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# Movimente program: effectiveness and moderators of a cluster-randomized controlled trial on self-reported physical activity among Brazilian adolescents

Jaqueline Aragoni da Silva<sup>1\*</sup>, Kelly Samara da Silva<sup>1</sup>, Bruno Gonçalves Galdino da Costa<sup>2</sup>, Marcus Vinicius Veber Lopes<sup>4</sup> and Jo Salmon<sup>3</sup>

## Abstract

**Background** School-based intervention are needed due to the low levels of physical activity among adolescents.

**Objective** To evaluate a school-based intervention's effectiveness and potential sociodemographic moderators on physical activity (PA) among Brazilian adolescents.

**Design** The *Movimente* Program was a cluster randomized controlled trial conducted at six elementary schools in southern Brazil in 2017.

**Methods** Participants ( $n=921$ ) were adolescents from 7th -9th grade (12 to 15 years). From March to December, intervention strategies included teacher training, educational actions, and environmental improvements designed to increase PA levels. PA was self-reported, and the primary outcome was weekly minutes in total PA; secondary outcomes were weekly minutes in leisure-time PA, adherence to guidelines, and diversity (e.g., number of activities). In addition, the moderation effect of sex, school grade, socioeconomic level, weight status, and baseline PA levels was explored. Mixed-model linear regressions were used to test changes between baseline and follow-up (difference-in-differences approach).

**Results** Participants were, on average,  $13.1 \pm 1.1$  years old, and 52% were female. Pre-post changes in PA volume did not differ between intervention and control groups ( $\beta$ : 6.64; 95% CI: -104.60; 117.89), nor did adherence to guidelines. No significant interaction effects of sex, socioeconomic level, or weight status were found. Pre-post changes of leisure PA diversity favored the intervention group among 8th but not 7th and 9th grade students.

**Conclusion** The *Movimente* Program was not effective in improving PA among the whole sample. Further studies are warranted to explore effective ways to improve PA among adolescents from Brazil.

**Trial registration** The research project is registered with Clinical Trials (NCT02944318 Date of registration 25/10/2016).

\*Correspondence:

Jaqueline Aragoni da Silva  
jaqueline.aragoni@outlook.com

Full list of author information is available at the end of the article



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**Keywords** Motor activity, School, Adolescents, Intervention, Public health

## Introduction

Regular physical activity (PA) is positively associated with health benefits such as physical, psychological, social, and mental health in youth [1, 2]. Meeting PA guidelines (average of 60 min of moderate-to-vigorous PA/day) is recognized as a way to improve and maintain adolescent health [1]. Globally, 85% of adolescent females and 78% of males do not meet global recommendations for PA [3]. Thus, the importance of promoting PA is highlighted in the 2018–2030 Global Plan of Action for Physical Activity, which aims to reduce by 15% the global prevalence of PA by 2030 [4]. Policies and interventions to increase PA levels, particularly among youth in developing nations, are encouraged to achieve this goal, and their implementation and effectiveness should be investigated.

Among the different settings to promote PA among youth, the school environment is recognized as a key setting [4]. Most adolescents attend school for the largest part of each year, spending considerable time engaging in school-related activities. It offers several opportunities, such as recess and physical education classes, a social and physical environment for PA, and the opportunity to teach health issues in class. Many school-based PA interventions have been proposed and tested, however, evidence shows that efforts have been minimally effective at increasing PA among adolescents [5, 6]. Research gaps in PA interventions in young people are even greater among low- and middle-income countries (LMIC) [7, 8], with a systematic review showing that only 3% of 50 studies about PA school-based intervention were from LMIC [8]. Considering that some countries have different starting points regarding their initiatives to promote PA [4] and each country has its own challenges, more evidence from disadvantaged countries is recognized as a research priority. In Brazil, for instance, data from the Global Matrix project indicated that the country scored low grades in all PA indicators [9]. This reinforces the need for studies on how to develop effective strategies to improve adolescents' PA.

It is argued that further intervention research focusing on implementation and intervention moderators is needed [5, 10]. Reporting only overall effects may mask important information that could contribute to increases in health disparities [11]. That is, it is not just important to report whether the intervention worked; it is also important to explore for whom did the intervention work. Studies suggest that sex [12, 13], weight status [13], socioeconomic level [14], age group [10, 15], and initial PA levels [13, 16] might be key characteristics that influence different responses to PA interventions. However, PA intervention effects are often reported for the whole

sample, but not whether subgroups have been equally impacted by the strategies [5, 11]. Exploring whether some groups respond better to an intervention than others can improve the development of the field [11] and the collaborative efforts to attenuate or eliminate disparities in PA and health [4].

