

Fundamental Movement Skills Development under the Influence of a Gymnastics Program and Everyday Physical Activity in Seven-Year-Old Children

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Abstract

Objective: The objectives of this study were: a) to examine the influence of an 18-week basic artistic gymnastics program on fundamental movement skills (FMS) development in seven-year-old children; b) to determine correlations between children's daily activities and successful performance of FMS and basic artistic gymnastics skills.

Methods: Seventy five first grade primary school children took part in this study. A physical education teacher specialized in artistic gymnastics conducted a gymnastics program for 18 weeks, three times a week. The level of gymnastics skills and FMS were identified at the beginning and at the end of the program. The level of gymnastics skills was evaluated by performance of eight artistic gymnastics skills, while FMS were evaluated by the use of FMS-polygon. Physical activity and inactivity was evaluated by using a proxy-questionnaire "Netherlands Physical Activity Questionnaire" (NPAQ).

Findings: According to the dependent samples t test, significant differences were found in the FMS-polygon and all gymnastics skills before and after the 18-week gymnastics program. Increasing correlations were established over time between gymnastics skills and the FMS-polygon. Unorganized daily activity of children significantly correlated with their mastering of gymnastics skills and FMS. The presented findings confirm: (1) the thesis that basic artistic gymnastics skills and FMS could be developed simultaneously, (2) the theory of positive transfer of similar skills between FMS and artistic gymnastic skills.

Conclusion: Mastering basic artistic gymnastics skills will provoke improvement of FMS and finally become a prerequisite for successful introduction of learning more complex gymnastics skills. The obtained results imply that an increase of children's unorganized daily activities can improve the mastering of basic gymnastics skills and simultaneously the development of FMS.

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Key Words: Transfer of Learning; Artistic Gymnastics; Motor Skills; Polygon; Organized Activities; Unorganized Activities

Introduction

Daily inactivity of young children is a major problem of societies all over the world. Numerous studies proved a connection of children's activities with their future health status^[1] and the trend of

progressive inactivity and obesity of children^[2]. Inactivity or lack of proper physical activity in childhood can result in a failure to develop fundamental movement skills (FMS) during preschool and primary school years and cause later failures in learning specialized movement

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skills^[3,4]. In contrast, mastering of these skills is a prerequisite for a successful introduction of specific sport activities^[5-7].

FMS include locomotor skills (e.g., run, gallop, hop, leap, horizontal jump and slide); object control skills (e.g. catch, kick, overhand throw and dribble) and body management skills (e.g., balance, climb and forward roll) and provide a base for more advanced motor skills^[5] such as artistic gymnastics skills. Moreover, the level of locomotor skills of children is positively correlated with the levels of participation in physical activities in adulthood^[8], which implies that the development of FMS has a great role in long-term health. As it is already known, FMS do not improve only because of growth and maturation^[9]. Children's daily activity^[10,11], learning various skills^[4,6], relevant feedback and encouragement^[5], motor abilities^[12,13] and morphological characteristics^[14], especially weight^[15], play significant roles in development of FMS. If the optimal age for mastering FMS is between the ages of 2 and 7 and the optimal age to start with an organized gymnastics program is between the ages of 5 and 7, then it is obviously important to find out how learning gymnastics skills reflects on the FMS status of seven-year-old children. Hypothetically, a positive transfer of skills from FMS to gymnastics skills can be expected, according to the identical elements theory established by Thorndike and later developed by Osgood^[16], meaning that similarities between the stimulus and response conditions of the two fundamental tasks are in the basis of positive transfer. Also, a positive transfer could occur when practice conditions require learners to engage in problem-solving processes similar to those required by the criterion task according to the appropriate processing theory^[17]. Delas Kalinski, Miletic and Bozanic^[18] found out that gymnastics skills learned at the age of 6.5 are retained over time after a period without any practice which makes them suitable for PE classes. Learning gymnastics skills in childhood can increase children's capacity for skill performance, improve their motor abilities, and, as we hypothesize in this investigation, to develop FMS as well. If a positive transfer occurred, there is no reason why FMS and basic gymnastics skills would not be developed simultaneously. The question is: will learning gymnastics skills develop all FMS including

locomotor, object control and body management skills equally? The activities that develop versatile FMS should be the major focus of primary school education.

