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Original Article

Efficiency of children's fitness training program with elements of sport dances in improving balance, strength and posture

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Abstract:
The article presents the results of the use of sports dance classes in children's fitness training programs. The **objective of the study** was to test the effectiveness of the fitness training program for preschool-age children with elements of sports dance, aimed at improving their physical condition parameters. To address this objective the following research methods were used: the search for and analysis of special literature, visual analysis of the state of the biogeometric profile of posture; pedagogical methods; stabilography; and methods of mathematical statistics. The study involved 24 girls and 24 boys aged six years, whose physical development and functional status corresponded to the norms described in the literature and had no statistically significant gender differences ($p>0.05$) in the studied parameters. The effectiveness of the program was evaluated in a pedagogical experiment that lasted 9 months. Positive changes and statistically significant ($p <0.05$) improvement were observed in the following parameters of the biogeometric profile of posture: the head angle improved by 35.3%, the knee angle improved by 31.3%, the waist triangles improved by 17.9%, and the feet position changed positively by 58.3%. After participation in sports dance classes, significant improvement in muscle strength was observed in children ($p<0.05$). In particular, after the pedagogical experiment, the results of the back muscles strength test increased by 41.9% and the strength of the abdominal muscles increased by 57.1%. No significant changes ($p> 0.05$) were found in the grip strength, although at the end of the pedagogical experiment this parameter increased by 8.8%-9.1% that to a greater extent reflects the natural processes of biological development. After children's participation in the fitness training program with elements of sports dance, the children's spinal flexibility and balance inmproved. Asymmetry in balance control was corrected and children were able to maintain balance in single leg stance for almost the same length of time for different legs. After 9 months of participation in sports dance classes, the range and frequency of postural sway decreased significantly by 38.6% and 31.1% in the medial/lateral direction (y) and by 43.6% and 37.0% in the anterior/posterior direction (x), respectively. These data indicate improvements in static and dynamic balance control.
Key words: fitness **program, sports dance, preschool-age children, musculoskeletal system**

Introduction.

Preschool age is the optimal period to form the child's need for physical activity and to develop physical qualities, because it is at this age period that the formation and functional development of the child's body occur (Krutsevich et al., 2013). Various reasons for restriction of movements, as well as duration and degree of their expression create a wide range of changes in the body: from adaptive-physiological to pathological ones (Andrieieva et al., 2019; Galan et al., 2018, 2020; Kashuba et al., 2018, 2020). Of particular concern to experts are an increase in mental load in preschool-age children involved in training in educational institutions of various types that starts from an early age and aimed at success in intellectual activity, on the one hand, and deterioration of physical health, limitation of the level of physical activity, loss of value orientation to a healthy lifestyle, on the other hand (Aubert et al., 2020; Mannocci et al., 2020; Savliuk et al., 2020). Deficiency of physical activity that is commonly seen in preschool and school age children draws considerable attention of experts and parents (Zhang et al., 2019). Furthermore, for many years, a large number of children has been dissatisfied with traditional physical education classes that results in a decreased level of their physical condition and a loss of interest in PE classes (Galan et al., 2021). This demonstrates the relevance of the search for effective ways of health improvement and harmonious development of preschool-age children, increasing the level of their physical fitness, and formation of interest in regular health-enhancing recreational physical activity.

The views of researchers and practitioners coincide in the fact that the preschool years are the most important period for the formation of personality and creation of fundamental prerequisites for their harmonious development and rational preparation for further life (Andrieieva et al., 2020). The achievements of Ukrainian

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science in the context of organizational, informational, and technological support of the process of recreational and health-enhancing activities for preschoolers are obvious. Fitness programs for children, which are very popular in fitness clubs and entertainment centers, have significant advantages in involving children in health-enhancing and recreational physical activity. The attractiveness of such activities is due to the high emotional background of the classes, the possibility of engaging children, who do not have experience in sports training and do not plan to build a sports career.

