

Strategies in physical education and their impact on student intensity, perceptions, and engagement.

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Abstract:

Purpose. Previous research indicates that physical education (PE) classes frequently fail to meet the recommended levels of moderate to vigorous physical activity (MVPA). This study aimed to compare the intensity levels achieved through different PE strategies, and, as a secondary objective, to evaluate students' perceptions of fun, motivation, and engagement. **Materials and Methods.** A total of 52 students (23 girls and 29 boys) participated in the study. The children were healthy and none of them were taking medication continuously or presented any orthopedic physical inability that would prevent them from performing the tests. All the children attended three PE classes on separate days; a recreational strategy, a circuit-based high-intensity interval training (circuit/HIIT) class, and a traditional class. All classes included games and activity content that followed the country's guidelines. Intensity levels were measured using portable heart rate (HR) monitors, and perceived exertion was assessed using the rate of perceived exertion (RPE) scale. For comparisons between each class strategy, the Kruskal-Wallis test and Dunn's test were used to identify significant differences ($P < 0.05$). Qualitative data are presented as percentages of interview responses. **Results.** All strategies led to a level of engagement in MVPA for more than 50% of the total class duration. The circuit/HIIT and recreational strategies demonstrated significantly higher proportions of time spent in MVPA compared to the traditional class ($P < 0.01$). The qualitative results showed that the recreational class received the highest number of positive responses, followed by the traditional class, while the circuit/HIIT received fewer positive responses. In addition, the RPE values aligned with the quantitative HR results, reflecting the class intensities. **Conclusion:** The circuit/HIIT strategy achieved the highest percentage (93.2%) of time in MVPA, followed by the recreational (91.8%) and traditional classes (77.6%). The results highlight the excellent percentage of time spent in MVPA in the recreational strategy, and qualitatively, the higher levels of fun, motivation, and engagement among students in this model. Thus, the recreational strategy led to excellent intensity of activity during the class, as well as positive responses in relation to the students' motivation and engagement.

Keywords: Child; healthy, heart rate; physical exertion

Introduction

The public school scenario in Brazil traditionally promotes a classroom with desks in rows, including daily hours of academic activities with students seated, passive behavior. Exceptional moments are Physical Education classes and recess periods. During these periods, sedentary behavior can or may be broken with motor activities that involve greater amounts of movement. However, in the contemporary world and with the hegemony of mobile electronic devices, such as cell phones and tablets, in our daily lives, it is very common for breaks/recesses to be spent in front of screens, which further increases immobility during school hours.

In this sense, the PE discipline can contribute to the discussion of the relations of movement and the increase in energy expenditure through practical application, the interpretation of concepts and questions, and finally in the search for transformation of the reality in which our students live. Thus, if on the one hand, the World Health Organization recommends that children and adolescents between 5 and 17 years of age perform 60 minutes of physical activity at moderate to vigorous intensity daily (WHO, 2020), on the other hand, previous studies reported that during PE classes, students remain in sitting positions for a substantial amount of time,

receiving instructions on activities and spending long periods of time in lines, while waiting to carry out the activities (Froberg et al., 2017; Hollis et al., 2017; Tanaka et al., 2018). Physical activity levels have been shown to be low across the world (Farooq et al., 2020), and are associated with an increase in obesity and the risk of chronic non-communicable diseases (Farooq et al., 2020; Mannocci et al., 2020).

In this sense, PE classes and the school setting are privileged spaces, with great possibilities for promoting positive changes in the lifestyle of children and adolescents (Hills, Dengel & Lubans, 2015; Kremer, Reichert & Hallal, 2012), and that have significant repercussions in adult life (Pangrazi & Beighle, 2019; Sierra-Díaz et al., 2019; Bento et al., 2021; Domaradzki et al., 2022; Ramer et al., 2021). Follow-up investigations over decades have provided evidence of how early motor proficiency is related to long-term physical activity (Telama et al., 2014; Lloyd et al., 2014). Thus, direct school interventions in PE classes can increase daily physical activity, as well as enhancing motor proficiency and physical fitness in children and adolescents (Adank et al., 2021; Borrego-Balsalobre et al., 2023). However, this is only effective in a dynamic and creative PE class, where children and adolescents are engaged in a motivational environment that fosters participation (Adank et al., 2021; Pangrazi & Beighle, 2019).