Based on the issues mentioned above and to address those knowledge gaps, the present study aimed to determine the effectiveness of a school-based program set in southern Brazil on adolescents' PA levels, and explore sex, grade, socioeconomic level, weight status, and baseline PA levels as potential moderators. The present study hypothesized that a school-based program implemented in southern Brazil would effectively increase PA levels among adolescents.

## Methods

### Study design and participants

The randomized controlled trial study was conducted in Florianópolis, southern Brazil, which has a population size of 421,240 habitants and a Human Development Index (HDI) of 0.847. The Municipal Board of Education covers 36 Public Elementary Schools (SME, 2015). Initially, meetings were held with the Secretary of Education, and upon their approval, information from the schools was obtained to check their eligibility based on pre-defined criteria. All schools were screened for eligibility according to the following inclusion criteria: (i) Having elementary level-2 grades ( $n=27$ ); (ii) schools having a minimum of two grades from years seven to nine ( $n=21$ ); and (iii) schools not being under construction or being renovated/repared ( $n=18$ ).

The eligible schools were then contacted by the research team, reaching out to the coordinators of each school, explaining the entire study to verify their acceptance to participate. A total of seven schools (39%) accepted. Schools were paired according to their size and geographic location (1:1 ratio), and one school was selected for the pilot study. Six schools were randomly allocated (computer generated numbers in Microsoft Excel) to the intervention group ( $n=3$ ) or the control group ( $n=3$ ). Eligible students were those enrolled in grades seven to nine and attending the first two weeks of the school year of 2017 ( $n=1,427$ ). Visits were made to the schools according to scheduled times with the coordination to explain the research to the students. Multiple visits were made to reach the maximum number of students. Students living with intellectual and/or physical disabilities that limited their participation in the study measurements were not considered eligible to participate

in the evaluation. More information is available elsewhere [17] and at [www.movimente.ufsc.br/en](http://www.movimente.ufsc.br/en).

The sample size calculation was performed a priori with a sample size of 474 participants considered sufficient to achieve a statistical power of 80% with a 5% significance level for two-tailed tests and an odds ratio of two (two students becoming active after the intervention -MVPA min/day). The estimated sample was doubled due to cluster sample selection at the school level [18] and then increased by 10% to account for follow-up losses ( $n = 1,042$  students). For continuous variables, in order to detect an effect size equal to or higher than 0.17 [19] a final sample size of  $n = 1,090$  participants was required.

All 7th to 9th grade students from the six schools ( $n = 1427$ ) were invited to participate, and informed consent was obtained by their parents or legal guardians who took part in the study. The methods were performed in accordance with the Declaration of Helsinki and the Ethics Committee of the Federal University of Santa Catarina approved the experimental protocol (protocol number: 1.259.910; CAAE: 49462015.0.0000.0121; date: November 23rd, 2015).

### Protocol

The *Movimente* program took place during the school year of 2017. The intervention was based on the Social Cognitive Theory, the Social Ecological, and the Health Promoting School's Framework. Strategies were based on intrapersonal, interpersonal, and environmental factors that might improve adolescents' PA and reduce their sedentary behaviour. Detailed information about the program was previously published [17]. Three strategy components were applied, which are briefly described below.

A teacher training program was developed to encourage discussion on health topics in the school curriculum, especially about PA and sedentary behaviour. The training was organized into three stages. (i) All teachers were invited to participate in a 4-hour training session at school, which included discussing the importance of a healthy lifestyle and practical examples of activities that could be implemented during classes. The training was accompanied by a handbook containing flexible and accessible activities to be applied by the teachers throughout the school year. Teacher training was delivered separately for Physical Education teachers and teachers of all other areas (here considered general teachers). (ii) Teachers were invited to log in to a website to allow interactions and share experiences and ideas among all teachers from the three intervention schools and the researchers.

The school environment was improved by creating line markings and providing sports equipment for each school in the intervention group. These changes were made to facilitate students' engagement in PA during school breaks before and/or after classes. Additionally,

principals and teachers were asked to encourage students to use the settings and provided materials for promoting PA.

Four types of banners (42:60 cm) were displayed at school, spreading messages about the importance of being active and reducing sedentary behaviour. Another set of banners (30:21 cm) was delivered to the school coordinators, who were asked to encourage teachers to use the material in their classes and to create strategies for the students delivering the material to their parents, allowing discussions about health at home. More detailed information about the methods of the *Movimente* intervention have been published elsewhere [17], and all the materials used for the intervention are freely available and can be found at <https://movimente.ufsc.br/en/>.

