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Original article

Effects of specialized Physical Education classes and handball training on health-related physical fitness in adolescent girls

Efectos de las clases de Educación Física especializada y el entrenamiento de balonmano en la condición física relacionada con la salud en niñas adolescentes

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Abstract

Aims: To identify the effects of an intervention in Physical Education classes and handball training on health-related physical fitness in adolescent girls. **Methods:** This is a quasi-experimental study with 26 girls (10 to 16 years old). Girls who reached 75% of participation in handball training (HT) (n= 12) composed the HT group. Girls who played only during Physical Education composed the PE group (n=14). Waist circumference (WC), body mass index (BMI), cardiorespiratory fitness (CRF), abdominal strength (ABDS), and flexibility were evaluated using PROESP-Br procedures. The delta of glass (DGlass) was adopted as the measure of the effectiveness of these analyses. **Results:** The girls involved in HT reduced WC and increased CRF, ABDS, and flexibility with large effect sizes (33% to 75% of individual improvements). We observed fewer improvements in the PE group, with a variation of 14% to 35% of positive effects. **Conclusion:** The HT in after-class time together Physical Education classes provide improvements until 75% in the physical fitness of adolescent girls. In another way, Physical Education classes also provided these effects; however, it was in a minor proportion of about 35%.

Keywords: physical fitness; physical education and training; health promotion; sport; young people.

Resumen

Objetivos: Identificar los efectos de una intervención en clases de Educación Física y entrenamiento de balonmano en aspectos relacionados con la aptitud física para la salud en niñas adolescentes. **Métodos:** Estudio cuasiexperimental con 26 niñas (10 a 16 años). Las niñas que alcanzaron el 75% de participación en el entrenamiento de balonmano (EB) (n= 12) compusieron el grupo EB. Las niñas que participaron sólo en Educación Física componían el grupo de EF (n=14). La circunferencia de la cintura (CC), el índice de masa corporal (IMC), la aptitud cardiorrespiratoria (ACR), la fuerza abdominal (ABD) y la flexibilidad se evaluaron mediante los procedimientos PROESP-Br. El *delta of glass* (DGlass) fue adoptado como medida de efectividad para estos análisis. **Resultados:** Las niñas involucradas en EB redujeron CC y aumentaron ACR, ABD y flexibilidad con tamaños de efecto grandes (33% a 75% de mejoras individuales). Observamos menos mejoras en el grupo EF, una variación del 14% al 35% de efectos positivos. **Conclusión:** El EB en el tiempo extracurricular junto con las clases de Educación Física proporciona mejoras de hasta un 75% en la aptitud física de las adolescentes. De otra manera, las clases de Educación Física también proporcionaron estos efectos, sin embargo, fue en una proporción menor de alrededor del 35%.

Palabras clave: aptitud física; educación física y entrenamiento; promoción de la salud; deporte; jóvenes.

Key points

- Sports practice after school hours enhances the effects of Physical Education classes.
- Assessing individual responses is an important strategy for analyzing data at school.
- Physical Education classes and sports at school are essential strategies for health promotion.

Introduction

Physical Education in schools is recommended as a favorable environment for interventions in various health concerns of children and adolescents¹⁻³. However, several studies reveal a reduction or maintenance of the already low participation of adolescents - mainly girls - in physical activities and sports within a scholastic environment^{4,5}. Considering the research carried out in different countries, the involvement of children and adolescents in sports ranges between 40 and 60%⁶. In Brazil, recent studies point out that, in some regions, only 40% of such populations practice sports^{7,8}.

Low physical activity and sports engagement may lead adolescents to develop unhealthy habits. Brazilian studies show that approximately 30% to 50% of adolescents perform below the minimum recommended for maintaining biological health parameters⁹⁻¹¹. Additionally, the highest occurrences of adolescents with low performances are recorded in cardiorespiratory fitness^{9,10}. These results become alarming when considering the evidence of the links between low levels of physical fitness and early increase in diseases such as type II diabetes, obesity, hypertension, and osteoporosis¹²⁻¹⁴.

To minimize this situation, several studies have promoted the importance of different intervention programs within the school environment¹⁵⁻¹⁷. Such studies have suggested that physical activity and sports should occur within the class schedule, in intervals, and with extra activities at other times. Similarly, the present study proposes an intervention performed in two stages: 1) Physical Education classes that promote health through high physical fitness levels; and 2) handball training with the goal of physical and technical development¹⁵⁻¹⁷.

