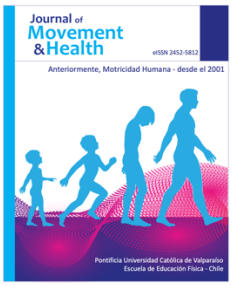
Journal of Movement and Health 2025,22(2):1-12.

DOI: https://doi.org/10.5027/jmh-Vol22-Issue2(2025)art259



eISSN: 2452-5812
http://jmh.pucv.cl/

Received: 08/04/2025
Accepted: 04/06/2025
Available: 24/06/2025
Published: 01/07/2025

Original article

Boosting health and fitness: The power of attendance in Physical Education classes

Impulsando la salud y el bienestar: El poder de la asistencia en las clases de Educación Física

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Abstract

Aim: To investigate the association between children's attendance in physical education (PE) classes at school and a score of health-related physical fitness (Z-HPF), and to describe the proportion of children and adolescents who increased physical fitness scores. **Method:** Descriptive association study with a quantitative approach, developed with 294 children (aged 6 to 12 years). PE classes were conducted three times a week, and attendance was quantified based on school attendance records. Physical fitness was assessed according to the Brazil Sport Project (PROESP-Br protocol). To quantify body composition, the skinfold thickness sum was performed, and body mass index (BMI) was calculated. **Results:** Those with higher attendance achieved better results in cardiorespiratory fitness and abdominal strength tests. The Z-HPF was better for those with higher attendance. 42.7% of children with high attendance in PE classes improved health-related physical fitness, compared to 22.6% in the low attendance group. **Conclusion:** Students who consistently attend PE classes demonstrate greater protection across various components of health and physical fitness.

Keywords: physical fitness; adolescents; cardiorespiratory fitness; muscular strength; body composition.

Resumen

Objetivo: Investigar la asociación entre la asistencia de los niños a las clases de educación física (EF) en la escuela y una puntuación de aptitud física relacionada con la salud (Z-HPF), así como describir la proporción de niños y adolescentes que mejoraron sus puntuaciones de aptitud física. **Método:** Estudio descriptivo de asociación con enfoque cuantitativo, desarrollado con 294 niños (de 6 a 12 años de edad). Las clases de EF se realizaron tres veces por semana, y la asistencia se cuantificó a partir de los registros escolares. La aptitud física se evaluó de acuerdo con el Proyecto Esporte Brasil (protocolo PROESP-Br). Se realizó la suma de pliegues cutáneos y se calculó el índice de masa corporal (IMC). **Resultados:** Aquellos con mayor asistencia obtuvieron mejores resultados en las pruebas de aptitud cardiorrespiratoria y fuerza abdominal. El Z-HPF fue mejor para quienes tuvieron mayor asistencia. El 42,7% de los niños con alta asistencia a las clases de EF mejoraron su aptitud física relacionada con la salud, en comparación con el 22,6% del grupo con baja asistencia. **Conclusión:** Los estudiantes que asisten de manera constante a las clases de EF demuestran una mayor protección en diversos componentes de la salud y la aptitud física.

Palabras clave: aptitud física; adolescentes; aptitud cardiorrespiratoria; fuerza muscular; composición corporal.

DOI: https://doi.org/10.5027/jmh-Vol22-Issue2(2025)art259

Highlights

- Consistent attendance in PE classes leads to better physical fitness outcomes in children.
- 42.7% of children with high PE attendance improved their health-related physical fitness.
- More physical education attendance improves cardio and core strength.

Introduction

Physical fitness is a powerful health marker in children[1]. This multifaceted concept, encompassing various physical capacities, plays a crucial role in children's development. It influences their ability to perform everyday tasks essential for health as well as their participation in sports and physical activities aimed at enhancing performance[2]. In this context, physical education (PE) plays a pivotal role in the comprehensive development of physical fitness, encompassing various components such as strength, flexibility, agility, cardiorespiratory fitness (CRF), and resistance capacities. Additionally, PE offers valuable opportunities to develop healthy habits from an early age[3–6].