A lot of research has been focused on the introduction of various kinds of children's physical activities in the process of physical education of preschool children (Krutsevich et al., 2013; Sekendiz, 2018). As has been reported, the following activities are especially attractive: gymnastics and athletics including aerobics, step aerobics, hip-hop, and fitball gymnastics, elements of rhythmic gymnastics; game-based activities such as active, musical, and developing games, dance classes, relay races and sports game-based activities, dance game-based gymnastics "Sa-Fi-Dance", active game training, game-based stretching, etc (Chatzopoulos et al., 2018; Galan et al., 2021; May et al., 2019).

The analysis of special scientific and methodological literature shows a significant interest in the development of innovative technologies on the basis of various types of physical activity and their implementation in health-enhancing activities for preschool-age children (Betul, 2018; Joosse et al., 2008). Especially in demand are technologies, which are based on the use of elements of health-enhancing fitness training (Huang et al., 2012). Children's fitness training is not so much an effective set of exercises as the proper motivation of children; the classes should be interesting, unconventional, and game-based (Castillo et al., 2015; Gao et al., 2013; Kulinna et al., 2018). One of the most popular types of physical activity for this age group is sports dance (Chatzopoulos et al., 2018). Sports dance classes promote comprehensive and harmonious development of the child's individuality and personality, improve posture, unlock their creative abilities, and shape their character (Scharoun, Greg, 2020). Scientists are unanimous in the opinion that during physical exercises with musical accompaniment, appropriate responses to external influences are formed, as well as connections are established between movement patterns, emotional and cognitive mental processes, and behavior (Rodrigues et al., 2019).

Researchers have identified the effects of sports dance on physical development and health (Anjosa et al., 2019; Grygus et al., 2020; May et al., 2019; Schroeder et al, 2017), weight loss, improvement of the emotional status of children and life satisfaction, reduction of anxiety and depression (Burkhardt et al., 2012; Anjosa et al., 2018).

However, the use of elements of sports dance in exercise programs for preschool-age children is not substantiated enough. There is no research on the use of sports dance as a part of fitness training for preschool children. This study is a non-randomized controlled trial aiming at investigating the effectiveness of a fitness training program with elements of sports dance for preschool-age children. To assess the effectiveness, we analyzed the data from the baseline and follow-up testing (9 months after baseline testing) by comparing changes in posture, balance, and strength. We hypothesized that participation of children in the fitness training program with elements of sports dances would promote gains in flexibility, static balance, strength, and general motor coordination.

Materials and Methods.

The study involved 48 children aged six years (24 girls and 24 boys). Participation in the study was voluntary and the written informed parental consent and child assent was obtained for participation in all stages of the pedagogical experiment, for further analysis and disclosure of their personal data during interpretation, and publication of the results of the study. The study was conducted in accordance with the ethical principles of the World Medical Association Declaration of Helsinki. The study was conducted at the National University of Ukraine on Physical Education and Sport (Kyiv, Ukraine). Ethical approval was obtained from the Ethics Commission of the NUUPES (No. 2 on 16.12.2020).

Theoretical analysis of special literature and generalization of practical experience allowed us to identify the relevance of the study, to clarify and specify the aim, objectives, and the focus of the study. Publications related to the studied problem from such databases Google Scholar, PubMed, MEDLINE, Web of Science, and SCOPUS were used. Publications that met the following criteria were analyzed: works published in the period from 2010-2021, longitudinal studies, a sample of respondents aged from 5 to 13 years. A descriptive method was used to analyze the obtained data.

The study was aimed at evaluating the effectiveness of the program of fitness classes using sports dance, which was designed using a block principle and included 5 blocks: choreographic, corrective, game-based, dance, and competitive.

Distribution of exercise load among the blocks of the program is shown in Table 1. The effectiveness of the fitness program was studied in the transformative pedagogical experiment on the basis of the sports club "Supadance" that lasted 9 months.