The proposal for increasing or maintaining physical fitness levels with Physical Education classes is known within the national scenario¹⁸. However, some theoretical schools of thought in Brazil still do not agree with sports in school when it aims for high performance¹⁹. Handball is one of the most practiced sports in Brazilian schools²⁰, containing a range of technical, tactical, and physical elements that require the effort, learning, and concentration of a person²¹.

Within this framework, the study hypothesis is that Physical Education classes combined with handball training have significant effects on physical fitness levels and, consequently, are effective in reducing health risks in schoolchildren^{17,22}. Thus, we aimed to identify the effects of an intervention in Physical Education classes and handball training on health-related aspects of physical fitness in adolescent girls.

Methods

Study Design

This work is a quasi-experimental study²³ developed in Charqueadas, a metropolitan city in the southernmost state of Brazil. This research follows the human research procedures described in the Helsinki Declaration and approved by the Ethics Committee of Universidade Federal do Rio Grande do Sul, number: 1.662.821. All subjects were authorized to participate in the study by legally responsible parents, who signed consent forms. The participants signed consent forms, as well.

Participants and the Organizing of the Intervention

The intervention was carried out by a group of 26 girls (13 years old on mean, 10 to 16 years old of range) allocated into two groups (Figure 1). Initially, the project was 80 girls available for research. They ranged between the 6th and 9th school grades. All girls were invited to participate in the project and compose (allocation) one of two groups, the Handball Training Group (HT) or the Physical Education Group (PE).

The inclusion criteria for the HT group were to be interested in making part of the handball training group and not have health conditions preventing sports practices. The inclusion criteria for the PE group were not participating in any sports group in the school program and being regularly enrolled in Physical Education. The exclusion criteria were not meeting 75% of the frequency in the handball training or Physical Education classes.

After these criteria application, 12 girls composed the HT group and 14 girls composed the PE group (n=14). It is important to point out that girls were not obligated to attend the HT, as it is an extracurricular activity offered by the school. They join handball classes due to their enjoyment and preference. The girls who participated in HT also were included in curricular Physical Education classes; thus, the HT sessions were an additional physical activity. PE is a subject required by elementary school laws in Brazil. The PE and HT occurred in 2017, starting in March and finishing in December, totalizing 38 weeks.