### Assessment

Baseline data collection was carried out between March and April of 2017, and follow-up data collection was conducted immediately after the intervention, between November and December 2017. A trained research team administered the questionnaire to students in the classroom during class time. One staff member read each question aloud, and students individually answered it. Although the research team were not blinded regarding the school allocation, they were instructed to apply the questionnaire in a standardized manner.

The Self-Administered PA Checklist was used to assess PA [20, 21]. The instrument has been previously validated [21] and applied in other research on Brazil [19, 22]. The instrument was validated for Brazilian students and showed acceptable reliability (Intraclass Correlation Coefficient (ICC): 0.71) and moderate correlation coefficients when compared with four different types of 24-hour PA recall ( $\rho = 0.62$ ;  $P < 0.001$ ) [21]. The PA instrument includes a list of 22 different types of PA (e.g., soccer, basketball, swimming). Students were asked to report the usual weekly frequency and daily duration of each type of PA. The first list included total PA (i.e., active transport, leisure-time PA, school PA), and the second list was about PA performed during leisure-time only. Those who did not perform any PA were asked to select the "I do not regularly practice PA" option.

The primary outcome was total weekly minutes in PA (calculated by multiplying the frequency and duration of all activities practiced during one regular week). Furthermore, secondary analyses were performed for the following outcomes: (i) leisure-time PA minutes per week (a quantitative variable generated by multiplying the frequency and duration of all activities performed out of school during a usual week); (ii) diversity of leisure-time PA (the count of different types of PA students performed out of school was created); (iii) diversity of total PA (the count of PA types students performed in total);

(iv) meeting PA guidelines (students who were engaged in an average of at least 60 min of PA daily were compared with those who were not) [1].

Sex and school grade were self-reported. Weight status (normal weight vs. overweight/obesity) was created based on height and weight measurements conducted by a trained research team. Cut-off points for the z-score of body mass index were used according to the growth curves of the World Health Organization [23]. A socioeconomic level proxy was based on the number of household items, obtained from a checklist based on the Brazilian Economic Classification Criteria (e.g., number of televisions, refrigerators, microwaves, cars). Using Principal Component Analysis, an index was calculated from a list of 16 household items. The variable was categorized into tertiles (the higher the scores, the greater the family's wealth).

### Data analysis

Data were analysed using STATA version 15.0. Participants' characteristics were presented using absolute and relative frequencies (categorical variables) and mean and standard deviation or median and interquartile ranges

**Table 1** Students' characteristics at baseline according to group allocation of the Movimente program. Brazil, 2017

Characteristics at baseline	Total % <i>(n)</i>	Control % <i>(n)</i>	Intervention % <i>(n)</i>
	<i>n</i> =921	<i>n</i> =383	<i>n</i> =538
<b>Sex</b>			
Boys	48.32 (445)	47.26 (181)	49.07 (264)
Girls	51.68 (476)	52.74 (202)	50.93 (274)
<b>Age<sup>b</sup></b>			
Mean	13.09 (1.06)	13.12 (1.09)	13.07 (1.04)
<b>School grade</b>			
7th grade	36.59 (337)	37.86 (145)	35.69 (192)
8th grade	32.03 (295)	31.07 (119)	32.71 (176)
9th grade	31.38 (289)	31.07 (119)	31.60 (170)
<b>Socioeconomic level</b>			
Low quartile (Q1)	33.41 (279)	36.92 (127)	30.96 (152)
Intermediate quartile (Q2)	33.29 (278)	30.52 (105)	35.23 (173)
High quartile (Q3)	33.29 (278)	32.56 (112)	33.81 (166)
<b>Weight status</b>			
Health weight	65.53 (559)	68.68 (250)	63.19 (309)
Overweight	34.47 (294)	31.32 (114)	36.81 (180)
<b>Volume of total PA (min/week)<sup>b, c</sup></b>	739.27 (832.84)	761.43 (866.99)	723.57 (808.23)
<b>Volume of leisure PA (min/week)<sup>b, c</sup></b>	555.81 (687.20)	588.66 (746.68)	533.38 (643.25)
<b>Diversity of total PA<sup>b, c</sup></b>	3.55 (2.32)	3.95 (2.50)	3.27 (2.13)
<b>Diversity of leisure PA<sup>b, c</sup></b>	2.41 (1.86)	2.54 (2.01)	2.32 (1.74)
<b>Meeting PA guidelines<sup>c</sup></b>	50.83 (457)	51.21 (191)	50.57 (266)

a: wilcoxon (continuous variables) and chi-square (categorical variables); <sup>b</sup>: mean and standard deviation; PA: physical activity; <sup>c</sup>: *n*=899

(continuous variables). Differences in the participants who remained versus those who dropped out of the study from baseline to follow-up (*n*=187) were compared using Student's t-tests (or equivalent non-parametric tests for skewed distributed variables) and Chi-square tests. Total weekly PA time was truncated at the 95th percentile in order to deal with implausible values.