Although all school subjects should promote healthy activities, PE has great potential in promoting well-being habits associated with a healthy lifestyle (Sierra-Díaz et al., 2019). In addition to healthy habits and an active lifestyle, PE plays a fundamental role in the child's integral development, enabling cognitive, psychomotor, and affective development, in addition to aspects such as socialization, team spirit, and motor and sports practice (Silva et al., 2022).

However, there is no consensus in the literature on the best strategies, or types of PE programs that can achieve intensity recommendations while improving motor proficiency and physical capabilities (Domaradzki et al., 2022; Heinrich et al., 2023). Among the strategies described in the literature, High Intensity Interval Training (HIIT) stands out as an efficient alternative for increasing the intensity of classes (Bento et al., 2021; Domaradzki et al., 2022; Heinrich et al., 2023; Minatto et al., 2016; Burford et al., 2022), being characterized as a model that enhances aerobic fitness and motor performance, and improves body composition (Ingul, et al., 2018; Delgado-Floody et al., 2018; Dias et al., 2018; Cao et al., 2019; Domaradzki et al., 2022; Ketelhut et al., 2020).

On the other hand, the incorporation and maintenance of healthy habits involving physical activities in childhood and adolescence is not linked only to reaching high intensities during physical activities (Ramer et al., 2021), but also to motivational factors (Sierra-Díaz et al., 2019), such as, child autonomy in motor practices (Burford et al., 2022), and a positive social climate and experiences in physical activity (Smedegaard et al., 2016), which are part of a “virtuous cycle” that improves self-concept and promotes general well-being in childhood and adolescence. Therefore, considering only technical aspects to increase the intensity of classes is insufficient to maintain student engagement, especially when monotonous and predictable strategies are applied.

In this complex and multifactorial context, diverse strategies for PE classes are essential to create a motivational environment that fosters satisfaction and engagement during practice, especially in pediatric groups who are experiencing a time of incorporating habits that can be reflected throughout their lives (Telama et al., 2014; Lloyd et al., 2014). However, few comparative studies have examined the practical application of these strategies and their biological and/or behavioral outcomes.

The current study aims to broaden the perspective, not only in terms of increasing the intensity of PE classes, but also to value the qualitative perceptions of what is felt and perceived by students in each proposed strategy. Thus, we hope to find the best scenario for achieving the recommendations for intensity of efforts during PE classes, and additionally recognize indicators of motivation and engagement in the activities reported by children. Therefore, the aim of this study was to compare the intensity achieved, as well as the motivation and engagement of students, when using different PE class strategies.

Material & methods

Participants

This is a cross-sectional study that included students aged 8 to 10 years of both sexes, enrolled in the public schools of Parana state, Brazil. The project was approved by the Ethics Committee of the institution (CAAE: 65294322.7.0000.5398). All participants and their parents or legal guardian signed the free informed consent form. Demographic data were established based on National Association of Market Research Companies (ABEP, 2014) guidelines.

Procedure/Test protocol/Skill test trial/Measure/Instruments

Figure I present the 4 stages of data collection, including the meeting with parents, who provided authorization to participate in the study, and the pilot test performed to test the equipment and verify the applicability of each strategy. This was followed by measures of physical growth and application of the circuit/HIIT, recreational, and traditional PE class strategies. All students completed the three classes, which included quantitative monitoring of intensity, and an interview at the end of each class. All classes contained games and activity content that followed the country's guidelines (Brazil, 2018; Paraná, 2018).

