

Changes in selected movement abilities through the use of movement games in physical education lessons at the gymnasium level

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Abstract:

The aim of this study was to enhance the understanding of the level and development of specific movement abilities in older school aged boys through the use of movement games. Based on the mentioned research results, we can emphasize that the development of movement performance over the last 20 years is not optimal. Our research took the form of physical education experiment performed in a gymnasium that lasted for 8 weeks. The study included 38 students in experimental group and 37 students in control group. The boys underwent initial and final measurements using a test battery that included standing broad jump, sit-ups in 1 min., overhead medicine ball throw (2 kg), 50 m sprint and 12 min. run. Processing and evaluation were done with basic statistical methods (arithmetic mean, standard deviation, Fisher-Snedecor F-test, parametric t-test for dependent and independent groups) and with logical methods. The level of selected movement abilities of boys was in all test significantly lower comparing former testing of Slovak population (both 1990 and 2011). By application of movement games significantly improved results in some tests in experimental group (standing broad jump, sit-ups in 1 minute and 50 m sprint) while in control group there were proved significant improvement in test overhead medicine ball throw and worsening in test 12 min run. From these results we can recommend the used movement games like training mean for improving explosive power, running speed and strength of trunk muscles in conditions of gymnasium school physical education lessons.

Key Words: movement abilities, movement games, physical education, gymnasium

Introduction

In the second half of the last century, the somatic, motor and physiological development of the Czech and Slovak school population took place with a slight acceleration. Research by several authors has shown a permanent acceleration of the school population in both somatic and motor parameters (Pavek 1977; Moravec et al 1990; Moravec, Kampmiller, Sedlacek et al 1996; Zapletalova 2011). This secular trend was recorded from the post-war years to the 1990s, when the acceleration trend began to gradually change to stagnation and a gradual reduction of several, especially motor parameters.

Research by several other authors (Bogucka and Glebocka 2017, Balko et al. 2017, Andrieieva et al. 2021, Rozim et al. 2022, Slovakova and Mandzakova 2024) also show an increase in somatic parameters compared to the past. In body height and body weight, several authors (Łubkowska et al. 2015, Huotari PRT et al. 2015, Walkowiak et al. 2017, Tomkinson et al. 2017, Colley RC et al. 2019, Emeljanovas et al. 2020) noted an increase of 2.3% – 3.5% compared to the past.

The research of Zapletalova (2011) shows that there are differences in the development trends of motor performance in the years 1987 and 2008/9 in individual motor tests. A different trend in the development of boys' performance is recorded in the 50m running test. The generation of 11-15-year-old boys is statistically significantly worse than their peers 20 years ago in the research of Moravec et al. (1990). In the standing long jump test, the performance development trend over the last 20 years is negative. The performance of today's boys is on average 7-37 cm worse than the level of performance of their peers in 1987; 11- to 13-year-old boys do not even reach the performance level of girls 21 years ago. The sit-ups test is the only test in which the performance in the 20-year period in boys is essentially unchanged. In aerobic abilities, which we evaluate with the 12-minute run test, we note a negative trend of performance development in boys. The generation of boys from the years 2008-9 is 8-15% worse in the entire age horizon compared to their peers 20 years ago. In individual age periods, boys ran 218-337m less than their peers 20 years ago. It is worth noting the fact that today's 11-14year old boys achieve an even lower level of performance in aerobic capacity than the performance level of girls in 1987.

The development trend is negative in the motor performance of 11-year-old boys. This is confirmed by research by foreign authors (Ramírez-Vélez R 2018, Lutkovskaya et al. 2021, Rozim et al. 2022, Ługowska et al. 2023).

Based on the mentioned research results, we can emphasize that the development of movement performance over the last 20 years is not optimal. The slight decrease observed in the 1990s was more pronounced in boys than in girls (Zapletalova 2002; Moravec, Kampmiller, Sedlacek 1996). The development of the level of explosive power of the lower and upper limbs in the age range of 11-15 years is also unfavorable (Zapletalova et al. 2011). In boys, especially during puberty, there is a decrease in performance, although compared to the previous generation, they are favored by the acceleration of development. In this context, we can say that youth who regularly play sports are less affected by motor disorders than youth who do not play sports (Moravec 2008). Balint G. (2022) propose a new concept regarding the use of dynamic games in the physical education class, starting from the premise that these games are more attractive for students and at the same time ensure the achievement of the objectives of school physical education.