Moreover, physical fitness is closely associated with direct health markers such as insulin levels, glucose regulation, metabolic indicators, and cardiovascular health[7,8]. Studies suggest that higher physical fitness levels correlate with better overall health outcomes[1,7,8]. Additionally, it is well-established that physical fitness, particularly its cardiorespiratory components, can contribute to improvements in cognition and learning[9,10]. Physical fitness serves as an important mediator between moderate to vigorous physical activity and performance on cognitive tests[11].

Within this context, students' attendance during PE classes assumes a fundamental role in promoting regular physical activity and fostering overall physical fitness, health and well-being[4,6,12]. Understanding the intricate relationship between class attendance and health-related physical fitness holds paramount importance in refining school PE programs and contributing to the formation of healthier individuals[13].

Previous Brazilian studies have indicated associations between students' attendance in PE classes and indicators of health/development, such as physical activity and sedentary behavior, as well as socioeconomic status and obesity[14,15]. The evidence about attendance and physical fitness in Brazil, such as strength, CRF, flexibility, and body composition, is scarce and remains a gap to be fulfilled[5,13].

Considering the available scientific evidence on the importance of physical fitness for the integral development of students, it is relevant to recognize the advances brought by the Base Nacional Comum Curricular (BNCC) in valuing Physical Education as a mandatory component of school education[16–18]. The document highlights fundamental aspects such as socialization, citizenship, and respect for diversity, significantly contributing to a broader and more humanistic approach to the discipline. However, it is noted that the BNCC could further enhance its formative potential by more explicitly incorporating health promotion through physical fitness, recognizing it as an essential dimension of the bodily experience in the school environment.

Nonetheless, although the BNCC emphasizes these fundamental elements, there is an opportunity to further expand its scope by explicitly including health promotion through physical fitness in schools[16]. This expansion could reinforce Physical Education as a space for social and civic development, as well as an important instrument for promoting students' health and well-being [19–21].

Thus, pedagogical practices in Physical Education that adopt a broad and humanistic approach are important for the integral development of students. Moreover, the application of concrete strategies aimed at developing health-related physical fitness contributes to a more

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meaningful and comprehensive education[1]. In light of these considerations, the primary objective of our study was (a) to investigate the association between children's attendance in school PE classes and a health-related physical fitness score considering one scholar year, and (b) to describe the proportion of children and adolescents that increased physical fitness scores relative to the proportion of attendance in PE classes.

Methods

Study Design and Ethical Procedures

This descriptive, association-based study with a quantitative approach was conducted in a municipality in Santa Catarina, a state in southern Brazil. The research aimed to evaluate physical fitness levels and analyze attendance rates (low or high) in final evaluations of PE classes after one academic year, concluding in December 2019. All ethical guidelines outlined in the Helsinki Declaration (World Medical Association, 2013) were strictly adhered to. Parents and students signed free and informed consent forms, and both provided assent, as required by existing school documentation. Individual reports on physical assessments were distributed to students and parents at the end of the 2019 school year. The study and its methodologies were approved by the National Research Ethics Committee (CEP) through the Estácio de Sá University Center.

Population and Sample

The target population for this study was estimated at approximately 800 participants. A convenience sample of 294 children aged 6 to 12 years was selected, aligning with the objective of enhancing the PE program to promote improved physical fitness and health outcomes in early elementary school grades (1st to 5th). The minimum required sample size was determined using G*Power software, applying statistical correlation test equations with a low to moderate effect size (r = 0.2 to 0.5), a statistical power of 0.80, a 5% margin of error, and up to six predictors.

School Physical Education Context

The school environment included a sports court, five classrooms for the lower grades (1st to 5th), and a playground, which served as the primary location for PE classes. The PE curriculum was implemented in accordance with the state laws of Santa Catarina and the Brazilian National Common Curricular Base[22]. PE classes were taught across 10 groups of initial years (grades 1–5) by a single teacher with seven years of teaching experience. Each class had 18 to 33 students and was held three times per week for 45 minutes per session. Five classes were held in the morning and another five in the afternoon.