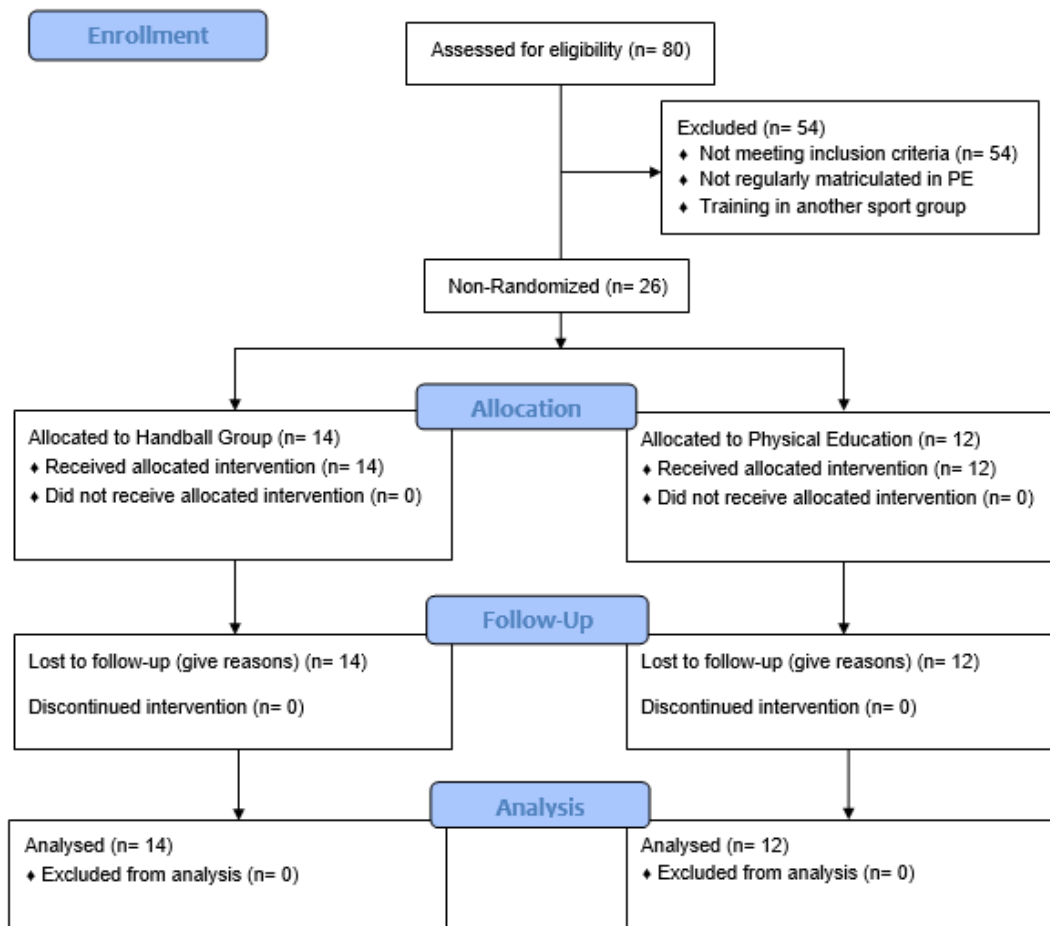


Figure 1. CONSORT flow diagram.

Handball Training at School

The Handball Training was carried out for 2 hours weekly in the afternoon, as opposed to the school period. Girls received handball training at different times than boys. The first hour of HT aimed to develop physical endurance and skills in small games of 2 x 2 and 3 x 3 players, focusing on motor skills and high levels of movement. The second hour focused on the formal game of handball (7x7), the teaching of the strategy, and game systems. During formal game training, the girls switched teams every 10 minutes. Training intensity kept moderate-vigorous, and the time mean in activity during training was 1,5 hours.

Physical Education

Physical Education classes were held twice a week for two separate 45-minute periods. In the first 15 minutes, students had bodyweight exercise instructions composed of calisthenic exercises, sprint runs, strengthening movements, ballistic training, and dynamic stretching exercises. The exercises were made in circuits, during a maximum of reps for one minute. The rest was 30 seconds among circuit stations. Mid-class, 20 to 25 minutes of PE, the central part of the lesson was cultivated, including games with movement and sports conditioned according to the school curriculum. From March to June, volleyball was chosen. July to September were focused on Brazilian and traditional communal games. From October to December, conditioning soccer games and motor skills were developed. In this class time, the intensity variate according to sports modalities, but in all classes, the intensity was moderate-vigorous. Students completed passive stretching exercises and relaxing activities for 5 to 10 minutes in the final classes. The PE classes had 20 to 30 students, both boys and girls, in each session. Additionally, in-between moments of Physical Education, during rest at the end of the lesson, the teacher would also speak and promote healthy habits of life, bringing up healthy eating and food, and explaining the importance of physical activity outside of the school environment.

Physical Fitness Evaluation

Physical fitness was assessed in March (one week before intervention) when school started and in December when the school year ended (after the intervention, one week after the last PE and HT classes). Waist circumference (WC), body mass index (BMI), cardiorespiratory fitness (CRF), abdominal strength (ABDS), and flexibility were evaluated using PROESP-BR procedures. Health-related physical fitness was characterized according to *Projeto Esporte Brasil (PROESP-Br)*²⁴, similar to previous interventions within the same age range¹⁸. WC was evaluated with a metallic tape (a total measure of 150 centimeters (cm), a precision of 0,01 cm), and it was placed horizontally at the midpoint between the lower edge of the last rib and the iliac crest and was tightly wound around the body without compressing the measured region²⁵

BMI was assessed using a digital anthropometric scale, from 0 to 150 kg, with a resolution of 0.05 kg, and recorded in kilograms. Height was measured using a metric tape fixed to the wall. The participant stays in an upright position, with feet and torso touching the wall²⁵. Then, BMI was calculated by dividing body mass (in kilograms) by height (in square meters).

CRF was assessed by a running and walking test in six minutes. The subject should accomplish the highest number of laps - running or walking - in a sports court, indicating meters on the ground cones. The test scores were obtained from the number of laps performed plus the meters traveled in the case of those who did not complete a full lap within the timeframe. The total distance available for the test is obtained by multiplying the number of laps by the perimeter of meters. In this case, the perimeter was a volleyball court with 54 square meters²⁵.

