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Effects of an Additional Basketball and Volleyball Program on Motor Abilities of Fifth Grade Elementary School Students

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A B S T R A C T

The aim was to evaluate the transformational effects of an additional weekly PE session based on team sports (basketball and volleyball) on students' motor status. The research was conducted on a sample of 125 eleven-year-old boys divided into three groups (two experimental and one control) which were examined by 12 motor tests at the beginning and at the end of the 9-month period. The tests included evaluation of explosive power, dynamic and static strength endurance, co-ordination, flexibility and hand frequency motion. Although all three treatments together, complemented by the natural growth and developmental factors, induced significant quantitative changes, the results showed the highest motor improvements in the basketball experimental group, followed by the volleyball experimental group. While explosive power mainly contributed toward significant difference between the control and experimental groups in the final measurement, univarate test results also showed distinctive improvements in dynamic strength, hand frequency motion and various factors of co-ordination within experimental groups. The general conclusion points to the fact that even one additional PE session per week of the given program is sufficient to produce significant changes in motor abilities of elementary school fifth graders. Therefore the authors' support the legal provisions of mandatory implementation of extra-curricular forms of physical activity in elementary schools.

Key words: *extra-curricular program, basketball, volleyball, motor abilities*

Introduction

Considering a constant decrease in demand of physical effort in the modern society, a process of organized and optimally programmed lifelong physical exercise becomes a crucial determinant of quality and health promoting modern living style and proper development amongst younger age groups. The negative trend of hypokinesis emphases the application of fundamental research findings in the area of applied science, particularly in pedagogy of physical education. Application of current scientific achievements, primarily within the field of kinesiology, including co-relational sciences that deal with education, provides assurance of physical education teaching methods in continuing the search for its epistemological conditions[1].

An initiative for this research comes from the essential proposition of sport within the schooling system – each child has a strong need and right to participate in all forms of curricular and extracurricular sports activities. Physical education (PE) is the most effective way to organize mass physical activity for children and young people. Considering the limited number of weekly PE classes, the didactics of PE focuses on the research directed on quality improvement of the existing curricula and syllabuses which should help introduction of highly proficient methods and models of teaching in the future. Innovations, additions, and corrections of subject contents and effective additional forms of education (elective physical courses, school sport clubs, etc.) should compensate for the limitations of regular PE curriculum.

Numerous research studies[2–7] have covered the effects of additional physical activity inside the schooling system. These studies treated different ages and genders of examinees, work contents, workload intensities, periods of application, and used analyses of various anthropologi-

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cal parameters. However, all had a unique goal to contribute to the design of the most functional kinesiological operators, which will optimally promote proper development of students' psycho-motor capabilities.

The application and analysis of the effects of an additional teaching form is the main topic of this paper. Specifically, the basic aim was to find out and analyze potential differences in changes of motor characteristics of 11-year-old (±6 months) students under the influence of a supplementary PE class of team ball games as opposed to those students who attended only the mandatory PE hours.

Aim

The main objective of this research was to analyze the effectiveness of two dissimilar experimental programs used as a supplement to the regular PE classes. The first experimental group had an additional class session per week made up of different exercises, drills and games of volleyball. The second experimental program had an additional class session based on the contents of different elements and games of basketball. The total amount of both the regular and additional PE classes during the school year for each of the analyzed experimental groups was 105 hours (70 regular contact hours + 35 additional contact hours).

The third group, the control group, consisted of students who were attending exclusively the PE classes according to the 5th grade regular curriculum – twice a week for 45 minutes, or a total of 70 hours per year.

Four hypotheses were set:

H_1 – the groups of examinees will not differ in the motor characteristics at the initial state;

H_2 – the groups of examinees will not significantly improve their motor characteristics during the school year;

H_3 – the control group in comparison with each experimental group will not differ in motor characteristics in the final state;

H_4 – the experimental groups will not differ in the final state

Research Methods

Sample of examinees

The research was conducted on a sample of 125 boys, aged 11 years (±6 months). Randomly selected students sample had a satisfactory health status (without any chronic health problems) and were not engaged in sports activities outside the school system. The examinees were divided into three groups – one control and two experimental. The control group (C), consisted of 42 students, the experimental group – volleyball (E_V) was made up of 45 students, and the experimental group – basketball (E_B) comprised 38 students.

Sample of variables

To establish changes caused by regular and the experimental program a battery of 12 tests was used, suitable for determining the basic motor abilities of the fifth graders.