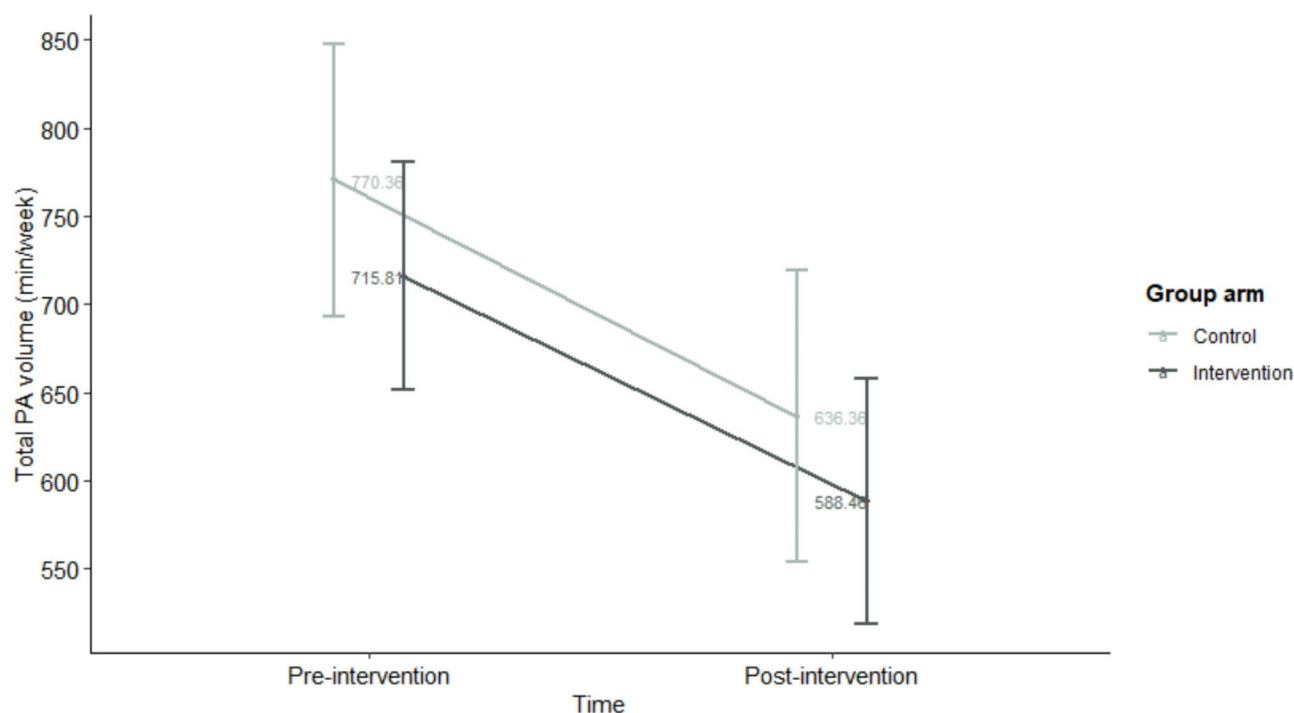
Generalized linear mixed models were used to identify between-group differences in PA change (differences in differences method). Mixed models have advantages such as being robust to the bias of missing outcome data and by taking into account the non-independency of observations [24]. For this, a base model was created by inserting an indicator variable for allocation (group), time (baseline or follow-up), and a group by time interaction term (group\*time) as fixed effects. A two-level hierarchical model was created considering the clustered nature of the data, with participants being treated as random intercepts (repeated measures within participants). Models did not include a random intercept for schools due to low inter-cluster variability (ICC estimates ranging from 0.01 to 0.04). An adjusted model was also created by including sex, grade, and socioeconomic level. Linear and logistic regression models were fitted for continuous and categorical outcomes, respectively. As continuous outcome variables were skewed, bootstrapping analyses (1000 resamples) were conducted in order to retrieve robust 95% confidence intervals [25].