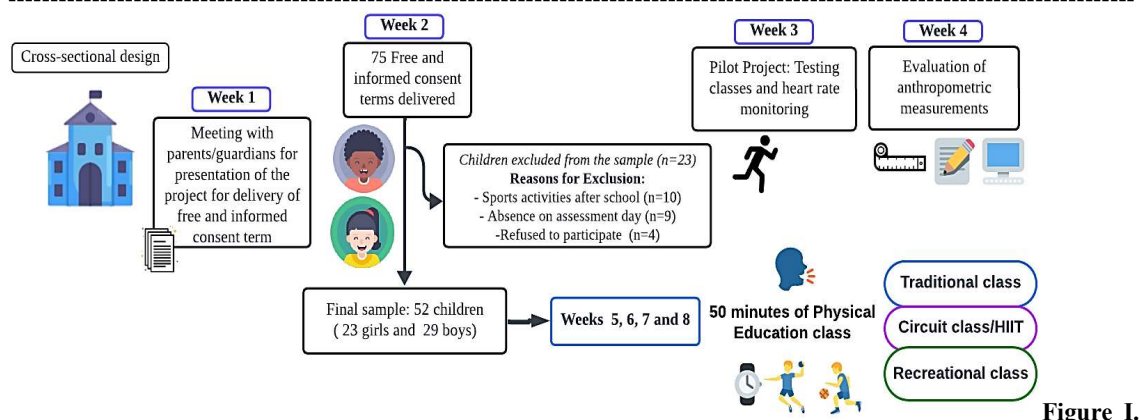


Figure I.

Data collection flowchart.

Non-inclusion criteria

The children were required to be healthy, without clinical or historical evidence of cardiovascular disease, hypertension, insulin-dependent diabetes mellitus, or neurodiversity. Any children taking medication continuously or who had any orthopaedic physical inability to perform the tests were excluded. The participants could not have participated in sports practices for a minimum of 3 months prior to the beginning the study, other than the school PE classes twice a week for 50 minutes each class.

Anthropometric measures

For the anthropometric evaluation, the children's body weight (kg) and height were measured according to the techniques recommended by Frisancho (1990). Based on weight and height data, the Body Mass Index (BMI) was determined.

Monitoring and strategies investigated for PE classes

Two strategies for PE classes were investigated and a traditional class was used as a control. The strategies were made up of a recreational model and a circuit/HIIT model, that included competitive games distributed in multicomponent stations with coordinating activities. The two strategies investigated were constructed intentionally with the objective that the classes reached moderate/vigorous intensity for at least 50% of the total time (CDC, 2013; Hollis et al., 2017).

The traditional class was structured and taught by a school teacher (JB), blind to the objectives of the study and who did not give too much importance to ensuring moderate to intense efforts. Minute-by-minute intensity monitoring was performed in all classes using a portable heart rate monitor. For each child, the predicted maximum HR (HRmax) was initially calculated using the predictive equation proposed by Tanaka and collaborators (2001) and recommended for pediatric groups (Mahon et al., 2010).

Qualitative perceptions of each class based on students' reports

Immediately after each class, the children were taken to a private room with a teacher collaborating in the study (KCSN). The children entered individually and confidentially responded to an interview. The interview asked about aspects of fun, motivation, and engagement in each class. Additionally, the interview included the perceived exertion, estimated using the 10-degree Omni scale for children (Robertson et al., 2005). For this, each participant marked, on a pictorial scale, the level of fatigue they experienced during the class (Figure II). The RPE was compared with the results of the objective assessment of the intensity of the physical effort.

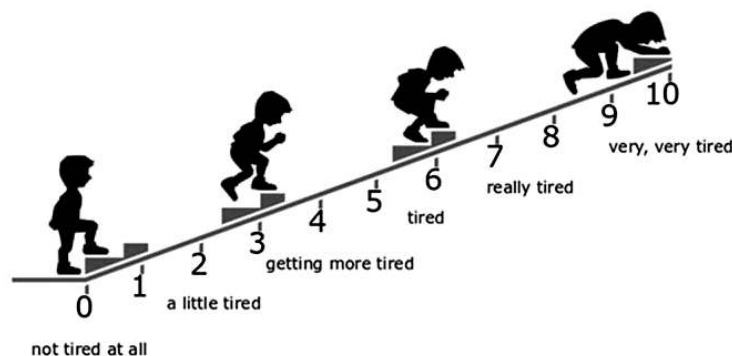


Figure II. Children's OMNI Scale of perceived exertion used in the experiment.

Quantitative evaluation of each class

The determination of intensities was quantified from the RR intervals recorded by a heart rate monitor (Polar® RS800, Kempele, Finland). Data were collected with a sampling frequency of 1000 Hz and the RR

interval records were filtered to eliminate possible noise arising from ectopic beats or device reading errors. Ectopic beats and artifacts (<3% of the recording) were checked visually and manually corrected by interpolation between the previous and subsequent beats. A single experienced evaluator filtered all measurements at all times of the study, without any information regarding the class investigated (CCS). Light intensity was considered as percentages lower than (>65% HRmax). For moderate to vigorous intensity, a range of 65 to 100% of HRmax was considered.