The motor skills' assessment tests were:

1. Standing long jump (MSDM) – measuring explosive power-jump type; the subject takes-off and lands with both legs; recorded best score out of three attempts; the length is expressed in 1/100 m;
2. 20 m sprint (M20V) – measuring explosive power--sprint type; 20 meter sprint from the standing position start; recorded fastest score out of three attempts; the time is expressed in 1/100 s
3. Medicine ball throw – measuring explosive power-throw type; the subject throws medicine ball (2 kg) from the supine position, arms fully extended; recorded best score out of three attempts; the length is expressed in 5/100 m
4. Sit-ups (MDTR) – measuring dynamic strength endurance of torso (abdominals and hip flexors) – laying position start, arms crossed touching shoulders, knees bent 90°, feet anchored by partner; recorded number of frequencies (elbows-knees contact) in 60 s; one attempt required
5. Flexed-arm hang (MIVZ) – measuring static strength endurance – the subject grasps the overhead bar with underhand grip with the armes flexed and the chin clearing the bar, the chest held close to bar with legs hanging straight; the subject holds this position for as long as possible; one attempt required
6. Obstacle course backwards (MPOL) – measuring co-ordination – the subject overcomes the 10 m obstacle course on all fours in reverse; recorded fastest score out of three attempts; the time is expressed in 10/100 s
7. 20 yards (M20J) – measuring co-ordination (agility) – three lines, five yards apart; the subject in start up position straddles the middle line and puts one hand down in a three-point stance: the subject runs and touches either the right or left line then runs 10 yards to the opposite line and then finally turns and finishes by running back through the start/finish line; recorded fastest score out of three attempts; the time is expressed in 1/100 s
8. Low beam stand (MSNG) – measuring co-ordination (balance) – the subject balances on low beam, with eyes closed, on one foot; recorded average score out of three attempts; the time is expressed in seconds
9. Forward bent (MPRK) – measuring flexibility – standing position start on a bench; the subject bends forward with both hands, legs outstretched; recorded the lowest reach out of four attempts; measured in 1/100 m
10. Wide leg forward bent (MPRR) – measuring flexibility – sitting position start on the floor; legs spread 45°; the subject bends forward with both hands; recorded the furthest reach out of four attempts; measured in 1/100 m

11. Shoulder circumduction – arms rotation (MISK) – measuring flexibility – the subjesct grips the cord that has a fixed handle on one end and a sliding handle on the other; sliding handle is adjusted so that the length of the cord between the inside of the two handles is equivalent to the subjects shoulder width (from acromion to acromion). The subject passes the cord, from in front of the body, over the head and as far back as possible; arms extended; recorded the best (lowest distance of handles) score out of three attempts; measured in 1/100 m.
12. Hand tapping (MTAP) – measuring hand frequency movement – the subject places non-dominant hand in the middle of two discs (60 cm apart); the subject moves the dominant hand back and forth between the discs over the hand in the middle as quickly as possible; recorded highest number of frequencies in 15 s out of three attempts.

Data analysis

Data processing included descriptive statistics of the scores the examinees achieved in the initial and final testing for each group. Inter-group comparison of motor status at the initial and final measurement, as well as testing of the first and fourth hypotheses was carried out by means of canonical discriminant analysis. Global motor changes and the verification of the second and third hypotheses, were calculated by the algorithm and program for quantitative analysis of changes under the model of differences (STA_DIFF)[8], which included evaluation of each variable by univariate analysis of variance (ANOVA).

Physical education curriculum for fifth grade

Regular mandatory PE elementary school program

According to age related developmental characteristics and needs of children, the main mission of PE teaching is focused on underpinning students' physical and psycho-social development to meet their primary biological motive in expressing themselves in play and physical motion creation. The official PE curriculum for the fifth grade of the elementary school is delivered in the total of 70 contact 45-minute hours in accordance with the Croatian Law on Primary Education. Such a program aims to meet the original human need for movement and ensures educational continuity of each student with respect to the current state of anthropological characteristics.

The program contents (Table 1) shows various forms of running, jumping and throwing, in other words, explosive power activities. An important place in the program is given to combat sports and dance elements. The PE curriculum is saturated even with by gymnastic elements and balance position, suitable for the development of static strength. However, the team games, that is elementary and relay games, and elements of handball, basketball and football permeated with agility drills (fast changes of motion) and explosive power drills have a predominant position in the program.

