



Effects of 15-minutes physical exercise on physical fitness of adolescents: A protocol study

Efeitos de 15 minutos de exercícios físicos na aptidão física de adolescentes: Estudo de protocolo

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ABSTRACT

Overweight, obesity, and low physical fitness (PF) are conditions associated with physical and mental health problems in children and adolescents. Schools and physical education (PE) classes provide ideal environments for promoting physical exercise, improving levels of PF, and preventing obesity in this population. This article outlines the protocol of an experimental study whose primary objective is to assess the effects of a 15-minute physical exercise program implemented during elementary school physical education classes on PF and anthropometric markers of overweight and obesity (AMOO). Enrolled students in 6th to 9th-grade classes within rural elementary schools located in a Southern city in Brazil will participate of the study. The participants will be randomized into the intervention group and control group. The intervention will last for 12 weeks with two sessions per week. Various components of PF and AMOO will be the primary dependent variables. Physical activity level, recreational screen time, sleep duration, physical self-concept, motivation for participating in PE classes, symptoms of anxiety, depression, and stress will be secondary dependent variables. Sociodemographic information and somatic maturation will serve as covariates. All variables will be measured pre and post-intervention. The study's findings will contribute to a better understanding of the potential of school PE classes to improve PF, AMOO, and, secondarily, health-related behaviors, motivation for participating in PE classes, and the mental health of students.

Keywords: Physical education; Obesity, School; Exercises; Health.

RESUMO

O sobrepeso, a obesidade e a baixa aptidão física (ApF) são condições associadas à problemas de saúde física e mental em crianças e adolescentes. A escola e as aulas de educação física (EF) são ambientes propícios para a promoção do exercício físico e a melhoria dos níveis de ApF e prevenção de obesidade nesta população. Este artigo descreve o protocolo de um estudo experimental que tem como objetivo primário identificar os efeitos de um programa de 15 minutos de exercícios físicos realizados durante as aulas de EF na ApF e em indicadores antropométricos de sobrepeso e obesidade (IASO) de escolares. Participação do estudo escolares do 6º ao 9º ano de ambos os sexos de escolas da zona rural de uma cidade do sul do Brasil. Os participantes serão randomizados em grupo intervenção e grupo controle. A intervenção terá duração de 12 semanas com duas sessões semanais. Diferentes componentes da ApF e IASO serão variáveis dependentes primárias. O nível de atividade física, tempo recreativo de tela, tempo de sono, autoconceito físico, motivação para a participação nas aulas de EF, sintomas de ansiedade, depressão e estresse serão variáveis dependentes secundárias. Informações sociodemográficas e maturação somática serão covariáveis. Todas variáveis serão medidas pré e pós intervenção. O resultado do estudo contribuirá para a melhor compreensão do potencial das aulas de EF escolar para a melhoria da APF, de IASO e, de forma secundária, em comportamentos relacionados à saúde, na motivação para participação nas aulas de EF e na saúde mental de estudantes.

Palavras-chave: Educação Física; Obesidade; Estudantes; Exercícios físicos; Saúde.

Introduction

Children and adolescents who are overweight, obese and unfit are more likely of developing physical and mental health problems, both in the short and in long term^{1,2}. Furthermore, these conditions exhibit bidirectional longitudinal associations throughout childhood and adolescence³ with a significant likelihood of trac-

king into adulthood^{4,5}.

Despite the compelling evidence pointing to the adverse health effects, there has been a global increase in the proportion of overweight and obese children and adolescents², accompanied by a decline in physical fitness (PF) levels⁶ over the past few decades. In Brazil, recent studies have unveiled a similar concerning trend,

with rising rates of overweight and obesity⁷ and a concurrent decrease in PF⁸.

Promoting physical activity (PA) and exercise practices is crucial for enhancing PF and preventing overweight and obesity in children and adolescents. Schools, especially through physical education (PE) classes, provide an ideal setting for interventions aimed at achieving these goals⁹⁻¹¹. The implementation of school-based interventions to enhance and promote PF is recognized as one of the top 10 international priorities for researching and monitoring the health of children and adolescents¹¹. A recent meta-analysis⁹ emphasized the positive impact of incorporating structured physical exercises during PE classes on students' PF, including anthropometric markers of overweight and obesity (AMOO).