Statistical analysis

The data were subjected to the Shapiro-Wilk normality test and, as they did not follow a normal distribution, non-parametric statistical tests were adopted, with results expressed as median values and interquartile range. Demographic results from the ABEP questionnaire are arranged in percentage frequency by sociodemographic stratum. For comparisons between each class strategy (circuit/HIIT and recreational) and the traditional/control class, the Kruskal-Wallis's test and the Dunn test were applied to identify significant differences between the practice models, as well as in the comparisons of HR and RPE. Statistical significance was considered at 5%.

Results

In total, 52 students participated in the study, 23 females (44.2%) and 29 males (55.8%). There were no withdrawals during participation. Table I contains the general characteristics of the sample, showing that no significant differences were detected between the sexes for the physical growth variables. Thus, from a general point of view, the group of students demonstrated homogeneity in these parameters.

Table I. Distribution of anthropometric data (median and interquartile range) of the students.

	Total Sample (n=52)	Girls (n=23)	Boys (n=29)	P Value
Centesimal age (years)	9.0 (9.0-10.0)	9.1 (9.0-10.0)	9.0 (9.0-9.1)	0.22
Body weight (kg)	34.3 (30.0-41.5)	36.0 (29.0-41.3)	32.7 (30.1-47.1)	0.92
Stature (m)	1.4 (1.3-1.4)	1.4 (1.3-1.4)	1.3 (1.3-1.4)	0.97
BMI (kg/m²)	17.1 (15.8-19.7)	17.5 (15.7-20.3)	16.6 (15.8-19.8)	0.60

Mann-Whitney U test, P<0.05.

M: Median; (Q1-Q3): interquartile range.

Regarding socio-demographic aspects, table II presents data on the classification of socioeconomic stratification criteria of the study sample. The results indicated that the smallest part of the sample fell into the highest classifications (B1 and B2), with 5.8% of the sample classified as B1 and 17.3% as B2. The majority of students come from families classified as C1 (32.7%) and C2 (19.2%), and 25% of the sample were classified in strata D-E. From these data, it is considered that the sample comes from middle to low socioeconomic quadrants.

Table II: Socioeconomic stratification criteria of the study sample through the application of the ABEP questionnaire.

Classification	Frequency (n=52)	Percentage (%)
B1	3	5.8
B2	9	17.3
C1	17	32.7
C2	10	19.2
D-E	13	25
Total	52	100

Regarding the quantitative aspects of the intensity of each strategy and the traditional class, the crude values of HR and RPE were analyzed (Table III).

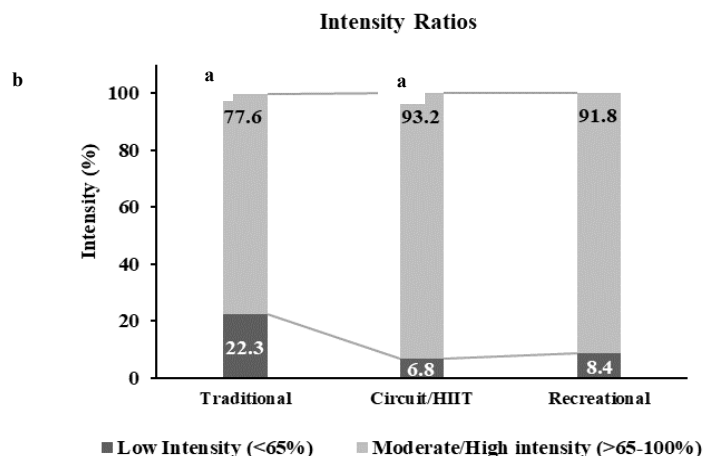
Table III: Median values and interquartile range of crude HR and RPE results (self-reported).

	Traditional	Circuit/HIIT	Recreational
HR (bpm)	155 (152 – 158) ^a	173 (167 – 177) ^b	165 (162 – 167) ^c
RPE	4 (3 – 5) ^a	10 (10 – 10) ^b	9 (8 – 10) ^b

Different letters indicate ≠ between the strategies used ($P<0.01$).