Table 1. Distribution of exercise load among the blocks of the program with elements of sports dance for preschool-age children

Blocks	I period	II period	III period
1. Choreographic	30%	30%	10%
2. Corrective	10%	20%	20%
3. Game-based	50%	20%	15%
4. Dance	10%	30%	50%
5. Competitive	–	–	5%

The choreographic block was focused on the development of musicality, the ability to move rhythmically, and to reproduce the rhythmic pattern of dance and choreographic images. It included the basics of choreographic literacy, rhythmic exercises for attention, rhythmic pattern, exercises with objects, choreographic exercises, dance steps, and dance with attributes. The game-based block was focused on the formation of motivational, emotional, and volitional readiness, learning to control their behavior according to social requirements, and formation of intellectual readiness through games aimed at the development of mental processes. The game-based block included musical active games to learn rhythmics, story-role games, educational dance games, game-based stretching, relay games, and game-based exercise training. The dance block included the ABCs of dance and elements of dance movements, the basics of the dances from Standard (waltz, quickstep) and Latin American (cha-cha-cha, jive) categories. The competitive block was focused on establishing a lasting interest in the further development of skills in dance sport and to assess individual achievements; it included participation in club competitions. At each stage of the developed program, appropriate methods of medical and pedagogical control were applied that allowed to monitor the indicators of physical condition and, if necessary, to make adjustments to the program. The study participants were tested twice: at the beginning and at the end of the program with an interval of nine months.

When developing the content of the testing program, we chose the measurement techniques, which meet the requirements of sports metrology and are the most informative for measuring the components of the physical condition of preschool-age children, have a theoretical basis, and have been tested in the practice of physical education.

To assess the effectiveness of the program we studied changes in the following indicators: the state of the biogeometric profile of posture, indicators of physical fitness, physiometric indicators of physical development, and vertical posture stability.

The state of the biogeometric profile of posture was accessed using visual screening according to the method of V. Kashuba (2019).

Physical fitness testing was performed during the main part of exercise classes. Flexibility was assessed using the sit and reach flexibility test (cm). The subject sits on a gymnastic bench with straight legs without gripping with the hands. Measurements are made with a long enough stationery ruler. On the “Go" command the subject leans forward and tries to get the feet with his figertips. The distance between the fingertips and the toes is measured. The score: good – the fingertips touch the toes; average – the distance between the fingertips and toes is 10-15 cm; low – the distance is more than 15 cm. Coordination abilities (static balance) of children were assessed using the Bondarevsky test (Stork balance stand test). The subject is asked to stand on one leg with the hands on the hips and the non-supporting foot positioned against the inside knee of the supporting leg. The person is required to stand on one leg for as long as possible. The stopwatch is started as the subject adopt a stable position and is stopped if the balance is lost. The total time of maintenance of static position in seconds is recorded. Static strength endurance of the extensor muscles and strength of the flexor muscles of the torso was assessed using exercise testing. Static strength endurance of the extensor muscles of the torso was measured with isometric back extensions test. Subjects lie face down on a bench, with their upper body from the waist hanging over the end of the bench. The subject's feet must be held or strapped down, and the hands clasped behind the neck. When ready, they must bring their body up to the horizontal position, and hold this as long as possible. The time of maintenance of the body in the horizontal position in seconds is recorded. The strength of the flexor muscles (abdominal muscles) of the trunk was measured with the sit up test. The subject lies on a flat surface with knees flexed, usually at 90 degrees, feet anchored to the ground, and the hands behind the head. The subject raises the trunk in a smooth motion, keeping the arms in position, curling up. Then, the trunk is lowered back to the floor so that the shoulder blades or upper back touch the floor. The maximum number of sit ups in a minute is recorded.

Measurement of physical development indicators was carried out in the morning. The assessment of the child's physical development was performed by comparing the physiometric indicators (the vital capacity of the lungs and the hand grip strength) with the age-related and regional norms. Vital capacity of the lungs was measured with a dry spirometer according to the commonly used procedures. Hand muscle strength was assessed by the measurement of grip strength with a handgrip dynamometer.

Vertical position stability was assessed with stabilography. Stabilographic studies were carried out on a computerized system including a force platform. The principle of the method is to record displacements of the projection of the body’s general center of gravity (COG) along the orthogonal axes. The measurements were

carried out with the examined child in an upright position (Romberg's test position) for 5 seconds. Recording of the stabilogram was carried out three times and the obtained measurements for each subject were averaged. The stabilograms were analyzed using the following parameters: A av. x, y – average range of motion of COG in the anterior/posterior and medial/lateral directions, mm; F av. x, y – average frequency of anterior/posterior and medial/lateral sway of COG, Hz; A av. x, y – maximal range of motion of COG in the anterior/posterior and medial/lateral directions, mm; A av. - average range of COG vector motion, mm; F av. - average frequency of COG vector motion, Hz; A max. - maximal range of COG vector motion, mm.