However, it's worth noting that out of the 17 studies included in the meta-analysis of García-Hermoso⁹ which incorporated oriented physical exercises during PE classes, 12 of them used most or all of the PE class time to implement their intervention programs. This approach may limit the practical applications of these interventions, as PE also plays a crucial role in developing various other skills, abilities, and capacities in students. From this perspective, the other five studies¹²⁻¹⁶ included in the meta-analysis⁹ conducted their intervention programs by incorporating physical exercises for only a portion (10 to 15 minutes) of the PE classes. Their results also indicated improvements in PF and AMOO, suggesting that this intervention design can be effective. Recent studies conducted in Brazil, which also included 15 minutes of physical exercises during PE, yielded results consistent with previous findings^{17,18}.

Nevertheless, it's important to acknowledge that some of these studies¹²⁻¹⁸ did not report sample size calculations, random group allocation, blinding of assessment teams, or intention-to-treat analyses, which can impact their methodological quality. Consequently, the results from these studies should be interpreted cautiously¹¹. Furthermore, few studies have simultaneously analyzed various components of PF and AMOO. To address these existing gaps and contribute to a deeper understanding of interventions incorporating structured physical exercises during PE classes, additional research is needed. In this context, this protocol article outlines the methodological procedures for an experimental study whose primary objective is to assess the effects of a 15-minute physical exercise program implemented during elementary school physical edu-

cation classes on PF and AMOO in students.

Methods

This study outlines the methodology for a parallel, two-arm experimental research project. The research will be conducted with students who are currently enrolled in 6th to 9th-grade classes within rural elementary schools located in a Southern city in Brazil. The intervention will consist of incorporating 15 minutes of physical exercises at the beginning of PE classes. Full-time rural schools are currently implemented in 10 rural schools, reaching approximately 1,380 students. The study protocol was reported in accordance with SPIRIT¹⁹ recommendations, approved by the Research Ethics Committee of the Federal University of Pelotas School of Physical Education (5,843,236), and is registered on the Clinical Trials platform (NCT 05879900).

Student will be randomized into a Control Group (CG) and an Intervention Group (IG). For the CG, PE classes will not undergo any changes compared to the previously planned curriculum by the subject teachers and pedagogical coordination of the schools. For the IG, approximately 15 minutes of PE will be included at the beginning of the PE classes. The remaining time of the IG class sessions will continue with their previously planned content. The intervention will last for 12 weeks with two sessions per week. In the full-time rural schools, there are three weekly periods/classes of physical education, each lasting 50 minutes. However, classes occur twice a week on non-consecutive days. On one of the days, there is a 50-minute class (one period), and on the other day, there are two consecutive 50-minute classes (two periods in a row). This way, the intervention program will take place over 12 weeks, totaling 24 sessions.

Students from the 6th to the 9th grade of both genders who are regularly enrolled in the full-time rural schools will be considered eligible for the study. Students with physical or health limitations that prevent them from participating in physical activities, as well as those with cognitive limitations that interfere with the proper completion of research instruments, will be excluded from the study analysis.

The sample size estimation was conducted using G3 Power software, considering the following parameters: a) Two-way repeated measures ANOVA with within and between-group interactions as the statistical test; b) Effect size of 0.1 (small). This effect size was chosen because the study comprises different dependent variables,

with one of them being body mass index (BMI), which has been shown to be less sensitive to physical exercise interventions involving children and adolescents¹⁴; c) Statistical significance (alpha) of 0.05; d) Power (beta) of 0.80 (80%); e) Two groups and two measures; f) Minimum correlation between repeated measures of 0.5; g) Sphericity correlation equal to 1.0; and, h) An additional 15% for potential losses and refusals. Using these parameters, the estimated sample size was 230 participants divided into the two study groups.

To operationalize the study, the following steps will be taken: a) Initially, contact will be made with the Municipal Secretary of Education, Sports, and Culture (MSES) and the school administration teams to present the study proposal and request permission to conduct it; b) After obtaining the necessary authorizations, the PE teachers associated with the ten full-time rural schools will be contacted, and the study's objectives and procedures will be presented to them; c) Each of the full-time rural schools has a PE teacher responsible for the discipline for all 6th to 9th-grade classes. These steps ensure that the study is properly introduced to the relevant authorities and educators and that it can be conducted with the necessary permissions and cooperation.