The results and stated reasons correspond with findings abroad (Vanhelst et al. 2016; Raczek 2010; Gustafson and Rhodes 2006; Reitmayer 1977), which we mentioned in the justification of the research follow-up. Abroad, the negative trend in the development of explosive strength of the upper and lower limbs and aerobic endurance is also pointed out. However, it is interesting that it turns out to be constant in running speed (Zapletalova et al. 2011).

Materials & Methods

Research problem

Based on the theoretical and practical knowledge of the authors in the area of movement skills and their condition, development and diagnosis in the gymnasium school environment, we set the following research questions:

1. What are the differences in the level of selected movement skills in the control and experimental groups after the 8-week experiment?
2. What is the level of selected movement skills of older school-aged boys compared to previous measurements?

Subjects The subjects of observation were 11-year-old boys from primary schools in Trebisov (Eastern Slovakia) in a total number of 75. The experimental group consisted of 38 boys. The control group consisted of 37 boys. The schools were selected in a deliberate manner according to approximately the same conditions for the physical education process. The boys completed 2 hours of physical and sports lessons per week (ISCED 2). They engaged in other physical activities (in their free time) less than 1 hour per week, or did not engage in it at all. Input and output measurements and the research itself (8 weeks) took place between September and November 2021.

In the experimental group, as an experimental factor, we chose a set of movement games consisting of exercises aimed at developing explosive strength of the upper and lower limbs, acceleration and maximum running speed, aerobic endurance and strength endurance.

Movements games and their volume in the lessons

In the experimental group, we applied 4 movement games (Tab. 1).

Tab. 1 Movements games and their volume in the lessons

GN	NAG	LT	RI	NS	PL
1	On wheelbarrows	30"	30"	4	main
2	For roosters	30"	30"	4	main
3	Blue and white	5"	40"	10	main
4	Avalanche	120"	180"	2	main

Notes: GN – game number; NAG – the name of the game; LT – load time; RI – rest interval; NS – number of series; PL – part of the lesson.

On wheelbarrows; game description: Players form pairs and stand behind the volleyball baseline. One of the pair does the support lying down and the other grabs him by the ankles and lifts him up. At a sound signal (whistle), the players - wheelbarrows start towards the line, where they exchange roles and go back. The pair that reaches the finish line first wins (Figure 1).

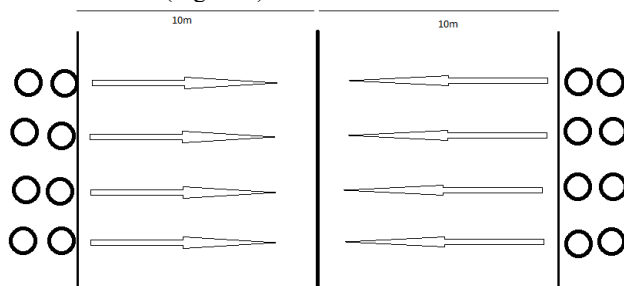


Fig. 1 Movement game on wheelbarrows

For roosters; game description: Two opponents enter a circle with a diameter of 2 meters, stand on one leg, put their hands behind their backs. At the signal, they start hopping on one leg and try to force the opponent to step on both legs or get out of the ring. Players may not switch legs during the fight and may only ram into each other with their shoulder (Figure 2).

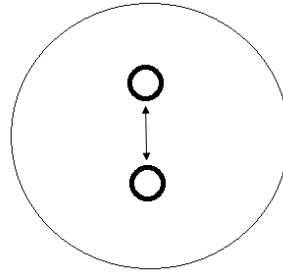


Fig. 2 Movement game for roosters

Blue and white; game description: Two teams stand opposite each other at a distance of 1 m from the center line. The first team represents blue and the second team represents white. The teacher stands at the center line and shouts the color of the chasing team. The team whose color is shouted, starts and chases the other team, which turns and runs behind the baseline of the volleyball court. The point is won by the team that manages to catch the opponent (Figure 3).