The purpose of this study was (1) to examine the influence of an 18-week basic gymnastics program on FMS development in seven-year-old children; (2) to determine correlations between daily activities and successful performance of FMS and basic gymnastics skills.

Subjects and Methods

Seventy five first grade pupils (30 boys and 45 girls) of primary school from Mostar, Bosnia and Herzegovina, participated in the study. They were all at the age of seven (± 6 months). All of them were chosen randomly, from a population of 270 children from three schools, and had written parental consent for their participation in this study. First grade pupils were chosen because of limited past experience with artistic gymnastics skills and because their FMS development is still in progress. Also, it is expected that their activity and inactivity outside of school would be similar.

The artistic gymnastics program was conducted three times a week for 45 minutes (for 18 weeks), by trained artistic gymnastics instructors and a PE teacher. The study procedure included initial and final a) evaluation of the performance quality of artistic gymnastics skills, b) measuring of the FMS-polygon. Eight artistic gymnastics skills (forward roll, descended backward roll, handstand against wall, dominant frontal cartwheel, springboard jump with running start and landing, switching positions on the rings, front of the foot walking on a small beam, straight forward jump-off of small beam) were chosen according to the following criteria: (1) they are teaching topics in the physical education curriculum; (2) according to their abilities and pre-knowledge 7-year-old pupils can learn the same and similar artistic gymnastics skills^[19]; 3) these skills represent basic skills in artistic gymnastics. The level of their performance was videotaped (at the beginning and at the end of the program) and evaluated according to standard procedure^[20,21] by independent assessment of five judges, on a five-

point Likert scale. Evaluation was based on FIG Code of Points, but adjusted in order to be suitable for the PE curriculum. The Likert scale was used accordingly: (5) performance without technical and/or aesthetic mistakes; (4) performance with small technical and/or aesthetic mistakes; (3) performance with medium technical and/or aesthetic mistakes; (2) performance with large technical and/or aesthetic mistakes; (1) performance was not/could not be done at all.

A new, quick and effective FMS, norm-referenced test which can be easily administered for PE purposes was developed^[22] and used for this research. In this study we applied the FMS assessment according to Zuvela et al^[23] for three reasons: (1) considerably less time was needed for assessing a large number of participants; (2) norm-referenced polygon FMS assessment tool can be easily identified by PE teachers, (3) this norm-reference polygon FMS test was validated with TGMD criterion-referenced test. After metric indicators had been precisely defined for a wider set of 24 FMS tests, four tests (tossing and catching the volleyball against a wall consecutively; running across obstacles; carrying the medicine balls; and straight running) with the highest factor scores were chosen to enter the final product: the FMS-polygon. The ICC for the FMS-polygon showed very high intra-rater reliability. Correlation with the Test of Gross Motor Development (TGMD-2) revealed the coefficient of -0.82, which indicates a proper validation for the FMS-polygon. As it is considered a reliable and valid assessment tool for 8-year-old children, the authors assumed that it would be appropriate for seven-year-old children as well. The test itself is consisted of 4 tasks: tossing and

catching the volleyball against a wall consecutively; running across obstacles; carrying the medicine balls; and straight running. The participants' task is: to stand on a starting line with the volleyball and begin the first task of tossing and catching a ball against the wall 6 times on the examiner's signal; to leave the ball and run across three obstacles finally passing through the cones; to lift and carry the first and the second medicine ball and put them on the Swedish vault; to run 20 meters until passing through the photocells. The final result of the test is the time needed to successfully accomplish the four mentioned tasks.

The estimation of physical activity and inactivity was done by a proxy-questionnaire "Netherlands Physical Activity Questionnaire" [NPAQ]. The questionnaire is designed for parents, who need to assess activity of their children, and has two parts: (1) the estimation of children's activity which consists of seven statements, scaled from 1 to 5, referring to children's activity habits and preferences; (2) the estimation of children's inactivity, which consists of two questions, which refer to children's daily sedentary activity such as watching TV or playing on PC. The average value from all answers represents scores for activity while the sum of two answers represents the scores for inactivity.