An exploratory moderation analysis was undertaken by inserting three-way interaction terms (arm allocation\*time\*moderator). The potential moderators examined included sex, school grade, socioeconomic level, and weight status [10, 13, 14]. When an interaction term was significant, the analyses were plotted according to the subgroups. The level of significance considered was *p*<0.05 for the main effects and *p*<0.10 for interaction terms due to the low statistical power for moderation analyses [13, 26].

### Results

Table 1 shows the baseline characteristics of the participants according to group allocation. Of the 1427 potentially eligible students in the six schools, a total of 921 (*n*=538 intervention group; *n*=383 control group; response rate: 65%) students answered the questionnaire at baseline (irrespective of whether they had all measurements or not). The main reasons for not being involved were due to not delivering the consent form and declining to participate in the evaluation. The mean age of participants was 13.1(±1.1) years and they were represented by girls (52%) from the 7th grade (37%), and health weight (65.5%).

Changes in the total volume of PA, measured in minutes per week, between baseline and post-intervention



**Fig. 1** Effectiveness of the *Movimente* program on total PA volume

**Table 2** Effect of the *Movimente* program on the secondary physical activity outcomes of the adolescents. Brazil, 2017

Outcomes	Time effect for the control group	Time effect for the intervention group	Intervention vs. control time effect contrast	p-value
Volume of leisure PA (median, IQ) <sup>a</sup>	-58.50 (-135.42; 18.42)	-25.93 (-89.60; 37.75)	32.87 (-67.17; 132.31)	0.522
Diversity of leisure PA (mean, SD) <sup>a</sup>	-0.20 (-0.40; 0.00)	-0.13 (-0.30; 0.03)	0.06 (-0.20; 0.32)	0.636
Diversity of total PA (mean, SD) <sup>a</sup>	-0.26 (-0.50; -0.03)	-0.22 (-0.30; 0.04)	0.04 (-0.26; 0.34)	0.786
Meeting PA guidelines (%; 95%CI) <sup>b</sup>	0.80 (0.55; 1.18)	0.90 (0.65; 1.24)	1.11 (0.67; 1.84)	0.934

models adjusted for sex, school grade, and socioeconomic status; SD: standard deviation; PA: physical activity;<sup>a</sup>: linear regression; <sup>b</sup>: logistic regression

for the control and intervention groups are shown in Fig. 1. The figure illustrates the means and 95% confidence intervals of PA at baseline and post-intervention for control and intervention groups. A total of 899 adolescents provided information regarding the outcome at baseline. Results showed that the time effect on the control and intervention group was  $-133.99$  (95% CI:  $-2191.22$ ;  $-48.77$ ) and  $-127.35$  (95% CI:  $-199.302$ ;  $-55.68$ ), respectively. The interaction effect was not statistically significant. Thus, there was no significant intervention effect on total PA ( $\beta$ :  $6.64$ ; 95% CI:  $-104.60$ ;  $117.89$ ).

Table 2 shows the multilevel analysis results of the secondary PA outcomes. There was no significant intervention effect on any of the secondary PA outcomes (diversity of PA, meeting PA guidelines, or the volume of PA during leisure time).

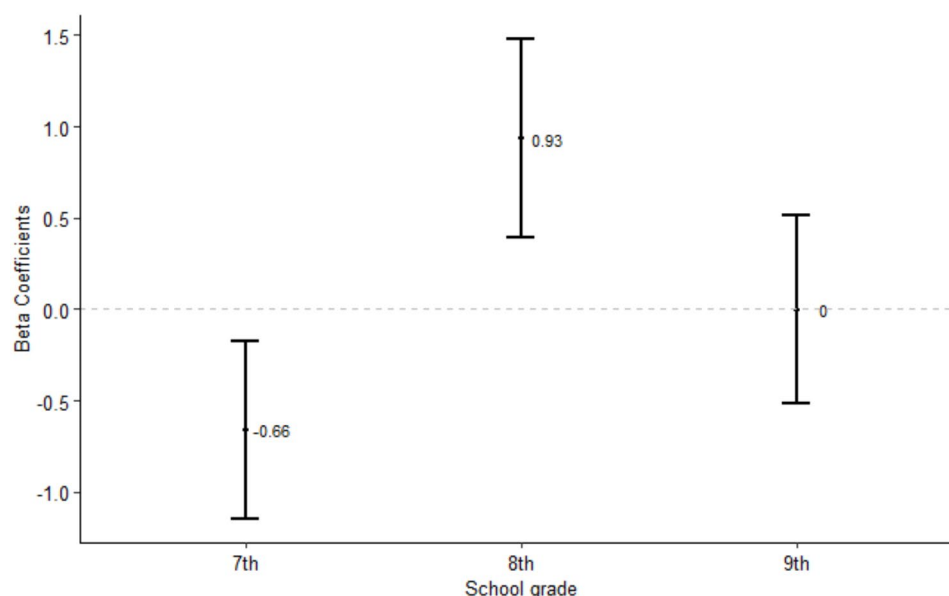
Exploratory analysis showed that the time\*group\*school grade interaction was significant for the diversity of total PA ( $p < 0.001$ ) and diversity of leisure-time PA ( $p = 0.006$ ). To further explore these results,

