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Research Article

Effects of Applying A Circuit Training Program During the Warm-Up Phase of Practical Physical Education Classes

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Abstract

This study aimed to analyze the effect of a training circuit, applied for 3 weeks, during the warm-up phase of practical physical education classes, and to verify the resulting effects on the analyzed variables. Twenty-five students participated in the study (mean ± age = 15.67 ± 1.02), weight (67.31 ± 9.29 kg), height (1.72 ± 0.08 m). The training program in circuit was applied twice a week, for 3 weeks, and it was containing burpees, jumping together, squats, sit-ups, push-ups, countermovement jumps, sprints with change direction. The students were analyzed in two moments (i.e., pre/post application of the training program). The results indicated that the application of the training program induced positive effects in the optimization of aerobics fitness, specifically in the shuttle test. The study also concluded that the circuit training program, in addition to inducing positive changes in the shuttle test, is also a viable alternative for warming up in the physical education class.

Introduction

Physical education plays a fundamental role in the integral development of the student, enabling cognitive, psychomotor, and affective development while also encouraging healthy lifestyles, socialization, team spirit, and sports practice. The benefits of regular physical activity are diverse; namely, improvements in cardiovascular and respiratory function, decreased levels of anxiety and depression, and increased sense of well-being, and the development of cognitive and social valences [1-43]. In contrast, a sedentary lifestyle in adults is associated with a decrease in functional capacity, an increase in morbidity and mortality, and chronic diseases [19-32]. Therefore, it is essential to promote healthy living habits and physical activity during childhood, which, when prolonged during adolescence until adulthood, can be useful in combating physical inactivity and have a beneficial influence on health in general [22-24].

Currently, and faced with an increasingly challenging and stimulating world, it would be expected that there would be concerns regarding the development of motor, social, and cognitive abilities from an early age [5-35]. However, the reality is that an increase in sedentary lifestyle, interaction problems, and less contact with nature is exponential and endangering the development of children's motor skills [40]. The daily recommendation for physical activity for young people is 60 of moderate to vigorous activity, 5 times a week [42]. However, in most cases, this is not the case, as most adolescents practice exercise only in a school context, particularly during physical education classes, hence its exponential importance in children's development [28]. Therefore, the school can be characterized as the perfect location to implement health promotion strategies and promote healthy lifestyle habits [18]. In particular, concening physical education classes, one of the strategies that can increase their efficiency, and which has been increasingly implemented in the school context, is circuit training, which, when properly adapted, enables the inclusion of various content and the development of several individual skills [10] and the enhancement of physical exercise practices [17]. In fact, the need for training and increased strength in children and young people has gained greater significance, as well as the

knowledge that significant improvements are associated with the application of these programs, provided that they be run in sufficient quantities-with functional loads that exceed the usual muscular activity-and are adequate, in that they strictly follow the methodological recommendations developing strength in children and young people [21].

This type of training program is conducted through interval training and consists of several stations that involve work on strength, balance, resistance, and coordination, depending on the objectives [37]. This type of training program has several advantages: it is easy to adapt to the target audience and existing resources; it enables the stimulation of several muscle groups in each season and the application of different loads, and allows results to be obtained in a short period [12]. In this regard, recent studies indicate that children and adolescents could benefit from this type of training program in a school context [2-30]. A recent study [7] showed significant improvements in all investigated physical capacities after the application of this type of program. The efficiency was demonstrated even in a short period, and these conclusions have been corroborated by a previous investigation [29]. Another study [2] also found improvements in the physical fitness of the students, although the program application time was different. Emphasizing these results [11] considered that physical fitness is an important health marker that should be monitored from a young age and be assessed through aptitude tests, which are easy to apply, do not require many resources, and enable an evaluation in a little time, therefore offering an excellent alternative for schools in symbiosis with the abovementioned training programs [36] mentioned the importance of physical education teachers using this type of test, given that, in addition to being a vehicle for promoting physical activity, it also detects certain health problems. Based on the evidence that indicates that physical fitness has a fundamental role in our society and health, at any age [34] as well as the indicators highlighted by some studies regarding the relevance of the application of programs of training in the school context, it is important to consolidate this idea and continue to investigate the effects of the application of training programs in the school context, to analyze the potential of application to the alternative development of students' physical condition in physical education classes. Despite the variability of studies on this subject, which emphasize the improvements resulting from the application of various training programs, there is still no consensus regarding the characteristics they should have, namely, concerning their duration, intensity, type of training, exercise, and ideal application time. Thus, this study analyzed the effect of a training circuit, applied for 3 weeks, at the beginning of each physical education class, and to verify the resulting effects on the analyzed variables. As a study hypothesis, it was considered that the varied program could have positive effects on the physical condition of the participants across determined variables, including the horizontal thrust, reciprocating, abdominals, and push-ups.

