PHYSICAL ACTIVITY PROTOCOLS DEVELOPED FOR ADOLESCENT SCHOOLCHILDREN

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Abstract:
Cardiovascular diseases are the leading cause of global mortality, and the risk factor for cardiovascular disease is associated with atherosclerotic progression, not only in youth but also in early adulthood. Researchers point out that there is a need to identify effective interventions that can modulate such risk factors early in life for the primary prevention of atherosclerosis. **Objective:** To identify the existing physical activity protocols that can be optimized for the health of children and adolescents within the school environment. Methodological path: The present is a systematic review of the scientific literature in which research results obtained from articles found in the following online databases were generated: PUBMED, SciELO, Capes Portal, and Virtual Health Library. After stratifying the selected studies, a final sample of 7 studies was obtained. **Results:** Among the findings in the research, two types of different physical activity protocols are included: the first being resistance training protocols and the second being high-intensity interval training, which included trial researches and clinical trials, in which the adolescents participated in the two aforementioned training sessions. There were also studies in which the student performed the protocol of continuous moderate-intensity exercises and received nutritional counseling. There were also programs carried out in several schools that encourage the practice of physical activity at school to improve the

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cardiorespiratory fitness of adolescents. **Conclusion:** The study demonstrates the need for research that establishes regional intraschool activity protocols capable of impacting the reduction of cardiovascular risk, and preventing future health complications of these adolescents, such as acute myocardial infarctions and strokes, especially in the school environment since it is the place where this population gathers for the longest time, and healthy lifestyle habits should be promoted in this space.

Keywords: protocols, cardiovascular disease, teenagers, respiratory fitness, physical activity

1. Introduction

In the last century, the accelerated growth of the urbanization process, linked to industrialization and technological development, has triggered changes in the lifestyle of populations, the adoption of inappropriate eating habits, and physical inactivity. This context contributed to a change in the main causes of mortality and morbidity with the predominance of Chronic Non-communicable Diseases (NCDs) concerning infectious diseases (Brito, 2016).

NCDs are the main cause of death worldwide, being responsible for premature deaths, and loss of quality of life, in addition to adverse economic and social impacts. NCDs are responsible for about 70% of global deaths, equivalent to more than 38 million deaths per year, significantly exceeding deaths from external causes and infectious diseases. Of about 45% of all NCD deaths in the world, Cardiovascular Disease (CVD) causes more than 17 million. A similar distribution is observed in Brazil, where 72% of deaths result from NCDs, with 30% due to CVD and 16% to neoplasms (Oliveira et al., 2022).

In this sense, cardiovascular diseases have been the main causes of disability and deaths in Brazil, both for women and men. According to the estimates of the GBD Study 2019 (Global Burden of Disease), among CVDs, ischemic heart disease (IHD) was the leading cause of death in Brazil, followed by stroke. IHD accounted for 32.3% of all CVD deaths in Brazil and stroke accounted for 27.8%. The highest proportion of mortality due to IHD occurred in Mato Grosso do Sul, Pernambuco, and São Paulo, while the highest proportion of stroke deaths occurred in Amazonas, Amapá, and Distrito Federal (Oliveira et al., 2022).

In this risk, when the percentage of disability-adjusted years of life (DALYs) is determined and the values are converted to estimated deaths due to IHDs, it is found that it was responsible for 4.78% of deaths in women and 6.48% in men. In 2019, in Brazil, the incidence rate of IHD (mainly acute myocardial infarction), standardized by age was 78 per 100,000 in women and 148 per 100,000 in men. Regarding chronic IHD (AMI - Acute myocardial infarction previous, stable angina or ischemic heart failure), the prevalence standardized by age was 1,046 per 100,000 women and 2,534 per 100,000 men (Oliveira, 2022).

Regarding this risk, it is known that the origin of CVD is multifactorial and since its genesis, the participation of risk factors (RF) is observed. These are variables that predispose to the onset and development of heart diseases, so their monitoring helps in the identification of precursor signs that, when modified, can decrease or even reverse the evolutionary process of dysfunctions (Canovas, 2012).

Therefore, the GBD study (2019), points out that among the risk factors for CVD in Brazilian women, systemic arterial hypertension, dietary risks, obesity, increased serum cholesterol and high fasting glycemia stand out. The RF that increased the most in Brazil, from 1990 to 2019, was the high body mass index (BMI), causing metabolic alterations that could lead to hypertension, diabetes, and dyslipidemia, increasing individual risk, especially for women (Brant, 2021). Specific risk factors for stroke in women include pregnancy, preeclampsia, gestational diabetes, use of oral contraception, use of hormones in menopause, and changes in hormonal status (Virani, 2021).

In this sense, cardiovascular diseases are the main causes of global mortality, and the status of the risk factor for CVD in early life is associated with atherosclerotic progression, not only in youth, but also in early adulthood. Skierspoint out that there is a need to identify effective interventions that can modulate risk factors for CVD early in life for the primary prevention of atherosclerosis, thus assisting in the development of health policies to improve awareness and access to life-saving interventions (Laitinen et al., 2012; Oliveira, 2022).