Due to limited physical space within the school, PE classes alternated between three teachers sharing a single sports court. The initial grades accessed the court every other week; on alternate weeks, it was used by upper grades and high school students. When access to the sports court was unavailable, alternative spaces were utilized, including a covered area in the schoolyard for motor skills circuits, classrooms for gymnastics lessons, and occasionally outdoor settings (with prior parental consent). These outdoor activities included walks, guided runs, athletics, and physical exercises conducted in plazas and streets within the neighborhood. The overarching goal of the PE the present school program for the initial grades was to enhance students' health indicators while fostering improvements in physical capacities, motor coordination, physical fitness, and psychomotor learning. It is only a piece of the curriculum of BNCC, and here it is the main focus. The program emphasized teaching and learning different aspects of human body culture, alongside conceptual elements such as the importance of health,

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physical activity, respect, and sports discipline. The detailed content of the PE classes is presented in Table 1.

Table 1. General Project: Physical Education Planning for Grades 1 to 5, Academic Year 2019.

Category of Content	Objectives
Conceptual Objectives	Develop the ability to understand the body's location in the physical space it occupies. Know how to identify body parts and the movements they perform. Improve and develop the sense and understanding of laterality. Understand the importance of performing body movement for one's own development as a human being. Perceive the importance of teamwork. Know how to differentiate what is a sport, a physical activity, a dance, a fight, a game, a joke, a competition, a cooperation activity. Understand and apply the rules combined during PE classes. Develop the ability to make practical decisions. Know the basic relationships of physical activity, physical exercise, and health with body self-care (notions of hygiene and personal care). Know and know how to differentiate different sports materials and spaces, and or the performance of physical activity practices and the different manifestations of the body culture of human movement. Understand in a basic way what are the anthropometric measures and physical fitness related to health (3, 4 and 5 years).
Procedural Objectives	Execute the basic motor skills and abilities required in PE classes. Know how to practice physical activity and physical exercises regularly aiming at maintaining and developing physical fitness. Know how to play, cooperate and compete in the activities proposed in PE classes according to age groups. Learn to combine basic motor and/or sports skills with complex and pre-sports skills (3, 4 and 5 years) in the sense of participating in collective and individual sports.
Attitudinal Objectives	Understand the feeling/emotion of knowing how to win, lose, compete and cooperate. Respecting all colleagues involved in practice. Know how to follow the rules and procedures defined in the group. Understand your individual role within the team. Your duties and responsibilities. Take care of the materials and goods used by the school and in PE classes. Respect colleagues, teachers and other members of the school community. Improve and develop attitudes of valuing friendship, affection and affection with colleagues, teachers and family. Value and know the importance of performing body movement during physical activity, sport, physical exercise and the different expressions of body culture of movement.
Main Objects of Knowledge/Content	Games with body movement / pre-sports/ mini-games. Traditional body movement games. Jokes. Fights. Rhythms and gymnastics. Relays. Contests. Circuits. Strength training. Flexibility training. Cardiorespiratory training. Jumping jacks. Wheel games. Sports techniques. Sports games. Physical activity and health. The importance of sport for life. Anthropometric and physical fitness evaluations (battery of tests from the Brazil Sport Project).
Main Skills	Walking, running, jumping, throwing, holding, launching, kicking, hitting targets, squatting, balancing, changing direction in motion. Complex motor skills (3, 4, 5 years): Running driving balls with feet; kicking and running; throwing and rebounding with feet and hands; squatting and jumping; running and bouncing balls with hands; running, jumping, throwing and launching in sequence; running and changing direction several times; walking/running forward and backward driving balls through bounce with hands or using touches with feet; running and kicking statistical implements; hitting moving targets through kicks, rebounds, throws, launches and touches with hands; knowing how to manipulate objects with hands and feet in various directions modes and techniques; knowing how to jump and hold implements. Physical fitness: cardiorespiratory, muscle endurance, flexibility.

Measurements

PE attendance: At the end of the school year, attendance in PE classes was quantified based on school attendance records maintained throughout the academic year. A 70% attendance rate was established as the cut-off to categorize students as having either high or low PE attendance. This threshold is considered pedagogically appropriate within this specific

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school environment, as it ensures that students maintain adequate levels of learning, focus, and comprehension across various subjects and disciplines[23].