ABDS was evaluated through the one-minute sit-up test, performed with the assessed individual in the supine position with knees flexed at 45 degrees, arms crossed over the thorax, and ankles fixated to the floor by the examiner. The subject flexed the torso until he/she touched their thighs with the elbows, returning to the starting position as many times as possible in one minute. The score was in the amount of complete repetitions²⁵.

Flexibility was evaluated by a sit-and-reach without a bench. This test was performed with a measuring tape fixed to the ground. At the 38 cm mark on the tape, a piece of 30 cm adhesive tape was fixated perpendicularly. Subjects were barefoot, with extended knees and overlapping hands; the assessed individual slowly bent forward and stretched out the hands as far as possible in two attempts, of which the closest one to the floor was recorded²⁵.

Statistical Analysis

In an exploratory analysis, normality and parametricity of all outcome variables were obtained by visual inspection and Shapiro Wilks test, HT, and PE groups. Therefore, the characterization of subjects was presented by mean, median, and standard deviation in the pre-testing phase, comparing variances according to the Mann-Whitney independent test for values of age, height, weight, WC, BMI, CRF, ABDS, and flexibility. To compare the dependent variable of pre-testing to post-testing in each one of the groups and verify the effect of the intervention, we utilized the Wilcoxon dependent test in HT and PE groups. The delta of glass (Δ Glass) was adopted as the measure of the effectiveness of these analyses due to the non-parametric and non-normality of variances and the different N of groups. The sizes between 0,01-0,10 indicated no effect, the small effect ranged between 0,11-0,30, the interval between 0,31-0,49 was the moderate effect, and when $>0,50$, the effect was high²⁶.

The prevalence of responses to PE and HT were calculated using the following method: (1) the variation between individual subjects was performed with delta percentage effect (Δ calculated according to the formula: variable value at follow-up, minus the value of baseline multiplied per 100, divided by baseline value; (2) to each outcome variable was considered a cut-point to effect Δ individual variability^{27,28}, according to previous studies with interventions to improve health indicators: BMI (effect individual $>4\%$); WC ($>4\%$); Flexibility, CRF, ABDS ($>10\%$)^{18,29-31}.

Afterward, we classified by the kind of response to each subject developed according to the physical fitness indicator and relation to health status. For instance, those subjects who had increased more than four percent in BMI were a negative health response; but if the girl presented a reduction of four percent in BMI, she had a positive health response. The participant was classified with a non-response to PE and HT when they did not reach the individual cut point in both possibilities' effects, negative or positive Δ . Considering all variables and the cut points upper cited, increasing in CRF, ABDS, and flexibility and decreasing in WC and BMI were considered positive effects. The results were presented in the prevalence table to responses in groups and bars graph to individual responses with each girl in their Δ .

Results

Table 1 shows the mean, median, and standard deviation of age, height, BMI, WC, CRF, ABDS, flexibility, and Mann-Whitney variability comparison in the pre-testing period. In this regard, a moderate effect of difference only in flexibility and age is verified, showing the girls in the PE group being the most flexible and slightly younger than the HT group.

Table 2 shows the effects of intervention in both groups and the comparison effects Δ of Glass in the post-testing period between these groups. Thus, girls allocated in the PE group have a greater effect

only in CRF. Alternatively, the HT group presents important effects in flexibility, CRF, and ABDS, small effects in flexibility, moderate effects in ABDS, and strong effects in CRF, overcoming the PE effects in this same variable. The median and mean of the post-testing period in the HT group are superior to those in the PE group. It is confirmed by a Δ Glass moderate in the group's post-testing comparison. The variability of ABDS of the HT girls is higher than the PE group, with a small effect.

Table 1. Sample characteristics and group comparison in the pre-testing phase.