Method

Participants

A group of 25 students belonging to a Portuguese school-mean age (15.67 ± 1.02), weight (67.31 ± 9.29 kg), height (1.72 ± 0.08 m) and index of body mass (BMI) (22.50 ± 2.65%)-participated in the study. None of the participants had regular strength training habits. Before the study began, students underwent a physical examination by a doctor, and each was considered free from any disorder that would prevent full participation in the investigation. All participants and the teacher were fully informed verbally and in writing about the study. As for the nature and requirements of the study, as well as the known health risks, the participants filled out a questionnaire about their health history and were informed that they could withdraw from the study at any time. All guardians provided their consent through informed consent, attesting to their children's voluntary participation in the study. The study was approved by the school's Ethical Advisory Committee and conducted in accordance with the Declaration of Helsinki.

Experimental Design

This study verified the effects of applying a circuit training program during the warm-up phase of practical physical education classes on specific physical fitness variables (i.e., shuttle test, sit-up test, push-up test, and horizontal impulse test). A varied circuit training program was applied, with the aim of stimulating increments in four indicators of physical fitness (i.e., shuttle, horizontal thrust, extension of arms, and abdominals). These were evaluated at two different points: before the start of the training program (pre-test) (T1) and after applying the training program (post-test) (T2). The training program lasted for 3 weeks and was run during the academic year, between February and March, during the warm-up period of physical education classes. In addition, on a weekly schedule of 3 per week, divided into 2 classes of 1h30min, the students took part in a training program that included exercises lasting 15. All experimental procedures were performed in coordination with the teachers and, therefore, did not cause any change in the individuals' routine. Pre and post-tests were carried out in the internal space to eliminate the effect of climatic conditions on the results. These tests were chosen because they could be applied quickly and because they did not influence the normal course of activities in the classroom.

Procedures

Four specific variables were analyzed with adaptations to previously used protocols: the shuttle test [14], sit-up test [9], push-up test [4], and horizontal impulse test [31]. These were evaluated in 2 distinct phases: before the application of the training program (i.e. pre-test) and after the application of the training program (i.e. post-test). The values for each test were recorded for subsequent

analysis. The anthropometric variables of height and body mass were measured for each subject, on a leveled platform scale (Año Sayol, Barcelona, Spain), with an accuracy of 0.001 m and 0.01 kg, respectively.

Training Program

The training program was applied twice a week for 3 weeks. The program had a weekly increment of one repetition. The exercises applied contained strength exercises: burpees, jumping together, squats, sit-ups, push-ups, and countermovement jumps. The program was also composed of sprints, with changes in direction (5 m) and speed (20 m), (Table 1), and were performed according to the protocol described in Figure 1 [15].

Table 1: Circuit Training Program.

Weeks	Sessions	Burpee	Sprint	Jumps	Squats	SCD	Push-ups	Sit-ups	CMJ
Week 1	Session 1	2 x 8	2 x 3	2 x 8	2 x 10	2 x 5	2 x 10	2 x 10	2 x 4
	Session 2	2 x 8	2 x 3	2 x 8	2 x 10	2 x 5	2 x 10	2 x 10	2 x 4
Week 2	Session 3	3 x 8	3 x 3	3 x 8	3 x 10	3 x 5	3 x 10	3 x 10	3 x 4
	Session 4	3 x 8	3 x 3	3 x 8	3 x 10	3 x 5	3 x 10	3 x 10	3 x 4
Week 3	Session 5	4 x 8	4 x 3	4 x 8	4 x 10	4 x 5	4 x 10	4 x10	4 x 4
	Session 6	4 x 8	4 x 3	4 x 8	4 x 10	4 x 5	4 x 10	4 x 10	4 x 4