Among the teachers who express interest and provide their informed consent to participate in the study (informed consent form), a simple random allocation process will be employed to assign them either to the CG or the IG. Teachers allocated to the IG will have their classes from 6th to 9th grade in elementary school assigned to the same group, and the same will apply to those assigned to the CG. Teachers assigned to the IG will be responsible for implementing the intervention program in their classes. They will undergo a theoretical and practical training on the program, including physical exercise routines, to standardize the procedures. Conversely, teachers allocated to the CG will receive training on Sport Praxeology and will be instructed to maintain the conduct of their classes according to the previously established curriculum. After the intervention period, teachers in the IG will be invited to participate in training on Sport Praxeology, while those in the CG will be invited to participate in training related to the physical exercise intervention program.

Once the teachers have been assigned to their respective groups, the number of classes and students from the 6th to the 9th grade under the responsibility of each teacher will be determined. Considering the

number of participants indicated by the sample size calculation, classes will be randomly selected to participate in the study. After selecting the classes and allocating them to their respective groups, the study's objectives and procedures will be presented to the students in the classroom. Students will be provided with an Informed Consent Form to take home to their legal guardians, and they will also receive an Informed Assent Form to sign themselves. Those students who are not interested in participating or are not authorized by their legal guardians to participate will continue with their regular PE classes but will not be included in the study. For students who are both authorized and interested in participating in the study, they will become part of the study sample and will undergo baseline measurements. Subsequently, after the 12-week intervention period, they will undergo post-intervention measurements.

The variables in this study will be organized into covariates, primary and secondary dependent variables, and the CG and IG as independent variables. Covariates will be used for sample characterization and, if necessary, for adjustment in statistical analyses. Sociodemographic and anthropometric information will be collected. Sociodemographic variables will include gender (male or female), age (difference between the date of birth and the date of data collection), current grade level (6th grade, 7th grade, 8th grade, 9th grade) and family income. Anthropometric variables will be measured following standard procedure²⁰ and it will include height (cm), body mass (Kg), sitting height (cm), and somatic maturation. Somatic maturation will be measured based on the method proposed by Mirwald et al.²¹, which involves estimating the distance, in years, that an individual is from their peak height velocity. This estimation will use the variables age, height, body mass, sitting height, and lower limb length (the difference between height and sitting height).

The primary dependent variables in this study will be PF and AMOO. PF will be operationalized through the following components: cardiorespiratory fitness (CRF), muscular strength/endurance, maximum strength, lower limb power, speed, agility, and flexibility. AMOO will include the following measures: BMI, waist circumference, waist-to-height ratio, and subscapular and tricipital skinfold thickness (Table 01). The secondary dependent variables will encompass the following measures: PA level, recreational screen time, sleep duration, physical self-concept, motivation for participation in physical education classes, and

symptoms of anxiety, depression, and stress (Table 1).

In this study, measurements conducted both before and after the intervention will be carried out by an evaluation team comprised of undergraduate and graduate students of PE. This team will undergo in-person theoretical and practical training on the procedures and standardizations for measuring the variables that constitute the study. The pre-intervention measures will take place one week before the commencement of the intervention at school facilities over two consecutive days. On the first day, questionnaires will be administered in the classroom. Following the completion

of the questionnaires, the evaluation team, in collaboration with the students, will review the instruments to ensure that all information has been properly recorded. On the second day, anthropometric measurements and PF tests will be conducted. Anthropometric measurements will be performed in a dedicated room provided by the schools, while the PF tests will take place in the PE practice spaces of each school. The same procedure will be followed for the measurement of post-intervention variables, which will occur in the week immediately following the conclusion of the intervention period. The blinding process will only apply to the evaluators

Table 1 – Primary and secondary dependent variables, instruments and measures operationalization.

