Protocols for studies on physical activity and health

RBAFS Revista Brasileira de Atividade Física & Saúde
SOCIEDADE BRASILEIRA DE ATIVIDADE FÍSICA & SAÚDE

rbafs.org.br

Effects of high-intensity interval training on different health outcomes among high school students in southern Brazil: Protocol for a cluster-randomized trial

Efeitos do treinamento intervalado de alta intensidade em diferentes desfechos em saúde de escolares do ensino médio do sul do Brasil: Protocolo de um ensaio randomizado por cluster

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10.12820/rbafs.30e0393i

ABSTRACT

Introduction: Although the benefits of regular physical activity on mental health parameters and cognitive performance are evident, there is a high prevalence of physical inactivity among adolescents. Therefore, it is important to identify exercise strategies that encourage greater participation within this population. Objective: To evaluate the effects of high-intensity interval training (HIIT) program on the mental health and cognitive performance of school-aged adolescents. Methods: This is a single-center, two-arm (intervention and control) cluster randomized trial protocol. Adolescents aged 15 to 18 years were exposed to the intervention for 6 weeks. The primary outcomes are mental health symptoms, measured by the Depression, Anxiety, and Stress Scale for adolescents, cognitive profile, inhibitory control, and executive function, measured by the General Cognitive Assessment Battery – Cognifit, Stroop Color Test and Trail Making Test, respectively. Secondary outcomes include weight and Body Mass Index, waist circumference and cardiorespiratory fitness. The results will be analyzed according to the protocol and on an intention-to-treat basis. The effects of the intervention will be analyzed with Generalized Estimating Equations, using linear and Poisson models, incorporating time variables, group, an interaction term and adjustment covariates. A significance level of 5% will be adopted for all two-tailed tests. Final considerations: This study is expected to produce results that can recommend HIIT as an effective training strategy for mental health and cognitive performance of adolescents.

Keywords: Physical activity; Mental health; Cognitive performance; Adolescents; Randomized trial.

Trial record: Brazilian Registry of Clinical Trials - ReBEC (RBR-733y6zq).

RESUMO

Introdução: Embora sejam evidentes os benefícios da prática regular de atividade física em parâmetros de saúde mental e no desempenho cognitivo, existe uma alta prevalência de inatividade física entre adolescentes. Assim, a busca por estratégias de exercício que possam gerar maior adesão a este público é importante. Objetivo: Verificar os efeitos de um programa de treinamento intervalado de alta intensidade (HIIT) na saúde mental e no desempenho cognitivo de adolescentes escolares. Métodos: Trata-se de um protocolo de ensaio randomizado por cluster, unicêntrico de dois braços (intervenção e controle). Adolescentes com idade entre 15 e 18 anos foram expostos a intervenção durante 6 semanas. Os desfechos primários são sintomas de saúde mental, mensurados pela Escala de Depressão, Ansiedade e Estresse para Adolescentes, o perfil cognitivo, controle inibitório e função executiva, mensurados pela Bateria de Avaliação Cognitiva Geral – Cognifit, Teste de Cores Stroop e Teste de Trilha, respectivamente. Os desfechos secundários incluem: o peso e índice de massa corporal, a circunferência da cintura e a aptidão cardiorrespiratória. Os resultados serão analisados por protocolo e intenção de tratar. Os efeitos da intervenção serão analisados com Equações de Estimativas Generalizadas, utilizando modelos lineares e de Poisson, incorporando variáveis de tempo, grupo, um termo de interação e covariáveis de ajuste. O nível de significância aceito para testes bicaudais será de 5%. Consideração final: Espera-se que este estudo produza resultados que possam recomendar o HIIT como uma estratégia de treinamento eficaz na saúde mental e desempenho cognitivo de adolescentes.

Palavras-chave: *Atividade física; Saúde mental; Desempenho cognitivo; Adolescentes; Ensaio randomizado.*

Registro do ensaio: *Registro Brasileiro de Ensaios Clínicos - ReBEC (RBR-733y6zq).*

Introduction

The regular practice of physical activity (PA) by children and adolescents has a positive impact on different health indicators, as well as helping to prevent and control non-communicable diseases[1]. However, 81% of adolescents aged between 11 and 17 are considered physically inactive, i.e. they do not meet the recommendations of 60 minutes of moderate to vigorous PA per day[2]. In addition, physical inactivity in this age group can lead to various health risks, such as reduced sleep quality, increased body fat, poor physical fitness and even cardiometabolic diseases[1], as well as impaired cognition and mental health[3].