The following statistical methods were applied in the study: statistical analysis of the data obtained in the pedagogical experiment that included the primary analysis of the obtained empirical data using descriptive statistics, and the sampling technique. To assess the normality of data the Shapiro-Wilk test was used. To analyze the statistical significance of the differences between the samples parametric and nonparametric tests were used at the significance level of $\alpha=0.05$ ($p<0.05$). The use of these statistical methods allowed to analyze the empirical data as well as contributed to their interpretation and formulation of conclusions. Systematization of the material and primary statistical analysis were performed using software packages MS Excel (Microsoft, USA) and Statistica 8.0 (StatSoft, USA).

Results.

The data of testing at the beginning of the pedagogical experiment revealed no statistically significant difference ($p>0.05$) between boys and girls that gave us a reason to combine children into one group. Statistical analysis of the experimental material clearly indicates the proposed program had a positive impact on some characteristics of the biogeometric profile of children's posture. The results are shown in Table 1. Statistically significant ($p <0.05$) improvement was observed in such parameters of the biogeometric profile of posture as the head angle, the knee angle, the waist triangles, and the feet position.

Table 1. Parameters of the biogeometric profile of posture of 6-year-old children, who participated in sports dance classes, before and after the experiment (n=48), points

Indicators of the biogeometric profile of the posture of children, points		Baseline mean		Follow-up mean		Increase, ± Δ		p
		$\overline{x}$	SD	$\overline{x}$	SD	arb.un.	%	
Sagittal plane	Head inclination angle (α_1)	1.73	0.25	2.34*	0.28	0.61	35.3	<0.05
	Thoracic kyphosis (distance l_1)	1.69	0.33	1.82	0.41	0.13	7.7	>0.05
	Trunk inclination angle (α_2)	1.82	0.37	1.91	0.46	0.09	4.9	>0.05
	Abdomen (distance l_2)	1.53	0.42	1.66	0.39	0,13	8.5	>0.05
	Lumbar lordosis (distance l_3)	1.56	0.67	1.65	0.19	0.09	5.8	>0.05
	Knee joint angle (α_3)	1.66	0.55	2.18*	0.27	0.52	31.3	<0.05
Frontal plane	Position of the pelvic bones (α_4)	1.77	0.22	1.90	0.21	0.1	7.3	>0.05
	Upper arm symmetry (α_5)	1.58	0.37	1.75	0.30	0.2	10.8	>0.05
	Waist triangles	1.56	0.58	1.84*	0.34	0.3	17.9	<0.05
	Symmetry of the inferior scapular angles (α_6)	1.71	0.28	1.84	0.18	0.1	7.6	>0.05
	Feet position	1.44	0.29	2.28*	0.25	0.8	58.3	<0.05

Note: * – the difference compared to the data obtained at the beginning of the experiment is statistically significant ($p<0.05$)

The results of the study indicate that dance and choreographic exercises are the most effective means of developing the child's body, formation of good posture, and preventing postural disorders.

To assess the impact of the fitness training program with elements of sports dance on the musculoskeletal system of 6-year-old children, we measured the endurance strength of the back and abdomen muscles, grip strength of the right and left hands, balance in the single leg stance on the right and left legs, and spinal flexibility. The obtained data indicate an increase in strength endurance of the back and abdomen muscles, as well as in the balance function and spinal flexibility. The changes were significant ($p <0.05$) (Table 2). The test results showed some specifics. right- and left-hand grip strength, single leg stance test of balance on the right and left legs, and spine flexibility test. The data obtained indicate an increase in strength endurance of the back and abdominal muscles, as well as in balance control and in spine flexibility. The changes were statistically significant ($p<0.05$) (Table 2). The changes in the test results show some specifics. For example, among the abdominal and hand muscles, flexor muscles are stronger that is consistent with the age-related anatomical and physiological characteristics of preschool-age children. The data show a significant ($p<0.05$) increase in the strength of the abdominal and back muscles after 9 months participation in the training program with the elements of sports dance.

