EFFECTS OF HIGH INTENSITY INTERVAL TRAINING (HIIT) INTERVENTION AMONGST SCHOOL ADOLESCENTS

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Abstract

Physical Education classes fail to reach the minimum levels of moderate-vigorous activity recommended by international policies (50% of the class duration). Although several methodological strategies have been suggested in scientific literature to combat this limitation, few proposals exist in educational practice in this context. In this sense, the objective of this work was to integrate the emerging high intensity interval training method into a traditional learning unit of Physical Education with the intention of increasing intensity. The results showed that the students analysed improve their body composition and some components of the physical condition, in a non-significant manner. In conclusion, it seems to be a priority to include methodological strategies during physical education classes in order to achieve adequate intensity. The method presented in this practical proposal shows a positive trend in improving health in schoolchildren, although future research is necessary to confirm or refute the results found.

Key words: Physical Education, intensity, high intensity interval training, active learning units, methodological strategies.

Introduction

Eighty percent (95% CI 80.1-80.5) of adolescents do not meet the minimum recommendations of physical activity [19]. In addition, the prevalence of weight increase and obesity in children and adolescents has increased worldwide from 16.9% (IU 16.1-17.7) to 23.8% (22.9-24.7) in children from 1980 to 2013, and from 16.2% (15.5-17.1) to 22.6% (21.7-23.6) in girls [30]. In fact, longitudinal studies have shown that physical activity decreases by 10% each year during adolescence; however healthy habits acquired during this period continue into adult life [15]. These worldwide problems position the adolescents as a priority for public health.

Schools represent an ideal place for the promotion of health-related physical fitness [21]. In fact, the subject of Physical Education (PE) seems to be the most suitable subject for this promotion. However, the scientific literature suggests that adolescents remain below the range of moderate to vigorous physical activity (MVPA) recommended during PE classes (at least 50%) [17, 22]. These data have been highlighted in a recent national study by Esteban-Cornejo et al. [16], in which it was found that 1780 Spanish adolescents achieved only 10.8% of the PE class time in the MVPA range. Being aware that the teaching load in this area cannot be modified by the teachers, they should introduce changes in the design of their classes in order to introduce greater physiological stimulus by means of increasing the intensity of work.

There has recently been increased interest in the effects of vigorous exercise intensity because of the potential benefits that could be achieved in health. In fact, there is evidence from cross-sectional and longitudinal studies that associate intense (non-moderate) physical activity with healthier waist circumference, systolic pressure and body mass index [12, 20]. At the national level and in this line we find the EDFIT study, whose objective was to analyse
the effects of an intervention program based on increasing volume and intensity in PE classes. The results of this study indicated that increase (duplicate) in the load of PE in school facilities achieve an improvement of physical fitness in general, if it is accompanied by an intensity increase [2].

In this context and in the last 10 years a trend has emerged in scientific literature that supports the possible effectiveness of high intensity interval training (HIIT) in improving certain parameters related to the health of adolescents [13]. Although there is no consensus on the definition of this method, it usually involves short periods (from 30 s to 4 min) but intense (more than 75% of maximum heart rate) of physical exercise interspersed with short breaks. Costigan et al. [13] in their systematic review have shown that HIIT can improve aerobic capacity in adolescents (non-standardized mean difference (MD) = 2.6 ml/kg/min, 95% CI 1.8 to 3.3). In this context, the randomized trial with the largest sample size (n=503) to date and one of the first on the field, showed significant changes in aerobic capacity and muscle strength after 10 weeks, where adolescents were prescribed with 10-second sprints at an intensity of between 100-120% of their maximum aerobic velocity [4]. In another systematic review, Logan et al. [25] found improvements in VO2max, insulin resistance, HDL cholesterol, and reductions in body fat, systolic blood pressure, waist circumference, glucose, cholesterol and triglyceride levels in adolescents following a HIIT intervention.

