of unhealthy aerobic capacity compared to their peers involved in physical activities, regardless of body composition, as this association persisted even among those with normal weight. Similar findings have been reported in previous studies[29–31,45]. This is concerning, as low aerobic capacity is linked to elevated blood pressure levels[10] and a significantly higher cardiovascular risk[19]. Additionally, data show that 53.3% of Brazilian adolescents have insufficient aerobic capacity[8], underscoring the need for interventions that promote physical activity. Organized sports during childhood and adolescence play a critical role in enhancing physical fitness and supporting overall health. Adolescents who participate in physical activities show better cardiovascular and metabolic outcomes than their peers who do not[27,28]. The positive impact of engaging in sports during adolescence extends into adulthood, fostering the development of individuals who remain physically active with a reduced risk of cardiovascular and chronic diseases[46–49]. Therefore, encouraging involvement in such activities not only yields immediate health benefits for adolescents but also has long-term advantages, emphasizing the importance of promoting sports both in schools and in their broader social contexts.

We found no significant association between extracurricular sports and body composition in the sample of private school adolescents. Previous studies on the relationship between BMI in the unhealthy zone among participants and non-participants in sports have yielded conflicting results[29–31]. Additionally, we did not identify studies that specifically investigated BF% as an outcome. Among the studies that focused on BMI, two reported a higher prevalence of unhealthy BMI among adolescents who did not engage in sports compared to those who did[29,30]. However, Miodutzki and colleagues observed no significant difference in BMI prevalence between the two groups[31]. In contrast, all studies consistently indicated a higher prevalence of unhealthy aerobic capacity among non-participants compared to those who engaged in sports activities[29–31]. Although no significant differences were observed in BMI and BF% between groups, there was a notable difference in the prevalence of unhealthy BF% — 43.7% in the sports participants group versus 55.6% in the non-sports participants group. This difference, although not statistically significant, may indicate clinical relevance, suggesting that

participation in sports might contribute to healthier body fat levels, even if it does not directly affect BMI. Given the strong links between body composition and health risks[10,12], these findings reinforce the importance of encouraging sports participation, which can help meet physical activity guidelines and promote long-term health benefits for adolescents, including those with excess weight. Moreover, the positive effects of sports participation during adolescence can extend into adulthood, even in individuals with obesity[46].

This study has several limitations that should be considered. First, it relied on a convenience sample from a single private school in a middle-to-high socioeconomic area of Natal/RN, which limits the external validity and prevents the generalization of the findings to all adolescents, particularly those from public schools. Second, body fat was measured using the skinfold caliper technique, which, although validated for this purpose, is not considered the most precise indirect method. Lastly, due to the cross-sectional design, it is not possible to establish causality or a dose-response relationship. Despite these limitations, this study is one of the first to explore the association between extracurricular sports participation and both aerobic capacity and body composition in adolescents from a private school, offering valuable insights into the health of this population. Furthermore, the findings could help promote sports activities within school contexts by emphasizing the importance of extracurricular physical activity for adolescents' health. Based on our results, we recommend conducting longitudinal observational studies and randomized controlled trials to better understand the impact of extracurricular sports participation on physical fitness among school-aged adolescents.

Conclusion

In conclusion, school adolescents who participate in extracurricular sports had a lower prevalence of unhealthy aerobic capacity compared to their non-participating peers, regardless of body composition. However, extracurricular sports participation was not associated with excess weight or body fat in this population. Therefore, the results of this study suggest that school-aged adolescents should be encouraged to engage in sports activities to improve and/or maintain healthy aerobic capacity.

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