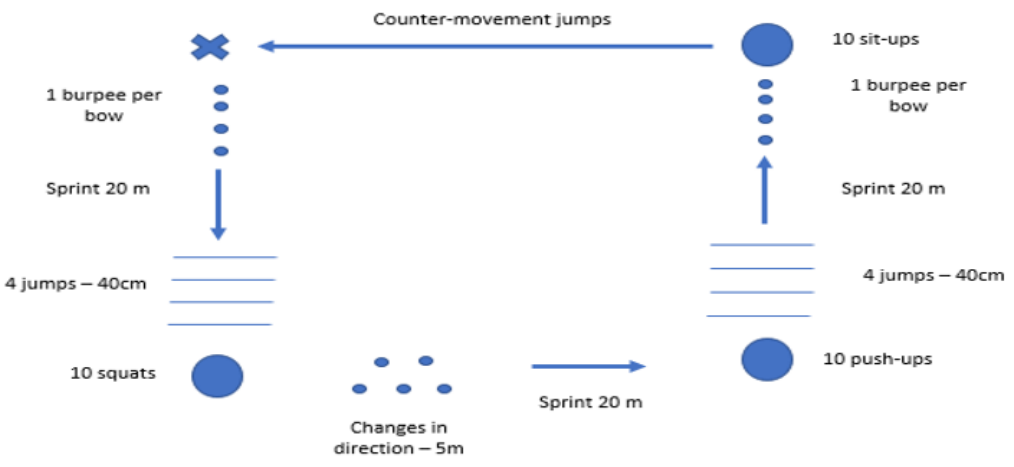

Figure 1: Training circuit [15].

Statistical Analysis

The calculation of means, standard deviations, and 95% confidence intervals (95% CI) was performed using standardized statistical methods. The normality of the distribution was examined using the Shapiro-Wilk test (n <30) and, depending on the existence of normality, parametric or nonparametric tests were adopted for data analysis. To compare the physiological variables at rest in the two assessment sessions and to compare responses to the exercises, the paired t-test and non-parametric correspondent, the Wilcoxin test, was used. The level of statistical significance was found to be p≤0.05. The effect size (TDE), with a 90% CI, was calculated using the Hedge's g formula, as it produces more reliable results when n <20 [20]. To classify the TDE, a modified classification system was used (trivial: 0.0–0.2; small: 0.2–0.6; moderate: 0.6–1.2; large: 1.2–2 , 0; very large:> 2.0; extremely large:> 4.0) (Hopkins et al., 2009). Percentage variations between the initial evaluation (pre) and the evaluation after the academic period (post) [(post-training - pre-training) / pre-training) x100] were also calculated and considered statistically significant when 95% of the difference confidence excluded the zero value.

Results

The two moments of evaluation were analyzed and paired, as shown in Table 2 (pre- vs post-training tests). The results showed that there were no statistically significant differences (p> 0.05) for the push-up test, sit-up test, and horizontal impulse test (p = 0.085; p = 1.0; p = 0.052) respectively. Regarding the effect size, the results showed a small effect for the push-up test (d = 0.18) a moderate effect for the sit-up test (d = 0.9), and a trivial effect for the horizontal push test (d = 0). concerning the shuttle test, there were statistically significant differences between the 2 evaluation moments (p <0.05) with a small effect size (d = 0.25). The difference between the pre and post-workout for the push-up test was 6.60%, whereas for the sit-up test it was 4.27%; the shuttle test, however, had a variation of 7.26%, whereas for the horizontal impulse it was 0%.

Table 2: Comparison between Pre- and Post-test Training.