Physical fitness: Was evaluated according to the procedures adopted by *Projeto Esporte Brasil* (PROESP-Br)[24]. The CRF was obtained from the walking and running test around the volleyball court for 6 minutes, the test result being the number of laps taken by the students multiplied by the measurement of the court's perimeter, plus the meters of stop at the end of the test. The BMI was determined by first measuring height using a wall-mounted tape measure, with participants standing barefoot, erect, and ensuring their buttocks, heels, and the back of their skull touched the wall. Body mass was measured using a digital scale with a precision of 0.01 kg (Omron HBF-226 - Supports from 2.0 to 150 kg with 0.1 kg increments). BMI was then calculated by dividing body mass (kg) by the square of the height (meters). The flexibility test was performed using the sit-and-reach method. This test measures the flexibility of the lower back and hamstring muscles and the result was given in centimeters. The abdominal strength test was performed by counting the number of abdominal crunches performed in one minute. This test measures the strength and endurance of the abdominal muscles.

Sum of Skin Folds (SSF): Skin folds were measured twice consecutively, adopting the average of the two and a tolerable error of 5% between measurements. This was done according to pre-established protocols[25]. The triceps fold was obtained in the posterior portion of the arm, intermediate region between the distal edge of the acromion and prominence of the olecranon[25]. The leg skin fold, obtained in the medial portion of the calf, with the knee flexed at 90 degrees, in the central region between the femur's trochanter and medial malleolus, both measured on the right side and noted in millimeters. The sum of these measurements was performed mathematically, in millimeters, to obtain the SSF[25].

Statistical analysis

The present statistical method was applied according to theoretical assumptions for studies with clinical and pedagogical purposes[26,27]. Firstly, the number of attendances in PE was calculated according to the criteria previously described, dividing the sample into two clusters, High PE Attendance with 157 students and Low PE attendance with 137 students. We carried out a descriptive exploratory analysis considering a division by PE attendance and sex, presenting means and confidence intervals for a bootstrapping of 1000 resamples.

The health-related physical fitness score was calculated through a transformation of variables into Z-scores (Z-HPF) and the subsequent sum of these, considering age and sex as adjustment variables. For this, the adjusted Z-scores of CRF, BMI (inversed), SSF (triceps and leg fold inversed), flexibility and abdominal were used, thus forming the Z-HPF. The aggregated dependent variable Z-HPF was also classified into tertiles so that we could observe possible non-parametric associations. The cut-points resulting from this tertile calculation were: Low Z-HPF < -0.44; Moderate from -0.44 to 0.44 Z-HPF, and High Z-HPF up to 0.44.

The methods used to identify the association between attendance in PE (Figure 1) were a description of the Z-HPF values of each of the participants, considering the cut-points of the high, moderate and low Z-HPF profile, with the description of the proportions in these categories in bar charts in each of the groups according to the attendances in PE, in this case for the High PE Attendance and the Low PE attendance. The chi-square test was applied to identify significant differences. The average distribution values of the Z-HPF among the PE attendance groups were compared using the delta (Δ) effect size measure and student's t-test and were also presented in a graph. All analyses were performed in IBM-SPSS software version 22.0 considering a significance level of 0.05.

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Results

The characteristics of the sample are presented in Table 2. Boys with high PE attendance are slightly older than girls with low PE attendance. Boys with high PE attendance also have a marginally higher mean body mass compared to girls with low PE attendance. Data concerning SSF suggests minimal differences in these measurements across the groups. In the CRF test, boys with high PE attendance covered the greatest distance, with a mean of 845 meters. The mean flexibility scores appear to be quite similar across all groups. Interestingly, children with high PE attendance, both girls and boys, demonstrated superior performance in the abdominal strength test. The mean BMI values showed small variation across all groups. However, the Z-HPF was slightly higher for children with high PE attendance, indicating better overall physical fitness. The remaining results of the present study are structured considering this preliminary descriptive exploration.

Table 2. Description of the Study Sample.