The World Health Organization estimates that one in seven (14%) young people aged between 10 and 19 have mental health problems and among young people aged between 15 and 19, the estimate is that 4.6% suffer from anxiety and 2.8% suffer from depression[4]. The Erica study[5] found a 30% prevalence of common mental disorders in Brazilian adolescents, and in the 15 and 17 age group this prevalence was 33.6%. In contrast, a review of 58 randomized studies found that regular PA protocols provided moderate improvements in mental well-being, reduced severity of depression and perceived stress compared to control participants who did not do any type of PA[6]. Given this context, the World Health Organization highlights the importance of this practice as a non-pharmacological alternative recognized as an important protective factor for the physical, cognitive and mental health of young people[1].

Therefore, considering that in Brazil it is compulsory for young people to be enrolled in school, this seems like an opportune scenario to encourage the practice of PA through interventions with students, given its accessibility, applicability and its role in promoting both education and health[7]. Although schools can present challenges for researchers, such as sustaining interventions and measuring their impact, there is good evidence of improvements in the health and well-being of young people. These are through school-based interventions and physical education classes, which include physical exercise initiatives of various intensities[8].

Among the existing strategies, high-intensity interval training (HIIT) has been highlighted as a viable strategy for improving various health outcomes[9], such as physical fitness[10], cardiorespiratory fitness[11,12], body composition[13-15], psychosocial being (well-being, self-esteem, improved sleep and mood[16], mental health[3,9,17,18] and cognitive performance[3,17,18]. This training is characterized as a type of exercise in which there are intermittent periods of vigorous activity (phases of effort), alternated with periods of active pause (low-intensity activities) or passive pause (rest)[19,20]. In addition, there are different types of interval training such as HIIT-short, HIIT-long, interval training of repeated sprints and interval training of sprints. HIIT-short, used in this protocol, is characterized as training in which the duration of the effort is less than 1 minute and the effort: pause ratio is close (for example: 30s:30s)[21].

Recent evidence suggests that physical exercise does not need to be of long duration to improve cognitive and emotional health. Systematic reviews indicate that both a single HIIT session and prolonged interventions have a positive effect on the cognitive performance of children and adoles-

cents. While the effects of a single session are typically acute and short-lived, prolonged interventions tend to yield more sustained and comprehensive improvements, particularly in executive functions and inhibitory control[3,17]. A meta-analysis[22] comparing the effect of HIIT and moderate continuous training on inhibitory control concluded that both HIIT and continuous training improved inhibitory control in healthy people. In addition, shorter protocols were able to improve cognitive performance scores[3].

Regarding mental health, a meta-analysis[18] suggested that HIIT may have a small positive effect on improving indicators of well-being (self-esteem, quality of life, positive affect) and reducing indicators of malaise (depression and anxiety) in children and adolescents. In addition, the authors observed stronger effects on well-being indicators for studies with interventions <8 weeks compared to those >8 weeks[18]. Thus, an eight-week intervention with adolescents, involving three sessions per week and two groups following different HIIT protocols alongside a control group receiving regular physical education classes, observed a modest improvement in psychological well-being in both HIIT groups[17]. However, these results should be interpreted with caution, as few studies have directly examined the effects of HIIT on mental health outcomes in adolescents. Further research is needed to better understand this potential relationship in this population.

However, despite being a promising intervention, the data obtained from current systematic reviews and meta-analyses are limited[3,10,13]. Only two of the cited studies were conducted with Brazilian adolescents[23,24], and both focused exclusively on overweight and obese populations. In addition, none of these studies were conducted within school physical education classes. This highlights a gap in the literature, as school environments in other countries often follow different standards. Successful interventions in such settings may be replicable in other schools, offering a sustainable, low-cost approach with high levels of participant adherence[25].

Considering: (i) the strategic role of the school in promoting PA and health among adolescents; (ii) the discipline of physical education as a powerful tool for this purpose (iii) the prevalence of physical inactivity and mental health problems in adolescents (iv) the scarcity in the literature of intervention studies with HIIT that evaluate the outcomes of cognitive performance and mental health in Brazilian adolescents. This study is important as it presents an opportunity to implement a HIIT program that may offer significant benefits to the physical, mental, and cognitive health of adolescents. Therefore, this protocol article outlines the methodological procedures of a cluster-randomized trial designed to evaluate the effects of a low-volume HIIT program, implemented during physical education classes, on various health indicators in adolescents.