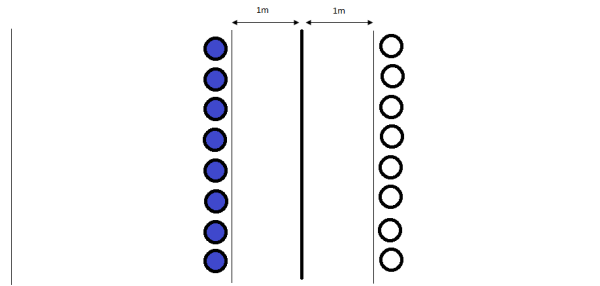


Fig. 3 Movement game for blue and white

Avalanche; game description: We will divide the players into 6 member teams. Teams will stand on the starting line and we will assign serial numbers to their members. In front of the teams, at a distance of 20 m, we will mark the finish line - a line parallel to the position of the teams. On command, all the first players run, run to the finish line and back, clap the hands of the others, run with them to the finish line and back, etc., until the whole team runs back and forth. Now the first will remain standing in their place, during the next run the second will remain standing, etc., until the last one runs alone to the finish line and back. The team whose last member is the first to return to its original place wins. Team players must run in one line. We choose the distance of the finish line according to age and maturity (Figure 4).

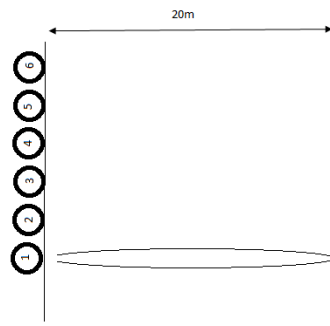


Fig. 4 Movement game for avalanche

The application of these games was specifically planned and implemented in each week (Tab 2).

Tab. 2 Inclusion of movement games during lessons of experimental group in individual weeks

LW	1st W	2nd W	3rd W	4th W	5th W	6th W	7th W	8th W
1st	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	-	1, 2, 3
2nd	1, 2, 4	1, 2, 4	1, 2, 4	1, 2, 4	1, 2, 4	-	1, 2, 4	1, 2, 4

Notes: LW – the lesson during the week; W – week; 1 – on wheelbarrows; 2 – for roosters; 3 – blue and white; 4 – avalanche

The boys completed 14 hours of physical and sports education (each hour lasted 45 minutes), which represents 630 minutes of physical and sports education over 8 weeks. The overall experimental stimulus in the physical education process was realized during 14 hours in 4 movement games, 3 of them lasting 28 minutes each (On wheelbarrows, For roosters, Avalanche) and the fourth lasting 5.83 minutes (Blue and white). Thus, the total load time in the experimental group was almost 90 minutes.

In the control group, physical and sports education was taught without the application of a set of movement games. We performed input and output measurements in the same time interval as in the experimental group. We also measured the boys' height and weight (BH, BW) before and after the research. To determine the level of selected movement skills, we used the motor tests that Simonek (2015) and Sedlacek – Cihova (2009) present in their publications.

The test battery consisted of the following tests: standing broad jump - explosive strength of the lower limbs (SBJ), sit-down in 1 minute - endurance in the strength of the abdominal and hip muscles (SU), throwing a 2kg full ball - explosive strength of the upper limbs and trunk (MBT), 50m run from a semi-high start - acceleration speed and maximum running speed (50m), 12-minute run - aerobic endurance (12 min).

We used the methods of descriptive and inductive statistics (Fisher-Snedecor F-test, parametric t-test for dependent files, parametric t-test for independent files) and logical methods to process and evaluate the obtained data.