	Low PE Attendance				High PE Attendance			
	Girls (n=72)		Boys (n=65)		Girls (n=69)		Boys (n=88)	
Variables	**Mean**	**(95%CI)**	**Mean**	**(95%CI)**	**Mean**	**(95%CI)**	**Mean**	**(95%CI)**
Age (years)	8.40	8.03; 8.80	8.60	8.14; 9.05	9.24	8.85; 9.65	9.26	8.95; 9.59
Body mass (kg)	29.62	27.68; 31.77	31.21	28.53; 34.13	33.11	30.47; 35.81	33.65	31.75; 35.69
Triceps Skinfold(mm)	12.75	11.73; 13.92	12.96	11.42; 14.75	13.63	12.28; 14.91	12.56	11.42; 13.90
Leg Skinfold (mm)	13.33	12.08; 14.70	13.33	11.75; 15.20	14.33	12.86; 15.82	13.34	12.13; 14.79
Sum of Skinfold	26.15	23.90; 28.62	25.85	22.86; 29.23	26.93	24.22; 29.69	25.09	22.77; 27.78
CRF (meters)	760	734; 790	789	750; 828	818	785; 856	845	816; 877
Flexibility (cm)	31.08	29.63; 32.47	28.06	26.29; 29.90	31.54	29.95; 33.22	29.08	27.23; 30.74
Abdominal Strength (reps)	18.35	16.35; 20.41	20.06	18.42; 21.68	22.29	20.50; 24.39	23.28	21.48; 21.48
BMI (kg/m^2)	17.96	17.27; 18.72	18.56	17.57; 19.68	18.36	17.48; 19.35	18.35	17.66; 19.15
Z-HPF	-0.14	-0.32; 0.07	-0.22	-0.42: -0.01	0.14	-0.10; 0.39	0.16	-0.04; 0.37

PE: Physical education; reps: repetitions; BMI: Body mass index, Z-HPF: aggregate z-score of physical fitness variables adjusted by age and sex.

The findings presented in Figure 1 and table 3 revealed a substantial association between children who displayed higher attendance in PE and a superior Z-HPF. The proportion of positive individual responses to these relationships was notably higher in the group with higher attendance in PE classes (42.7% vs. 22.6%) and achieved significantly superior scores in overall physical fitness, surpassing the group with low attendance in PE by 1.89 times (with a high and significant effect X2=12.34 / p=0.001, Table 3). Moreover, these results were corroborated by the delta effect observed in the T-test between the groups, where increased attendance in PE led to higher Z-HPF (Figure 1).

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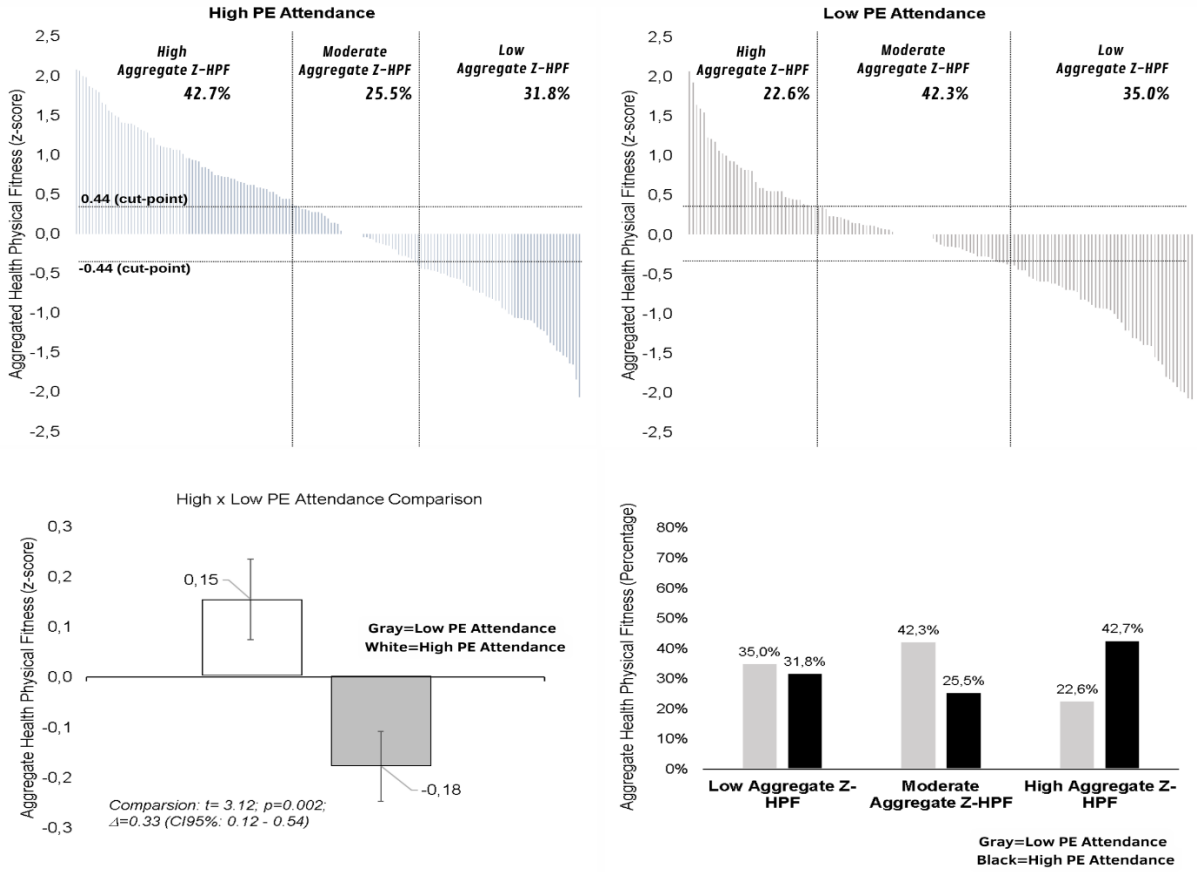
Figure 1. Associations of Physical Education Attendance with an aggregate health physical fitness z-score adjusted by age and sexes.