Methods

Type of study

This study is presented as the original protocol for a single-center, parallel, two-arm (intervention and control) cluster-randomized trial conducted in 2024 in the municipality of Rio Grande, in the state of Rio Grande do Sul, Brazil. The study protocol adheres to the recommendations of the Standard Protocol Items: Recommendations of Interventional Trials - SPIRIT[26], was approved by the Research Ethics Committee of the Federal University of Rio Grande, registration number 5.846.123 (CAAE: 65508322.8.0000.5324) and approved in the Brazilian Registry of Clinical Trials - ReBEC (RBR-733y6zq).

Sample and selection criteria

The study was conducted with second-year high school classes at the Federal Institute of Education, Science and Technology of Rio Grande do Sul (*Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Sul* - IFRS) – Rio Grande Campus. Both the classes and the school were selected based on convenience sampling. These classes had two physical education sessions per week, scheduled 48 hours apart. During the intervention period, the planned content was focused on 'Gymnastics.' The sample included male and female students enrolled in six second-year classes at the institution who consented to participate in the intervention. Eligible participants included male and female students aged 15 to 18 years who were enrolled in physical education classes, capable of performing the proposed physical exercises, not taking medications that could interfere with the analyzed variables (e.g., insulin or beta-blockers), and free from heart or kidney disease, severe asthma, or any disabling physical or mental condition. To ensure the inclusion of all students in the class, those who were unable to perform the exercises without adaptation due to specific motor or cognitive conditions participated in the in-

tervention with appropriate modifications. However, their data will not be included in the analysis. Students aged 18 or older signed the Free and Informed Consent Form. For those under 18, the Free and Informed Assent Form was signed by the students themselves, while their parents or guardians signed the Free and Informed Consent Form, thereby formalizing their participation in the study. Following these authorizations, students in both groups participated in baseline measurements (pre-intervention) and again after the six-week intervention.

Randomization

The institute's six second-year classes were randomized and allocated into two groups: (1) the Intervention Group, which participated in HIIT-short (n = 65); and (2) the Control Group, which continued with regular physical education classes (n = 134). The assignment of classes to each group was conducted on the premises of the IFRS, in the presence of both researchers and institutional teachers, using a simple random drawing with sealed envelopes.

Blinding

This randomized study was evaluator-blinded; that is, the researchers responsible for data collection (at baseline and post-intervention) and statistical analysis were unaware of participants' group allocation (intervention vs. control). This approach was adopted because it was not feasible to blind the researchers conducting the intervention (HIIT-short program) to group assignment. The researchers did not perform any activities with the control group, which continued to participate in their regular physical education classes.

Participation and attendance at the intervention

This study comprises 12 sessions of HIIT-short delivered over six weeks, with participants training twice per week. Adherence to the protocol will be assessed based on the number of HIIT-short sessions attended. To determine whether adherence is adequate or inadequate, the ratio of attended sessions to the total number of planned sessions will be calculated. Participants will be considered to have adequate adherence if they attend at least 66% of the sessions—that is, 8 out of the 12 HIIT-short sessions. To minimize bias, individuals with insufficient adherence will still be included in the analyses to explore specific characteristics that may explain low adherence.

Sample size

The sample size for mental health symptoms was calculated by reducing the 60% prevalence of these symptoms found in the study by Rosa et al.[27] by 20 percentage points, i.e. from 60% to 33% with a power of 80% and an alpha error of 5%, which would generate a prevalence ratio of 1.5. A sample size of 64 students was therefore estimated for each arm of the study, resulting in a total of 128 participants.

Study variables

The dependent variables (primary and secondary outcomes) are presented in Table 1. These variables were measured during the physical education classes of each respective group over two weeks prior to the start of the HIIT-short intervention. An additional two-week period following the intervention was used for post-intervention evaluation.

The potential confounding factors (intervening variables) are listed in Table 2 and were assessed using standardized questionnaires adapted from the National School Health Survey (*Pesquisa Nacional da Saúde do Escolar* - PeNSE). These questionnaires were administered both before and after the 6-week period for the HIIT-short and control groups.