Experimental programs

Experimental programs of volleyball and basketball were introduced throughout the school year as an additional hour per week (35 contact 45-minute hours a year), thus along with the regular PE classes producing a total of 105 hours of exercise. Teaching units and topics were primarily selected according to developmental state of 11-year olds, so that the experimental curriculum contents could contribute to the development of students' capabilities and their mastering of the specific motor skills. A lesson's work load was defined by the ratio of energy expenditure and information supply. High energy consumption was emphasized during the performance of simple motion patterns, on the other hand, high information load was mainly introduced during learning of new motion patterns, and new specific volleyball or basketball tasks. Complexities of specific basketball and volleyball movement patterns also regulated the ratio of work intensity and its extent. It is important to mention the specific didactic requirements of work with children – lots of play, versatility, imagination, individuality, friendship and fair-play, rivalry, promotion, and so forth. Besides the sport specific movement patterns that were introduced and exercised primarily during the main »A« part of the session, a set of basic conditioning exercises were used as a component of the introductory part of a lesson. It aimed at developing motor abilities that were the relevant prerequisites for mastering various volleyball and basketball skills.

The additional volleyball program (Table 2) contained the basic elements of the game – overhand and underhand pass, and serve (underhand). Those elements were drilled enough to assure constant improvement of performance, which in turn served as an essential prerequisite for quality and long-term adoption of more complex, from the information point of view, tasks application (games, technique, tactics), and, consequently, led to positive motor transformation.

The basketball program (Table 3) was formed to allow a high performance frequency of basic basketball movements (running, jumping, passing and catching). In the area of technical development the movements with ball (dribbling) and shooting the ball into the basket predominated while the tactical teaching and games provided elementary knowledge of proper court movements of players in defense and offense.

Results and Discussion

Analysis of descriptive statistical parameters for students' motor assessment

Comparing motor measure values obtained during the initial testing for the total sample of examinees with the norms of peer general population in the Republic of Croatia[9] it can be stated that there were no significant differences. Arithmetic means were around average or slightly below the average of their population peers. This is a consequence of a randomly selected sample of non-

TABLE 1
REGULAR PROGRAM FOR FIFTH GRADE

No	Teaching units	Teaching topics
1.	Running	Cyclic movement at different paces up to 6 minutes
2.		Quick running (sprint) up to 50 m from the starting blocks
3.		Obstacle course
4.	Jumping	Long jump over obstacles
5.		High jump, »scissors« technique
6.	Throwing	Throwing a medicine ball (1 kg) with the left and right hand
7.		Throwing the ball (200 g) for a distance and aiming at the target
8.	Gymnastics	Simple routine on a high bar
9.		Simple routine on parallel bars
10.		Simple routine on rings (swinging)
11.		Climbing on ladders and poles, using arms and legs (up to 3 m)
12.	Balance	Handstand with assistance
13.		Walking low beam while catching and throwing the ball
14.	Athletics	Hurdles
15.	Combative sports	The basic fighting position in a standing position and on the mat
16.		Elementary forms of wrestling
17.	Dance	Realization of 2/4 and 4/4 rhythmic form
18.		Formation of circles from the free movement (walking, running and hops)
19.		Folk dance (selection)
20.	Games	Elementary and relay games
21.		Catching and passing the ball with one or two hands in standing or in the movement with changes of speed and directions of movement (handball and basketball)
22.		Picking the ball off the floor with one hand with the help of the other and with both hands (handball and basketball)
23.		Dribbling (the left and right hand) with changes of speed and directions of movement (handball and basketball)
24.		Shooting from standing positions or from the movement (handball)
25.		Handball tactics (defense 5:0, 6:0)
26.		Handball tactics (attack)
27.		Handball (play)
28.		Dribbling (football)
29.		Kicking the ball (football)
30.		Handling the ball (football)
31.		Passing the ball (football)
32.		Football (play)
33.		Shooting with one hand (basketball)
34.		Hitting the ball (overhand and underhand) (volleyball)
35.		Serving (volleyball)
36.		Volleyball (play)

-athletes taken in this research. Actually, considering the fact that students have not been active in sports, along with the belief that most of them have never been seriously involved in sports activities before, except attending the regular PE classes taught by their class elementary school teachers (not PE specialists), motor parameters of the initial results indicate satisfactory levels as compared to the given norms.

Table 4. shows absolute improvements of the arithmetic mean values between initial and the final testing in almost all measured motor characteristics. However, its important to notice that no distinct improvements were shown in medicine ball throw (MBML), agility test (M20J) and forward bent (MPRK) of the control group. Generally, the results of skewness and kurtosis show no major deviation from the normal distribution.

