Original Article

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Harmonious physique development and obesity prevention of preschool girls

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Abstract

Introduction: The main threats to the health and harmonious physical development of preschool children are overweight, obesity and abnormalities in the physique development. The aim of the study was to verify if particular (harmonious physique development and obesity prevention) PE intervention is more effective than standard PE classes for preschool children. *Material and methods: Participants:* The thirty healthy preschool girls (5-6 aged). All children practiced PE classes 3 times a week. Group 1 practiced the traditional PE sessions (games, gymnastic and dancing). Group 2 except games and dancing used a particular PE training (purposeful development of the shoulder girdle, upper limbs and motor abilities). The study used methods for estimating height and body weight, BMI, body composition, participants' biacromial breadth and Rees-Eysenck body index (REBI). *Results:* There were significant ($p \leq 0.05$) differences in BMI and biacromial breadth values between of participants' group in the study ending. Group 2 had a significantly ($p \leq 0.05$) lower BMI and a larger shoulder width values. Body composition assessment showed a significantly ($p \leq 0.05$) higher percentage of bone and muscle mass in group 2. There was a significant decrease in the participants' number of normosthenic body type in group 1. A significant increase in the participants' number of normosthenic body type and decrease in the in the participants' number of pyknic body type were found in group 2. *Conclusions:* PE programs related to the purposeful development of the shoulder girdle, upper limbs and motor skills contributes to the process of harmonious physique development of preschool girls (aged 5-6). An higher positive effect of using this PE practice in the control of body weight and BMI dynamics in preschool girls was found.

Keywords: preschool children, physique types, preschool physical education, obesity, shoulder girdle

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INTRODUCTION

The preschool age is reasonably considered as the most significant period in the process of a child's body harmonious formation. It is at this particular age that the foundation is laid for personal physical fitness and health [1, 2]. The impact of a sedentary lifestyle during childhood and adolescence on pathological processes has become a major public health threat. Regular participation in a variety of physical activities during the pediatric years could reduce chronic disease in adult life and improve the quality of life of active children's [3]. Studies show, that during the first childhood a significant proportion of preschool children have insufficient physical activity (PA) level to ensure optimal physical and functional state [4]. In the best case that only half of preschool children are engaged in PA in sufficient levels [5]. Children today are less physically active on the account of a sedentary way of life. Consequently, the incidence of overweight and obesity is increasing and negatively affects of children's health [6, 7]. The daily PA level of children does not have a developing and training effect in PE practice and sports, as well as in independent motor activity [8, 9]. Interventions PE programs to enhance cardiorespiratory fitness level from early ages are urgently needed for present and future youth health, and as a cost-effective strategy [10, 11].

An increased prevalence of obesity during childhood can also lead to chronic diseases related to inactivity and obesity in adulthood. Currently childhood obesity is one of the major concerns regarding long-term health [12]. A significant part of the preschool children (4-6 aged) have were overweight or obesity today [13]. More effective strategies must be stablished to fight with combat childhood obesity [14]. Physical fitness level is a potent biomarker of health from an early age, the improvements of physical fitness performance through the promotion of PA could be important for the health of preschool children, particularly in obesity prevention [15]. The preschool years have been identified as a crucial time to promote healthy lifestyle habits, which could assist in the prevention of obesity and chronic diseases as children age. However, few studies have focused on the effects of PA interventions in this population [16, 17].

The study of children's body movement in kindergarten (motor skills, motor education) is an experience of fundamental importance for the pedagogical development of children [18]. Main task of various programs by training and education in preschool educational institutions is harmonious development children [19]. Studies show an increase in the number of children of preschool and primary school age who have deviations in harmonious physical development and have pointed to a significant increase in the incidence rate of the main categories of diseases and disability due to diseases among the children population [20]. Scientists point out that starting from the age of 5-6 old, that there is a stable relationship between of motor fitness indicators and anthropometric data of preschool children [21]. Ukrainian experts showed, that harmonious physical development have 58.3% boys and 46.6% girls in age 5-8. The discrepancy between of length and body weight parameters, which is estimated as disharmonious development, is more often manifested in the excess weight of the body in relation to its length [22]. Scientists noted that every 6th boy and every 5th girl from Ukrainian children have overweight [23].

It is known that most preschool PE teachers such PA methods as outdoor or out-of-class play and motor development activities (e.g., yoga) [24]. Although preschool PE teachers are making efforts to increase PA, such efforts need to be intensified. Experts point to the need to use new methods in the physical education (PE) practice of children and adolescents [25, 26]. These methods should contribute to the harmonious biological development of children population [27]. Scientists point, that the methodology of modern PE classes must be based on the model dynamic exercise and intense motor skills repetition [28]. The most popular activity in PE classes of children is playing sports games, the least popular are gymnastic exercises [29]. Experts note, that the aerobic games programs in the school setting improved physical fitness in preschool children. Similar PA programs mast be based on the execution of play exercise, aerobic games, or locomotor movements [30, 31].