Variables	Physical Education (14)			Handball Training (12)			Mann Whitney		Δ Glass
	Mean	Median	SD	Mean	Median	SD	U	p	
Age (years)	12.50	12.00	1.83	13.25	13.00	1.66	63	0.271	0.41
Weight (kg)	54.09	54.75	12.76	54.89	53.80	9.11	79.5	0.817	0.06
Height (meter)	1.54	1.56	0.07	1.56	1.57	0.06	73.5	0.587	0.26
BMI (kg/m ²)	22.58	21.99	4.63	22.46	23.26	3.26	81	0.877	0.02
WC (cm)	72.04	69.50	10.03	72.17	71.50	9.32	79	0.797	0.01
CRF (meter)	691.57	669.50	162.18	699.08	681.50	88.15	72	0.536	0.05
ABDS (rep)	16.93	18.50	11.96	18.42	20.50	8.74	78	0.757	0.12
Flexibility (cm)	32.14	32.00	10.79	27.92	28.00	8.51	64	0.302	0.39

SD: standard deviation; p: significance level; BMI: body mass index; WC: waist circumference; CRF: cardiorespiratory fitness; ABDS : abdominal strength; U: Mann Whitney Test value; Δ Glass: Effect size.

Table 2. Effects of an intervention with Physical Education and handball training in each one of the groups, and effects between groups on post-testing evaluation.

		Physical Education (14)			Wilcoxon			Handball Training (12)			Wilcoxon			Δ Glass PE x HT in post-test
		Mean	Median	SD	Z	p	Δ Glass	Mean	Median	SD	Z	p	Δ Glass	
WC	Pre-test	72.04	69.50	10.03	-0.44	0.660	0.01	72.17	71.50	9.32	1.14	0.255	0.24	0.22
	Post-test	71.96	67.50	9.75				69.78	69.30	7.32				
BMI	Pre-test	22.58	21.99	4.63	-0.10	0.920	0.03	22.46	23.26	3.26	-0.54	0.580	0.07	0.06
	Post-test	22.50	21.69	4.59				22.77	23.11	3.23				
CRF	Pre-test	691.57	669.50	162.18	1.88	0.060	0.61	699.08	681.50	88.15	2.99	0.003	0.90	0.57
	Post-test	752.50	742.50	168.84				848.33	880.00	113.09				
ABDS	Pre-test	16.93	18.50	11.96	-0.09	0.930	0.05	18.42	20.50	8.74	-1.25	0.220	0.29	0.46
	Post-test	16.50	17.50	11.58				21.83	25.50	9.69				
Flexibility	Pre-test	32.14	32.00	10.79	-0.12	0.900	0.07	27.92	28.00	8.51	-0.92	0.360	0.15	0.21
	Post-test	31.57	33.50	9.67				29.50	28.00	8.67				

PE: Physical Education group; HT: handball training group; SD: standard deviation; p: significance level; BMI: body mass index; WC: waist circumference; CRF: cardiorespiratory fitness; ABDS : abdominal strength; Z: Wilcoxon Test value; Δ Glass: Effect size.

Table 3 shows the prevalence of responses to PE and HT groups. It is possible to verify that prevalence in the PE group of positive responders for the reductions in WC and BMI is respectively 28.6% and 35.7%. This positive results in CRF, ABDS, and flexibility correspond to an increase in respective prevalence, about 35.7%, 14.3%, and 21.4%. On the other hand, reductions in WC and BMI in the HT group occur in different proportions, 33.3% and 16.7% of cases. Already, the effect of improvement in CRF happens in 75% of subjects, as well as an increase in ABDS and Flexibility in 58.3%.

The proportions of negative responses to PE and HT groups in WC and BMI are less than 30%. The reductions in CRF, ABDS, and flexibility prevalence range from 0 to 25%. It is important to highlight that CRF has fewer negative responses, with 7.1% in the PE group and 0% in the HT. Girls who do not

respond are about 35.7% to 64.3% in the PE group and 16.7% to 58.3% in the HT group. These results suggest that participation in HT provides additional effects for those in PE, regarding maintenance and improvements, mainly in CRF, ABDS, and flexibility. However, some girls in PE provide similar prevalence effects to the improvement of WC and a better effect on the reduction of BMI than HT girls. The variance of reduction in fitness variables is similar in both groups, which suggests that PE and HT provided at least maintenance of the physical fitness levels of most of these girls.

Table 3. Prevalence of girls' response types in physical fitness outcomes.

Group	Effect	Prevalence (%) of responses in physical fitness				
		WC	BMI	CRF	ABDS	Flexibility
Physical Education	Reduction	28,6	35,7	7,1	21,4	14,3
	Non-response	57,1	35,7	57,1	64,3	64,3
	Increasing	14,3	28,6	35,7	14,3	21,4
Handball Training	Reduction	33,3	16,7	0	25	16,7
	Non-response	41,7	58,3	25	16,7	25
	Increasing	25	25	75	58,3	58,3

BMI: body mass index; WC: waist circumference; CRF: cardiorespiratory fitness; ABDS : abdominal strength; (%): percentage effect value.