The HIIT-short intervention protocol

The HIIT-short intervention lasted six weeks, with sessions conducted twice per week (totaling 12 sessions) and a minimum interval of 48 hours between them. The sessions were held in the IFRS sports gym (Rio Grande Campus), which features an official 40 × 20 m indoor court, bleachers, restrooms, and a drinking fountain. The protocol was implemented exclusively by three physical education professionals and was consistently conducted at the beginning of physical education classes, each comprising 30 to 32 students. The teacher responsible for the selected classes did not participate in the intervention. To assess exercise intensity and enhance the reproducibility of the protocol, students completed a rating of perceived exertion (RPE) assessment after each HIIT-short session using the modified Borg CR10 scale[28]. Based on the RPE ratings and session duration, the internal training load was calculated as: RPE score × session duration (in minutes). Following the HIIT-short session, students resumed the regular class activities planned by their teachers. The control group continued with their usual physical education curriculum as scheduled by their

Table 1 – Primary and secondary outcomes and instruments used.

Variables	Instruments	Operationalization
		Primary outcomes
Mental health	Depression, Anxiety and Stress Scale for Adolescents (DASS-A)	Likert scale from 0 to 3 points. Composed of 21 items subdivided into seven items for anxiety, depression and stress. Cut-off points: 1. Depression: normal (0 to 9 points); mild (10 to 13); moderate (14 to 20); severe (21 to 27); extremely severe (≥ 28 points); 2. Anxiety: normal (0 to 7); mild (8 to 9); moderate (10 to 14); severe (15 to 19); extremely severe (≥ 20 points), 3. Stress: normal (0 to 14); mild (15 to 18); moderate (19 to 25); severe (26 to 33); extremely severe (≥34 points) Application time: 10 minutes
Cognitive profile	General Cognitive Assessment Battery - Cognifit®	A battery of computerized tests comprising 17 tasks that assess 22 cognitive abilities related to executive function, attention, memory, coordination and mental flexibility (reasoning). The final data set provides a cognitive profile of the participant generated by associating the scores, as well as data on the percentage of correct answers, classification, scores, execution time and reaction time Application time: 30 minutes. Further information on the battery of cognitive tests can be found in the supplementary table.
Inhibitory control	Stroop Color Test	It consists of three cards, each with 24 items organized into six lines of four words. The evaluation takes into account the speed of execution and the number of errors. Application time: 5 minutes.
Executive function	Trail Test (Part A and Part B)	The test consists of connecting numbers or letters in order and is scored according to the time it takes to complete. Application time: 5 minutes.
		Secondary outcomes
Height	Stadiometer	-
Weight and body mass index	Omron HBF-514C Scale	1 = Underweight; 2= Eutrophic; 3 = Overweight; 4 Obesity
Waist circumference	Tape measure	Scale 1 and 2. 1 = Adequate; 2 = Inadequate
Cardiorespiratory Fitness	Léger 20-meter "Come and Go" test	Number of laps and calculation of VO_2 max (mL/kg.min). The last complete stage the student completed will indicate the maximum speed reached

Table 2 – Intervening variables (possible confounding factors)

Variables	Instrument	Operationalization
Sociodemographic profile	Age, gender, skin color or race, neighborhood, class, work, living with family, house they live in and how many people	-
Index of goods	PeNSE Questionnaire	Scale from 1 to 3. 1= Lower tertile; 2= Middle tertile; 3= Upper tertile.
Menarche (self-reported)	Age in years (female adolescents)	-
Cigarette consumption (self-reported)	Adapted PeNSE Questionnaire	Scale 1 and 2. 1 = Yes; 2 = No
Use of illicit drugs (self-reported)	Adapted PeNSE Questionnaire	Scale 1 and 2. 1 = Yes; 2 = No
Level of physical activity and sedentary lifestyle	Adapted PeNSE Questionnaire	Scale 1 to 3. 1= Inactive; 2 = Insufficiently active; 3= Active

PeNSE = National School Health Survey

respective teachers.

All participants in the HIIT-short group wore Polar H10 heart rate monitors during each session. At the end of every session, the following data were recorded using the Polar Club app: (i) total effort time in the different training phases (main part), (ii) total effort time spent in each of the five heart rate (HR) zones (zone 1 = 50–59%; zone 2 = 60–69%; zone 3 = 70–79%; zone 4 = 80–89%; zone 5 = ≥90% HRmax), and (iii) average HR, peak HR, and their respective percentages. The Polar Club app also allowed researchers to monitor students' heart rates in real time and provide guidance for adjusting effort during the task. This strategy was employed to monitor all training sessions.