Z-HPF: health physical fitness z-score adjusted by age and sex; PE: physical education; Eng: Engaging; D: delta effect in T-test independent; p: significance level <0.05; t: t-test value; CI95%: confidence interval of 95%;

Table 3. Terciles categorical comparison between high and low PE attendance percentages

Terciles Categorical Comparisons							
	High PE Attendance	**N**	**Low PE Attendance**	**N**	**RP**	**X2**	**P-value**
Low Aggregate Z-HPF	31.8%	50	35.0%	48	0.91	0.20	0.649
Moderate Aggregate Z-HPF	25.5%	40	42.3%	58	0.60	8.61	0.003
High Aggregate Z-HPF	42.7%	67	22.6%	31	1.89	12.34	0.001

RP: Prevalence Ratio; X2: chi-square in contingence table test; P-value: significance level in X2 <0.05; N: absolute frequencies.

Discussion

The main findings of the present study indicated a significant relationship between children's attendance in PE and their aggregate score of health-related physical fitness. Children with higher attendance in PE classes demonstrated significantly better overall physical fitness scores compared to those with low attendance. The group with high attendance in PE showed a 1.89 times greater likelihood of achieving higher health-related physical fitness scores than the low-attendance group, indicating that 42.7% of the children and adolescents with high attendance in PE classes improved the health-related physical fitness, compared to 22.6% in the group with low attendance.

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It's essential to note the scarcity of studies specifically examining the link between attendance in PE classes and physical fitness. Although studies like those by Chen et al., 2018[28] and Coledam et al., (2018)[29] have explored related aspects, few have directly linked attendance in PE to physical fitness outcomes. Therefore, we will discuss the general sense of participation in physical activities and PE at school.

PE plays a significant role in promoting health among young people[29]. A systematic review indicate that participation in PE classes is positively associated with a variety of health-related behaviors[30]. However, unlike our study, these studies do not directly relate attendance in PE classes to physical fitness as a health parameter. Furthermore, in agreement with the present results, Chen et al., (2018)[28] suggest that components of health-related physical fitness (CRF, strength, muscular endurance, and flexibility) are directly associated with children's participation in PE classes. Tarp et al., (2018)[31] demonstrate that children with higher attendance in PE classes, encouraged by the opportunities provided by the school, exhibit higher CRF and lower BMI. This is also confirmed by other studies, indicating that participating in PE classes is associated with an increase in CRF and muscular strength[29,32]. Lee et al., (2021) have also reported positive effects on body composition and physical fitness in adolescents participating in different types of physical conditioning in school PE. However, unlike our study, and except for the work of Chen et al., (2018)[28], these mentioned articles do not provide an aggregated score to comprehensively assess the relationship between attendance in PE classes and overall physical fitness.