Figures 2 and 3 show individual delta effects in a percentage of physical fitness variation on girls of each group. In the first impression is important to point out that there is a greater difference in individual delta effects, which suggests that each girl responded in a distinct form to PE classes and HT training. Four girls in HT and PE groups have positive health responses in WC with individual reductions, between 4.0% to 26.2%. Two girls in HT and four in PE obtain positive health responses in BMI; it is approximately 4.0% in HT and about 4.3% to 11.1% in the PE group. Nine girls present positive health responses in CRF, between 14.1% at 61.5%. It happens in the PE group for five girls, with individual effects of 11.1% at 88.9%. Two girls in the PE group have improvements in ABDS with a greater difference compared to the others, one of them increasing 22.2% and a girl reaching 250%. This large range result is present in ABDS to HT group. However, seven girls appear with positive health responses. These improvements are about 16.7% at 150%. Girls' flexibility improves in seven girls in HT, with effects from 11.8% to 52.9%. Only three subjects improve this variable in the PE group, the effects are 13.3% to 20.0%. The prevalence of negative health responses in PE and HT groups is less than in positive responses. The individual reductions in CRF, ABDS, and flexibility in HT and PE groups occur in 11 girls, with an individual delta range of 22% to 59%.

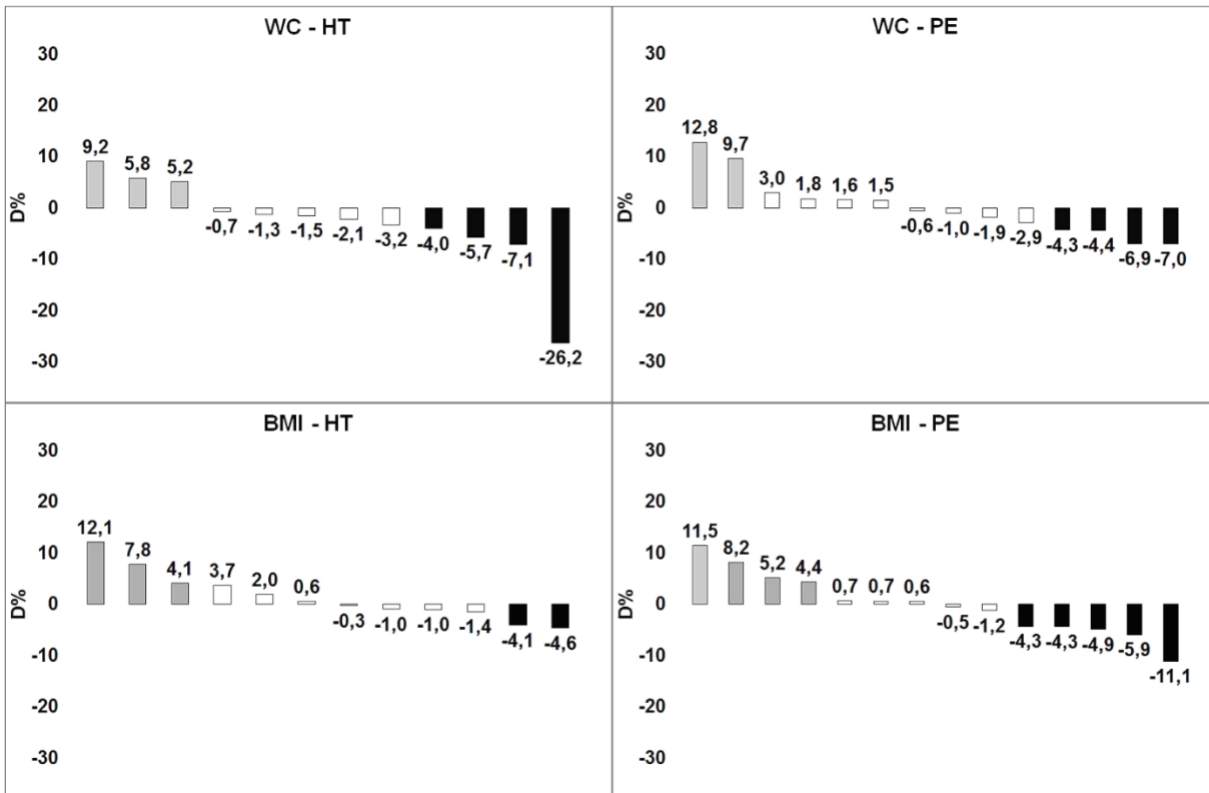


Figure 2. Individual Responses in handball training and Physical Education groups for WC and BMI. Gray bars represent girls with negative health responses; Black bars represent girls with positive health responses; white bars represent girls that are non-response. D%: percentage of variation in delta (the percentage of individual post-test – pre-test values). BMI: body mass index; HT: handball group; PE: Physical Education group.