The analysis of data was performed by the STATISTICA for Windows 7.0, package and the level of statistical significance was set at $P < 0.05$. Basic descriptive statistics were calculated (mean value and standard deviation). The objectivity was investigated earlier^[18] and presented by ICC coefficients. T-test for dependent samples was used to determine the differences between

Table 1: Results of FMS-polygon and gymnastics skills before and after the gymnastics treatment

Variable	Pre-testing Mean (SD)	Post-testing Mean (SD)	P. Value
FMS-polygon	33.68 (5.53)	29.28 (4.39)	<0.001
Forward roll	1.91 (0.66)	3.56 (0.82)	<0.001
Descended backward roll	1.72 (0.61)	3.50 (1.00)	<0.001
Handstand against wall	1.18 (0.41)	2.56 (1.25)	<0.001
Dominant frontal cartwheel	1.47 (0.76)	2.67 (1.32)	<0.001
Springboard jump with running start and landing	1.58 (0.53)	3.20 (0.90)	<0.001
Switching positions on the rings	1.27 (0.60)	2.49 (1.45)	<0.001
Front of the foot walking on a small beam	2.24 (0.55)	3.55 (0.84)	<0.001
Straight forward jump-off of small beam	2.17 (0.43)	3.66 (0.81)	<0.001

FMS: Fundamental movement skills; SD: Standard deviation; t test for dependent samples between the measurements

Table 2: Correlation analysis between gymnastics skills and FMS-polygon before and after 18-week gymnastics program

Variable	FMS Pre-testing	P. Value	FMS Post-testing	P. Value
	r		r	
Forward roll	-0.30	<0.001	-0.58	<0.001
Descended backward roll	-0.47	<0.001	-0.49	<0.001
Handstand against wall	-0.33	<0.001	-0.50	<0.001
Dominant frontal cartwheel	-0.30	<0.001	-0.58	<0.001
Springboard jump with running start and landing	-0.16	<0.001	-0.63	<0.001
Switching positions on the rings	-0.35	<0.001	-0.60	<0.001
Front of the foot walking on a small beam	-0.44	<0.001	-0.66	<0.001
Straight forward jump-off of small beam	-0.35	<0.001	-0.60	<0.001

FMS: Fundamental movement skills; r: Correlation analysis

participants' performance at the beginning and at the end of the program. For analyzing: a) correlations between gymnastics skills and the FMS-polygon (at the beginning and at the end of the program) and b) correlations between the FMS-polygon and activity and non-activity variables, Spearman's correlation coefficients were calculated.

Findings

Boys averaged 132.0±5.5 cm in height and 31.4±5.8 kg in weight and had a BMI of 17.3±2.6, while girls averaged 129.6±5.0 cm in height and 29.3±5.2 kg in weight, with a BMI of 16.8±2.9. Height and weight were measured by standard metric procedures.

This study evaluated the effects of an 18-week artistic gymnastics program, provided three times a week for 45 minutes, on mastering gymnastics skills and on development of FMS, on seven-year-old children. According to the results of mean values and standard deviations, determined at the beginning and at the end of the gymnastics program, presented in Table 1, significant differences were found in the FMS-polygon and all gymnastic skills. The objectivity of judges of gymnastics skills was previously established by an intra-class correlation coefficient. Their values ranged from 0.88 to 0.97, which indicates high reliability for estimating the level of performance of basic gymnastic skills among beginners. The biggest differences between the means, between the initial and the final measurement point, were evaluated in descended backward roll (1.72 - 3.50) and forward roll (1.91 - 3.56), while the smallest

differences occurred in dominant frontal cartwheel (1.47 - 2.67) and switching positions on the rings (1.27 - 2.49) elements. Significant correlations were established between gymnastics skills and the FMS-polygon at the beginning and after 18 weeks of gymnastics program (Table 2).