TABLE 2
EXPERIMENTAL VOLLEYBALL PROGRAM

No	Teaching units	Teaching topics	Frequency
1.	Running	Defensive movements	2
2.		Lateral movements in basic volleyball	2
3.	Jumping	Takeoff from semi-squat position with the imitation of hitting the ball	4
4.	Hitting	Formation of volleyball cups with the imitation of hitting	2
5.		Overhand hit in front of the head	6
6.		Overhand hit above the head	6
7.		Underhand hit	10
8.	Balance	Low defense stance	2
9.		Middle defense stance	2
10.	Volleyball a) technique	Serving	6
11.		Set-throw and underhand hit	4
12.		Overhand hit against the wall	2
13.		Passing the ball with different tasks	5
14.	Volleyball b) tactics	Tactical drills (2:2)	2
15.		Tactical drills (3:3)	2
16.		Tactical drills (4:4)	2
17.		Tactical drills (»cooking«)	1
18.	Volleyball c) play	Elementary games	10
19.		Mini volleyball (3:3)	10
20.		Volleyball (play)	4

TABLE 3
EXPERIMENTAL BASKETBALL PROGRAM

No	Teaching units	Teaching topics	Frequency
1.	Running	Gross movements with changes of speed and directions	8
2.		Defensive movements (lateral; back; »zig-zag«)	4
3.	Jumping	Defensive rebounds	2
4.		Jump-catch and jump-pass	5
5.	Balance	Piston position	2
6.		Pivoting	1
7.	Technique – passing and shooting	Chest pass (both hands; left hand; right hand)	4
8.		Shooting from standing positions or from the movement	8
9.		Passing on a move	10
10.	Technique – dribbling	Dribbling (both hands); dribbling in eights	14
11.		Picking the ball off the floor with one hand with the help of the other and with both hands	6
12.		Dribbling and piston stance	4
13.	Tactic	»Double pass«	2
14.	Play	Relay games	11
15.		3 on 3 (street basketball)	7
16.		Mini basketball	5