Based on the World Health Organization (2012), one of these interventions is the promotion of physical activity since the time spent performing physical activities of moderate to vigorous intensity in youth is inversely associated with the future risk of CVD. However, only one in five children and adolescents reaches the recommended daily minimum of 60 minutes of moderate to vigorous intensity physical activity. A recent meta-analysis highlighted that currently, physical activity interventions at school have only a small effect on the increase in general levels of moderate to vigorous activity in children and adolescents (Hallal et al., 2012).

Associated with a low incidence of physical activity in childhood and youth, other risk factors stand out, such as obesity and smoking as a consequence of excessive exposure to screens. Hancox et al., (2004) demonstrated that excessive exposure to television screens in this phase of life was associated with smoking, low physical fitness, being overweight and high cholesterol in adulthood. Thus, the study states that school programs that used longer children's time for extra-class activities could minimize exposure to sedentary behaviors such as prolonged exposure to screens.

In this sense, according to the above-mentioned aspects, identifying the problem that chronic degenerative diseases are of great concern to public health in Brazil, and that the life habits prevalent in childhood and youth may be able to reduce the incidence of cardiovascular diseases in adulthood, associated with the fact that individuals in this age group of life are on average two-thirds of the active day in the school unit, the following guide question arises: What protocols have the possibility of acting in the prevention/reduction of cardiovascular risks? Thus, the present study aims to highlight

the protocols of physical activity in the school environment which are capable of preventing cardiovascular risks.

As a result, there is interest in identifying which are the existing physical activity protocols that can be optimized for the health of children and adolescents within the school environment, since in this place, it is possible to find most of these individuals gathered at the same time and space.

2. Material and Methods

The present is a systematic review of the scientific literature in which results of research obtained in articles found in the following online databases were generated: PUBMED, SciELO, Portal Capes, and Virtual Health Library. This search in the aforementioned databases aims to gather and synthesize the scientific knowledge already produced on the researched theme, allowing the screening, evaluation, and synthesis of numerous foundations available for its conformation in practice, contributing to the deepening of academic scientific knowledge.

According to the recommendations for conducting a systematic review of the literature, and starting from the search for the best evidence, the fundamental question of the present study was defined from the PICO method (P = participants; I = intervention; C = comparison; O = result) (Toti, 2020). This type of study can provide potential contributions and is a valuable part of the process of creation and organization of the body of knowledge on a given topic.

Thus, to meet the objectives of the present study, the review followed the defined criteria and was based on the following methodological steps: 1. Selection of the question for review; 2. Sample selection; 3. Definition of the characteristics of the sample studies based on inclusion criteria defined by the authors; 4. Conducting the search for studies in the databases; 5. Consensus meeting to define the studies that would make up the research; 6. Stratification and writing of the discussion of the results found and 7. Presentation and dissemination of the results.

Initially, the descriptors were delimited through the website of descriptors in health sciences (Decs), in which they were established in Portuguese (Protocols; Cardiovascular Disease; Adolescents), and in English (Protocols, Cardiovascular disease, Teenagers), as well as the use of Boolean AND to perform the crossing of the descriptors. Based on the search strategy, the abstracts of relevant research studies found were downloaded and selected independently. The studies considered fit for the inclusion and exclusion criteria that were fully available were downloaded. After the pre-selection of the articles, a consensus meeting was held among three researchers to interchange the relevance of those for the review in question and was independently evaluated for relevance by two authors using the criteria predetermined below.

Inclusion criteria were: a) Portuguese and English languages; b) The present is a field study using a physical activity protocol; c) Be available in full; d) Have been developed in the school environment with adolescents; (e) Have been published between 2016 and 2022. Exclusion criteria were: a) Duplicate studies in databases; b) Studies that

do not present the theme; c) Several articles that come from the same study using the same target audience and the same protocol; d) Literature reviews; (e) Studies that are not available in full text; f) Those that do not meet the inclusion criteria.

In the PubMed database, applying the inclusion criteria of publications of the last 5 years, with the crossing of the descriptors: Protocols AND "Cardiovascular disease" AND Adolescents did not obtain any results, and when the following English terms were used: "Protocols" AND "Cardiovascular disease " AND "Teenagers," 115 results were found, of which, after applying the other inclusion and exclusion criteria mentioned above, 8 articles were selected, so that when analyzing the studies at the end of the database, in similar articles, it was also possible to select 12 studies related to the theme due to their relevance. Thus, after reading the 20 studies in full, and holding a consensus meeting between the three authors, 13 articles were excluded for not objectively answering the primary objective of the present review, thus seven articles participated in the present study.

In the SciELO databases, Portal Capes, and Virtual Health Library (VHL), the research was carried out with the same descriptors mentioned in the PUBMED database and with the same technical rigor, so that, with the crossing of descriptors in Portuguese, there were no results.