Variables	Instruments	Measure operationalization
Primary dependent variables – Physical Fitness		
Cardiorespiratory fitness	6 minutes run/walk test ²⁰	- Distance covered, in meters, at the end of the test time (6 minutes)..
Muscular endurance	Sit-up test ²⁰	- Number of complete movements performed during one minute (repetitions per minute)..
Maximal strength	hydraulic hand-grip dynamometer ²³	- The best result out of three measurements taken with both hands (left/right) of maximal hand-grip strength (kgf)
Lower limb power strength	Horizontal jump test ²⁰	- The best result of two attempts will be recorded (cm).
Sprint	20 meter Sprint test ²⁰	- The best result of the test distance (20 meters) in two attempts (sec).
Agility	4x4 meters square test ²⁰	- The best result of the square course (4x4 meters) in two attempts (sec).
Flexibility	Sit and reach test ²⁰	- The best result achieved in two attempts (cm).
Primary dependent variables – Anthropometric Markers of Overweight and Obesity		
Body mass index (IMC)	BMI equation ²⁰	- Result of the ratio (division) between body mass measurement and height in meters squared (kg/m ²).
Waist circumference	Anthropometric tape ²⁰	- Result of the measurement taken from the midpoint between the lower edge of the last rib and the upper edge of the iliac crest (cm).
Waist-to-height ratio (W/H)	W/H equation ²⁰	- Result of the ratio between the waist circumference measurement and height, both in centimeters.
Triceps and subscapular skinfolds	Scientific adipometer ²⁴	- The measures of triceps and subscapular skinfolds thickness will be taken according standard procedure (mm).
Secondary dependent variables		
Physical activity	QAFA ²⁵	- A list of 19 physical activities and the possibility to insert two more activities to indicate the frequency (days / week) and duration (minutes / day) of activities practiced in the last week prior to data collection for at least 10 minutes at each occasion. A moderate to vigorous physical activity score (minutes / week) is produced from the sum of multiplications of frequency by the respective durations of each activity (min/week).
Recreational screen time	Self-report	- Self-reported daily screen time watching TV, playing video game, using computer, smartphone and tablets for fun (free time), and using computer, smartphone and tablets for study or school activities. Measured in week and weekends days (min/day).
Sleep duration	Self-report	- Sleep duration based on self-reported time to go to bed and wake up in both, weekdays and weekend (hours/day).
Physical self-concept	QAF ²⁶	- A five-point Likert scale comprising 36 items subdivided in six physical self-concept domains (Physical Skill; Physical Condition; Physical Attraction; Physical Strength; General Physical Self-Concept; and General Cconcept).
Motivation for physical education classes	PLOCQ ²⁷	- A seven-point Likert scale comprising 20 items subdivided in six motivation domains (Intrinsic; Identified Extrinsic; Introjected Extrinsic; External Extrinsic; and Amotivation).
Symptoms of anxiety, depression and stress	EDA-E-A ²⁸	- A four-point Likert scale comprising 21 items subdivided in seven items for anxiety, for depression and for stress.

QAFA = Adolescent Physical Activity Questionnaire; QuesST = Questionnaire for Screen Time of Adolescents; QAF = Physical Self-Concept Questionnaire; PLOCQ = Perceived Locus of Causality Questionnaire; EDAE-A = Adolescent Anxiety, Depression and Stress Scale.

of pre- and post-intervention variables and those responsible for data tabulation and analysis. In terms of blinding the sample and the teachers responsible for the intervention, it will not be feasible due to the clarity and understanding of the intervention by the group participating in the study.

The intervention program will consist of physical exercises involving natural body movements such as running, jumping, hopping, pulling, squatting, rotating, and pushing. These exercises will be organized into stations with a proportional distribution based on the number of students. The physical exercise program will be divided into four cycles (preparation, progression, progression maintenance, and final progression), with progression achieved through increased intensity, volume, and complexity of exercises. Chart 1 outlines the intervention program over the course of 12 weeks according to the periodization cycles. It includes information on the number of stations, the number of repetitions per station, the interval between exercise execution and station change, and intensity control based on exertional perception²². Chart 2 provides examples of the organization of physical exercises (cardiorespiratory, and muscular strength and endurance exercises) that will be utilized in the intervention program, taking into account the progression in the complexity of execution.