The exception is the springboard jump with running start and landing which had no significant correlation at the beginning, but had a significant correlation with the FMS-polygon at the end of the gymnastic program (-0.63). The highest value of correlation in the initial measuring point was found in the *descended backward roll* (-0.47) and in the *front of the foot walking on a small beam* (-0.44), and in the final measuring point in all gymnastics skills that are pointed as basic gymnastics skills on different apparatus (from -0.60 to -0.66). The results gathered by a proxy-questionnaire (NPAQ), which defines daily activities, show a mean value of 3.80 (range from 2.29 to 5), while sedentary activities were averagely 159.38 minutes daily. Minimum daily time spent in sedentary activities was 25 minutes, and maximum was 420 minutes. The FMS-polygon was significantly correlated with children's daily activity (-0.38), while the correlation with daily inactivity was not significant (Table 3). The correlations between gymnastic skills and children's daily activity were all significant (from 0.25 to 0.36), with the exception of the *handstand against wall* (0.21).

Discussion

Significant differences found in the FMS-polygon and in all gymnastic skills, at the beginning and at

Table 3: Results of correlation analysis between FMS-Polygon, final results of gymnastics skills and activity (A) and non-activity (N-A) variables

Variable	A	P. Value	N-A	P. Value
FMS-Polygon	-0.38	<0.001	0.00	<0.001
Forward roll	0.31	<0.001	-0.08	<0.001
Descended backward roll	0.29	<0.001	-0.07	<0.001
Handstand against wall	0.21	>0.05	0.04	>0.05
Dominant frontal cartwheel	0.25	<0.001	0.00	<0.001
Springboard jump with running start and landing	0.29	<0.001	0.07	<0.001
Switching positions on the rings	0.36	<0.001	0.07	<0.001
Front of the foot walking on a small beam	0.25	<0.001	-0.04	<0.001
Straight forward jump-off of small beam	0.33	<0.001	-0.06	<0.001

FMS: Fundamental movement skills

the end of the 18-week gymnastic program, are a proof of an efficient motor learning process. Pointed differences in the level of mastered gymnastics skills, between pre and post measuring, can be explained through complexity of those skills. Forward and backward rolls are considered as simple gymnastics skills, while dominant frontal cartwheel is a complex gymnastics skill for seven-year-old children. Since the applied program has prescribed the same learning time for all investigated gymnastics skills, we can presume that the complexity of skills affected the learning process. Furthermore, the authors are aware that other factors such as style and learning strategy, fatigue, anxiety and lack of motivation can also affect the learning process and these questions still remain open. From the aspect of applying gymnastics skills in PE curricula and implementing the principle of progression in the learning process, it is important to point out simple and complex basic gymnastics skills. Lower results of the *switching positions on the rings* in the final measurement point can be explained by insufficient strength of arms and shoulders that should be developed in progress. In conclusion, the period of 18 weeks and 39 school lessons is enough for appropriate acquisition of basic artistic gymnastics skills for seven-year-old children, and the complexity of skills should be considered in the PE curriculum design.

According to the correlation analysis between gymnastics skills and the FMS-polygon, at the beginning and at the end of the 18-weeks gymnastics program, all gymnastics skills were found to be in significant progress, confirming the thesis that basic gymnastics skills and FMS could be developed simultaneously. Significant progress in the FMS-polygon during the 18 weeks period,

according to the dependent samples t-test, higher values of gymnastic skills, and progressing correlation between gymnastics skills and the FMS-polygon over time, suggests that a positive transfer occurred between gymnastics skills and FMS. Analyzing the described gymnastics skills and locomotor skills, we can conclude that the theory of positive transfer of similar skills, defined by Osgood^[16], has occurred. A lot of FMS, such as skills for surmounting obstacles (jumping, landing, vaulting, wriggling and climbing), represent basic gymnastics skills in their original or modified form (e.g., landing with or without running start, with or without swing, on one or both feet etc.). That is why it is not always possible to categorize a skill exclusively in a certain group of FMS or as a gymnastics skill, and that is why artistic gymnastics is a basic sport suitable especially for young children.

