



## THE USE OF THE “EDUBALL” EDUCATIONAL BALL IN RURAL AND URBAN PRIMARY SCHOOLS AND THE PHYSICAL FITNESS LEVELS OF CHILDREN

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### ABSTRACT

**Purpose.** Our study aimed at assessing the effects of introducing a modified physical educational program that uses “eduball” educational balls during exercise, play-time and games on the physical fitness of first-grade primary school students. In addition, the study also took under consideration whether any noted changes depended on where the students lived, i.e., in an urban or rural environment. **Methods.** A total of 127 first-grade students were selected to participate in the pedagogical experiment, with 48 students from a primary school in an urban environment and 79 students from two primary schools located in rural villages. The physical fitness levels of the children were assessed by using selected batteries from the International Physical Fitness Test before and after implementing the “eduball” physical education program. **Results.** The results found that physical fitness levels were not affected by the use of the “eduball” educational ball, regardless of the environment. However, the physical fitness results of both the boys and girls in the rural experimental group may confirm that the activities that used the educational balls, which emphasize running, can have an impact on the motor development of children’s speed and agility skills. **Conclusions.** The boys from the urban experimental and urban control groups in both tests achieved better results than their peers from rural areas. However, this may be more strongly related to the overall higher physical fitness levels of the boys from an urban environment (as was found in the first test), rather than their place of residence or their schools’ sports facilities, which were found to be comparable. In the groups of girls, a somewhat different trend was observed, with girls from the urban environment performing better than girls from rural areas among the analyzed fitness variables in the first test, but with the differences leveling out by the second test.

**Key words:** movement, educational balls, physical fitness

### Introduction

A child’s initial foray into the school educational system determines in a large part their relationship to education as well as their overall development. Of particular interest and importance is the motor development of children, which has been a subject of research for many years. Many studies have been conducted on children’s motor development [1–7], but knowledge on this subject is still limited and requires constant revision and updating. At the same time it should be noted with regret that many educators do not possess the appropriate competence in the field of physical education; few pay due attention to a child’s psychomotor development and unknowingly work to the detriment of children’s motor development. Among the many changes that children undergo at this stage of development when beginning school (around seven years of age), the proper development of physical fitness is of extreme importance.

Physical fitness is not only associated with the function of the musculoskeletal system, but in a large part with the overall biological functioning of the entire body. Its impact is not only relegated to mastering movement exercises, but it is also essential in the efficient

functioning of all organs and bodily system, the capabilities of many motor abilities (strength, speed, endurance and coordination) and even some aspects of maintaining an active lifestyle [8].

When speaking about the significance of motor skill development in school-aged youth, with a focus on physical activity, it is essential to remember that the basic form of physical activity for children at this stage is fun; its goal is to create innumerable opportunities of pleasure, to create a sense of group membership as well as to strengthen their self-esteem [9]. Therefore, it is possible to encourage children to participate in school activities as long as they see an aspect of fun within the exercise.

When taking these issues into consideration, it should also be remembered that the most dynamic subject within a school is the child, who at this stage of individual development is very active. Children naturally expect that a new environment will provide them with a wide gamut of active opportunities. Every teacher and parent knows that fun and games for children are a natural way for them to get rid of excess energy and address their needs for coexisting with their peers. With teachers, well thought-out children’s games frequently teach children new and important skills or experience.

In order to encourage children to participate in physical activities, it is important to reach out to unconven-

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tional strategies and equipment to make these activities more fun. In addition, in this regard it should also encourage children to independently seek their own interesting solutions for fun. In such a way can the process of developing motor skills be conducted with the children’s awareness and acceptance [8].

In this context, the idea of using additional teaching aids that can be seen as both activating and being attractive for children at this early stage of development seems entirely reasonable. The aim of this study was to research the use of the “eduball” educational ball as an alternative form of physical activity as it emphasizes running, and can better support a child’s motor and mental development [10]. It was hoped to determine what impact can such a modified physical education curriculum using the “eduball” have on the physical fitness levels of first-grade students. Therefore, the following research questions were selected:

1. Are there changes in the physical fitness levels of children after participating in physical activities that use the “eduball”?
2. Do the changes in the physical fitness of children depend on where they live (in an urban or rural environment)?

### Material and methods

A total of 127 pupils from primary schools located in Czarny Bor, Sułów, and Wrocław (Poland) participated in the study. The villages of Czarny Bor and Sułów comprised the rural aspect of this study, from which 79 first-grade students attending local primary schools during the 2004/2005 school year were selected. This part of the study was conducted under a grant provided by the Ministry of Science and Higher Education (No. 2PO5D058), whose principal researcher was the co-author of this study, Andrzej Rokita. Due to the high comparability of both rural schools, the students were divided into an experimental (18 girls and 19 boys) and control (22 girls and 20 boys) group [7].