Results

Table 3 presents statistical analysis by Fisher-Snedecor F test; in all analyzed tests (BH, BW, SBJ, SU, MBT, 50m and 12min) the validity of the inequality $p > 0.05$ was confirmed. It follows from the above that in all analyzed cases there is no significant difference in the variance of the results of the control group of boys and the experimental group of boys.

Based on these results, we proceed with further analysis using parametric tests.

Tab. 3 Statistical analysis by Fisher-Snedecor F test

Parameters	p-value	α	comparison
BH (cm)	0.053	0.05	$p > \alpha$
BW (kg)	0.791	0.05	$p > \alpha$
SBJ (cm)	0.402	0.05	$p > \alpha$
SU (l)	0.066	0.05	$p > \alpha$
MBT (cm)	0.063	0.05	$p > \alpha$
50m (s)	0.945	0.05	$p > \alpha$
12min (m)	0.393	0.05	$p > \alpha$

Notes: BH – body height; BW – body weight; SBJ – standing broad jump; SU – sit-ups (1 min); MBT – medicine ball throw (2 kg); 50m – 50-meter sprint; 12min – 12 min run

Basic statistical characteristics of the control and experimental groups of input and output measurements can be seen in Table 4.

Tab. 4 Statistical analysis by Fisher-Snedecor F test

In, Out	C, E	SP	BH (cm)	BW (kg)	SBJ (cm)	SU (l)	MBT (cm)	50m	(s)	12min (m)
In	C	x	147.31	43.08	142.70	26.27	369.59	11.13		1573.38
		SD	7.38	8.79	18.08	4.49	45.08	1.34		173.57
		V _R	30	42	80	16	170	6.83		900
In	E	x	146.04	46.29	140.08	23.05	373.95	11.22		1527.63
		SD	4.78	8.41	21.27	7.35	68.35	1.36		150.54
		V _R	25	35	91	30	290	7.89		700
Out	C	x	147.65	42.51	144.08	26.57	366.49	11.07		1499.73
		SD	7.25	7.84	16.96	4.27	41.98	1.33		155.36
		V _R	29	38	70	17	190	6.85		750
Out	E	x	146.29	45.95	144.79	25.03	376.84	10.97		1502.89
		SD	4.83	7.57	18.38	5.72	65.09	1.17		122.78
		V _R	23.5	31	75	23	270	15.90		490

Notes: In – input measurement; Out - output measurement; C – control group; E – experimental group; SP – statistical parameters; x – arithmetical mean; SD – standard deviation; V_R- variation range; BH – body height; BW – body weight; SBJ – standing broad jump; SU – sit-ups (1 min); MBT – medicine ball throw (2 kg); 50m – 50-meter sprint; 12min – 12 min run

Table 5 shows statistical relations between control and experimental groups and between input and output measurements.

Tab. 5 Statistical relations between control and experimental groups and between input and output measurements

In, Out	C, E	TDS	BH (cm)	BW (kg)	SBJ (cm)	SU (l)	MBT (cm)	50m (s)	12min (m)
In-In	C - E	PuTt	0.381	0.154	0.067	0.025*	0.043*	0.757	0.527
In-Out	C - C	PpTt	0.302	0.502	0.307	0.393	0.012*	0.428	0.002**
In-Out	E - E	PpTt	0.751	0.461	0.002**	0.001**	0.176	0.001**	0.084
Out-Out	C - E	PuTt	0.324	0.089	0.864	0.193	0.012*	0.744	0.923

Notes: In – input measurement; Out - output measurement; C – control group; E – experimental group; TDS – tests to determine the significance of differences; PuTt – parametric unpaired t-test; PpTt – parametric paired t-test; BH – body height; BW – body weight; SBJ – standing broad jump; SU – sit-ups (1 min); MBT – medicine ball throw (2 kg); 50m – 50-meter sprint; 12min – 12 min run; $p < 0,01^{**}$, $p < 0,05^{*}$

In Table 6 are stated statistical comparisons of boys' (11 y. old) somatic parameters and movement performance in selected motor tests between measurements of Stun (2021) and former results of Zapletalova (2011) and Moravec (1990).