analyses were stratified by 7th, 8th, and 9th school grades. Figures 2 and 3 illustrates the beta coefficients and 95% confidence intervals from the linear regression analysis of the effect of the intervention on PA diversity according to school grade. For diversity of total PA, there were significant group-by-time effects among 7th and 8th grades students ( $\beta$ :  $-0.66$ ; 95%CI:  $-1.15$ ,  $-0.18$ ;  $\beta$ :  $0.93$ ; 95%CI:  $0.39$ ,  $1.48$ , respectively) (Fig. 2). For diversity of leisure PA, among 8th -grade students, the group-by-time effect was statistically significant ( $\beta$ :  $0.52$ ; 95%CI:  $0.04$ ,  $1.00$ ), suggesting a different effect of the *Movimente* Program according to the school grade (Fig. 3).

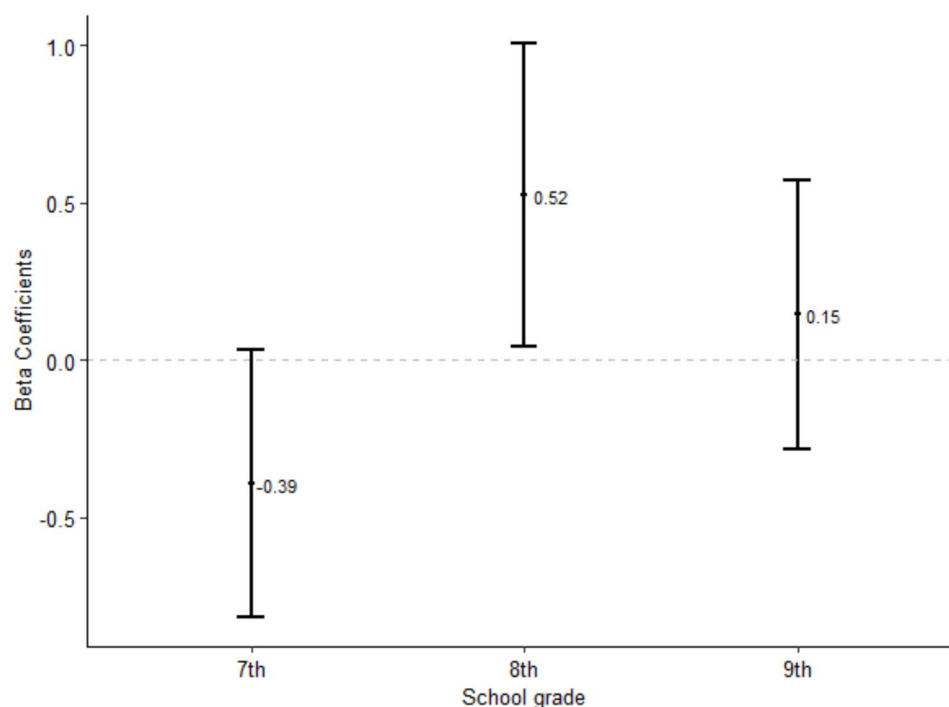
## Discussion

This study investigated the effectiveness of a school-based multicomponent intervention promoting PA among Brazilian adolescents. The results suggest that the intervention was not successful in increasing self-reported PA outcomes, which is consistent with previous meta-analyses that observed null-effects for school-based





**Fig. 2** Effectiveness of the *Movimente* program on diversity of total PA according to school grade. Note: circles represent the 'Intervention vs. Control time effect contrast' and the error bars indicate the 95%CI



**Fig. 3** Effectiveness of the *Movimente* program on diversity of leisure PA according to school grade. Note: circles represent the 'Intervention vs. Control time effect contrast' and the error bars indicate the 95%CI

interventions on PA among adolescents [10, 11]. Understanding the reason for unsuccessful effects is important as lessons can be learned from these studies [27].