The results for both HR and RPE indicated that the traditional class demonstrated significantly lower medians when compared to the experimental circuit/HIIT and recreational strategies. No significant differences were observed between the circuit/HIIT and recreational strategies.

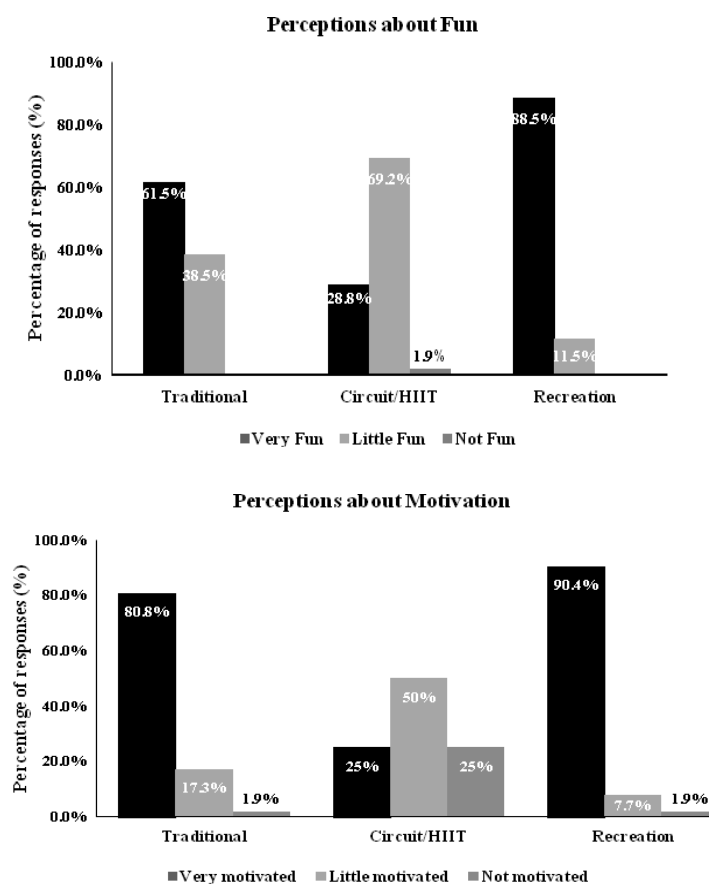
Graph I presents the percentage values of time spent in the light intensity and moderate to vigorous intensity strata for the adopted strategies and the traditional class.

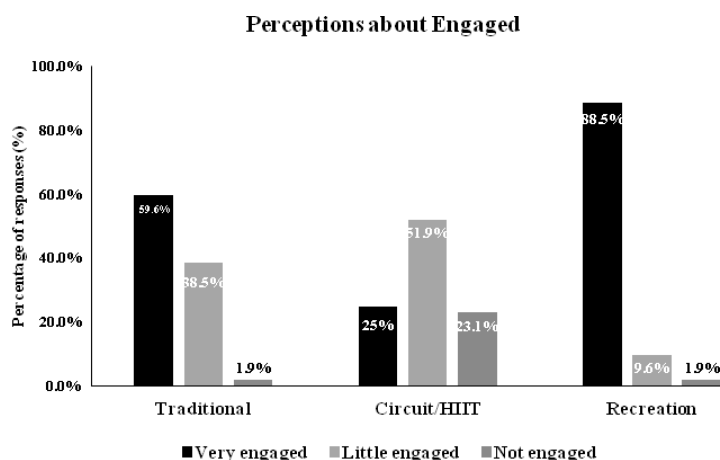


Graph I: Proportion of time of each class spent at light intensity (<65% of HRmax) and moderate to vigorous intensity (>65% of HRmax). Different letters indicate statistically significant differences ($P<0.01$).

The results indicate that the traditional class demonstrated a greater percentage of time at light intensity compared to the two strategies tested ($P<0.01$). No significant differences were found between the circuit/HIIT and recreational strategy for time spent at moderate to vigorous intensity, however both had longer times when compared to the traditional class ($P<0.01$). Additionally, it is important to report that the traditional class, despite indicating lower values in the proportion of time spent in moderate to vigorous physical activities compared to the other strategies, presented a median in this intensity stratum of 77.6%, exceeding the recommendations of 50% of the time class at moderate to vigorous intensity.