With terms in English, there were 45,797 results in the SciELO. With terms in Portuguese, there were 260, and in English, there were 2,968 results in the Portal Capes. Regarding the terms in English, there were 187 results, and 68 results were found in Portuguese in the VHL database, however, the results did not meet the inclusion and exclusion criteria previously defined, making it impossible to compose the results of the present study.

3. Results

In total, 7 studies were included in the final synthesis. The selection process of the studies is shown in the PRISMA flow diagram, as shown in Figure 1 below.

Figure 1: Data search stratification flowchart
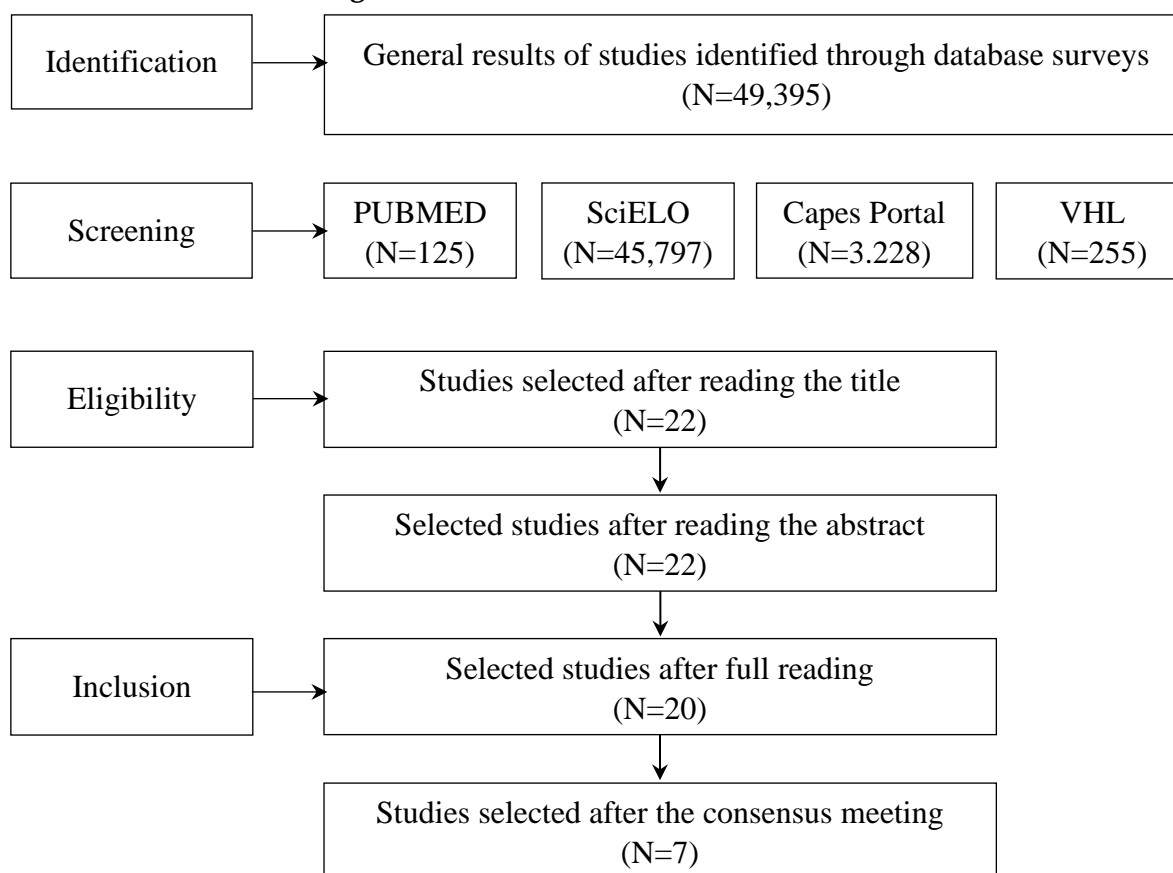
Source: Author' research, 2022.

Considering the above, the stratification table was constructed with relevant information from each study, which is responsible for answering the initial questions and objectives proposed in the present research. The table presents the database in which the article is hosted, the title, author, and years of publication, as well as the objective and aspects related to the participants of each study, and finally, the protocol that was used in each of these studies.

Table 1: Stratification of the studies that are part of the sample of the present study

Data Base	Title/Author/Year	Objective	Aspects Related to Participants	Protocol Used
PUBMED	The effects of aerobic training, resistance training, combined training and healthy eating recommendations on lipid profile and body mass index on overweight of obese children and adolescents: a	Evaluate the effects of 8 weeks of aerobic training, resistance training (RT), combined training, and nutritional recommendations on lipid profile and body mass index (BMI) in obese and	The study was conducted in Iran, between the years 2017 to 2018; **Participants:** 120 overweight or obese children and adolescents; **Age:** 10 and 19 years;	*Resistance training (RT); *High-intensity interval training (HIIT); *RT + HIIT; The protocols were divided into 4 groups with 30 participants each: 1st RT Group; 2nd HIIT