The children from an urban environment were 48 first-grade students from School No. 11 in the city of Wrocław. This part of the study was conducted by Ireneusz Cichy during the 2006/2007 school year. Similarly, the students were divided into an experimental group consisting of 14 boys and 15 girls and a control group of 11 boys and 8 girls. The study was conducted with a parallel group technique, obtained from a previous pedagogical study by Rokita and Cichy [11]. Prior to the experiment, approval was obtained from the Senate Committee on Ethics at the University of Physical Education in Wrocław and from the children’s parents.

The study was conducted under the moniker of “Happy School”, which was used in the selected first-grade classes at the primary schools in Czarny Bor, Sułów and Wrocław. In the experimental groups, students participated in physical activity with the educational balls as part of their normal daily class routine, which was

guided by their class teacher. The exercises and games they were to play were a number pre-prepared scenarios, designed with the consultation of the class’ teacher. The exercise content was guided by strengthening or improving tasks that were either too difficult for the students to learn or those that were considered important enough to warrant additional focus. The principal structure of all the scenarios was to provide a form of fun. The time spent playing with the educational balls accounted for approximately 60% of the total duration of physical activity. The remaining time was devoted to other forms of physical activity that were part of the physical education curriculum. In the control groups, which continued to conduct the physical education component of their class in a standard manner, classes were also led by (as in the experimental groups) by their class teacher.

In order to assess the differences in using the “eduball” on children’s physical activity levels, this study employed the standard International Physical Fitness Test [12]. Only seven of the eight test batteries were employed, as the test of endurance (running a distance of 600 m) was not accepted by all of the children’s’ parents. In addition, the primary school in Wrocław (located in the city center) did not have an area where this test could be performed. Research on both the rural/urban groups was conducted before the start of the experiment and after it concluded, i.e., at the beginning of the school year in September and at the end of the school year in late May/early June, respectively.

The results were calculated with basic statistical measures such as arithmetic mean and standard deviation. The data concerning the two groups was referred to the results (not to the data) Rokita [7], therefore, it was possible to compare the village and town groups with the use of planned comparisons. Thus, the presented analysis is a compilation of variance analyses and *t*-Student test for dependent and independent groups. The significance of the observed differences was determined at  $p \leq 0.05$ .

The results obtained from the physical fitness tests at the beginning and end of the school year were then subjected to multivariate analysis. Due to the size of the sample, the two research groups and their places of residence, those children from the city of Wrocław were labeled as urban experimental (UE) or urban control (UC), while those from the rural schools in Czarny Bor and Sułów were labeled as either rural experimental (RE) or rural control (RC).

### Results

A summary of the mean values obtained by the girls from the urban experimental (UE) and rural experimental (RE) groups are presented in Table 1. It can be seen in the 50 m race and palm dynamometry (handgrip strength) in the first test and the flexed arm hang in both the first and second test that the girls from

Table 1. Comparison of the average physical fitness values obtained by girls in the urban experimental (UE) and rural experimental (RE) groups

Variable	UE			RE			<i>p</i>	Difference
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run_1 (s)	15	10.51	0.65	16	11.91	0.83	0.0000*	1.40
Jump_1 (m)	15	1.09	0.14	16	1.05	0.24	0.5556	0.04
Dynam._1 (kg)	15	12.60	1.28	16	0.83	0.2	0.0000*	11.77
Hang_1 (s)	15	10.51	6.03	16	2.76	4.26	0.0003*	7.75
4 × 10 run_1 (s)	15	15.58	1.35	16	15.14	1.03	0.3155	0.44
Sit-ups_1 (num.)	15	13.87	3.85	16	13.75	4.39	0.9380	0.12
Toe touch_1 (cm)	15	2.67	5.03	16	-5.25	7.35	0.0016*	7.92
50 run_2 (s)	15	10.12	0.76	16	10.52	1.22	0.2894	0.40
Jump_2 (m)	15	1.17	0.15	16	1.15	0.17	0.7764	0.02
Dynam._2 (kg)	15	12.73	1.59	16	14.44	2.45	0.0298*	1.71
Hang_2 (s)	15	11.79	6.75	16	3.87	4.42	0.0005*	7.92
4 × 10 run_2 (s)	15	15.12	1.00	16	14.16	0.79	0.0057*	0.96
Sit-ups_2 (num.)	15	15.67	2.76	16	17	4.97	0.3680	1.33
Toe touch_2 (cm)	15	3.13	6.49	16	-1.94	9.62	0.0981	5.07

Legend for Tables 1–16

50 run – running a distance of 50 m

4 × 10 run – 4 × 10 m shuttle run with wooden blocks

Jump – standing long jump

Sit-ups – sit-ups from a lying position

Dynam. – palm dynamometry (handgrip strength)