TABLE 4
DESCRIPTIVE STATISTIC PARAMETERS AND UNIVARIATE TEST RESULTS BETWEEN INITIAL AND FINAL MEASUREMENT

	Control group (N=42)									Exp. group – volleyball (N=45)									Exp. group – basketball (N=38)								
	AM	Min	Max	S.D	Sk	Ku	F	p	%	AM	Min	Max	S.D	Sk	Ku	F	p	%	AM	Min	Max	S.D	Sk	Ku	F	p	%
MSDM_I	162.8	117	202	22.0	0	–1	28.6	0	5.9	163.1	119	206	20	0.1	0	5.62	0.02	9.0	162.6	123	190	16.0	0	0	47	0	6.4
MSDM_F	173.0	134	204	19.0	0	–1				179.1	136	212	18	0	0				173.8	144	211	18.0	0	0			
M20V_I	4.31	3.3	5.7	0.4	0.8	2.1	4.22	0.06	6.3	4.28	3.4	5.9	0.5	1.1	2.7	16.7	0	6.3	4.24	3.5	5.0	0.4	0.1	–1	88.3	0	11.6
M20V_F	4.04	3.4	5.0	0.4	0.6	0				4.01	3.0	5.1	0.4	0.3	1.5				3.80	3.1	4.3	0.3	–1	0			
MBML_I	6.1	3.6	8.8	1.0	0.2	0.2	0.09	0.71	–3.4	5.9	4.1	7.3	0.7	0	0	15.1	0	7.8	5.8	4.8	7.5	0.8	0.4	–1	80.1	0	14.7
MBML_F	5.9	4.1	7.8	0.9	0.2	–1				6.4	3.9	8.5	1	0	0				6.8	5.4	9.3	0.9	0.8	0			
MDTR_I	32.2	15	49	8.3	0	–1	6.76	0.01	7.5	31.9	16	44	6.3	0	0.2	14.1	0	9.9	31.6	19	47	6.0	0.3	0.1	9.33	0	9.8
MDTR_F	34.8	19	46	6.4	–1	0				35.4	21	56	7.9	0.5	0				35.0	24	56	6.2	1	2.1			
MIVZ_I	28.1	0.0	62	21.0	1.8	3	0.53	0.47	7.6	34.2	3.0	82	24	0.5	–1	0.18	0.67	8.6	32.6	7.9	86	17.0	1.2	1.7	1.66	0.21	7.6
MIVZ_F	30.4	5.0	53	14.0	0.4	–1				37.4	14.0	88	19	1.1	0.6				35.3	12.0	84	15.0	1.1	1.4			
M20J_I	6.0	5.0	6.9	0.4	0.2	0	2.72	0.11	–3.2	5.9	4.9	7.8	0.6	0.9	1.9	1.18	0.28	3.5	6.0	5.3	8.3	0.6	2.1	6.4	6.59	0.01	5.3
M20J_F	6.2	5.1	7.2	0.6	0	0				5.7	4.6	7.9	0.8	0.8	0.1				5.7	4.6	7.9	0.8	0.8	0.8			
MPOL_I	20.02	15.1	31.1	4.2	1.4	1.3	6.59	0.01	9.8	19.61	11.2	31.4	5	0.5	–1	8.86	0	6.8	19.94	14.4	31.4	4.0	1	0.7	26.2	0	12.0
MPOL_F	18.24	14.2	26.4	3.0	0.9	0.1				18.36	12.1	32.2	4.3	–1	1.8				17.80	12.0	27.1	3.4	0.6	0.3			
MSNG_I	15.1	1.2	57	10.0	2	6.1	2.07	0.16	–16.3	14.1	2.0	50	12	1.2	1.3	3.4	0.07	22.5	13.3	2.2	48.4	9.3	1.7	4	4.79	0.03	28.5
MSNG_F	18.0	2.2	75	17.0	1.9	3.4				18.2	2.2	90	18	–2	5.3				18.6	4.2	68.3	15.0	–2	3.7			
MPRK_I	–2.4	–17	15	6.7	0	0.4	0.04	0.84	–7.7	–2.4	–15	10	5.9	0	–1	0.01	0.94	0	–2.5	–16	7	7	–1	–1	3.79	0.06	78.6
MPRK_F	–2.6	–18	13	7.1	0	0				–2.4	–15	8	6.5	0	–1				–1.4	–18	8	8	–1	0			
MPRR_I	45.1	24	62	9.2	–1	0	2.31	0.14	3.6	45.2	19	73	11	0.1	0.6	0	0.95	–0.2	45.4	27.0	65	9	0	0	0.32	0.58	1.9
MPRR_F	46.8	25	67	9.9	0	–1				45.1	25	67	9.8	0	0				46.3	24.0	68	11	0	0			
MISK_I	73.0	47	110	15.0	0.5	0	3.52	0.07	5.5	72.9	57	106	10	0.9	1	0.35	0.56	0.1	73.1	42.0	113	16	0.1	0	0.01	0.91	0.3
MISK_F	69.2	46	92	13.0	0	–2				71.9	58	94	8.9	0.9	0				72.9	25.0	99	16	–1	0.6			
MTAP_I	24.1	19	30	2.8	0.2	–1	53.1	0	8.4	24.3	19	30	2.5	0	0	46.3	0	9.0	24.2	17.0	31	3	0.5	0.5	31.6	0	8.7
MTAP_F	26.3	20	34	3.5	0.3	0				26.7	22	34	2.4	0.6	0.8				26.5	22.0	31	2	0	–1			

N – number of examinees; AM – arithmetic mean; Min – minimal result; Max – maximal result; S.D– standard deviation; Sk – skewness; Ku – kurtosis; F – univariate test value; p – level of significance; % – percent of AM difference

Analysis of the differences among the control group and both experimental groups in the indicators of motor abilities in the initial testing

The second phase of the study evaluated possible differences between groups in the scores of the initial testing. Parameters of discriminant functions (EV → Wλ= 0.98, Eigenvalue=0.02, p=1.00; EB → Wλ=0.77, Eigenvalue=0.02, p=1.00) indicated no significant differences between the control group and experimental groups, which confirmed the first hypothesis (H1) and proved the assumption that all the participants belonged to the same population at the beginning of the experiment. It may be concluded that the overall kinesiological treatment up to that point, in interaction with the developmental characteristics, affected all the examinees just about equally.

Analysis of changes in the indicators of motor abilities under the influence of the control and experimental programs throughout the school year

Table 5 reveals significant broad changes in motor abilities after the 9-month programs' application, in all three analyzed groups. Based on this fact the second hypothesis (H2) is rejected. All three types of applied programs, including the endogenous factors of growth and development, had a positive impact on the students' motor dimensions.