	randomized clinical trial. **Alireza Ahmadi**, *et al*.; 2020.	overweight children and adolescents.	**Training time:** 8 weeks; **Exclusion Criterion:** Participants with some comorbidities.	Group; 3rd Mixed Group RT + HIIT and 4th Control Group, which did not intervene.
PUBMED	Evaluation of the process of a high-intensity interval training program based on school for older adolescents. **Kennedy, Sarah G**. *et al*; 2020.	Write the process evaluation of a high-intensity interval training program based on school (HIIT) for older adolescent students.	The study was conducted in New South Wales, Australia, between 2018 and 2020. **Participants:** The program was evaluated through a randomized cluster group controlled in 20 schools (10 schools participating in the intervention, and 10 schools considered the control group). **Age:** 15 to 19 years. **Evaluation time:** 24 months;	Burn 2 Learn (B2L): School physical activity program designed to improve CRF (cardiorespiratory fitness) of older adolescents; The protocol used in the program was high-intensity interval training - HIIT.
PUBMED	Sex differences in high-intensity interval training - are HIIT protocols interchangeable between women and men? **Schmitz, Boris.** *et al*.; 2020.	Characterize the differences in training performance of two HIIT protocols with different periods of relief (30 vs. 180 s) for women and moderately trained men in a real-world environment.	The study conducted at the Institute of Sports Medicine of Muenster University Hospital; **Participants:** 50 young female and male students with moderate, healthy training were recruited, but 12 were excluded because they presented some injury/disease not related to the study.	HIIT - High-intensity interval training; Two HIIT protocols of total execution of 4×30s with time and workload matching were compared: a 4×30:180 protocol and a 4×30:30.

			Age: Over 18 years;	
PUBMED	Acute cardiorespiratory, perceptual and pleasure responses to high-intensity interval exercise in adolescents. **Malik, Adam A.** *et al.*, 2020.	Describe the acute cardiorespiratory picture (HR and V-O2) and perceptual responses (RPE) of adolescent boys and girls during an 8× 1 min HIIE protocol;	The study was conducted at the Blundell's school in Devon, UK; **Participants:** 54 adolescents, 27 of whom were male **Age:** 12 to 15 years;	Protocols: High-intensity interval exercises (HIIE); and continuous moderate-intensity exercises (IMC).
PUBMED	Associations between gender, school, socioeconomic status, and cardiorespiratory fitness among elementary and high school students. **Walker, Timothy J.** *et al.*; 2020.	Examine gender differences in cardiorespiratory fitness among elementary and high school students; Evaluate the relationship between the socioeconomic status (SES) at the school level and the students' levels of cardiorespiratory fitness.	The study was conducted by schools in the Dallas, Texas (USA) metropolitan area **Participants:** There were 67 schools and 15,052 students included in the analysis for 3 years. The study was evaluated in 2017 and 2018.	HZS Program: FitnessGram assessment is carried out in all participating schools and activities offered throughout the school year to its students. The aerobic capacity of the students is performed using one of the three tests: a) the 20 m pacemaker; b) the 15 m pacemaker; c) a one-mile run and its results are inserted into the FitnessGram software provided to the schools.
PUBMED	Effects of exercise intensity and nutritional counseling on myocardial function in obese children and adolescents: a randomized controlled multicenter study protocol. **Dias, Katrin A.** *et al.*; 2016.	Compare the efficacy of three 12-month interventions: HIIT and nutritional counseling, MICT, nutritional counseling, or just nutritional counseling on myocardial function in obese children and adolescents.	The study was conducted at the Norwegian University of Science and Technology (NTNU), Trondheim, Norway, and the University of Queensland (UQ), Brisbane, Australia; **Participants:** 100 obese and 100 thin, children or adolescents who entered the	HIIT (high-intensity interval training) and the MICT protocol (moderate-intensity continuous training); Strategy: Group 1 - HIIT and nutritional counseling; 2 - MICT and nutritional counseling; 3 - nutritional counseling only. Note: Obese participants were randomized to one of the three groups and stratified according to age and gender;

			control group, who are healthy aged between 7 and 16 years of age; **Evaluation time:** 12 months.	the thin ones were stratified for the same group, but no intervention was administered.
PUBMED	High-intensity interval running improves physical fitness measures, but not metabolic measures of cardiovascular disease risk in healthy adolescents. **Buchan, Duncan S**. *et al*. 2013.	Examine the effects of a HIT intervention on several CVD risk factors.	The study was conducted in Scotland, United Kingdom. **Participants:** 89 school-age adolescents, attending between the 5th and 6th grade of elementary school; participants were in the control group (34 boys, 13 girls), who were instructed to continue their normal behavior; the participants of the HIIT group (30 boys, 12 girls), were instructed to complete a maximum effort sprint of 30 s at a distance of 20 m separated by cones.	HIIT (high-intensity interval training).

Source: Author' research, 2022.