Toe touch – forward bend from a standing position on a bench

Hang – flexed arm hang

*N* – number of participants,  $\bar{x}$  – arithmetic mean, *SD* – standard deviation

The designation \_1 and \_2 tells if the data was collected in the 1<sup>st</sup> or 2<sup>nd</sup> test

\* the significance of the observed differences at  $p \leq 0.05$

Table 2. Comparison of the average physical fitness values obtained by boys in the urban experimental (UE) and rural experimental (RE) groups

Variable	UE			RE			<i>p</i>	Difference
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run_1 (s)	14	10.34	1.26	18	11.53	0.74	0.0023*	1.19
Jump_1 (m)	14	1.15	0.19	18	1.05	0.15	0.1017	0.10
Dynam._1 (kg)	14	14.93	3.11	18	2	1.34	0.0000*	12.93
Hang_1 (s)	14	10.58	9.03	18	1.78	1.9	0.0003*	8.80
4 × 10 run_1 (s)	14	15.28	1.66	18	14.93	0.8	0.4444	0.35
Sit-ups_1 (num.)	14	16.79	3.70	18	14	3.71	0.0434*	2.79
Toe touch_1 (cm)	14	-1.86	4.54	18	-4.72	7.31	0.2093	2.86
50 run_2 (s)	14	9.72	1.21	18	10.5	0.88	0.0425	0.78
Jump_2 (m)	14	1.25	0.21	18	1.08	0.12	0.0061*	0.17
Dynam._2 (kg)	14	15.21	3.34	18	15	3.43	0.8605	0.21
Hang_2 (s)	14	11.34	9.51	18	4.96	8.06	0.0488*	6.38
4 × 10 run_2 (s)	14	15.01	1.65	18	13.97	0.8	0.0253*	1.04
Sit-ups_2 (num.)	14	17.00	3.90	18	14	3.71	0.0341*	3.00
Toe touch_2 (cm)	14	-2.50	4.12	18	-3.54	9.58	0.7075	1.04

the school in Wrocław (urban setting) obtained better results, with the differences being statistically significant. It is worth noting that the girls in the rural experimental group in the second test performed better in the palm dynamometry (handgrip strength) test and in the 4 × 10 m run (Tab. 1).

Based on adopted statistical indicators, significant differences were found in the first test between the urban

experimental (UE) and rural experimental (RE) groups of boys in the 50 m run, palm dynamometry (handgrip strength), flexed arm hang and sit-ups (Tab. 2). In each of these trials, the boys in the urban experimental group achieved significantly better results. In the second test, at the end of the school year, the boys in the urban experimental group again achieved better results that were statistically significant in the standing long jump, flexed

Table 3. Comparison of the average physical fitness values obtained by girls in the urban control (UC) and rural control (RC) groups

Variable	UC			RC			<i>p</i>	Difference
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run_1 (s)	8	11.09	1.43	20	11.68	1.69	0.3931	0.59
Jump_1 (m)	8	1.20	0.02	20	0.95	0.2	0.0017*	0.25
Dynam._1 (kg)	8	13.13	2.90	20	0.9	0.99	0.0000*	12.23
Hang_1 (s)	8	6.45	3.43	20	3.93	2.61	0.0445*	2.52
4×10 run_1 (s)	8	16.54	1.74	20	15.06	2.1	0.0910	1.48
Sit-ups_1 (num.)	8	13.00	2.73	20	13.4	5.59	0.8493	0.40
Toe touch_1 (cm)	8	4.00	9.84	20	0.25	4.43	0.1704	3.75
50 run_2 (s)	8	9.38	0.59	21	11.06	1.77	0.0146*	1.68
Jump_2 (m)	8	1.19	0.10	21	1.06	0.23	0.1438	0.13
Dynam._2 (kg)	8	13.13	3.40	21	16.05	3.12	0.0363*	2.93
Hang_2 (s)	8	7.86	4.33	21	14.45	1.56	0.0000*	6.59
4×10 run_2 (s)	8	14.91	1.14	21	14.45	1.56	0.4544	0.46
Sit-ups_2 (num.)	8	13.50	2.45	21	15.29	4.15	0.2648	1.79
Toe touch_2 (cm)	8	0.75	5.75	21	0.48	7.85	0.9303	0.27

Table 4. Comparison of the average physical fitness values obtained by boys in the urban control (UC) and rural control (RC) groups