One of the threats to harmonious development is a significant percentage of deviations in the development of the physique of preschool children population. Russian scientists points out the presence of a significant number of retardant children among preschool children [32]. A significant proportion of children have deviations from a harmonious physique in the direction of the asthenic or pyknic body type. Experts point out that the harmonious physique formation is possible when using

certain PE methods in the PE practice of preschool children. These methods should include the necessary amount of strength training and targeted development of the back muscles and upper limbs of preschool children. Strength abilities development of a PE classes, is considered a necessary condition for improving the educational process of children [33]. The development of the back and shoulder girdle muscles contributes to the harmonious physical development of children [32]. The Russian scientists showed the 6-7 year-old children being poorly physically fit, with particularly low strength, speed-strength and coordination abilities of the overall physical fitness [34, 35].

A scientific review has shown that the main threats to the health and harmonious physical development of preschool children are overweight and obesity and abnormalities in the physique development [9, 14, 23, 32]. Most of the preschool children's PE programs are focused on eliminating the threat of obesity. There is a need for the development and use of children's PE programs that allow correcting the physique development of preschool children. Such children's PE programs should be based on the purposeful development of strength abilities and upper body muscles.

The authors suggested that the use of particular PE training (contributing to the purposeful development of the shoulder girdle, upper limbs and motor abilities) will more positive impact on the harmonious physique development and obesity prevention of preschool children. The aim of the study was to verify if particular (directed towards harmonious physique development and obesity prevention) PE intervention is more effective than standard PE classes for preschool children (girls 5-6 aged).

MATERIALS AND METHODS

Participants

Healthy preschool girls (5-6 aged), who did not have any diseases or injuries. All children (n = 30; average: age = 5.32±0.17 years, height = 112.37±6.22 cm, weight = 21.07±3.18 kg) had similar indicators of physical development and fitness. The identification of morph type of the participants (Rees-Eysenck body index) showed of normosthenic body type in the first place (58.06%), pyknic body type in the second place (25.35%) and asthenic body type in the third place (16.59%).

All ethical principles were observed. The parents' consent to the research was obtained. The study complied with the Declaration of Helsinki and was approved by the ethics commission (№36/19 of 2019 May 22) of the Institute of Physical Culture, Sport and Tourism (Siberian Federal University) in Russian Federation.

The Research Design

The overall study period was 10 months (September 2019 – June 2020). All participants were randomly divided into 2 equal groups. PE classes for children were held 3 times a week. Each PE session lasts from 30 to 40 minutes. Group 1 (G-1) practiced the traditional PE sessions. The G-1 girls' PE program included: Adequate warm-up (5 min), games (15-20 minutes per PE session), gymnastic exercises (10 minutes per PE session) or dancing (10 minutes per PE session).

Group 2 (G-2) used a particular PE sessions. Each PE session includes exercises that contribute to the purposeful development of the shoulder girdle, upper limbs and motor abilities of children. Upper body exercises and shoulder strengthening activities can help children develop the muscles necessary for so many motor skills. During each PE session, training devices, crossbars, ladders with different levels of height (from 1.0 to 2.0 m) and the size of handrails (from 2.0 to 5.0 cm) were used. Children (G-2) completed tasks related to the passage of these devices in a certain sequence in the play form. Monkey Bars and climbing walls or playground equipment ie ladders and ropes were used. Static holding of the body weight on straight or bent arms for various time intervals (from 20 to 120 seconds) was used. The duration of such PE training is 10-20 minutes of each PE session (10 minutes for the first three months, 15 minutes for the next three months, and 20 minutes for the following). The G-2 girls' PE classes also included games (10 minutes per PE session) or dancing (10 minutes per PE session). The particular PE programmes for participants (G-1 and G-2) are presented in Table 1.

Table 1. The particular PE interventions for studied preschoolers.

PE programmes (September 2019 – June 2020) for participants			
Participants	1–12-week (min)	13–24-week (min)	25–40-week (min)
Adequate warm-up			
G-1 (n=15)	2.0–2.5	2.0–2.5	2.0–2.5
G-2 (n=15)	2.0–2.5	2.0–2.5	2.0–2.5
Movement games			
G-1 (n=15)	14.0–15.0	14.5–15.0	14.5–15.0
G-2 (n=15)	9.0–10.0	9.5–10.0	9.5–10.0
Gymnastic or dancing			
G-1 (n=15)	9.0–10.0	9.0–10.0	9.5–10.0
G-2 (n=15)	9.0–10.0	9.0–10.0	9.5–10.0
Special upper body exercises (SUBE)			
G-2 (n=15)	9.5–10.0	14.5–15.0	19.5–20.0
Exercises and movements	The particular PE interventions		
	G-1	G-2	Training time (min)
Adequate warm-up	Look around, arm circles, high reaches, jog in place		2.0–2.5
Dancing movements	Body part dancing		1.5–2.5
Movement games	Get Rolling or Tight-Rope Walkers		2.5–3.0
Gymnastic / SUBE	Jumping, hopping, tumbling	Jumping rope, Monkey Bars	3.0–5.0
Dancing movements	Aerobic dance (Box step, Step touch, Toe touch)		2.5–3.0
Movement games / SUBE	Tape Jumping or Hopscotch	Flexed arms on crossbar, Bear Walk	3.5–5.0
Gymnastic or dancing	Jumping, hopping, tumbling or Zoomba Kids		3.5–4.5
Movement games	Tissue Dance	Playing catch with a weighted ball (1.0 kg)	2.0–3.5
Movement games	Obstacle Course		2.0–2.5
Movement games / SUBE	Yoga-Kids	Climbing (ladders, ropes and walls)	3.5–7.0
Dancing movements	Kids Choreography		3.0–3.5

Procedures

Assessment of participants' height and body weight, participants' biacromial breadth, body type assessment by the Rees-Eysenck body index (1945), BMI and body composition (body fat, bone mass, muscle mass) were used in the study.