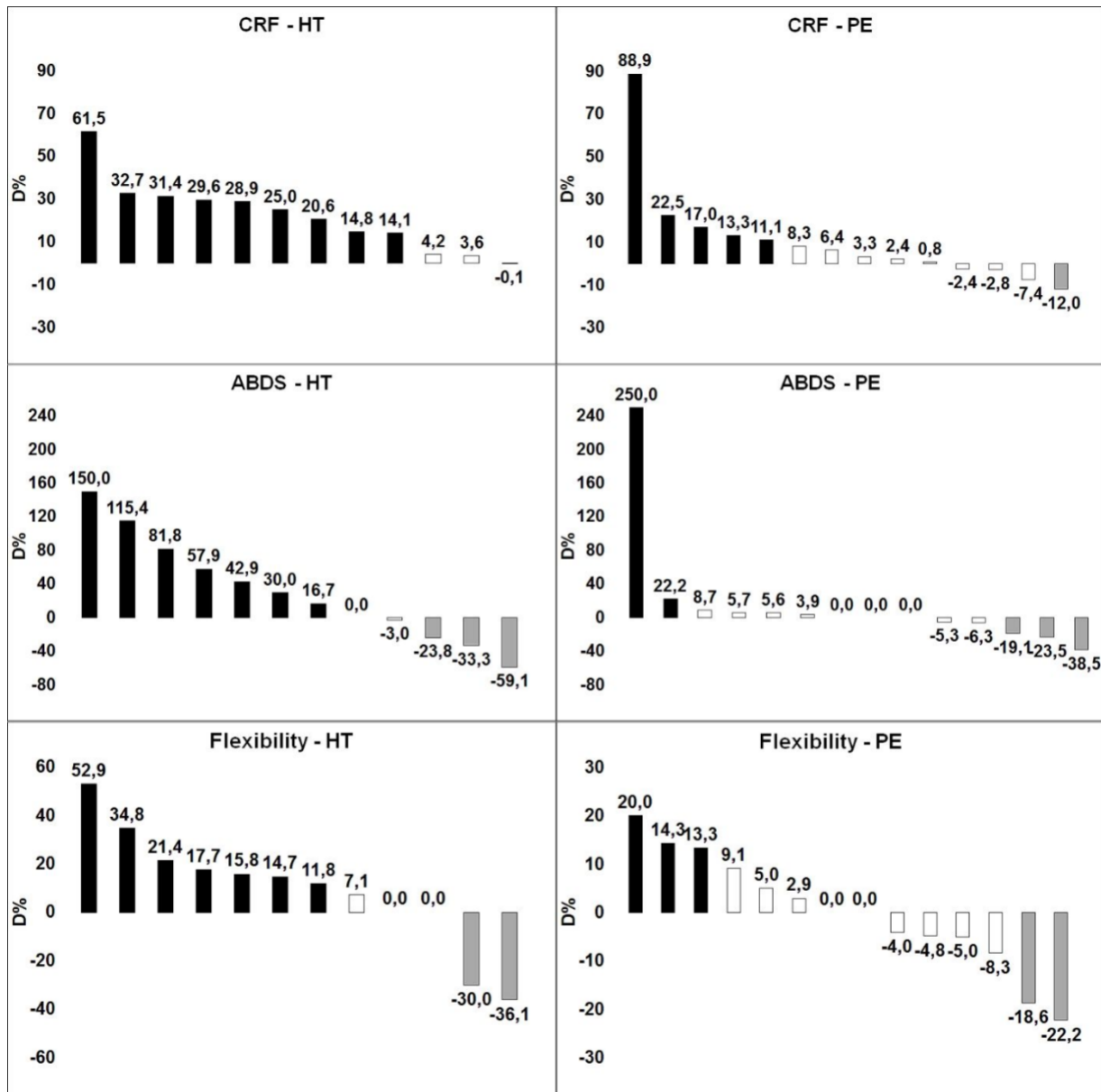


Figure 3. Individual Responses in handball training and Physical Education groups for CRF, ABDS, and Flexibility. Gray bars represent girls with negative health responses; Black bars represent girls with positive health responses; white bars represent girls that are non-response. D%: percentage of variation in delta (the percentage of individual post-test – pre-test values). CRF: cardiorespiratory fitness; ABDS: abdominal sit-up; HT: handball group; PE: Physical Education group