Variable	UC			RC			<i>p</i>	Difference
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run_1 (s)	11	10.54	1.51	18	10.75	1.73	0.7392	0.21
Jump_1 (m)	11	1.21	0.03	18	1	0.22	0.0044*	0.21
Dynam._1 (kg)	11	15.18	1.33	18	0.85	0.19	0.0000*	14.33
Hang_1 (s)	11	10.23	4.02	18	1.92	2.38	0.0000*	8.31
4 × 10 run_1 (s)	11	15.63	2.25	18	16.67	2.22	0.2326	1.04
Sit-ups_1 (num.)	11	14.91	2.51	18	12.11	5.16	0.1057	2.80
Toe touch_1 (cm)	11	6.73	8.40	18	-2.5	7.06	0.0037*	9.23
50 run_2 (s)	11	9.68	1.36	17	10.35	1.54	0.2473	0.67
Jump_2 (m)	11	1.29	0.15	17	1.11	0.19	0.0151*	0.18
Dynam._2 (kg)	11	15.82	2.27	17	14.18	3.3	0.1628	1.64
Hang_2 (s)	11	10.33	4.05	17	2.58	2.55	0.0000*	7.75
4×10 run_2 (s)	11	15.00	1.86	17	14.97	2.28	0.9721	0.03
Sit-ups_2 (num.)	11	16.00	2.28	17	13.18	4.32	0.0578	2.82
Toe touch_2 (cm)	11	3.09	7.91	17	-1.24	4.93	0.0847	4.33

arm hang and sit-ups. The boys in the rural experimental group achieved better results that were statistically significant only in the 4 × 10 m shuttle run. It was therefore concluded that the students in the urban experimental group surpassed their rural peers in terms of hand and upper limb functional strength both before and after the “eduball” physical education program.

Based on the results obtained from the pupils in the urban control (UC) and rural control (RC) groups (Tab. 3), it was found that the girls from Wrocław (UC) in the first test achieved statistically significant better results in the standing long jump, palm dynamometry (handgrip strength) and flexed arm hang. When taking into account the second test, the girls in the urban con-

trol group were better than their peers in the 50 m run, palm dynamometry and bent arm hang, with significance differences noted among these results.

When comparing the results obtained by the boys in the urban control (UC) and rural control groups (RC), a statistically significant difference in favor of the first-graders from Wrocław was found in the standing long jump, palm dynamometry (handgrip strength), bent arm hang and toe touch in the first test (Tab. 4). Comparative analysis of the results obtained by the same groups of students in the second test confirmed the advantage of the students from Wrocław (UC) in nearly all samples, with the differences in the standing long jump and bent arm hang found to be statistically significant. The results

Table 5. Comparison of the average physical fitness values obtained by girls in the urban experimental (UE) and rural control (RC) groups

Variable	UE			RC			<i>p</i>	Difference
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run_1 (s)	15	10.51	0.65	20	11.68	1.69	0.0158*	1.17
Jump_1 (m)	15	1.09	0.14	20	0.95	0.2	0.0252*	0.14
Dynam._1 (kg)	15	12.60	1.28	20	0.9	0.99	0.0000*	11.70
Hang_1 (s)	15	10.51	6.03	20	3.93	2.61	0.0001*	6.58
4 × 10 run_1 (s)	15	15.58	1.35	20	15.06	2.1	0.4104	0.52
Sit-ups_1 (num.)	15	13.87	3.85	20	13.4	5.59	0.7832	0.47
Toe touch_1 (cm)	15	2.67	5.03	20	0.25	4.43	0.1412	2.42
50 run_2 (s)	15	10.12	0.76	21	11.06	1.77	0.0630	0.94
Jump_2 (m)	15	1.17	0.15	21	1.06	0.23	0.1271	0.11
Dynam._2 (kg)	15	12.73	1.59	21	16.05	3.12	0.0006*	3.32
Hang_2 (s)	15	11.79	6.75	21	14.45	1.56	0.0884	2.66
4 × 10 run_2 (s)	15	15.12	1.00	21	14.45	1.56	0.1509	0.67
Sit-ups_2 (num.)	15	15.67	2.76	21	15.29	4.15	0.7616	0.38
Toe touch_2 (cm)	15	3.13	6.49	21	0.48	7.85	0.2912	2.65

Table 6. Comparison of the average physical fitness values obtained by boys in the urban experimental (UE) and rural control (RC) group

Variable	UE			RC			<i>p</i>	Difference
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run_1 (s)	14	10.34	1.26	18	10.75	1.73	0.4623	0.41
Jump_1 (m)	14	1.15	0.19	18	1	0.22	0.0496	0.15
Dynam._1 (kg)	14	14.93	3.11	18	0.85	0.19	0.0000*	14.08
Hang_1 (s)	14	10.58	9.03	18	1.92	2.38	0.0005*	8.66
4 × 10 run_1 (s)	14	15.28	1.66	18	16.67	2.22	0.0594	1.39
Sit-ups_1 (num.)	14	16.79	3.70	18	12.11	5.16	0.0076*	4.68
Toe touch_1 (cm)	14	-1.86	4.54	18	-2.5	7.06	0.7693	0.64
50 run_2 (s)	14	9.72	1.21	17	10.35	1.54	0.2211	0.63
Jump_2 (m)	14	1.25	0.21	17	1.11	0.19	0.0553	0.14
Dynam._2 (kg)	14	15.21	3.34	17	14.18	3.3	0.3950	1.03
Hang_2 (s)	14	11.34	9.51	17	2.58	2.55	0.0010*	8.76
4×10 run_2 (s)	14	15.01	1.65	17	14.97	2.28	0.9551	0.04
Sit-ups_2 (num.)	14	17.00	3.90	17	13.18	4.32	0.0160*	3.82
Toe touch_2 (cm)	14	-2.50	4.12	17	-1.24	4.93	0.4525	1.26