The prescription and progression of the HIIT-short training were based on the maximum speed attained during a progressive effort test. To this end, each student's VO_2 max was estimated using the 20-meter shuttle run test ("Come and Go" test)[29], using the formula by Mahar et al.[30]: VO_2 max = 41.76799 + (0.49261 x Laps) – (0.00290 x Laps2) – (0.61613 x BMI) + (0.34787 x Sex x Age) (laps = number of laps completed; BMI = body mass index; Sex = 1 for boys and 0 for girls). Next, the maximum aerobic speed (MAS) was calculated by converting the final speed from kilometers per hour (km/h) to meters per second (m/s). For this calculation, the speed from the last completed stage of the 20-meter shuttle run test ("Come and Go" test) was used.

Chart 1 illustrates that, during the first three weeks, the exercise intensity was set at 110% of MAS. In the fourth week, it increased to 115%, and in the fifth and sixth weeks, it was further elevated to 120%.

The HIIT-short training sessions were subdivided into three distinct moments (Figure 1):

1) The placement of the Polar H10 heart monitor (with prior instructions given to the students) was followed by a three-minute warm-up, maintaining an intensity below 70% of the maximum heart rate. The warm-up included recreational activities aimed at improving motor coordination, agility, and standardized running drills for both intervention groups.
2) The main component of the HIIT-short training involved a gradual increase in individual intensity over a duration of 10 minutes, which consisted of short sprints (see Chart 2). Each intervention session was divided into three groups based on their MAS levels (low, intermediate, high), as determined by the 20-meter "Come and Go" test. During each session, participants were required to reach a marker (cone) placed at a specific distance.
3) The final three minutes consisted of a low-intensity walk, with the heart rate maintained below 60% of its maximum, followed by light, static stretching.

The total duration of each session ranged from 16 to 18 minutes.

Training of professionals and modifications to the HIIT-short protocol

All professionals and collaborators involved in data collection received training on the HIIT methodology and the use of heart monitors, provided by Prof. Dr. Fabrício Boscolo Del Vecchio from the Federal University of Pelotas (*Universidade Federal de Pelotas* - UFPel)[21]. Additionally, a pilot study was conducted with two classes from the institution that did not participate in the intervention, aimed at refining the intervention's logistics.

Any modifications that may affect the conduct or outcomes of the study, the potential benefits to participants, or the safety of participants—including changes to the objectives, design, population, sample sizes, or procedures—will require a formal amendment to the protocol, to be submitted to the ethics committee.

Control group

The classes in the control group followed the physical education curriculum as planned by the teacher, focusing on the theme of 'Gymnastics'. Similarly, the intervention classes also included these activities, but after applying the HIIT-short protocol, which utilized only the initial part of the session. During the 6-week intervention, activities focused on body-awareness gymnastics (such as Yoga, Acroyoga, Pilates, Stretching, and Relaxation) and fitness gymnastics (including Tabata Training, Jump Circuits, plank exercises, squats, push-ups, burpees, and sit-ups, interspersed with stationary running and jumping jacks) were implemented.

Statistical analysis

The data will be analyzed in two ways: by protocol (considering those who adhered to the intervention, i.e., participated in at least 66% of the sessions) and by intention-to-treat (based on the randomization conducted at the beginning of the study). The effects of the intervention will be assessed using General-

Chart 1 – Progression of HIIT-short training (15 to 60 seconds) over 6 weeks (2 sessions per week).

Weeks	Week 1 to 3	Week 4	Week 5 to 6
Maximal aerobic speed intensity	Intensity 110%	Intensity 115%	Intensity 120%
Pause	Passive pause Session 1, 2 and 3	-	Passive pause Session 10
	Active pause Session 4, 5 and 6	Active pause Session 7 and 8	Active pause Session 9, 11 and 12

Chart 2 – Ten-minute High Intensity Interval Training (HIIT-short) protocol for high school students at the Federal Institute of Rio Grande, Rio Grande, 2024.