Motor improvement in the control group was mostly noticeable in the variables: standing long jump (MSDM), sit-ups (MDTR), obstacle course backwards (MPOL), hand tapping (MTAP). It can be concluded that the implementation of regular PE curriculum for the fifth grade is sufficient to cause the significant positive changes in students' motor status, especially in explosive power-jump type, dynamic strength endurance, alternate hand movements frequency, and, partially, in coordination. Reflecting the positive effects in relation to the contents of the regular program, it is certain that the applied teaching sections of Running and Jumping mainly affected strength of the lower extremities; furthermore, teaching sections Games primarily influenced the development of alternate hand movements frequency, while the interactions of various sections influenced the development dynamic abdominal strength endurance and co-ordination.

It was expected that the effects of additional programs would upgrade the positive changes obtained by the PE curriculum. This expectation was verified by the obtained results motor skill transformation of the control and experimental groups in each test.

The regular PE classes in combination with the additional volleyball program promoted positive effects on the measures of students' explosive power (standing long jump – MSDM; 20 m sprint – M20V; medicine ball throw – MBML) and dynamic strength (sit-ups – MDTR), frequency of alternate hand movements (hand tapping – MTAP) and partially co-ordination as well (obstacle course backwards – MPOL). High saturation of various passing elements including the overhand and underhand hits within the volleyball program (Table 2) effectively helped the development of the arms and shoulder muscle region, thus improving explosive power of a throw type. The progress in explosive power – sprint type is primarily a reflection of a general conditioning drills conducted during the preparation phase of each lesson which included various kinds of high rate running over short distances.

TABLE 5
GLOBAL CHANGES IN THE INDICATORS OF MOTOR ABILITIES OF CONTROL GROUP AND EXPERIMENTAL GROUPS BETWEEN INITIAL AND FINAL TEST

	Maha.dis / d2	df1	df2	F	p
C	5.88	12	30	15.1	0.00
E_V	6.93	12	33	18.2	0.00
E_B	8.14	12	26	18.1	0.00

Maha.dis – Mahalanobis distance; df – degrees of freedom; F – perimeter value; p – level of significance

The most significant changes between the initial and final measurement occurred in the motor variables of the experimental group – basketball, where a major increase was visible within dimensions of the explosive power (standing long jump – MSDM; 20 m sprint – M20V; medicine ball throw – MBML) and co-ordination (obstacle course backwards – MPOL; 20 yards – M20J; low beam stand – MSNG) and also in dynamic strength endurance (sit-ups – MDTR) and hand frequency movement (hand tapping – MTAP). It is obvious that the obtained changes are consequences of high number of running and jumping drills, a lot of technical elements practiced in the main part of each lesson, as well as basic physical conditioning drills applied in the preparation part of each class.

On the other hand, no significant progress in the measures of static strength and flexibility was obtained in any group, which suggested that in the future more attention should be devoted to the exercises aimed at developing those motor skills when preparing and implementing the program content for the regular fifth grade PE classes, as well as other variations of additional physical activities.

Analysis of the differences between the control group and experimental groups in the indicators of motor abilities in the final testing

The quantitative difference in motor variables at the final testing was analyzed between the control group and each of the experimental groups.

Table 6 shows the significant differences between the control group and experimental groups of the examinees in the final measurement – all in favor of the experimental groups (EV → Wλ=0.33, Eigenvalue=0.75, p=0.03; EB → Wλ=0.45, Eigenvalue=0.69, p=0.01). It proves

TABLE 6
THE RESULTS OF DISCRIMINATE ANALYSIS BETWEEN CONTROL GROUP AND EXPERIMENTAL GROUPS AT THE FINAL TESTING

	Eigen-value	Canon. R	Wilks' λ	χ^2	df	p-level
E_V – C	0.33	0.50	0.75	22.26	12	0.03
E_B – C	0.45	0.56	0.69	26.51	12	0.01

Eigen-value – characteristic root; Canon. R – coefficient of canonic correlation; Wilks' lambda – discriminant value; Chi-sqr. – chi-square test; df – degrees of freedom; p-level – level of significance

that the additional programs, applied once a week throughout the school year, are sufficient to produce substantial positive changes in total motor status of fifth grade students. Thus, the third hypothesis (H3) can be rejected. Comparing the control and experimental volleyball group, it is clear that the highest correlation with the discriminant function (Table 7) hold the variables: s*tanding long jump* – MSDM and *20 yards* – M20J. These variables contributed mainly to the significant difference between the groups in the final assessment of the motor abilities.