Tab. 6 Statistic comparison of boys (11 y. old) somatic parameters and movement performance in selected motor tests between Stun (2021) and former results of Zapletalova (2011) and Moravec (1990)

Boys (11 y. old)	S, n = 75 (38 + 37)		Z, n = 163		S - Z	M, n = 833		S - M
Tests	x	SD	x	SD	PuTt	x	SD	PuTt
BH (cm)	146.7	6.15	148.9	7.88	.023*	146.35	7.13	.0572
BW (kg)	44.7	8.68	42.36	10.44	.0062**	38.35	7.53	.0037**
SBJ (cm)	141.37	19.54	151.3	22.58	.0000**	164.23	19.68	.0000**
SU (l)	24.64	6.24	35.3	9.77	.0000**	33.57	9.07	.0000**
MBT (cm)	371.8	57.32	418.6	86.4	.0001**	461	86	.0001**
50m (s)	11.17	1.34	9.53	0.93	.0002**	8.94	0.82	.0007**
12min (m)	1550.2	161.7	1909.5	365	.0000**	2245.7	359.7	.0007**

Notes: S – author Stun; Z – author Zapletalova; M – author Moravec; x – arithmetical mean; SD – standard deviation; PuTt – parametric unpaired t-test; PpTt – parametric paired t-test; BH – body height; BW – body weight; SBJ – standing broad jump; SU – sit-ups (1 min); MBT – medicine ball throw (2 kg); 50m – 50-meter sprint; 12min – 12 min run; $p < 0,01^{**}$, $p < 0,05^{*}$

Discussion

Based on the analysis of the results (Table 4), we can state that the differences in somatic parameters between the control and experimental groups on both the input and output measurements do not reach statistically significant differences (Table 5). Likewise, we did not find statistically significant differences between the input and output measurements in either the control or the experimental group (Table 5). This is in line with our expectations given the relatively short duration of our experiment (8 weeks). Compared to the results of the authors' measurements (Slovakova and Mandzakova 2024, Rozim et al. 2022, Andrieieva et al. 2021, Bogucka and Glebocka 2017, Balko et al. 2017), the average body height measured by us is 3.25 - 4.85 cm higher. The maximum body weight of boys in our control group is 68 kg, which is 2.2 - 4.8 kg more than in the research group recorded by the authors (Emeljanovas et al. 2020, Colley RC et al. 2019, Walkowiak et al. 2017, Tomkinson et al. 2017, Łubkowska et al. 2015, Huotari PRT et al. 2015).

When comparing the initial measurements in the control group in the motor performance tests for boys, we note an average value in the SBJ test of 142.70 cm, which is 2.62 cm more compared to the experimental group. In the control as well as in the experimental group of boys, we recorded a lower average value of 8-17 cm in the standing long jump test compared to the results of the authors' research (Ługowska et al. 2023, Rozim et al. 2022; Lutkovskaya et al. 2021, Ramírez-Vélez R 2018). In the SU test, which evaluates endurance in the strength of the abdominal muscles, we recorded a higher average value of 3.22 (repetitions) in favor of the boys in the control group. Comparison with other authors shows a lower average value of 5-10 (repetitions) compared to the results of the authors' research (Ma N et al. 2022, Lee S et al. 2017, Golle K et al. 2015). In the acceleration and maximum running speed evaluated by the 50 m run test, the average value in the control group is 11.13 s, which is 0.01 s more compared to the boys in the experimental group. Compared with the authors' research (Ma N et al. 2022, Zhang F et al. 2021, Dobosz J. 2015) are results of our both groups worse by 0.41 – 1.25 s. In aerobic endurance, we recorded a higher average value of 45.75 m in favor of the boys in the control group. The maximum value for boys in the control group is 2050 m, which is 100 m more than in the

experimental group. Our research set of boys lags behind by 95-165m compared to the results of measurements by other authors (Masanovic B et al. 2020, Venckunas et al. 2018). In the test of 2 kg MBT, our group of students, both in the control group and in the experimental group, is worse by 5%-8% compared to the authors' research group (Duncan et al. 2018, Gillen et al. 2018, Larsen et al. 2015, (Harris et al. 2011, Salonia et al. 2004).