Pre-intervention assessment				
SESSION	Maximal aerobic speed	Pause type	Effort: Pause	Stimulus
Session 1	110%	Passive pause	15:15 Training 1	20x
Session 2	110%	Passive pause	15:15 Training 2	20x
Session 3	110%	Passive pause	30:30 Training 3	10x
Session 4	110%	Active pause	15:15 Training 4	20x
Session 5	110%	Active pause	30:20 Training 5	12x
Session 6	110%	Active pause	30:20 Training 6	12x
Session 7	115%	Active pause	15:15 Training 7	20x
Session 8	115%	Active pause	30:20 Training 8	12x
Session 9	120%	Active pause	15:15 Training 9	20x
Session 10	120%	Passive pause	30:20 Training 10	12x
Session 11	120%	Active pause	30:20 Training 11	12x
Session 12	120%	Active pause	30:20 Training 12	12x
Post-intervention evaluations				

Protocol based on: Guilherme et al.[31]; Eddolls et al.[32] e Wen et al.[33]. Time of each session/workout: 3 minutes warm-up + 10 minutes HIIT-short (main part) + 3 minutes return to calm. VO_2 max: obtained by the Léger test and maximal aerobic speed by converting km/h to m/s. Passive pause: standing, squatting or sitting (at the student's discretion). Active pause: brisk walk for the time indicated until the next whistle (start command). Total HIIT training time in each sessions: 10 minutes.

ized Estimating Equations, assuming linear models for normally distributed variables and Poisson models for categorical variables. Time (pre- and post-intervention) and group (intervention and control) will be included as independent variables, along with an interaction term (group × time) and other adjustment covariates. Regression coefficients (β) and incidence rate ratios (IRR) will be calculated as indicators of effect. All analyses will be conducted using Stata 14.0. The minimum accepted level of statistical significance will be 5% for two-tailed tests.

Discussion

This article presents a methodological approach to a cluster-randomized trial aimed at assessing whether ten minutes of HIIT-short performed at the beginning of school physical education classes, is sufficient to improve indicators of mental health and cognitive performance. It is important to note that, to date, no studies in Brazil have examined the effects of a HIIT-short protocol on adolescents during regular physical education classes. This gap highlights the potential for replicating the proposed approach in a wide range of school settings, with a particular focus on changes in anxiety, depression, stress, memory, attention, and overall cognitive performance.

Regarding the outcomes of interest, the intensity and progression of effort used in this HIIT-short protocol align with the recommendations from the systematic review by Eddolls et al.[32]. The authors suggest that HIIT should focus on running at an intensity greater than 90% of maximum heart rate or 100–130% of maximum aerobic speed, performed two to three times per week for at least 7 weeks. However, there is evidence indicating that single HIIT sessions[3,18] also have the potential to influence the outcomes studied. Therefore, our proposal was to test a HIIT-short protocol, based on running at an intensity of 110–120% of maximum aerobic speed, twice a week, with each session lasting 10 minutes over a 6-week period. Cao et al.[34] also observed

Figure 1 – Flowchart of the HIIT-short intervention.

positive effects on VO_2 max in this age group following HIIT protocols, but over a period of more than 8 weeks. These protocols involved running sessions lasting less than 20 minutes each. They concluded that the level of cardiorespiratory fitness may influence mental health (depression) and well-being (self-esteem).

Some studies suggest that HIIT interventions may improve parameters related to mental health. However, the effectiveness of this approach in the adolescent population has not yet been firmly established[3,17,18]. In this context, systematic reviews recommend the development of new studies to further explore the potential for creating school-based interventions involving HIIT. These studies should include active control groups and evaluate mental health as a primary outcome in this population[3,6,9,18]. The aim of this study is to evaluate whether the proposed HIIT-short program reduces symptoms of depression, anxiety, and stress in adolescents.

In addition to the expected effects on mental health, the characteristics of HIIT-short may also influence cognitive performance. Eight-minute HIIT sessions appear to enhance cognitive performance scores[3]. Recent meta-analyses[35,36] have shown that HIIT improves inhibitory and executive functions in adolescents. Given the documented effects of HIIT on anthropometric, cardiovascular, metabolic, mental, and cognitive health in schoolchildren, this project aims to expand the understanding of the potential effects of HIIT interventions within the school community across Brazil.

This study aims to assess whether the HIIT-short intervention, conducted during the first 10 minutes of physical education classes twice a week for 6 weeks, can effectively influence mental health and cognitive performance. Specifically, it seeks to reduce symptoms of depression, anxiety, and stress, while enhancing concentration, memory, and attention in adolescents. By implementing a short-term strategy with potential for long-term sustainability, the study may provide valuable insights for policymakers, educators, and health professionals in developing and adopting new health promotion strategies for both this population and the broader school environment.