The major limitation of the previous studies is that many of them have been carried out under clinical conditions and with trained participants; therefore, there is little evidence about its effects on the general population. In this sense, the incorporation of HIIT during the school day has begun to be explored [3, 4, 8, 11, 14, 24, 32]. However, most studies have prescribed sprints as a method of increasing the intensity of physical activity. Only Lambrick et al. [24] and Weston et al. [32] used fun activities or circuits as a different strategy for increasing intensity. Thus, the objective of this study is to examine the effects of a 2-month high-intensity interval training program implemented during PE classes at the level of compulsory secondary education on physical fitness in adolescents between 15-16 years.

Materials and Methods

Participants

To conduct this research, an intervention study was carried out; the sample was conveniently selected. A total of 80 participants were part of the intervention, of whom 55 received the intensity program and the other 25 constituted the control group. The mean age of participants was 15.84 ± 0.59 years.

Instruments

Measures were taken before and after the intervention. The order in which the measurements were done was as follows: weight, height, (BMI), waist circumference, body fat, muscular strength, speed-agility and aerobic capacity.

The protocol used for each of the measurements was based on the fitness assessment batteries developed for national and European research projects ALPHA-FIT and PREFIT:

**Weight**

The child, barefoot, was placed in the center of the platform of the scale distributing their weight across both feet, facing the front, with their arms along the body, and without making any movement. The measurement was made at that moment and taking as reference the highest point of the head, leaving the hair compressed. The percentage of body fat was obtained through the formulas integrated in the scale and through the bioimpedance method.

**Height**

The child, barefoot, stood erect, placed his heels together and his arms along his body. The heels, buttocks and upper back should be in contact with the rod. The head was oriented in such a way that the upper protuberance of the tragus of the ear and the lower edge of the orbit of the eye (Frankfort plane) remained in the same horizontal plane. The child breathed deeply and kept his breath, the measurement was made at that moment and taking as reference the highest point of the head, leaving the hair compressed. Hair adornments and braids were not allowed. To perform this measurement, the Seca 213 portable stadiometer was used.
Waist circumference
The examiner wrapped the tape around the child's waist, who then lowered his arms to a relaxed, abducted position. The measurement was performed at the navel level and so that the tape formed a horizontal plane parallel to the floor. For this measurement the ergonomic metric tape Seca 201 was used.

Muscular strength
The child squeezed the dynamometer gradually and continuously for at least 2 seconds, performing the test twice (alternately with both hands) with the optimum grip adjustment at 4.0 cm and allowing a short rest between measurements. An analog dynamometer was used, namely the Takei model, TKK 5002. For lower muscular strength the student stood behind the jump line, with a foot separation equal to the width of his shoulders. From that position, he bent his knees with his arms in front of his body and parallel to the ground, swinging his arms, pushed hard and jumped as far as possible. He touched the ground with both feet simultaneously and upright. At that time the measurement was taken.

Speed-agility
The 4x10 test run and turn at maximum speed (4x10 m) was used to assess speed-agility. Two parallel lines were drawn on the ground (with ribbons) 10 meters away. When the start was indicated, the child ran as fast as possible to the other line, returned to the starting line, crossing both lines with both feet and hitting the examiner's hand. Then, again, he ran as fast as he could to the opposite line, and ran back to the initial exit line where he hit the examiner's hand. The time needed to cover that distance was chosen.

Aerobic capacity
The child moved from one line to another located 20 meters away and making the change of direction at the rate indicated by a sound signal that was progressively accelerated (20 meter shuttle run test). The initial speed of the signal was 8.5 km/h, and increased by 0.5 km/h/min (1 minute is equal to 1 stage). The test ended when the child was not able to arrive for the second consecutive time to one of the lines with the audio signal. Otherwise, the test ended when the child was stopped by fatigue.