Graph II displays the qualitative analysis of students' perceptions regarding fun, motivation, and engagement respectively.





Graph II- Percentage values of fun, motivation, and engagement reported by students for each class.

The recreational model received the highest proportion of positive responses, with 88.6% of children reporting the class as fun, followed by the traditional class, which presented 61.6% of positive responses, and the circuit/HIIT model, which received only 28.8%. Regarding motivation in each class, the recreational class received 90.4% of motivated responses from students, followed by the traditional class with 80.8%, and, finally, the circuit/HIIT strategy with only 25% of motivated responses. For the circuit/HIIT strategy, 25% of the responses reported the child as not at all motivated and 50% of the children indicated little motivation for this strategy.

Considering the percentage values related to student engagement, the results show that the recreational strategy class engaged the most students, with approximately 88.6% reporting high engagement, followed by the traditional class with 58.8% engagement, and the circuit/HIIT strategy, with only 26% of positive responses regarding student engagement. The circuit/HIIT class also received a higher proportion of negative responses in relation to engagement, with 23.1% of responses reported as not at all engaged, and 51.8% declaring themselves somewhat engaged.

Discussion

The main findings of this study indicate that the circuit/HIIT strategy quantitatively achieved the highest proportion of time spent at moderate to vigorous intensity, followed by the recreational strategy and, finally, the traditional PE class. However, in the qualitative analysis, for fun, motivation, and engagement, the children responded that the recreational strategy achieved the highest positive percentages, followed by the traditional class, and then the circuit/HIIT model, which demonstrated the lowest percentages.

Corroborating our findings, Costigan and collaborators (2015) described that circuit/HIIT training has been shown to be an efficient strategy to enhance cardiorespiratory fitness and improve body composition in adolescents. For some authors, implementing the HIIT strategy in PE classes can promote learning opportunities and at the same time stimulate physical conditioning (Dudley, Weaver & Cairney 2020; Poon et al., 2023). In this sense, a recent randomized clinical trial aimed to determine the effectiveness of an HIIT program implemented during PE classes for 12 weeks (Juric et al., 2023), in which adolescents aged 10 to 15 performed 10 minutes of HIIT at the beginning of PE classes twice a week, while the control group maintained regular PE classes. The results demonstrated that, even though it was a short-term intervention, the intervention group presented significantly improved performance in the 20-meter running test (Juric et al., 2023). HIIT was also successful in enhancing cardiorespiratory fitness and aspects of body composition (Domaradzki et al., 2020). However, some authors state that PE classes should contain varied content and motor practices in order to meet other health components and expand motor vocabulary (Fröberg et al., 2017; Heinrich et al., 2023).

PE classes are an important curricular component of the lives of children and young people and can contribute to achieving the recommendations of 60 minutes of moderate to vigorous physical activity daily for children and adolescents aged 7 to 19 (WHO, 2020), in addition to providing contents inherent to the school subject. However, previous studies have shown that PE classes do not meet the recommendations of a minimum of 50% of class time being spent at moderate to vigorous intensities (CDC, 2013). In the present study, the traditional PE class demonstrated a percentage of 77.6% of time spent in moderate to vigorous activities. This finding is noteworthy, since in previous studies, traditional PE classes were not efficient in meeting these recommendations (Bento et al., 2021; Fröberg et al., 2017). These data were confirmed in a large systematic review (Hollis et al., 2017), with a meta-analytic design that included 15 investigations. The results indicated that students spend an average of 40.5% of the time in PE classes in moderate to vigorous activity. Studies using accelerometers observed an average of 34.7% of PE classes in moderate to vigorous activity, while in

observational studies the percentage was 44.4%. With direct HR measurements, the meta-analysis indicated an average of 43.1% of class time, and for studies using a pedometer, approximately 35.9% was spent in moderate to vigorous activity (Hollis et al., 2017).

Increasing the intensity of PE classes can be achieved with simple strategies added intentionally, such as reducing the transition time between activities and maximizing opportunities for students to move, for example, with a greater number of balls or other implements, increasing the activity space, and proposing new challenges during the progression of the game or activities (Hills, Dengel & Lubans 2015).