indicate a much faster rate of physical development in boys who live in urban areas, which may be associated with better personal development.

Comparison of the results obtained by the girls in the urban experimental (EU) and rural control (RC) groups found that in the first test, before the experiment was conducted, the girls from the urban control group presented better results in running speed, explosive strength, static strength in the hands and upper extremities, with the results being statistically significant (Tab. 5). After a year of being subjected to the experimental conditions, these differences were not as pronounced, with grip strength of the girls from Czarny Bor and Sułów (RC) found to be clearly better. Based

on the obtained results, it can be assumed that the implementation of the “eduball” educational ball in a primary school setting does not have an effect on the development on static strength of the hands.

The differences in the results between the urban experimental (EU) and rural control (RC) groups of boys (Tab. 6) were similar to what was found in the group of girls (Tab. 5), finding that the physical fitness levels of urban students were better than their peers living in a village both in the first and second physical fitness test. The boys from Wrocław obtained better results in most of the test variables, with the differences being statistically significant in palm dynamometry (hand-grip strength) in the first test, and the bent arm hang



Table 7. Comparison of the average physical fitness values obtained by girls in the urban control (UC) and rural experimental (RE) groups

Variable	UC			RE			<i>p</i>	Difference
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run_1 (s)	8	11.09	1.43	16	11.91	0.83	0.0874	0.82
Jump_1 (m)	8	1.20	0.02	16	1.05	0.24	0.0949	0.15
Dynam._1 (kg)	8	13.13	2.90	16	0.83	0.2	0.0000*	12.30
Hang_1 (s)	8	6.45	3.43	16	2.76	4.26	0.0452*	3.69
4 × 10 run_1 (s)	8	16.54	1.74	16	15.14	1.03	0.0212*	1.40
Sit-ups_1 (num.)	8	13.00	2.73	16	13.75	4.39	0.6643	0.75
Toe touch_1 (cm)	8	4.00	9.84	16	-5.25	7.35	0.0164*	9.25
50 run_2 (s)	8	9.38	0.59	16	10.52	1.22	0.0208*	1.14
Jump_2 (m)	8	1.19	0.10	16	1.15	0.17	0.5704	0.04
Dynam._2 (kg)	8	13.13	3.40	16	14.44	2.45	0.2877	1.32
Hang_2 (s)	8	7.86	4.33	16	3.87	4.42	0.0476*	3.99
4×10 run_2 (s)	8	14.91	1.14	16	14.16	0.79	0.0713	0.75
Sit-ups_2 (num.)	8	13.50	2.45	16	17	4.97	0.0753	3.50
Toe touch_2 (cm)	8	0.75	5.75	16	-1.94	9.62	0.4767	2.69

Table 8. Comparison of the average physical fitness values obtained by boys in the urban control (UC) and rural experimental (RE) groups

Variable	UC			RE			<i>p</i>	Difference
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run_1 (s)	11	10.54	1.51	18	11.53	0.74	0.0247*	0.99
Jump_1 (m)	11	1.21	0.03	18	1.05	0.15	0.0018*	0.16
Dynam._1 (kg)	11	15.18	1.33	18	2	1.34	0.0000*	13.18
Hang_1 (s)	11	10.23	4.02	18	1.78	1.9	0.0000*	8.45
4 × 10 run_1 (s)	11	15.63	2.25	18	14.93	0.8	0.2392	0.70
Sit-ups_1 (num.)	11	14.91	2.51	18	14	3.71	0.4799	0.91
Toe touch_1 (cm)	11	6.73	8.40	18	-4.72	7.31	0.0006*	11.45
50 run_2 (s)	11	9.68	1.36	18	10.5	0.88	0.0567	0.82
Jump_2 (m)	11	1.29	0.15	18	1.08	0.12	0.0003*	0.21
Dynam._2 (kg)	11	15.82	2.27	18	15	3.43	0.4897	0.82
Hang_2 (s)	11	10.33	4.05	18	4.96	8.06	0.0504	5.37
4×10 run_2 (s)	11	15.00	1.86	18	13.97	0.8	0.0482*	1.03
Sit-ups_2 (num.)	11	16.00	2.28	18	14	3.71	0.1200	2.00
Toe touch_2 (cm)	11	3.09	7.91	18	-3.54	9.58	0.0647	6.63

and sit-ups in both the first and second test. Therefore, it can be concluded that the boys in the urban experimental group that participated in activities with the “eduball” not only improved their physical fitness, but performed much better than their peers from Czarny Bor and Sułów.