Intervention
The intervention consisted of a high intensity physical exercise program, internationally called HIIT, of a duration of 5 months. The exercise program was implemented at the rate of 2 sessions per week during Physical Education classes. The intervention consisted of a circuit of ten stations, where a high intensity activity was performed at each one. 3 students were at each station and remained together during the 10 stations, performing the activity of each station simultaneously (all three at the same time). The groups of 3 students started the circuit at one station and had to rotate clockwise for the remaining 9. The working time at each station was 45 " and the rest time was 15 " (3:1). The break included the time needed to move from one station to another and to be ready for starting the next station. To correctly control the times, the beginning and the end of each station was marked by the teacher who supervised the physical exercise protocol. Therefore, during one session each student performed 7 minutes and a half of high intensity (HIIT) and 2 and a half minutes of rest. The optimal intensity of working time was greater than 85% of maximal heart rate. Finally, the physical education classes were modified and their timing was as follows: 5 minutes of warm-up + 10 minutes of HIIT + 40 minutes of other curricular content + 5 minutes (intended for, before and after the PE classes). The 10 minutes of HIIT were prescribed by a professional of the group GICAFE-UIB and the remainder of the class was conducted by the professor of PE. Taking into account the school calendar, physical exercise intervention lasted 16 weeks (excluding holidays and evaluation periods), being 32 classes of PE of 60 minutes, which resulted in a total of 226 minutes of vigorous activity.

RESULTS
The main results of this work are presented below. Table 1 shows the main characteristics of the sample. It can be observed that at the beginning of the intervention there were no significant differences between the HIIT group and the control group.
Table 1. Characteristics of participants.

<table>
<thead>
<tr>
<th></th>
<th>HIIT (n=55)</th>
<th>CG (n=25)</th>
<th>Sig.</th>
<th>t</th>
<th>95% Inferior</th>
<th>95% Superior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>-4.44</td>
<td>0.71</td>
<td>0.053</td>
<td>-1.00</td>
<td>-15.46</td>
<td>5.16</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>-2.88</td>
<td>-0.69</td>
<td>0.299</td>
<td>-0.37</td>
<td>-14.05</td>
<td>9.68</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>0.15</td>
<td>0.45</td>
<td>0.304</td>
<td>-1.73</td>
<td>-0.64</td>
<td>0.05</td>
</tr>
<tr>
<td>Waist circumference</td>
<td>-1.44</td>
<td>0.03</td>
<td>0.264</td>
<td>-0.38</td>
<td>-9.27</td>
<td>6.32</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>-1.50</td>
<td>0.18</td>
<td>0.118</td>
<td>-0.61</td>
<td>-7.18</td>
<td>3.82</td>
</tr>
<tr>
<td>Standing broad jump</td>
<td>12.90</td>
<td>11.47</td>
<td>0.495</td>
<td>-2.21</td>
<td>29.78</td>
<td></td>
</tr>
<tr>
<td>Speed-agility 4x10 (s)</td>
<td>0.38</td>
<td>0.78</td>
<td>0.800</td>
<td>-0.45</td>
<td>1.39</td>
<td></td>
</tr>
<tr>
<td>Handgrip strength test (kg) a</td>
<td>1.00</td>
<td>1.97</td>
<td>0.171</td>
<td>-0.92</td>
<td>3.08</td>
<td>1.14</td>
</tr>
<tr>
<td>Handgrip strength test (kg) b</td>
<td>0.63</td>
<td>2.53</td>
<td>0.936</td>
<td>-4.30</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>Aerobic capacity (stages)</td>
<td>-3.36</td>
<td>-1.47</td>
<td>0.008</td>
<td>-1.74</td>
<td>4.05</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Table 2. Effects of the HIIT intervention among groups and compared to control group.