Among the reasons that could explain the limited effectiveness of school-based interventions, poor fidelity and level of implementation have been often reported in studies [28–30]. The link between outcomes and

implementation of interventions has been previously highlighted [31], and a systematic review of school-based interventions also confirms that the level of implementation is positively related to PA outcomes [7]. Despite the *Movimente* program offering flexible times to engage in the session training and teachers being given independence to adjust the program activities to suit their needs

and skills, the program had low participation by teachers. Several barriers were faced during implementation, further described elsewhere [32]. For example, time constraints were cited as a factor that hindered teachers' participation. Additionally, teachers found it challenging to incorporate health topics into their classes. There was also a recognized need for a more integrated approach, involving the entire community in the intervention. This would include not only efforts within the school but also extending beyond it by engaging parents and other community members to reinforce the impact of the intervention [32].

Teachers play a central role essential to a successful intervention with educational and in-class strategies [31, 33, 34]. Several features can influence program adoption [31]; for example, the teachers' individual characteristics (self-efficacy, skill proficiency) and the value they give to PA [27]. On the other hand, time constraints, competing priorities, and lack of institutional support can be barriers to implementing intervention strategies and actions [27, 31]. The intervention program was carried out during a critical period regarding political issues in Brazil. In 2017, the school community faced several days of strikes and political meetings spread over the year. Thus, aligned to their typical high workload, may be one of the reasons for the low adoption of the program, even when feeling motivated and recognizing the importance of promoting PA among students. The gap between feeling motivated and actual implementation by teachers has been reported in previous research, which identified a lack of time as the main barrier to implementation [34].

Due to the workload of multicomponent interventions, researchers have raised questions about the level of complexity of the intervention that might be challenging to implement [28, 35]. Qualitative data has shown that teachers and principals have reported simplicity as a need for interventions to be implemented [34]. The lessons provided by the *Movimente* Program were "ready-to-use" with no extra material required with simple and flexible activities. However, it is also essential to recognize that the Program comprised several components and embodied PA content and issues related to sedentary behaviour, nutrition, and other health contents (not reported in the current paper). This broader approach could be perceived as overwhelming by teachers, precluding the teachers' participation as they could see too many challenges leading to poor implementation.

A strategy to overcome these barriers and reinforce implementation that has been recognized as successful is by providing a dedicated staff member responsible for delivering the program [10, 36, 37]. This has been shown in Brazil in a recent multicomponent randomized trial that was effective in improving adolescents' PA when a trained researcher led 15-minute gym sessions twice a

week at participating schools [19]. Yet, the *Movimente Program* focused on external validity in the real world, which in theory should be scalable and sustainable, instead of promoting strategies that could not be continued after the intervention period was over [38].

An additional challenge with school-based interventions in Brazil is that the school system is predominantly comprised of part-time schools with students spending only four hours at school per day, in 'split shifts'. That is, half of the adolescent population attends school in the morning (generally between 8 am to 12 pm), and the other half attends school in the afternoon (generally between 1:30 pm to 5 pm). This means that Brazilian students have less exposure to school-based interventions and spend more time outside of school compared to the school system in other countries, where students spend between six-and-a-half to nine hours daily in school [39]. The *Movimente* Program did try to reach students' families, but it is unclear whether the proposed strategies were properly delivered as the extent of engagement with parents was not assessed. Future interventions in Brazil should consider extending the strategy to beyond the school context, effectively engaging parents and other sectors (e.g., community) [34, 39–41].

In addition to the fact that active community participation and parental involvement are often limited, making it challenging to support and sustain practices outside the school environment, the low- and middle-income countries context also may include other particularities including the lack of adequate infrastructure, such as proper sports facilities and equipment, limiting opportunities for PA. Additionally, socioeconomic issues often lead to the prioritization of basic needs, like food and safety. School time is frequently limited and primarily focused on academic subjects, making it difficult to regularly integrate PA into the curriculum. These challenges highlight the need for creative and contextually appropriate solutions to promote PA in such settings [42].

Furthermore, it is possible that the strategies implemented may not have aligned with the interests of the adolescents, potentially limiting their effectiveness. For instance, the materials provided, and the revitalized environment might not have catered to the activities they most enjoy, as only about one-third of the students reported using them [32]. To address this, future studies should explore a wider range of sports equipment and activities that better match the interests of the students, potentially increasing their engagement in physical activity. Additionally, many of the strategies were more theoretical in nature, such as educational materials and lessons during class, with only around half of the students reporting that they received these materials [32]. Given their limited time in school (4 h per day), expanding opportunities and offering additional time for PA might

be more effective in promoting sustained engagement. This approach could help students integrate PA into their daily routines more consistently. These hypotheses should be explored further in future research. Moreover, the duration of one year may not have been enough for students to fully recognize and utilize the new facilities, emphasizing the need for a longer period to facilitate the incorporation of these changes into their routines.