In the study by Ahmadi *et al*., (2020), preliminary data were obtained before the beginning of the application of the interventions and after 8 weeks of the intervention in the four groups by filling out a checklist, measuring anthropometric indices, including weight, height, waist circumference, and hip circumference and BMI., Blood samples were also collected for blood tests, lipid profiles, including triglycerides, cholesterol, HDL, and low-density lipoprotein (LDL) were performed.

After the collected data, educational interventions were performed at separate times, and guidance was carried out with the HIIT, RT, and the combined HIIT + RT groups with nutritional counseling in an individualized way with the specific groups. The nutritional recommendations were held in three educational sessions of 60 minutes of lecture with questions by the researchers and their guardians, and answers were

provided by the nutritional professional. At the end of the sessions, participants received educational sports exercise brochures and healthy eating recommendations to continue learning at home.

At the end of the educational sessions, the intervention groups exercised based on the training program elaborated in the form of the 3 aforementioned HIIT, RT, or combined HIIT + RT programs. The training program totaled 24 training sessions. Each exercise session included 10 minutes of warm-up, performed using on-site running and stretching movements, followed by 10 minutes of cooling, performing stretching movements in this period. The exercises related to the HIIT group had an estimated total time of 30 minutes of training, followed by a rest time of 20 seconds between each exercise performed so that the exercises would not be infringed.

For the components of the high-intensity interval training program and its settings, nine types of exercises were used, so that the performance time for each was 3 minutes. They consisted of C-burpee; Floor tap squat; Side to side burpee; Knee lifting exercise; Jump squat; Lung, lung, lung, lung. Squat jack; Controlled burpee and Scissor squats.

In the RT group, the interventions were performed in 3 sets, each containing 3 items, and Set 1 was composed of the following exercises: Squats= 8 to 10 repetitions; Push-ups= over 12 repetitions; Crunches= 30 to 45 seconds; Glute bridge= more than 12 repetitions. Set 2 consisted of the following exercises: Pull-ups= 8 to 12 repetitions; Bicycle crunches= 30 to 45 seconds; Shoulder press= 8 to 12 repetitions; in Set 3, the exercises included: Bent-knee bench dip= more than 12 repetitions; lying back extension for 30 to 45 seconds.

For the RT group, the rest of 30 seconds was oriented between each exercise performed, and 60 seconds of rest between one set of exercises and another was considered the ideal total time to perform the 30 minutes. Within the RT + HIIT groups, HIIT and RT exercises were performed at 3-minute intervals for each session, and the estimated time for completing the 30-minute training activity was also considered.

The instructions for the intervention groups, with the demonstration of the correct way to perform the movements of the exercises, were offered in the Outpatient Clinic of the Pediatric Cardiovascular Research Center, and later, the participants continued the exercises at home. To monitor the program of exercises of the participants, telephone calls were made every week to obtain information regarding the development of the protocol. Since no specific sports intervention was considered for the control group, the participants of this group only performed routine activities, and at the end of the research, there was again the exposure of ethical considerations regarding the study, which included explaining the effective methods of weight loss and dietary counseling and physical training for the control group.

Also, regarding the task for analyzing training programs capable of reducing cardiovascular risk factors, the study by Kennedy *et al* were found. (2020) Burn 2 Learn (B2L) is a school physical activity program designed to improve the cardiorespiratory fitness (CRF) of older adolescents who are considered to be between 15 and 19 years of age.

Data collection and delivery of the intervention occurred through two cohorts of 10 schools (Cohort 1: February 2018 - February 2019; Cohort 2: February 2019 - February 2020). The schools within each cohort were paired, and the pairs were randomly assigned to the B2L intervention or to a waiting list control condition (i.e., continued normal school activities), for the 12-month study period. Two teachers from each study school were recruited as school champions (i.e., teachers willing to facilitate the application of the intervention).

The teachers of the schools allocated to the intervention group received training to carry out the B2L program. In the present study, the B2L intervention was carried out in three phases: Phase 1 – Starting, which lasted 3 months (May to July 2018/19); Phase 2 - Maintaining the student's interest, also lasting 3 months (July-September 2018/19) and Phase 3 - Towards independence, lasting 6 months (October 19, 2018, to February 20, 2019/20).

In Phase 1, the school champions were instructed to focus on developing HIIT competence and students' self-esteem (e.g., developing/reinforcing the correct technique and knowledge of the HIIT session structure). Phase 2 provided a greater emphasis on student autonomy and responsibility, providing choice and allowing students to design their HIIT sessions based on the knowledge offered to them. In Phase 3, students were encouraged by teachers to complete their HIIT sessions outside of school hours.

HIIT training was demonstrated with current themes and simple movements, involving a combination of aerobic exercises that can be performed by all fit adolescents (e.g., shuttle races, skipping rope, and dance movements), and muscle strengthening exercises (e.g., triceps diving and body weight squatting).