<table>
<thead>
<tr>
<th></th>
<th>Total (n=80)</th>
<th>HIIT (n=55)</th>
<th>CG (n=25)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD.</td>
<td>Mean</td>
</tr>
<tr>
<td>Edad (años)</td>
<td>15.84</td>
<td>0.59</td>
<td>15.85</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>60.72</td>
<td>11.35</td>
<td>61.51</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>167.76</td>
<td>8.73</td>
<td>167.41</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>21.55</td>
<td>3.57</td>
<td>21.91</td>
</tr>
<tr>
<td>Waist circumference</td>
<td>72.21</td>
<td>9.03</td>
<td>72.85</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>21.88</td>
<td>8.07</td>
<td>22.42</td>
</tr>
<tr>
<td>Standing broad jump</td>
<td>159.25</td>
<td>54.60</td>
<td>158.52</td>
</tr>
<tr>
<td>Speed-agility 4x10 (s)</td>
<td>10.30</td>
<td>2.96</td>
<td>10.19</td>
</tr>
<tr>
<td>Handgrip strength test (kg) a</td>
<td>30.62</td>
<td>31.19</td>
<td>28.89</td>
</tr>
<tr>
<td>Handgrip strength test (kg) b</td>
<td>28.83</td>
<td>29.51</td>
<td>26.78</td>
</tr>
<tr>
<td>Aerobic capacity (stages)</td>
<td>7.36</td>
<td>7.49</td>
<td>7.49</td>
</tr>
</tbody>
</table>

The results of the intervention are presented in Table 2. Negative means represent that they declined after the intervention program and the means in positive denote that the variables increased after the intervention. It should be noted that the intervention did not have significant improvements in any of the variables analysed in comparison to the control group; despite this, the majority of variables analysed resulted in a positive change in the overall health of adolescents.

Discussion
The results of this work show that the intervention carried out in this study has not been enough to produce positive changes at the
physiological level. From these results, several conclusions are drawn; the HIIT method can be feasibly carried out in Physical Education classes although there is still a need for greater knowledge about its prescription in the school population to provoke significant and positive changes in the physical health of adolescents.

It is important to note that most of the variables analysed in this study have shown a tendency toward a positive change for health, although as we have pointed out, it is not enough to be significant. This data indicates that the HIIT is able to stimulate the analysed variables at the physiological level, although not determinant to be statistically relevant. All this leads to the belief that future research is warranted to increase the frequency and volume of this type of methodological strategy in school settings. Due to the limited time dedicated to Physical Education at the curricular level, teachers in this area should seek and implement alternative methodological strategies that increase the intensity levels in physical activity.

In this sense, it is important to highlight the role of the school in achieving positive aspects of health. Schools are ideal environments for the promotion of healthy habits, since childhood is a time of vital development in which the main habits of life are acquired [6]. In this specific case, PE is a compulsory part of school programs in most countries including Spain; and although the PE begins to be considered indispensable within the official curriculum, optimal levels of intense physical activity to promote health benefits in school population are needed [27].

Data from the AVENA study (Feeding and Assessment of the Nutritional Status of Adolescents) show that the Spanish adolescent population has an excessively low level of physical fitness compared to adolescents across other countries. The current situation of sedentary lifestyles, which is increasingly present in the school community, makes PE a more relevant subject, contributing to and facilitating the conservation and improvement of health [18]. It is fundamental to reconsider its role not only from the formative and pedagogical point of view, but also in terms of health, in order to promote healthy lifestyles.

In this line of work, it is important to emphasize the concept of health-related physical fitness, including cardiorespiratory or aerobic capacity, strength, muscular endurance, flexibility and body composition, since a direct relationship between physical fitness and cardiovascular risk in adulthood has been observed [30, 31].

In the case of the EDUFIT study, whose objective was to analyse the programs of an intervention program based on increasing volume and intensity in PE classes on the physical fitness of adolescents, the results indicated that increasing (doubling) the EF load in schools increases aerobic capacity and flexibility [1]. According to the same authors, and despite the difficulty of incorporating these types of programs into the curriculum for mainly bureaucratic and administrative issues, these results can potentially be extrapolated to other educational centres.

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