While the current intervention was not effective on increasing PA levels for the overall sample, it may have worked better for specific sub-groups. We observed a moderating effect by school grade level, with analyses suggesting that those who were in 8th school grade were favoured with more diversity of PA practice among the intervention group. Although the intervention training and curriculum resources were applicable to all students from 7th to 9th grade, it could be that schools and teachers may have approached teaching the lessons differently, which may have influenced the outcomes according to grade [38]. However, results should be seen as suggestive and interpreted with caution as sub-group analyses were exploratory due to limited power [43].

### Limitations

The limitations of the present study include the recruitment of public schools only and the use of self-reported PA measures which could reflect bias in measurement [41]. Self-report data is subjected to memory bias, social desirability [44], and pre-existing expectations [45]. In addition, the instrument was not able to capture PA during school time. Nevertheless, the instrument used was previously validated and provided additional information about frequency and type of PA, which represents important components of the behavior that are currently infeasible to be assessed with objective measurements. Such information is important for further understanding the effectiveness of interventions and informing future intervention development or refinement [40]. In addition, the research team was not blinded to group allocation, but efforts were made in staff training to ensure standardized measurement protocols. With response rates, incomplete measures, and losses to follow-up, the sample size was not optimal, which may have resulted in a lack of power to detect significant intervention outcomes. Another limitation was teacher engagement in the training and intervention fidelity; despite conducting a pilot to test feasibility in an initial school, the low implementation makes it challenging to determine true effectiveness. Finally, the intervention period may not have been sufficient to fully capture the PA effects. Future studies should explore longer intervention periods and data collection at multiple time points to better elucidate this point.

The present study also has many strengths. The intervention was one of the first in Brazil, which is a country

that urgently needs strategies to increase adolescent PA [46]. Such information is important for providing insights that inform the development of future programs and policies. Another strength of this study is the cluster randomized controlled design. Randomization occurred at the school level, which helps to reduce the risk of contamination among groups. The data were modelled using robust statistical procedures that accounted for the hierarchical structure of the data (i.e., repeated measures nested within participants) and unbalanced data (i.e., drop-outs).

### Conclusions

This study evaluated the effectiveness of one of the first cluster randomized trials aiming at increasing PA levels among Brazilian adolescents. Results showed that the intervention did not increase adolescents' total PA but suggested some favourable outcomes in PA diversity among 8th -grade students. The study reinforces that improving adolescent PA through school-based interventions is complex and challenging. The low participation of teachers suggests that future studies should employ more effective recruitment strategies to enhance program uptake and implementation. Given that interventions in PA are needed, and the field remains understudied, especially in LMIC settings, further research is required in order to advance knowledge. More participation from the community and involvement of parents might help to enhance successful interventions.

### Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-22130-7>.

Supplementary Material 1

Supplementary Material 2

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### Author contributions

All authors contributed to the study's conception. JAS drafts the manuscript. JAS, BGGC, and MVVL performed the material preparation, data collection, and analyses. KSS and JS provided intellectual contributions. All authors read and approved the final version of the manuscript.

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#### Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

#### Declarations

##### Ethics approval and consent to participate

The research project is registered with Clinical Trials (NCT02944318) and was approved by the National Research Ethics System (number 1.807.825, 25/10/2016). Informed consent was obtained by their parents or legal guardians who took part in the study.

##### Consent for publication

Not Applicable.

##### Competing interests

The authors declare no competing interests.

##### Author details

<sup>1</sup>Department of Physical Education, Federal University of Santa Catarina, Engenheiro Agrônomo Andrei Cristian Ferreira, Trindade, Florianópolis, Santa Catarina 88040-900, Brazil

<sup>2</sup>Department of Kinesiology & Physical Education, McGill University, 475 Avenue des Pins Ouest, Montreal, Québec, Canada

<sup>3</sup>Institute for Physical Activity and Nutrition, Deakin University, 221 Burwood Highway, Burwood, Melbourne, VIC 3125, Australia

<sup>4</sup>Healthy Active Living and Obesity Research Group, Children's Hospital of Eastern Ontario Research Institute, 401 Smyth Rd, Ottawa, Ontario, Canada

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