Chart 1 – Physical exercise intervention program description.

Cycles	Cycle 1 Preparation	Cycle 2 Progression	Cycle 3 Maintenance of the progression	Cycle 4 Final progression
Numbers of Weeks	Three weeks (weeks 1 to 3)	Three weeks (weeks 4 to 6)	Three weeks (weeks 7 to 9)	Three weeks (weeks 10 to 12)
Number of Stations	4 Stations	4 Stations	5 Stations	5 Stations
Exercises Types by Stations	- one station of aerobic exercise - three stations of strength exercises	- one station of aerobic exercise - three stations of strength exercises	- two station of aerobic exercise - three stations of strength exercises	- two station of aerobic exercise - three stations of strength exercises
Length of Exercise Execution	1 minute	1 minute	1 minute	1 minute
Executions by Stations	2 executions	2 executions	2 executions	2 executions
Interval time among stations	1 minute	45 seconds	30 seconds	30 seconds
Exercise Intensity Control	Without intensity control. Focused on learning the movements of the exercises	Exertional perception is rated at 6 on a scale of 1 to 10 (moderate)	Exertional perception is rated at 7 on a scale of 1 to 10 (moderate to vigorous).	Exertional perception is rated at 8 on a scale of 1 to 10 (vigorous).

The quality control of the intervention will be carried out through weekly meetings with the teachers throughout the intervention phase of the study. The meetings will be held remotely, via virtual means, on a day of the week to be arranged with the teachers. The purpose of these meetings is to assess the application process of the activities, address any difficulties, and clarify any doubts that may arise during the intervention period. The project leaders will monitor the implementation of the activities without interference during the sessions. When necessary, the study’s coordinators will provide feedback and guide the teachers to make the sessions more appropriate and aligned with the project’s objectives. The selection of visited schools will be determined by a random drawing. Additionally, the responsible researchers will provide teachers with phone contacts and instant messaging (WhatsApp) for direct communication.

The classes that will be allocated the CG will participate in PE lessons according to the previously devised planning. Following the conclusion of the intervention period, the classes comprising the CG will also have the opportunity to engage in the physical exercise intervention program.

For the statistical analyses, the data will be entered into the EpiData 3.1 software with double entry, export-

Chart 2 – Example of the progression/complexity of the physical exercises during intervention program period

Weeks (Cycles)	Aerobic exercises	Strength Exercises		
		Upper Limbs	Lower Limbs	Trunk
Weeks 1-3 (Cycle 1)	Stationary running	Push-ups on the wall	Partial Squat	Plank with supported knees
Weeks 4-6 (Cycle 2)	Suicide running	Push-ups with supported knees	Squat	Plank
Weeks 7-9 (Cycle 3)	Zig-zag running and jumping jacks	Push-ups on step	Squat with Weight	Plank touching hand on shoulders
Weeks 10-12 (Cycle 4)	Running and burpees	Push-ups on step	Squat plus a jump	Knee/elbow plank

ed, and analyzed using the statistical software package SPSS version 20.0. Initially, numerical variables will be assessed for the normality of their distributions using the Shapiro-Wilk test. Description of numerical variables will be performed using mean (\bar{x}) and standard deviation (SD) or median and interquartile range. Description of categorical variables will be done using absolute (n) and relative frequencies (%) followed by their respective 95% confidence intervals (CI95%). For the comparison of covariates between groups, independent samples t-test and Chi-square test will be used for numerical and categorical variables, respectively. Generalized Estimating Equations and the Bonferroni post-hoc test will be used for the comparison between time points (pre and post-intervention) within groups and for identifying the group*time interaction. Effect sizes will be estimated using Cohen's "d" and categorized as small (0.20 to 0.49), medium (0.50 to 0.79), large (0.80 to 1.29), very large (≥ 1.30). Analyses will be conducted on an intention-to-treat and per protocol. In intention-to-treat analyses, all participants included in the study will be analyzed. In per protocol analyses, participants with inconsistent data at least in one of the time points (pre and/or post-intervention) and those who do not participate in at least 75% of the classes will be excluded. The level of significance adopted will be 5% for all statistical analyses.