Variables	Pre-Training	Post-Training	Pre- vs Post-Training		
	Mean ± SD	Mean ± SD	p	Δ (%)	d
Push-Up Test	15.9 ± 5.24	16.95± 6.12	0.085	6.6	0.18
Sit-Up Test	46.8±20.9	48.8± 21.24	1	4.27	0.09
Shuttle Test	68.9±19.22	73.9 ± 20.30	0.005	7.26	0.25
Horizontal Impulse Test (cm)	196.6±19.72	196.6 ± 20.62	0.052	0	0

Discussion

This study analyzed the effects of applying a training circuit on the physical condition of a school community. This circuit consisted of exercises such as burpees, sit-ups, squats, sprints, push-ups, and changes in direction. The findings indicate that it induced positive effects in the optimization of aerobic fitness. The results of this study demonstrate that the training program has a positive effect for the shuttle test only. The shuttle test variable was the only one that showed significant differences after the application of a training circuit in the school context, manifesting changes between the pre-and the post-test, which contradicts previous studies [27-29]. In this regard, another study [2] also found improvements in the performance of the shuttle test, concluding that circuit training could be an effective way to develop resilience in school. In fact, these results contradict a previous investigation [23], where benefits resulting from the application of training circuits were evidenced, such as an increase in muscular strength and muscular endurance capacity as well as a reduction in the risk of occurrences of injuries during the practice of physical and recreational activities.

The analysis of the push-up variable showed that there were no significant changes, probably due to the limited time of application of the circuit, although there was a slight variation between the pre-training and post-training moments. In addition, previous studies have shown that push-up tests are those with the highest failure rates [6-41].

Regarding the horizontal impulse test, it was found that tthis study contradicts the data found in previous investigations [8], as there were no significant changes. However, it was expected that there would be an improvement in the results based on the regular use of the muscles of the lower limbs during the daily activities [2]. Other investigations that evaluated the horizontal impulse [38,39] found average values of 177.89 cm after application of the training program, whereas the results of this study show average values of 196.6 cm, a much higher value that could be related to the height of the participants, based on the strong correlation between height and the force of the impulse [38]. The lack of evolution in this variable could also be related to the fact that the students have not assimilated the correct mechanics of the exercises and, therefore, there could be a deficiency in the technique that will not translate into exercise efficiency [44]. Likewise, there were also no significant differences between the moments of analysis (i.e., pre-workout and post-workout) in the sit-up test. In this regard, other investigations that have investigated this variable [13-33] obtained mean values of 35.6 cm, but the current investigation obtained a considerably higher value (i.e., 46.8 cm); this result could be related to the practice of physical activity outside the school context, which was previously considered decisive for the test result [26]. A study of characteristics similar to ours [25] found significant differences in the variables considered after the application of the training program, which consisted of a training circuit applied weekly, where the degree of difficulty of the exercises increased each week.

The fact that the training program had a significant effect only on the variable of aerobic fitness could also be because the students do not yet have an established action plan. In other words, the action scheme is enhanced and developed using repeated action, which occurs in all sports movements. This same scheme is kept in memory and can be evoked later. In this specific case, students had little time to assimilate the circuit diagram, which helps to justify the results found. It is also important to note that comparison with other investigations becomes a little reductive due to the methodological differences verified between the studies, such as circuit duration, distinct and adapted circuits, and the sample size, as well as their characteristics.

Conclusion

This investigated the effects of the application of a training program in a circuit format in the initial part of physical education classes, and to verify its impact on physical fitness variables in students aged between 15 and 18. After 3 weeks of application of the training circuit, the results indicate that despite the short time of exercise applied, significant improvements were obtained in the variable of aerobic fitness (the shuttle test). However, and most likely due to the short period of application of the training program, the remaining analyzed variables did not show statistically significant differences, which also allow for the possibility that if the training program was applied over a longer period, the results of the analyzed variables could show a significant increase. Nevertheless, it appears that the development of similar programs in the school context and during the teaching of teaching units could be beneficial for students in terms of improving their physical fitness and implementing training habits, as well as regular and healthy

lifestyles. This investigation also presents a different proposal for the initial part of the physical education class that could be more motivating for the student, in addition to guaranteeing different practical utility in relation to time traditionally dedicated to warming up. About study limitations, the fact that only one female member participated in the investigation prevented the results from being compared between genders, which would have been an interesting and enriching route for the study and is therefore recommended for further research. Finally, food and sleep hours were not controlled during pre-training and post-training and are variables that can affect students' performance.

Disclosure Statement

The authors declare that there are no conflicts of interest.

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