Participation in PE classes, including circuits of moderate to high-intensity exercises, can yield significant benefits in body composition, body fat percentage, and basic components of health-related physical fitness, such as CRF, muscular strength, muscular endurance, and flexibility[32]. It is relevant to mention that attendance and participation in PE classes tend to decrease with age[32,33]. Thus, PE classes should propose methodologies and activities that encourage active attendance and participation of students.

School PE provides a significant opportunity to improve physical fitness in childhood and adolescence[32]. An important point to consider is the intensity of PE classes, which is a relevant factor for promoting improvements in physical fitness, including CRF[34–36]. Engaging in vigorous activities in PE class, combined with motivating activities such as games, is associated with positive development in CRF[34]. It is likely that the intensity imposed by sports games leads to chronic adaptations that result in greater development of physical fitness[37].

From a public health perspective, PE classes can play a significant role in promoting health-related fitness and, therefore, improving the health of children and adolescents. Worldwide, children and adolescents lead unhealthy lifestyles and have multiple modifiable risk factors for their current and future health[38,39]. Therefore, schools and PE are key contexts for promoting healthy lifestyles, and there is a need for increased interest in health-focused activities and curricular interventions in physical education[40].

Practical applications of the findings suggest that schools, together with physical education teachers, should reinforce the culture of valuing and respecting the PE curriculum component throughout the entire school community. In addition, they should develop strategies to incorporate diverse and engaging content, ensuring that PE classes are of moderate to vigorous intensity to improve health-related physical fitness.

Strength and limitations

While these practical implications highlight important steps that can be taken within the school environment, it is also necessary to acknowledge the limitations of the present study. It is worth noting that, being a cross-sectional study, cause-and-effect relationships cannot be established. Moreover, the use of a convenience sample may restrict the generalizability of the findings to broader populations, and factors such as socioeconomic characteristics, motivation,

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and disposition of participants can influence the results. At the same time, the data analysis was based only on attendance in PE classes and did not associate participation and engagement in various activities developed in those classes as a factor. It is also important to consider that extracurricular physical activity was not accounted for and may represent a potential confounding variable, as it could contribute additional minutes of physical activity that were not included in the analysis. On the other hand, the main strength of our work is to add relevant evidence about students' attendance in PE classes and its impact on health-related physical fitness, as the existing literature on this topic is scarce, providing a starting point for future research.

Given these limitations, future studies should consider longitudinal designs to better examine causal relationships between PE attendance and improvements in health-related physical fitness. Further research should also explore contextual factors such as students' motivation, engagement during PE classes, and socioeconomic characteristics, which may influence participation and outcomes. Including measures of activity intensity and type, beyond attendance, could provide a more comprehensive understanding of how PE contributes to physical fitness. Moreover, considering extracurricular physical activity is important.

Conclusion

In conclusion, students with higher attendance in PE classes, assessed over an academic year, are also those who are more protected in terms of various components of health and physical fitness when evaluated in an aggregated health score. Similarly, children and adolescents with higher attendance in PE classes are proportionally more likely to improve health-related physical fitness compared to their peers who attend less frequently. It is thus emphasized that parents, teachers, managers and communities should foster participation in PE, motivating students and providing conditions, structure and material so that these classes can be developed with better quality in order to guarantee greater school attendance. These initiatives are very welcome in public schools in developing countries, such as Brazil and others in Latin America. All of this indicates that strengthening the engagement of students and teachers is essential to ensure regular participation in PE classes, thereby promoting improvements in health and physical fitness.

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Conflict of Interest
The authors declare no conflicts of interest related to the published article.

Statement on the Use of Generative AI and AI-Assisted Technologies in the Writing Process
The authors declare that no generative AI or AI-assisted technologies were used in the writing process.