By statistical analysis (Table 5), we found the validity of the inequality $p=0.025<0.05$, which claims that there is a significant difference between the boys in the control and experimental groups in the SU test in 1 minute and in the test of MBT; once in favor of the control (SU) and once in favor of the experimental (MBT) group. In the other analyzed cases (SBJ, 50m, 12min), we did not confirm a significant difference between the boys in the control and experimental groups. We believe that body weight negatively affected the performance in the SU test in 1 minute, therefore there was a significant difference in favor of the experimental group, similar results were found by Kanellopoulou et al. 2021, Barroso et al. 2020 and Buscemi et al. 2018. In other tests, no significant differences in performance were confirmed, and therefore we can consider the groups of boys to be at approximately the same level of performance.

In the next part of our work, we assess the differences in the level of selected movement skills in the control and experimental groups after the 8-week experiment (Table 4 and 5). For the experimental group, we record improvements in performance in four tests, while in three the change is statistically significant (SBJ, SU and 50M). A slightly statistically insignificant deterioration of performance is recorded in the 12 min test; mentioned may also be caused by climatic differences between the September and November measurements, because this test is performed in an open stadium. In the control group, we recorded a slight improvement in the output measurement (statistically insignificant) in three tests (SBJ, SU and 50m), while we noted a deterioration of motor performance in the other two MBT and 12min tests (statistically significant in one case at $p < 0.05$ *, in the second at $p < 0.01$ **); while we are aware that the deterioration in the 12min test may be due to the same climatic reasons as in the experimental group. In the statistical comparison of output measurements between the control and experimental groups (Table 4 and 5), we can state that the performance of the experimental group is at a slightly higher level than the control group. Although the control group is slightly better in the SU test (statistically insignificant difference), the experimental group is slightly better in the other tests, while a statistically significant difference is recorded in the MBT test. We consider the context with changes in input and output measurements to be important, which confirms our initial indications that our experimental factor affects strength and speed-power development more significantly than classical teaching according to the usual curriculum. When comparing somatic parameters and movement performance in selected motor tests (Table 6) between the authors Stun (2021), Zapletalova (2011) and Moravec (1990), we can state that we recorded the highest average value in body height (statistically significant at $p < 0.05$ *), while the difference between the measurements of Stun and Moravec was smaller, statistically insignificant in favor of Stun (2021). We consider the finding that the BW of Zapletalova as well as Moravec to be significantly lower than that of Stun; in the first case by a difference of 2.34 kg, in the second by up to 4.35 kg. It goes without saying that these differences are statistically significant compared to the Stun measurement from 2021 at $p < 0.01$ **.

A comparison of the motor performance of Stun from 2021 with the measurements of Zapletalova (2011) and Moravec (1990) clearly shows the worse motor performance of the present school generation of boys aged 11 years. Differences in all tests are statistically significant at $p < 0.01$ ** (Table 6). The drop in motor performance in these monitored parameters is unprecedented. It can be said that the older the measurement, the better the motor performance (except for the SU test, where Zapletalova's set has a slightly higher performance than Moravec's set). The differences in the MBT, 50m and 12 min tests can be considered particularly significant.

Conclusion

After an 8-week experiment, when we increasingly included movement games within the mandatory hours of physical and sports education for 11-year-old boys, it had a positive effect on the development of fitness skills (especially strength and speed-strength). On the basis of the above, we can recommend the movement games in question as a suitable and somewhat entertaining means of developing the fitness of younger school-age pupils. The comparison of this Stun (2021) measurement with previous measurements clearly points to unfavorable somatic parameters as well as fundamentally worse motor performance of today's school population of boys in Slovakia.

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Ethical Approval Information Measurements were taken according to the ethical standards of the Declaration of Helsinki. Participation in the study was fully voluntary and anonymous. A participant's legal guardian received a written description of the study procedures before testing and submitted a written informed consent to participate in this study.

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