Another finding of the research is the study by Malik (2017), in which the HIIE protocol consisted of heating of 3 min to 20 W, followed by intervals of 8 × 1 min to 90% of the given peak power of the ramp test to exhaustion, interspersed with 75 seconds of recovery at an intensity of 20 W, before cooling for 2 minutes with the intensity of 20 W. The CMIE protocol incorporated continuous cycling of moderate intensity to 90% of the total energy expenditure (TEE). Participants were encouraged to maintain a constant cadence between 70 and 85 rpm and remain seated in both the HIIE and IMC protocols. Samples of expired gases during the cardiorespiratory fitness test and exercise protocols were measured breath by breath using a calibrated metabolic cart (*Cortex Metalyzer III B, Leipzig*, Germany). Heart rate responses were continuously recorded using a telemetry system (Polar Electro, Kempele, Finland). Gas exchange and HR data were subsequently calculated at 10-second intervals.

Perceived pleasure after the HIIE and IMC was measured using modified PACES for adolescents, which is validated for use with adolescents (Motl *et al.*, 2001). PACES includes 16 items that are evaluated on a 5-point scale (score 1 = "strongly disagree" to score 5 = "I fully agree"). The total pleasure was calculated by adding the 16 answers after seven items were scored in reverse. This resulted in a possible score range of 16 to 80, with a higher score representing greater pleasure. In addition, the scores of the individual items were also taken into account for the analysis. Participants completed PACES within 5 minutes of the end of each exercise protocol.

In this sense, it is important to highlight the study with a randomized and controlled multicenter study protocol conducted by Dias *et al.*, (2016) phase I of the mentioned study examined the efficacy of an intensive period of 3 months on the results with evaluations at the beginning of the study and after 3 months of supervised training. Phase II determined the amount of supervision required to maintain exercise habits during a 9-month home training period. For this phase, participants were randomized to: (1) monthly supervised exercises or (2) home exercises only. The final evaluations were completed at 12 months.

The proposed exercise intervention involves a combination of supervised and unsupervised exercise training sessions. Participants participated in at least two, and up to three supervised training sessions each week for 12 weeks. If participants choose to attend two supervised sessions, they will be required to complete the third session of unsupervised exercises at home. After the 3-month supervised period, participants in each of the two exercise groups will be randomized to 'monthly supervised exercise' or 'home exercise only' from 3 to 12 months.

During this time, participants from the HIIT and MICT groups were asked to complete three unsupervised training sessions each week for 9 months, and for the 'monthly supervised exercise,' the group was invited to participate in supervised training sessions once a month at the clinical center. Supervised exercise training (HIIT and MICT) consisted of walking or running on a treadmill or pedaling on an exercise bike, according to the participant's preference. During the unsupervised exercise session, the mode may vary. The necessary speed/tilt and resistance adjustments will be made throughout the intervention to ensure that the target heart rate zones are reached at all times. Heart rate perceived effort assessment (RPE) according to the Stress Assessment Table (PCERT), and exercise mode will be recorded in a training booklet during supervised and unsupervised exercise sessions. The training protocols were followed as directed below:

A. HIIT: High-intensity interval training
Participants randomized to the HIIT performed a warm-up of 10 min at 60-70% of the maximum heart rate (HRmax). Next, they walked, ran or pedaled at 85-95% of their HRmax for four minutes, with 3 min of active recovery (50-70% of HRmax) between intervals. The participants performed a cooling period of 5 minutes, in the end, totaling a total exercise time of 40 minutes.

B. MICT: Moderate intensity continuous training
Participants randomized to the MICT group walked, ran, or cycled continuously at 60-70% HRmax for 44 min to approximate the average energy expended by the HIIT Group, as previously calculated by the research group.

C. Nutritional advice
The HIIT, MICT, and nutrition groups received 8 to 10 sessions of 20 minutes of individual nutritional counseling with a nutritionist during the 12-month period. The content of the sessions included healthy food choices, portion sizes, and regular meal

times. The nutritional advice offered was related to current Norwegian and Australian dietary guidelines and was in accordance with local specifications. The nutrition group will not receive any prescribed supervised exercise.

D. Heart rate variability

Participants lay in the supine position for 10 minutes in a quiet and dark environment before the start of the procedure. Participants were asked to remain as still as possible for 5 minutes while an ECG tracing is monitored and recorded to calculate the heart rate variability. The RR intervals obtained on the ECG were processed in the Kubios HRV program (University of Eastern Finland, Finland).

E. Body composition

At the Brisbane site, dual-energy X-ray absorptiometry (DXA) was used to determine body composition (adipose tissue and lean muscle mass). This required the participant to lie motionless while an x-ray of his/her entire body is taken with the DXA scanner (Hologic, QDR Series, Massachusetts, and USA). The duration of a full-body scan was 7 minutes.

Venous blood samples were collected from an antecubital vein according to standard phlebotomy procedures. Samples will be collected in three *vacutainers* containing EDTA, uoret phloxalate, and clot activators. *Vacutainers* were stored in ice or left to coagulate at room temperature for at least 30 min (serum samples). The samples were analyzed for lipids (total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides), glucose, and insulin (to establish insulin resistance and β cellular function, using evaluation of the homeostatic model of insulin resistance (HOMA-IR), and C-reactive protein (CRP).