The adoption of complex motor skills after mastering simple motor skills is very important in gymnastics. When the level of difficulty of a task is not compatible with the current skills level of the learner, practice becomes futile and unsuccessful^[24]. Mastering of basic gymnastic skills will provoke improvement of FMS and finally be a prerequisite for successful introduction in learning more complex gymnastic skills.

Basically, gymnastics skills belong to the categories of *discrete* and *closed* motor skills^[25], characterized by short and well defined action which includes moving from the beginning and/or rotating of the whole body around one or more axis. Frequent practice of these skills naturally improves locomotor FMS, and higher level of FMS allows continuous learning of new skills as well as adjustment of dynamics of learning processes to individual characteristics and abilities.

Table 4: Comparison of FMS-Polygon Gross Motor Quotient in this study with results obtained by Zuvela (2009) on eight year old children

Category (Gross Motor Quotient)	This study % (n)		Zuvela study [23] % (n)	
	Boys	Girls	Boys	Girls
Very superior (<20.50)	0 (0)	0 (0)	6.3 (3)	4.2 (2)
Superior (20.51 – 22.00)	0 (0)	0 (0)	20.9 (10)	2.2 (1)
Above average (22.01 – 23.50)	10 (3)	0 (0)	31.2 (15)	23.4 (11)
Average (23.51 – 25.00)	13.3 (4)	8.8 (4)	10.4 (5)	36.2 (17)
Below average (25.01 – 26.50)	23.3 (7)	13.3 (6)	12.5 (6)	21.3 (10)
Poor (26.51 – 28.00)	10 (3)	8.8 (4)	10.4 (5)	8.5 (4)
Very poor (>28.01)	43.3 (13)	68.8 (31)	8.3 (4)	4.2 (2)
Total	100 (30)	100 (45)	100 (48)	100 (47)

FMS: Fundamental movement skills

Table 4 is designed to point out the differences between boys and girls in mastering the FMS-polygon and to compare the results obtained here on seven-year-old children with results obtained by Zuvela^[23] on eight-year-old children. When comparing the results of the FMS-polygon separately by gender with those of children who are one year older (Table 4), we can conclude that the FMS-polygon is age sensitive which is one of the study limitations. New, wider investigations are necessary to establish age and gender sensitive categories of Gross Motor Quotient for FMS-polygon. Also, one more study limitation arises. The question if learning gymnastics skills develops all FMS skills equally can't be answered by this investigation simply because FMS-polygon assesses the whole range of FMS skills by a single number. To reach these answers, FMS-polygon tasks need to be assessed individually. It can be predicted that gymnastics program does develop locomotor and object control skills because it was proven in previous research of preschool children^[26], but it needs to be verified in future investigations. Finally, a lack of assessment of other external factors such as style and learning strategy, fatigue, anxiety and lack of motivation that also affect skill acquisition present a certain study limitation, which needs to be represented in future investigation.

In this study children's daily unorganized activities and inactivity were measured because of the possible influence on mastering gymnastics skills and development of FMS. The significant correlations of gymnastics skills and FMS-polygon imply that increased children's unorganized daily activities can improve the mastering of basic gymnastics skills, and simultaneous development of FMS. In this way, this investigation is congruent

with previous research^[3,4] and brings to a conclusion that inactivity among seven-year-old children can cause later failures in learning specialized movement skills.

Conclusion

Studies analyzing relations between organized learning and mastering of specific skills and FMS development along with children's daily activity and inactivity are rare. It is not only organized gymnastics program that has effects on development of seven-year-old children's FMS. Daily activity of children affects both: the development of gymnastics skills and the development of FMS. According to the results obtained by the FMS-polygon, basic gymnastics program, in combination with proper daily activity of young children, can improve FMS in general. For more exact results further research is needed with the possibility of separating locomotor, object control and body management FMS.

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Authors' Contribution

Z. Culjak: Study design, Acquisition of data.
 D. Miletic: Concept/design, Critical revision of the manuscript, Preparing the draft of the manuscript.
 S.D. Kalinski: Acquisition of data
 A. Kezic: Data analysis and interpretation, Preparing the draft of the manuscript
 F. Zuvela: Acquisition of data
 All authors approved final version of the paper.

Conflict of Interest: None

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