In the present study, although the circuit/HIIT strategy generated the greatest intensity, it was the worst model in the qualitative analysis, considering the fun, motivation, and engagement of the students. In this sense, the literature shows that the promotion and development of health in PE should not be limited to aiming to meet physical activity recommendations and increase motor competence or physical fitness, but should also provide children and adolescents with the motivation, confidence, and knowledge needed for an active life (Fernández-Bustos et al., 2024; Moral-Garcia et al., 2021). Boiché and collaborators observed the links between motivation measures based on Self-Determination Theory and indicators of physical activity in adolescents between 9 and 13 years of age (Boiché, Escalera & Chanal, 2020). Self-Determination Theory covers intrinsic motivation, extrinsic motivation, and demotivation. To meet the objectives of the study, the authors observed 40 PE classes, where teenagers practiced different physical activities and sports. The results showed that motivation is a significant correlate of behaviors related to physical activity and that basic psychological needs were positively related to moderate to vigorous physical activity (Boiché, Escalera & Chanal, 2020).

These findings corroborate the results of the recreational class in the present study, where in addition to achieving moderate to vigorous intensity, the strategy was also reported by students to have a higher proportion of fun, motivation, and engagement. The recreational class was made up of multiple playful activities, challenges, collaborations, and movements, involving a large number of children. In contrast, the circuit/HIIT model applied here was intermittent, timed, and with high predictability of the stations, which demonstrated great efficiency in achieving high intensity, but did not correspond to good levels of motivation and engagement among children. Burford and collaborators highlighted that perceptions of pleasure, perceived competence, and motivation probably influence long-term adherence to motor practices, and these aspects are essential for understanding how circuit/HIIT can be implemented in schools (Burford et al., 2022). These authors investigated the pleasure and perceived competence in 402 children aged between 9 and 13 years, undergoing HIIT activities under two conditions; in the first condition, the students were led by teachers, characterized as non-autonomous, and in the second condition, they were led by their peers, independent students. Students' satisfaction and perceived competence were assessed in both conditions. The results indicated that although children reported positive enjoyment and perceived competence in both conditions, they demonstrated a significant preference and felt more competent during the autonomous HIIT condition than in the non-autonomous condition (Burford et al., 2022). The importance of engagement and motivation for motor practices in childhood is anchored in longitudinal studies that observed the long-term effects. Lloyd and colleagues (2014) investigated the potential long-term association between motor skill proficiency at age 6 and self-reported physical activity at age 26. Motor proficiency at age 6 was related to self-reported proficiency at age 16 ($P=0.006$) and to self-reported proficiency between ages 16 and 26 ($P<0.01$). Additionally, motor proficiency at age 6 was positively associated with leisure-time physical activity at age 26. The study showed that individuals who performed physical activity during childhood also showed greater proficiency in motor skills in adulthood (Lloyd et al., 2014).

In this scenario, PE classes are highlighted as a structured tool to propose organized physical activity, which can have acute outcomes on health, cognition, and physical performance (Heinrich et al. 2023; Silva et al. 2023) and also impact on future life (Telama et al., 2014; Lloyd et al., 2014). It is recognized that the school environment is challenging, considering cognitive aspects, academic performance, and cultivation of responsible personal and social behaviors towards improving and maintaining good levels of health.

Conclusions

The results presented reinforce previous data from the literature that indicate a circuit/HIIT strategy as effective in achieving high intensities. However, the present study adds that in the qualitative report of the students, this strategy was considered to be the least fun, motivating, and engaging. The results found show that the recreational strategy positively combined the quantitative assessment of reaching moderate to vigorous intensity with high percentages of fun, motivation, and engagement, while the traditional class exceeded the percentage of 50% of the time spent in moderate/vigorous activities and with a good percentage of engagement and motivation of the students. Thus, it is considered that PE classes can be managed with different strategies, such as those demonstrated in the present study, but above all, that it is possible to apply the models in a combined way, that is, to include intermittent, timed activities, such as the one presented in the circuit/HIIT strategy, associated with recreational activities, including pre-sports games, and/or gymnastics activities, and/or fight sports, in order to cover different content and enhance the engagement and motivation of students.

Thus, future studies can structure combined programs to contribute to aspects of health, intensity of physical effort, and motor performance in childhood and adolescence, as well as enhancing engagement in motor practices with motivation and positive memories, so that physical activity can be carried out throughout life.

Conflicts of interest: No potential conflict of interest was reported by the authors.

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