Based on the results obtained by the girls in the urban control (UC) and rural experimental (RE) groups, it was found that during the initial test the first-graders from Wrocław had a definite advantage in physical fitness levels (Tab. 7). Statistically significant differences were found in the test variables of: palm dynamometry (handgrip strength), bent arm hang, 4 × 10 m shuttle run and toe touch. The second test found the results

evened out in most of the variables, other than the 50 m run and bent arm hang.

Comparison of the results obtained by the boys in the urban control (UC) and rural experimental (RE) groups found a pattern similar to what was with the girls, i.e., a higher physical fitness levels of the boys from Wrocław (Tab. 8). The resulting differences were found to be statistically significant in the 50 m run, standing long jump, palm dynamometry (handgrip strength) and bent arm hang. However, no significant differences were found in the second test. The boys from Czarny Bor and Sułów did improve their performance, which provided a confirmation that the use of the “eduball” educational balls does not adversely affect physical fitness levels [7, 8, 10].

Table 9. Comparison of the average physical fitness values obtained by girls in the urban experimental (UE) group in tests 1 and 2

Variable	Test 1 (T1)			Test 2 (T2)			T1-T2	<i>p</i>
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run (s)	15	10.51	0.650	15	10.12	0.76	1.49	0.1485
Jump (m)	15	1.09	0.143	15	1.17	0.15	1.37	0.1823
Dynam. (kg)	15	12.60	1.281	15	12.73	1.59	0.25	0.8019
Hang (s)	15	10.51	6.029	15	11.79	6.75	0.55	0.5897
4 × 10 run (s)	15	15.58	1.346	15	15.12	1.00	1.05	0.3043
Sit-ups (num.)	15	13.87	3.846	15	15.67	2.76	1.47	0.1520
Toe touch (cm)	15	2.67	5.030	15	3.13	6.49	0.22	0.8273

Table 10. Comparison of the average physical fitness values obtained by boys in the urban experimental (UE) group in tests 1 and 2

Variable	Test 1 (T1)			Test 2 (T2)			T1-T2	<i>p</i>
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run (s)	14	10.34	1.26	14	9.72	1.21	1.33	0.1944
Jump (m)	14	1.15	0.19	14	1.25	0.21	1.38	0.1784
Dynam. (kg)	14	14.93	3.11	14	15.21	3.34	0.23	0.8166
Hang (s)	14	10.58	9.03	14	11.34	9.51	0.22	0.8298
4 × 10 run (s)	14	15.28	1.66	14	15.01	1.65	0.42	0.6771
Sit-ups (num.)	14	16.79	3.70	14	17.00	3.90	0.15	0.8826
Toe touch (cm)	14	-1.86	4.54	14	-2.50	4.12	0.39	0.6979

Table 11. Comparison of the average physical fitness values obtained by girls in the urban control (UC) group in tests 1 and 2

Variable	Test 1 (T1)			Test 2 (T2)			T1-T2	<i>p</i>
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run (s)	8	11.09	1.43	8	9.38	0.59	3.13	0.0073*
Jump (m)	8	1.20	0.02	8	1.19	0.10	0.36	0.7224
Dynam. (kg)	8	13.13	2.90	8	13.13	3.40	0.00	1.0000
Hang (s)	8	6.45	3.43	8	7.86	4.33	0.72	0.4828
4 × 10 run (s)	8	16.54	1.74	8	14.91	1.14	2.21	0.0442*
Sit-ups (num.)	8	13.00	2.73	8	13.50	2.45	0.39	0.7054
Toe touch (cm)	8	4.00	9.84	8	0.75	5.75	0.81	0.4335

Table 12. Comparison of the average physical fitness values obtained by boys in the rural control (RC) group in tests 1 and 2

Variable	Test 1 (T1)			Test 2 (T2)			T1-T2	<i>p</i>
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run (s)	11	10.54	1.51	11	9.68	1.36	1.41	0.1747
Jump (m)	11	1.21	0.03	11	1.29	0.15	1.69	0.1061
Dynam. (kg)	11	15.18	1.33	11	15.82	2.27	0.80	0.4320
Hang (s)	11	10.23	4.02	11	10.33	4.05	0.06	0.9554
4 × 10 run (s)	11	15.63	2.25	11	15.00	1.86	0.71	0.4851
Sit-ups (num.)	11	14.91	2.51	11	16.00	2.28	1.07	0.2985
Toe touch (cm)	11	6.73	8.40	11	3.09	7.91	1.05	0.3083