Thus, it can be suggested that the means of sports dance are effective for the formation and correction of posture disorders in 6-year-old children.

Table 2. Changes in physiometric indicators of physical development and physical fitness of 6-year-old children, who participated in the fitness training program (n = 48)

Parameter	Baseline mean		Follow-up mean		Increase, ±Δ	p
	$\bar{x}$	SD	$\bar{x}$	SD		
Vital capacity, L	1.39	0.01	1.53	0.01	10.1	>0.05
Back muscles strength, min	0.31	0.08	0.44*	0.07	41.9	<0.05
Abdominal muscles strength, number of reps	8.4	1.36	13.2	0.65	57.1	<0.05
Right hand grip strength, kg	5.7	1.16	6.2	1.25	8.8	>0.05
Left hand grip strength, kg	5.5	1.19	6.0	1.32	9.1	>0.05
Bondarevskiy test right leg, sec	5.3	0.21	8.1*	0.16	52.8	<0.05
Bondarevskiy test left leg, sec	3.6	0.32	7.1*	0.29	97.2	<0.05
Spine flexibility, cm	3.5	0.92	8.2*	0.40	134.3	<0.05

Note: * – the difference compared to the data obtained at the beginning of the experiment is statistically significant (p<0.05)

An increase was observed in the strength endurance of the back muscles by an average of 13 seconds (41.9%) and in the strength of the abdominal muscles by 57.1%. The results of coordination test improved significantly, in particular, the time of balance maintenance in single leg stance on the left leg increased by 97.2%. Therefore, the changes in this indicator undoubtedly indicate the great effectiveness of the sports dance-based training program used in this study that creates conditions for correction the asymmetry in the development of coordination abilities. The spine flexibility also improved significantly (p <0.05) under the influence of the training program. The largest increase in the average group data was observed for spine flexibility and amounted to 134.3%. High variation in the measured grip strength indicates individuality in the development of this quality in children.

After the experiment, we evaluated the effects of the program of health fitness classes with elements of sports dance on the parameters of stabilography. The results are presented in Table 3. Changes in the parameters of stabilogram such as frequency and range of the body's COG motions reflect both the age-related, genetically determined dynamics of the balance function and the effect of the performed physical exercises on the neuromuscular system, the articular-ligamentous system, and musculo-articular and vestibular reception, i.e., on those components of the functional system of balance control, which play a key role in ensuring postural stability.

Table 3. Changes in the parameters of body's COG motions in 6-year-old children, who participated in sports dance classes, before and after the experiment (n=48)

Parameter	Baseline mean		Follow-up mean		Increase, ±Δ	p
	$\bar{x}$	SD	$\bar{x}$	SD		
Average range of anterior/posterior COG sway, mm	8.16	0.87	5.01*	0.31	38.6	<0.05
Average range of medial/lateral COG sway, mm	9.27	0.92	5.23*	0.34	43.6	<0.05
Average frequency of sway of COG along x-coordinates, Hz	7.31	0.67	5.04*	0.42	31.1	<0.05
Average frequency of sway of COG along y-coordinates, Hz	6.54	0.75	4.12*	0.19	37.0	<0.05

Note: * – the difference compared to the data obtained at the beginning of the experiment is statistically significant (p<0.05)

In particular, such indicator as the postural sway range in the medial/lateral (y) and anterior/posterior (x) directions decreased significantly in children. This fact suggests an improvement of the balance function in children after participation in sports dance-based exercise program that proves the need for special training of the organs and systems of the child's body which will provide the development of static and dynamic balance control.

Another, no less significant indicator of stability, the frequency of postural sway improved qualitatively in children by 31.1% in the medial/lateral (y) and by 37.0% in the anterior/posterior (x) directions. This indicates that after 9 months of sports dance classes, children require less time to solve motor tasks associated with the need to make postural adjustments in response to changes in body position. It is important to note that children at the age of 6 years solve motor tasks associated with maintaining balance in various ways. Common to all children are: change of the feet position, body movements, and changes in the whole-body position.