TABLE 7
CORRELATION OF MOTOR INDICATORS WITH DISCRIMINANT FUNCTION

	E_V – C	E_B – C
	Root 1	Root 1
MSDM	0.290	–0.031
M20V	–0.124	0.486
MBML	0.142	–0.465
MDTR	0.072	–0.023
MIVZ	0.078	–0.009
M20J	0.745	0.194
MPOL	0.039	0.099
MSNG	0.212	–0.032
MPRK	0.016	0.117
MPRR	–0.149	0.037
MISK	0.214	–0.187
MTAP	0.120	0.035

The position of group centroids (C:cont= –0.58; C:e. vol.=0.55) in Table 8 define the experimental volleyball group as the group with better explosive power – jump type and agility.

The significant distance between the group centroids of the control group and basketball experimental group (C:cont=0.63; C:e.bas.= –0.69) is also clearly noticeable. The discriminant function is defined by a positive projection of variables: 20 m sprint – M20V; bent arm hang – MIVZ; 20 yards – M20J; Obstacle course backwards – MPOL; Wide legs – forward bend – MPRR, and the negative projection of the variables: standing long jump – MSDM; medicine ball throw – MBML; sit-ups – MDTR; low beam stand – MSNG; forward bent – MPRK, shoulder circumduction – MISK; and hand tapping – MTAP (Table 7). Taking into account the reversely scaled variables, it can be concluded that the greatest influence on the given difference between the groups had the variable sprint 20 meters from the standing start (M20V) and medicine ball throw from the prone position (MBML), indicating significantly improved speed and throwing force of the entities in basketball experimental group. Extensive improvements of these abilities can be explained as a consequence of specific basketball movements within the additional program.

TABLE 8
POSITION OF GROUP CENTROIDS ON DISCRIMINANT FUNCTION

	Root 1
G_1 : C	–0.58
G_2 : E_V	0.55
	Root 1
G_1 : C	0.63
G_2 : E_B	–0.69

Comparison of efficiency of the two additional experimental programs

According to the criterion of energy consumption, volleyball and basketball belong to the category of anaerobic sports[10]. Both of them contain plenty of explosive patterns of movement, require high level of agility, specific types of coordination, speed of reaction and others. From the standpoint of conceptual structure, these sports are different; however, by motor structure of players' motions and movements, they show certain similarities. For example, jumps, defensive stances, and shooting/overhand pass are the basic technical elements of both games. Therefore, the authors presumed no significant differences would occur between the two experimental groups. Nevertheless, comparative analysis between the experimental groups confirmed statistically significant difference (Wλ=0:33, Eigenvalue=0.76, p=0.04) which is evident just inside the dimension of explosive power. This statement invalidates the fourth hypothesis (H4) and proves that the analyzed experimental groups do not belong to the same population in terms of motor ability.

Of the experimental group students, volleyball scored better in explosive power – jump type, while the students of the experimental group – basketball performed better in explosive power – type sprint and type throw. The analysis of the structure of three motor tests: standing long jump – MSDM; medicine ball throw – MBML; 20 m sprint – M20V reveals that only 20 m sprint is only basketball specific test, therefore, the considerably better

TABLE 9
THE DIFFERENCES BETWEEN THE INITIAL AND FINAL MOTOR ASSESSMENT IN THE EXPERIMENTAL GROUPS

	Eigen-value	Canon. R	Wilks' λ	χ^2	df	p-level
IM	0.00	0.08	0.99	0.52	12	1.00
FM	0.33	0.50	0.75	21.42	12	0.04

IM – initial measurement; FM – final measurement; Eigenvalue – characteristic root; Canon. R – coefficient of kanonic correlation; Wilks' lambda – discrimination value; Chi-sqr. – chi-square test; df – degrees of freedom; p-level – level of significance

TABLE 10
CORRELATION OF MOTOR VARIABLES WITH DISCRIMINANT FUNCTION OF THE TWO EXPERIMENTAL GROUPS AT THE FINAL MEASUREMENT

	Root 1
MSDM_F	–0.265
M20V_F	–0.381
MBML_F	0.358
MDTR_F	–0.050
MIVZ_F	–0.108
M20J_F	–0.199
MPOL_F	–0.131
MSNG_F	0.022
MPRK_F	0.125
MPRR_F	0.099
MISK_F	0.064
MTAP_F	0.097

performance of explosive power – sprint type of the experimental group – basketball in the final measurement was not surprising. Explosive power – type jump and type throw are fundamental motor dimension in both sports. Since the volleyball group was superior in the test explosive power – jump type, and basketball group in explosive power – throw type, such a result is primarily accredited to the particular program contents which provided more sport specific drills to such movements. The position of the centroids of the experimental groups on the discriminant function is shown in Table 11.