Table 13. Comparison of the average physical fitness values obtained by girls in the rural experimental (RE) group in tests 1 and 2

Variable	Test 1 (T1)			Test 2 (T2)			T1-T2	<i>p</i>
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run (s)	16	11.91	0.83	16	10.52	1.22	3.81	0.0006*
Jump (m)	16	1.05	0.24	16	1.15	0.17	1.39	0.1744
Dynam. (kg)	16	0.83	0.2	16	14.44	2.45	22.15	0.0000*
Hang (s)	16	2.76	4.26	16	3.87	4.42	0.74	0.4679
4 × 10 run (s)	16	15.14	1.03	16	14.16	0.79	3.09	0.0043*
Sit-ups (num.)	16	13.75	4.39	16	17	4.97	1.99	0.0558
Toe touch (cm)	16	-5.25	7.35	16	-1.94	9.62	1.11	0.2770

Table 14. Comparison of the average physical fitness values obtained by boys in the rural experimental (RE) group in tests 1 and 2

Variable	Test 1 (T1)			Test 2 (T2)			T1-T2	<i>p</i>
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run (s)	18	11.53	0.74	18	10.50	0.88	4.00	0.0003*
Jump (m)	18	1.05	0.15	18	1.08	0.12	0.72	0.4789
Dynam. (kg)	18	2.00	1.34	18	15.00	3.43	15.22	0.0000*
Hang (s)	18	1.78	1.90	18	4.96	8.06	1.64	0.1103
4 × 10 run (s)	18	14.93	0.80	18	13.97	0.80	3.83	0.0005*
Sit-ups (num.)	18	14.00	3.71	18	14.00	3.71	0.00	1.0000
Toe touch (cm)	18	-4.72	7.31	18	-3.54	9.58	0.43	0.6665

Table 15. Comparison of the average physical fitness values obtained by girls in the rural control (RC) group in tests 1 and 2

Variable	Test 1 (T1)			Test 2 (T2)			T1-T2	<i>p</i>
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run (s)	20	11.68	1.69	21	11.06	1.77	1.36	0.1833
Jump (m)	20	0.95	0.2	21	1.06	0.23	1.89	0.0662
Dynam. (kg)	20	0.90	0.99	21	16.05	3.12	21.32	0.0000*
Hang (s)	20	3.93	2.61	21	14.45	1.56	21.16	0.0000*
4 × 10 run (s)	20	15.06	2.1	21	14.45	1.56	1.35	0.1837
Sit-ups (num.)	20	13.40	5.59	21	15.29	4.15	1.58	0.1231
Toe touch (cm)	20	0.25	4.43	21	0.48	7.85	0.12	0.9020

Table 16. Comparison of the average physical fitness values obtained by boys in the rural control (RC) group in tests 1 and 2

Variable	Test 1 (T1)			Test 2 (T2)			T1-T2	<i>p</i>
	<i>N</i>	$\bar{x}$	<i>S</i>	<i>N</i>	$\bar{x}$	<i>S</i>		
50 run (s)	18	10.75	1.73	17	10.35	1.54	0.835	0.4096
Jump (m)	18	1.00	0.22	17	1.11	0.19	1.837	0.0750
Dynam. (kg)	18	0.85	0.19	17	14.18	3.30	17.121	0.0000*
Hang (s)	18	1.92	2.38	17	2.58	2.55	0.893	0.3782
4 × 10 run (s)	18	16.67	2.22	17	14.97	2.28	2.535	0.0160*
Sit-ups (num.)	18	12.11	5.16	17	13.18	4.32	0.775	0.4438
Toe touch (cm)	18	-2.50	7.06	17	-1.24	4.93	0.730	0.4704



Comparison of the results obtained by both girls and boys from the Wrocław primary school in both the first and second test showed no statistically significant differences in the experimental groups (Tab. 9 and 10). The girls in the control group (Tab. 11) featured statistically significant differences in the 50 m run and 4 × 10 m shuttle run. Most of the obtained results point to the natural physical development of children, which itself is not dependent on any specific form of physical activity. In the control group of boys from Wrocław, as in the case of the girls and boys in the experimental group from Wrocław, there were no statistically significant differences between the first and second tests (Tab. 12).

When taking into account the results obtained from the first and second test in the experimental group of girls (Tab. 13) and boys (Tab. 14) from Czarny Bor and Sułów (RE), significantly better results were obtained in the second test in all the test variables, with the results being statistically significant in the 50 m run, the 4 × 10 m shuttle run and palm dynamometry (handgrip strength). These results can confirm that the type of educational games played with the “eduball” (which emphasize running) were a determinant of the changes in both the speed and agility of children.