This study has several limitations, including: (i) the use of a self-reported questionnaire to assess mental health outcomes; (ii) the lack of validation of the general assessment battery, Cognifit®, in Brazil; and (iii) the limited generalizability of the results, as the sample was selected for convenience, representing a specific school context within the municipality. Therefore, further research is needed to implement this intervention in additional schools to externally validate the findings.

Regarding the strengths, this is the first study conducted in Brazil that involves an intervention using HIIT within the school environment, during physical education classes, with an adolescent population. It evaluates the effect of HIIT on primary outcomes such as cognitive performance and mental health. Furthermore, the study has observed that both single-session HIIT interventions and prolonged interventions can have a positive impact on these outcomes[3,18]. Thus, it is believed that a six-week intervention involving two sessions of HIIT per week has the potential to modify the studied outcomes and can be implemented in the school environment. This is because it is a short-term, low-volume intervention that does not interfere with the high school curriculum and is easy to apply, as it is based solely on running.

Conflict of interest

The authors declare no conflict of interest.

Funding

This work was carried out with the support of the Coordination for the Improvement of Higher Education Personnel - Brazil (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* - CAPES) - Financing Code 001. This work was also carried out with the support of the Research Support Foundation of the State of Rio Grande do Sul - Brazil (*Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul* - FAPERGS) – Grant agreement number: 21/2551-0002003-3 (FAPERGS Gaúcho Researcher Public Notice 07/2021).

Author's contributions

Oleiro V and Alexandrino EG: Conceptualization; Methodology; Validation; Investigation; Resources; Data curation; Project administration; Writing – original draft; Writing – review & editing; Approval of the final version. Rodrigues YG: Conceptualization; Methodology; Resources; Project administration; Writing – original draft; Writing – review & editing; Approval of the final version. Almeida BP and Castro YM: Conceptualization; Writing – review & editing; Approval of the final version. Freitas MPS, Corrêa LQ, Rodrigues R and Costa EC: Conceptualization; Methodology; Writing – review & editing; Approval of the final version. Volz PM: Conceptualization; Supervision; Project administration; Writing – review & editing; Approval of the final version. Zabisky C: Conceptualization; Visualization; Writing – review & editing; Approval of the final version. Silva MP: Conceptualization; Methodology; Investigation; Data curation; Writing – review &

editing; Approval of the final version. Del Vecchio FB: Conceptualization; Supervision; Project administration; Writing – review & editing; Approval of the final version. Dumith SC: Conceptualization; Methodology; Investigation; Data curation; Supervision; Project administration; Funding acquisition; Writing – review & editing; Approval of the final version.

Declaration regarding the use of artificial intelligence tools in the article writing process

The authors did not use artificial intelligence tools for preparation of the manuscript.

Availability of research data and other materials

The contents underlying the research text are contained in the manuscript.

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Received: 12/26/2024
Reviewed: 02/14/2025
Approved: 03/21/2025

Cite this article as:

Oleiro V, Alexandrino EG, Rodrigues YG, Almeida BP, Freitas MPS, Volz PM, Castro YM, Zabisky C, Corrêa LQ, Rodrigues R, Silva MP, Costa EC, Del Vecchio FB, Dumith SC. Effects of high-intensity interval training on different health outcomes among high school students in southern Brazil: Protocol for a cluster-randomized trial. Rev. Bras. Ativ. Fis. Saúde. 2025;30:e0393i. doi: 10.12820/rbafs.30e0393i

Supplementary Material

Supplementary Table - General Cognitive Assessment Battery – Cognifit®.

Cognitive ability assessed	Cognitive test
Divided attention	DIAT-SHIF Simultaneity Test.
Focus	REST-HECOOR Speed Test
Inhibition	REST-INH Processing Test INH-REST Equivalence Test
	UPDA-SHIF Synchronization Test
	INH-REST Equivalence Test
Update	COM-NAM Identification Test REST-INH Processing Test
	COOR accuracy test
	HECOOR Coordination Test
Phonological short-term memory	WOM-ASM Sequential Test
Contextual memory	COM-NAM Identification Test REST-COM Research Test
Short-term memory	WOM-ASM Sequential Test
	VISMEM-PLAN Concentration Test

The "General Cognitive Assessment Battery - CAB" from the Cognifit® platform (www.cognifit.com) is made up of 17 tasks that assess different cognitive abilities with an application time of approximately 30 minutes. This battery was applied in the IFRS - Rio Grande Campus computer room the week before the start of the HIIT-short intervention and immediately the week after the end of the intervention to assess the possible effects of HIIT training on brain functions.