Other Measurements: Height, weight, waist circumference (WC) and hip circumference (CK), and blood pressure were measured using standard approaches.

The present pilot study states that it provided an opportunity to receive feedback from the patient population in question. While a proportion of obese adolescents did not like HIIT until they improved their cardiorespiratory fitness levels, most reported liking it, which resulted in high attendance and training adherence. Freedom with the exercise modality also increased the viability of HIIT in this group.

During the ongoing clinical trial, feedback from participants and families was welcomed and resulted in minor protocol adjustments. Notable adjustments included the structure of evaluations and the frequency of supervised exercise sessions offered to assist in the treatment, however, in the present study, there was no disclosure of the data found regarding the measures performed.

Another study found in the review was that of Buchan *et al.,* (2013), in which, for the participants of the HIIT group, the protocol was performed 3 times a week. Training progression was implemented by increasing the number of repetitions from four during weeks 1 and 2, to five during weeks 3 and 4, to six during weeks 5 and 6. During week 7, participants still performed six repetitions, but each was interspersed by only 20 seconds

of recovery. Overall, participants performed 54 minutes of exercises during the intervention period.

Participants received a familiarization test of four low-intensity executions before the beginning of the intervention. The sprint time and recovery period were manually recorded by the same investigator. All participants completed a validated physical activity questionnaire for adolescents (PAQ-A).

In general, 20 participants were classified as overweight, 69 of them with a healthy weight. Eating habits were also similar, with both groups consuming diets higher than the recommended limit for intake of saturated and total fat. Of the 21 exercise sessions, the average attendance of the participants involved in the intervention was 16.6 ± 1.5. The absences were due to illness, medical consultation, lack of adequate clothing, or attendance at the internship. No injuries were reported during the intervention, and in terms of compliance, no participant withdrew from the study. This is encouraging since intense and vigorous exercise for youths is often considered unfeasible for many.

4. Discussion

At the end of the study conducted by Ahmadi et al., (2020), the statistical analysis of demographic information did not show significant differences between the groups regarding age and gender. When observing the comparison of physical variables and blood lipid profile, it was evident that there were no significant differences between the case groups and the control group before the intervention, however, after the intervention, there was a significant difference between the groups regarding HDL levels, and the lowest mean was observed in the control group, and the HIIT group presented the highest mean.

The study showed that the combined RT + HIIT program had a significant effect on the reduction of BMI of the participants. However, the post-intervention weight of the groups did not present significant alterations, except for the RT group, in which the weight increased significantly after the intervention, a fact that may be associated with the gain of lean mass due to the type of physical exercise performed in this modality, but it is not possible to affirm because the study did not perform skinfold and bioimpedance measurements of the participants.

Another finding of the study was that waist and hip circumferences after the intervention had a greater increase in the RT group, and the mean hip circumference was also observed as higher after the intervention in the HIIT RT + HIIT groups, respectively, which were significantly different compared to the control group. Lipid profile evaluation showed that cholesterol levels in the RT and HIIT groups decreased after exercise. In the control group, there was also a significant decrease in HDL, and this group presented the lowest mean among the other groups.

One of the most important strengths of the present study was the attention to exercise at home after elementary school, which can be done with minimal costs and facilities for all overweight and obese children and adolescents at any socioeconomic level. The study recognizes that the training time may have been small, as well as the

execution of the technique, considering that there was no face-to-face follow-up of a professional, because in other studies, such as that of Khammassi et al. (2018) who evaluated the effect of a HIIT program on the lipid profile of young people, reported improvements in weight, BMI and waist circumference as a result of the program, but the actual time was 12 weeks, 4 weeks longer than the aforementioned study.

Corroborating the aforementioned statements, the study by Dias et al., (2016), pointed out that participants in the HIIT group experienced a significant decrease in post-intervention Systolic Blood Pressure. The results revealed that body mass and waist circumference were maintained in the HIIT group, although significant increases in these measurements were evident in the control group. This suggests that the intervention may have affected the maintenance of body mass and waist circumference by limiting its increase during the intervention period, as observed in the control group.

The results of the present study indicate that it is feasible to implement HIIT interventions for adolescents within the school environment through a strict physical activity protocol. The results of the focus groups and informal discussions revealed that adolescents could perform strenuous intense exercises and enjoy the benefits of the activity. Although pleasure was not specifically measured, the study demonstrates that the participants' responses are accurate, given that the average rate of participation for the 21 exercise sessions was 16.6 ± 1.5 (~ 80%).

The results suggest that HIIT is an effective strategy to improve physical fitness measures in cohorts of adolescents. However, questions remain regarding the use of HIIT as an effective alternative for health and well-being concerning the recommendations of more traditional resistance exercises, and more studies are needed to apply HIIT and analyze its impacts on adolescent health.