The control groups of girls (Tab. 15) and boys (Tab. 16) from Czarny Bor and Sulow (RC) featured positive changes in all of the physical fitness variables taken under consideration. Statistically significant differences were noted in palm dynamometry (handgrip strength) and the bent arm hang in the group of girls and the palm dynamometry (handgrip strength) and the 4 × 10 m run in the group of boys.

It should be noted that two parallel studies were conducted along with the experiment found here that yielded interesting results. In Czarny Bor and Sułów additional research was conducted on the search for a relationship between the use of the “eduball” physical education programs and reading and writing skills, while in Wrocław the use of the “eduball” was studied with the acquisition of additional learning abilities. The studies found that physical activity conducted with the “eduball” in the group of rural children had an impact on their rate of acquiring reading skills [7], while the urban schoolchildren from Wrocław achieved better results on a number of educational aptitude tests [8].

## Discussion

The aim of early childhood education is to support a child’s intellectual, emotional, social ethical, physical and aesthetic development [13]. It is recommended that a child should start their formal education after reaching the age of school maturity [14], which is a concept that not only takes into consideration the level of mental development that would allow a child to study, but also the degree of their socio-moral behavior, which would allow to them work and play with their peers.

A very important part of school maturity is also gross and fine motor development, which, unfortunately, has been often overlooked in pedagogical studies, even though it determines a number of changes in the overall development of early school-aged children (including reading and writing).

Nonetheless, a number of publications in recent years have focused on the motor development of children and educational growth. In Poland, the importance of physical fitness on a child’s ability to work and play in a school environment has been analyzed by Szuman, Dzierżanka, Gniewkowska and Wilgocka-Okoń [in: 14]. These authors found that motor skill development was tied to children’s social development, such as if a child performs well in games and activities (including those with balls) it becomes easier for them to facilitate their “entry” within a group of their peers [in: 15].

In addition, recent studies have also been conducted on demonstrating the effectiveness of selected teaching methods, forms and materials on improving children’s educational achievements. These include studies conducted by researchers associated with the University of Physical Education in Wrocław on the use of the “eduball” educational ball.

Literature that dealt specifically with the use of “eduballs” can be traced back to pilot studies conducted in 2002 [16, 17] as well as more recent [7, 8, 10, 15, 18] studies on both pre-school and primary school education. These studies pointed to a number of interesting results on the effects of using the “eduball” on physical fitness as well as learning selected skills. Among others, Cichy and Rzepa analyzed the relationship between the use of the “eduball” and physical fitness development in grades one through three in primary schools [17]. Once concluding a year-long parallel-group pedagogical experiment, the authors noted that a curriculum that includes the use of educational balls can effect children’s motor development in the same way as a traditional curriculum.

Pawłucki [19] and Wojcik-Grzyb [20] also reported interesting results, with their belief that motor development, more specifically the development of coordination, is closely related to children’s speed in learning reading and writing skills. Rokita [10], implementing a study in a rural environment, and Rzepa and Wójcik [21], working on children in an urban environment, both stated that the setting where the “eduball” is used is insignificant, and that children’s fitness levels are dependent more on individual development than the introduction of an experimental factor such as the “eduball” [7].

Taking into regard the results attained by the aforementioned authors, it can be stated that the use of such educational balls during physical activity does not cause any adverse effects on overall physical fitness and body coordination [18] and may in fact contribute to more effective development of children’s learning skills at this age.

The authors of this study would like to highlight the need to include participants' somatic parameters in future pedagogical studies of this sort, as they often play a large role in the development of selected physical fitness variables, as was evidenced by, among others, Pangrazi et al., Burdukiewicz, Fisher et al. and Malina et al. [6, 22–24]. Such information could specify whether the differences recorded in physical fitness levels are determined more by somatic build or gender dimorphism at this early stage of development (at an age of around seven years), as was indicated by Malina et al. [25, 26].

### Conclusion

1. The overall majority of the obtained results on physical fitness levels were found not to result from using the “eduball” educational ball. However, both the girls and boys in the rural experimental groups provided results that could confirm this study's assumptions due to the amount of running involved in the physical activities that use the “eduball”, which can positively affect the speed and agility of the children.

2. Changes in the physical fitness levels of pupils participating in physical activities with the “eduball” depend whether they live in an urban or rural environment. The boys in the urban experimental and control groups performed better than their peers residing in rural areas. However, this may be more strongly related to the overall higher physical fitness levels of the boys from an urban environment (as was found in the first test), rather than their place of residence or their schools' sports facilities, which were found to be comparable. In the groups of girls a somewhat different trend was observed, with girls from the urban environment performing better than girls from rural areas among the analyzed fitness variables in the first test, but with the differences leveling out by the second test. In addition, the girls from the rural environment showed higher strength levels in the second test.

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