By reviewing previously presented results of motor changes between the initial and final measurement along with the analysis of the differences in motor skills in the final measurement between the groups, it can be concluded that the experimental basketball program, in interaction with natural growth and developmental factors of the subjects, caused the greatest progress among the observed graders. It would certainly be of great interest for further scientific research to evaluate the precise impact of additional (third) weekly hour of standard physical education, as well as, to compare it with the additional volleyball and basketball program. However, it is a fact that implementation of various basketball and volleyball elements in standard PE program will enhance the students' motor abilities primarily in the domain of speed, agility, explosive power and coordination.

TABLE 11
POSITION OF THE CENTROIDS OF THE EXPERIMENTAL GROUPS ON THE DISCRIMINANT FUNCTION

	Root 1
G_1: E_V	–0.52
G_2: E_B	0.62

Nevertheless, considerable motor improvements during the observed school year occurred in all the groups analyzed. However, the significant influence of the additional physical activity, in the form of an extra 35 contact »hours« of well elaborated sport games curricula, contributed to far greater progress in motor development. Therefore, the introduction of additional hours of exercise is rational and beneficial for students involved in PE area. For that purpose, schools should ensure appropriate working conditions, human resources, a variety of extracurricular activities, elective sport activities and various forms of physical education.

Conclusion

The essence of planned and systematically applied physical education requires a careful selection of adequate stimulants with precisely defined partial effects that seek a long-term global integration and raise of skills quality to the expected levels. Considering the limited number of weekly PE classes, various forms of extracurricular activities become valuable. It should be acknowledged that even one additional hour of organized exercise per week throughout the school year, based on the given sport, is sufficient to cause significant positive changes in motor status of the 11-year-old students. Effects of PE program indicate the transformation of various dimensions of motor ability. The results of additional programs are, of course, upgrade to the regular PE program but mainly in those motor characteristics that are, by the sport-in-question factorial structure, predominant in it. According to the structure of the applied experimental programs, the obtained differences can be interpreted as a consequence of high performance frequency of sport specific movements. By analyzing the degree of improvement between the initial and final testing and evaluating the quantitative difference in motor abilities between the three groups, it can be confirmed that the most effective program was the one applied in the experimental group – basketball, followed by the experimental group – volleyball and, finally, the control group of examinees.

However, the main purpose of the article was not to determine the effects of basketball and volleyball on the students' motor improvements, but to provide an attractive wide range of natural forms of movement, as well as, high complexity physical activities that stimulate the

achievement of multiple objectives of PE and extracurricular activities. Basketball and volleyball provide a repertoire of exactly those kinds of movements and additionally they ensure more interesting, more social and motivational forms of activity. According to the complexities of each task and final outcomes of the given experimental program, there are open possibilities of correction or enrichment of current curricular tasks. This study offers further deliberation on optimization and rationalization of physical education and extracurricular physical activities.

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UTJECAJ DODATNOG NASTAVNOG PROGRAMA KOŠARKE I ODBOJKE NA MOTORIČKE SPOSOBNOSTI UČENIKA PETOG RAZREDA

SAŽETAK

Cilj je radu procijeniti transformacijsku učinkovitost dodatnog školskoga sata tjelesne i zdravstvene kulture temeljenog na timskom sportu (košarci ili odbojci) na motoričke sposobnosti učenika. Istraživanje je provedeno na uzorku od 125 jedanaestogodišnjih dječaka podijeljenih u tri skupine (dvije eksperimentalne i jednu kontrolnu). Na ispitanicima se u dva navrata, s vremenskim intervalom od devet mjeseci, primijenilo 12 motoričkih mjernih instrumenata poradi procjene eksplozivne, repeptitivne i statičke snage, koordinacije, fleksibilnosti i frekvencije pokreta rukom. Rezultati istraživanja su pokazali da su najveće pozitivne promjene primjetne u eksperimentalnoj skupini uključenoj u dodatni program vježbanja košarke, zatim u eksperimentalnoj skupini koja je odrađivala dodatni program odbojke, te naposljetku, u kontrolnoj skupini. Generalni zaključak upućuje na činjenicu da je već jedan dodatan školski sat tjedno prikazanog programa dostatan da proizvede značajne promjene u motoričkim sposobnostima učenika petog razreda. Osnovna preporuka autora se temelji na potpori zakonske odredbe o obveznoj provedbi dodatnih organizacijskih oblika rada.