Discussion

The present study aimed to identify the effects of an intervention in Physical Education classes and handball training on health-related physical fitness in adolescent girls. The main results showed that handball and Physical Education classes were effective intervention methods to improve the health-physical fitness of adolescent girls.

The handball training presented the strongest effects on the median and the means of CRF and ABDS variables. Therefore, this study showed the importance of showing individual effects, too. The girls involved in handball training reduced WC and increased CRF, ABDS, and flexibility with large effect

sizes, 33% to 75% of individual improvements. In another way, it was impossible to perceive the same positive effects on health in girls who practice only Physical Education. In this sense, we observed fewer improvements in this group, with a variation of 14% to 35% of positive effects.

Comparatively to the handball training group, the results provided by Physical Education were small. Nevertheless, in our view, sports training, in this case, handball was an important additional health improvement strategy. Offering sports practices out of school time and Physical Education classes was the key to greater effects of the handball group compared to those who were only in the Physical Education classes. Thus, it is possible to say that the two interventions are important to the health of adolescents because both bring benefits to girls' health.

Several studies showed positive health results with sports and Physical Education on adolescents' health^{17,18,32,33}. The main strategies demonstrated by this evidence showed classes with adequate training volume, well-defined parts, and intensity control. In the same way, it is very important to work on big games, circuits of motor skills, specific fitness capacities, and sports practice to achieve volumes and intensities of physical exercise capable of making physiological changes to improve the health of adolescents¹⁷.

The main contribution of the present study to literature comes from the difficulty of finding a study with handball effects on the health of adolescent girls in the Brazilian context. Its perspective is very important because girls had some boundaries to sports practice, as social and familiar factors^{34,35}. And in this sense, the present study breaks this boundary presenting that sports and Physical Education are very important for girls' health.

Besides, the training methods of handball applied in the present study were very close to the proposal of the small-sided games. One aspect is health gains through well-structured planning, with volume and intensity appropriate to practitioners³⁶. In specific sports, handball studies³⁷⁻³⁹, are found within this theme. In the population with school practitioners and health context, the study with the closest theme demonstrated effectiveness in the BMI variable, with a difference between the pre and post-test averages, but we do not have a significant probability⁴⁰. Inside health, interventions aimed at preventing injuries to adolescent athletes through strength training have proven effective in protecting the athlete's health and physical integrity^{41,42}. Several other studies have chosen to apply a school intervention with handball under different contexts aimed directly at performance within the context of specific training⁴³⁻⁴⁵.

The main limitation of this research was a non-representative and non-randomized sample. This limitation prevents the present results from being extrapolated to other adolescents. Additionally, the present results show that the more consistent direction of effects relative to positive health was the improvements in physical fitness. The results of girls that reduced fitness or increased BMI and WC were inconsistent. It shows that both intervention methods were not responsible for these results. In this sense, some studies showed a similar perspective. An explication to there are people that not present responses to physical exercise and sports interventions can be low engagement, low enjoyment, and other lifestyle habits such as sedentary time and inadequate food intake in BMI and WC cases⁴⁶⁻⁴⁸.

Conclusion

In Conclusion, handball training, in opposition to scholar shift together Physical Education classes, provides improvements to 75% in adolescent girls' physical fitness. In another way, Physical Education classes also provided these effects; however, it was in a fewer proportion of about 35%.

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Authorship Contributions

Vanilson Lemes and Guilherme Caporal participated in all the processes of project organization and data analysis, in addition to draft the manuscript. Júlio Mello participated in data analysis and draft the manuscript, in addition to reviewing and approving the final version. Anelise Gaya e Adroaldo Gaya participated in reviewing and approving the final version.

Declaration of conflict of interest

The authors declare no conflict of interest.



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