Discussion

This article outlined the methodological approach employed in an experimental study aimed at analyzing the effects of a 15-minute physical exercise program conducted during PE classes on PF and AMOO in 6th to 9th elementary school students. Previous studies employing a similar methodological approach has suggested that the integration of physical exercises into a portion of PE classes may be effective in enhancing PF, AMOO, and other health markers among students⁹. Nevertheless, in addition to the limited number of studies in this issue, some methodological constraints and heterogeneity in exercise protocols necessitate further investigations to reach a more comprehensive understanding of the potential of this intervention design for improving PF, AMOO, and other health markers within this population.

The development of the intervention protocol outlined in this article presents a set of strengths that could significantly contribute to a better understanding of the effects of incorporating physical exercise into a por-

tion of PE classes on students' health markers. From a methodological perspective, the calculation of sample size, random allocation of groups, blinding of the assessment, and data tabulation and analysis teams, along with the implementation of intention-to-treat analyses, are characteristics that mitigate the risk of bias and address gaps observed in prior studies. Among the studies that implemented interventions involving physical exercises within PE classes¹²⁻¹⁶ included in García-Hermoso et al.'s meta-analysis⁹, only one conducted intention-to-treat analyses¹⁶, and one performed a sample size calculation¹³, although considering only the primary dependent variable of the study as reference (CRF).

Another strength of our protocol intervention lies in its potential to identify the effects of the intervention program on an expanded range of components of PF. Despite previous studies having conducted such analyses¹²⁻¹⁸, few of them examined the effects on CRF and at least one indicator of muscular strength^{13,15,17,18}. Faigenbaum and Mediate's study¹⁴ was the unique to assess the effects of the intervention across various measures of muscular strength, speed, agility, and flexibility. However, CRF was not included as an outcome in that study. Furthermore, considering the secondary dependent variables incorporated in our protocol intervention, it will be possible to identify the effects of the intervention on health-related behaviors (PA, ST, and SD), motivation for participation in PE classes, and indicators of mental health.

The implementation of the intervention by the PE teachers in the IG is another important feature to be highlighted. The training provided for the application of the intervention protocol not only contributes to the professional development and ongoing updating of these educators but also empowers them, emphasizing their importance as integral participants in the study. This approach may encourage the incorporation of physical exercises as part of the curriculum even after the intervention concludes. Previous studies^{29,30} have indicated that direct instruction by teachers on performing physical exercises during PE classes increases students' levels of moderate to vigorous PA, thereby making a general contribution to improved health. Additionally, the selection of physical exercises within the intervention protocol and the instruments used for measuring the dependent variables were carefully tailored for application within the school setting, making it feasible for the intervention protocol to be easily replicated. Finally, the outcomes of this study will con-

tribute to a deeper understanding of the potential of school PE classes. This understanding extends to improving PF and AMOO as primary goals, while also examining their influence on health-related behaviors, motivation for participation in PE classes, and students' mental health as secondary outcomes.

Despite the numerous strengths of our protocol, it is crucial to acknowledge that the execution of the intervention program by the PE teachers in the IG could be viewed as a limitation. Even with the suggested quality control measures, it may not be feasible to guarantee that the intervention program will be implemented according to the plan and across all 24 sessions. Nevertheless, this limitation is inherent to the adopted methodological model, which was chosen with the practical and ecological application of the intervention program in mind.

Conflict of interest

The authors declare no conflict of interest.

Author's contributions

Rocha RZ: Conceptualization, Methodology, Data analysis, Investigation, Project administration, Writing original draft, Writing review & editing, Approval of the final version. Ribeiro FS: Methodology, Investigation, Writing original draft, Approval of the final version. Romig IDK: Methodology, Investigation, Writing original draft, Approval of the final version. Arrieira HO: Methodology, Investigation, Writing original draft, Approval of the final version. Cunha GOK: Methodology, Investigation, Writing original draft, Approval of the final version. Bergmann GG: Conceptualization, Methodology, Data analysis, Investigation, Supervision, Project administration, Writing original draft, Writing review & editing, Approval of the final version.

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

The manuscript did not use artificial intelligence tools for its preparation.

Availability of research data and other materials

The data of this study is available on demand from referees.


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