Thus, we highlight the study of the Burn 2 Learn (B2L) program, in which it was demonstrated that one of the main barriers, if not the greatest of them, is the lack of time to practice physical activity in adolescence. On the other hand, scheduling, that is, the allocation of a specific time for physical activity opportunities facilitates implementation. With this program, a total of 10 schools were reached, and 337 students and 22 teachers actively participated in the research, 50% of the students were female and 55% of the teachers represented the female gender.

The results indicate that the B2L program was successfully implemented in Phases 1 and 2, with positive results in terms of reach, fidelity, and intention to deliver/participate in future physical activities autonomously. There were also positive results for many implementation determinants. The fully completed curriculum is a considerable barrier to the implementation of physical activity interventions in schools. Despite the adaptability of the program and the program during the first two phases, once given the option, fewer teachers implemented the sessions, and there is little evidence that students completed the sessions outside of school hours during Phase 3.

Professional learning was provided to teachers before the application of the B2L intervention to increase their knowledge, skills, and confidence to implement the program. The study demonstrates that the provision of teacher training with professional

learning workshops is essential for the high-quality implementation of physical activity programs.

The B2L intervention was successfully implemented with a series of positive perceptions related to the program reported by teachers and students. The results of the present study provide recommendations on the need for continuous support for students and teachers, and the incorporation of activity opportunities within the school day to maximize implementation with quality and sustained participation in physical activity throughout life.

Nevertheless, to achieve the regularity and continuity of physical activity, it must be pleasurable, thus, Malik's study (2017) in cardiorespiratory, perceptual and pleasure acute sports to high-intensity interval exercise in adolescents aimed to describe the acute cardiorespiratory condition (HR and VO2), and perceptual responses (RPE) of adolescent boys and girls during an HIIE protocol compared to the work-compatible moderate-intensity continuous exercise protocol (IMC).

According to the participants of Malik's research (2017), for the general perception of the exercise protocols, 81% of the participants expressed a preference for the performance of the IHI in relation to the IMC. Together with the greatest pleasure after HIIE, the results support the idea that exercise pleasure can serve as a potential mediator for the promotion of Juvenile Physical Activity (PA), since it may influence future participation and non-participation in exercises, a fact already established by Allender, Cowburn, & Foster (2006) and Salmon, Brown, and Hume (2009).

HIIE could be an effective health improvement strategy in contrast to the IMC due to high pleasure and preference. In the present study, however, exercise pleasure was measured after the exercise, and a recent debate on the application of HIIE as a public health strategy to promote PA questioned the role of HIIE due to high unpleasant feelings during high-intensity exercises (Biddle & Batterham, 2015), therefore, pleasure responses during exercise along with affective assessments (i.e., feelings of pleasure/displeasure), are necessary for future studies of HIIE in children and adolescents.

Several limitations must be recognized. The present study documented the acute cardiorespiratory, perceptual, and pleasure responses to HIIE performed in an ergometer cycle and it is not possible to extrapolate with other exercise modalities (e.g., running), due to potential differences in cardiorespiratory responses and preference for exercise mode. Another potential limitation is that pleasure was quantified after, but not during, exercise sessions (Millet, Vleck & Bentley, 2009).

5. Conclusion

To take studies show that the unhealthy nutritional transition, with an increase in the consumption of food low in nutrients and rich in energy, can lead to atrophied growth along with weight gain in children, adolescents, and adults, resulting in higher BMI and worse health outcomes throughout life. In this sense, interventions to control weight and reduce the adverse effects of obesity, including intensive behavioral therapy for diet and exercise change, screening and treatment of hypertension, glucose intolerance,

dyslipidemia, and abnormal liver function in children and adolescents with obesity, and in extreme cases, bariatric surgery is necessary (NCD Risk Factor Collaboration, 2017).

The review in question showed studies that outline parameters to promote physical activity among adolescents in school environments, demonstrating several techniques that can be used, including satisfactory results in reducing cardiovascular risk factors, however, it is emphasized that in Brazil, there is a broad regional diversity with different specific environmental and cultural characteristics.

Thus, the study demonstrates the need for research that points to regional intraschool activity protocols capable of impacting the reduction of cardiovascular risk, avoiding future complications to the health of these young adults, such as acute myocardial infarctions and strokes, especially in the school environment, since it is the place where this population meets for the longest time periods, and healthy habits of life should be opportunistic in this space.

6. Research's contribution to the field

Cardiovascular diseases are the leading cause of global mortality. A risk factor for cardiovascular disease is associated with atherosclerotic progression, not only in youth but also in early adulthood. In this sense, an ally in preventing these diseases is the practice of physical activity in adolescence. In this context, this review contributes positively to its field of study, as it brings together studies involving applied physical activity protocols and their respective results, demonstrating that they are capable of positively influencing the cardiorespiratory health of adolescents, serving as a reference for teacher's use in their daily practice.

Author's Contributions
M. H. J. Batista and T. S. Nunes designed, wrote, and edited the manuscript. L. dos Santos edited and corrected the manuscript. All authors approved the submitted version.

Conflict of Interest Statement
The authors declare no conflicts of interest.

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