Discussion:

The study was focused on evaluating the effectiveness of the fitness training program with elements of sports dances on the indicators of strength, coordination, and posture of preschool children. Despite the assessment of some aspects of the impact of sports dance classes by researchers, none of the previous studies considered the use of sports dance in a comprehensive fitness training program for 6-year-old children. Limited data indicate the effectiveness of the use of sports dance elements to improve physical condition and emotional status. In particular, there are studies that the participation in sports dance programs offers several benefits such as improving the quality of life including being more satisfied with life and happier, and feeling less anxious and depressed. The review included published findings from 977 participants from six countries: China, Korea, India, Turkey, Sweden, and the United States. It has been established that the children's participation in health-enhancing programs with elements of sports dance is associated with improved well-being including social attachment, satisfaction, success, confidence, interpersonal skills, happiness, relaxation, creative skills and expressions, aspirations, and ambitions (Santos et al., 2021). The data of other researchers on the effectiveness of children's participation in sports dance programs to improve cardiovascular performance and bone health were confirmed (Bajek et al., 2015). Positive effects related to the normalization of body weight were also observed (Santos et al., 2021). It is reported that these means can contribute to preventing or reducing overweight and obesity in children (Anjosa et al, 2018; Bajek et al, 2015). There are also anecdotal evidence of the impact of dance classes on the mental state of children, in particular, it was shown that participation in such classes can improve self-concept and body image, as well as reduce anxiety (Santos et al., 2021).

The results of this study will serve as a basis for developing further measures focused on improving the level of physical activity of children, involving them in interesting, attractive, and effective fitness-training classes based on sports dance. The results of our study are consisted with the opinion of experts that dance and choreographic exercises can be one of the most effective means of developing the child's body, formation of good posture, and preventing postural disorders (Gao et al, 2013; Kashuba et al, 2021; May et al, 2019). The obtained results contribute to existing knowledge on the use of means of sports dance in improving the indicators of physical development and physical fitness (Schroeder et al., 2017). Furthermore, the study confirms previous findings and extends our knowledge on the evaluation of the effectiveness of health-enhancing programs based on the use of sports dance elements for improving physical fitness and physical condition of children (Moskalenko et al, 2019). Our data enhance existing experience in the organization of health-enhancing classes for children's population in conditions of dance clubs and fitness centers on the basis of integral use of traditional and innovative means of health-enhancing fitness training and sports dance to improve physical condition, biogeometric profile of a posture, and physical fitness of preschool-age children.

This study has several strengths. For example, the developed program can be easily implemented on the basis of a fitness club using available resources and at low cost. Also, this study has several limitations such as a limited sample of research participants and the need for additional training of instructors to use sports dance means.

Conclusions.

When developing the fitness program, we took into account the previous positive experience of organizing the classes using the block principle. Therefore, the developed program consisted of five blocks: choreographic, corrective, game-based, dance, and competitive. Their rational and effective combination with elements of sports dance at different stages of the fitness program allowed to maintain the proper motivation of children to health-enhancing exercise classes.

Taking into account the state of the musculoskeletal system and the peculiarities of the biomechanics of movements of preschool children formed the basis for determining the content of classes. Performing dance movements and ballet exercises allowed to reduce the static and dynamic load on the foot, while loading the trunk and leg muscles. These exercises contributed to the correct alignment and positioning of the body, arms and head, as well as coordination of movements. To prevent and correct functional disorders of the musculoskeletal system in preschool children, fitball exercises were used.

The results of the pedagogical experiment lasting 9 months proved the effectiveness of the previously developed program of fitness training classes with the use of sports dance elements for 6-year-old children. Statistical analysis of experimental data showed that the following indicators improved after participation in the program: the state of the biogeometric profile of posture, coordination abilities, flexibility, and strength. Furthermore, significant changes ($p < 0.05$) were observed in the stabilogram parameters, i.e. in the frequency and amplitude of the postural sway.

Therefore the dance and choreographic exercises, which are accessible and emotionally attractive means of children's physical education can be one of the most effective means of developing the child's body and good posture, and preventing postural disorders.

Conflict of Interest. The authors declare that there is no conflict of interest that could be perceived as interfering with publication of the article.

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