Measuring Height. Each participant's height was measured using a mechanical stadiometer (SECA-217, Germany). Each participant's held position with their back to the measuring rod on the stadiometer, ensuring their feet are together and facing forward and their heels are touching the heel plate or wall. The participant's knees should be straight, and their shoulders, buttocks and head should touch the stadiometer. The participant to look straight ahead. Height indicators were recorded in centimeters (cm).

Measuring Weight. Each participant's weight was measured using a electronic scale (TANITA BC-313, Japan). The participant is standing freely not leaning on anyone. The participant's feet are square on the scales. Also we identified data on body composition (body fat percentage, bone mass percentage, muscle mass percentage), using a electronic scale (TANITA BC-313, Japan). Three consecutive measurement procedures were performed. The average value was taken.

Measuring of width between shoulders (Biacromial breadth - BB). Biacromial (shoulder) breadth – horizontal distance across the shoulders measured between the acromia (bony points). These measures were performed according to standard procedure. The subject stands while the measurer locates the most lateral borders of the acromion processes and makes the measurements across the back of the individual. For the measurement procedures a special anthropometric compass (KAFA 600, Russia) was used.

Measuring of Transverse diameter of the chest. These measures were performed with a special anthropometric compass (KAFA 600, Russia) between the points located at the intersection of the

middle axillary line and the horizontal line drawn through the place of attachment of the IV rib to the breastbone.

Calculation of Rees-Eysenck body index (REBI). We are combined the measurement of height and transverse diameter of the chest in a ratio: height x 100 / transverse diameter of the chest x 6. Women pyknic constitution index is less than 95.9, normosthenic – 95.9-104.3, asthenic – more 104.3 [36].

BMI calculation. The participants' height and weight indicators were used for the BMI calculation procedure. The participants' BMI were assessed with WHO standards for children of this age [37].

Statistical analysis.

The results of the study were analyzed using SPSS Statistics for Windows 17.0 (Chicago: SPSS Inc.). The general characteristics of the participants are presented as means and standard deviations (SD). The differences between the participant's group were determined using the Mann-Whitney U-test. The level of significance for all of the statistical analyses was $p \leq 0.05$.

RESULTS

All participants had similar height and body weight values at the study beginning. Participants' BMI was within the normal range (WHO standard). The participants' biacromial breadth (BB) values did not differ significantly. There were no significant differences in body composition of studied participants. All studied children showed similar results of body composition (body fat, bone mass and muscle mass rates).

Some differences at the study ending were found. Participants (G-2) had slightly higher height rates. There were no significant differences in body weight of participants. There were significant ($p \leq 0.05$) differences in BMI and BB values between of participants' group. Girls (G-2) had a significantly ($p \leq 0.05$) lower BMI and a larger BB values. There were no significant differences in body fat rates of studied girls. There were significant ($p \leq 0.05$) differences in bone mass and muscle mass rates between of participants' group. Children (G-2) had a significantly ($p \leq 0.05$) higher percentage of bone mass and muscle mass in body composition. The results of a comparative analysis of preschool children group's values are contains in Table 2.

The REBI values of the participant' groups did not differ significantly at the study beginning (September 2019). There was a predominance of normosthenic body type in both participants groups. In second place in both groups were participants with pyknic body type. The least participants had a asthenic body type.

Table 2. Dynamics of the changes' values of the studied children.

Indicators	September 2019		p	June 2020		p
	G-1 (n=15)	G-2 (n=15)		G-1 (n=15)	G-2 (n=15)	
Heigth [cm]	112.65±6.23	112.28±6.22	0.371	118.39±7.16	120.45±6.34	0.124
Weight [kg]	21.34±3.47	21.41±3.29	0.256	24.36±6.13	24.29±6.42	0.509
BMI	16.82±0.21	16.87±0.17	0.201	17.38±0.22	16.74±0.19	0.027*
BB [cm]	21.39±3.65	21.43±3.52	0.562	22.43±3.46	25.08±2.37	0.004*
Body fat [%]	19.22±2.09	19.16±2.13	0.341	19.03±2.12	18.68±2.01	0.221
Bone mass [%]	21.56±1.42	21.62±1.35	0.322	21.37±1.27	22.53±1.24	0.002*
Muscle mass [%]	35.93±2.34	35.78±2.27	0.316	36.53±2.16	37.42±2.19	0.048*

* $p \leq 0.05$ – significance level

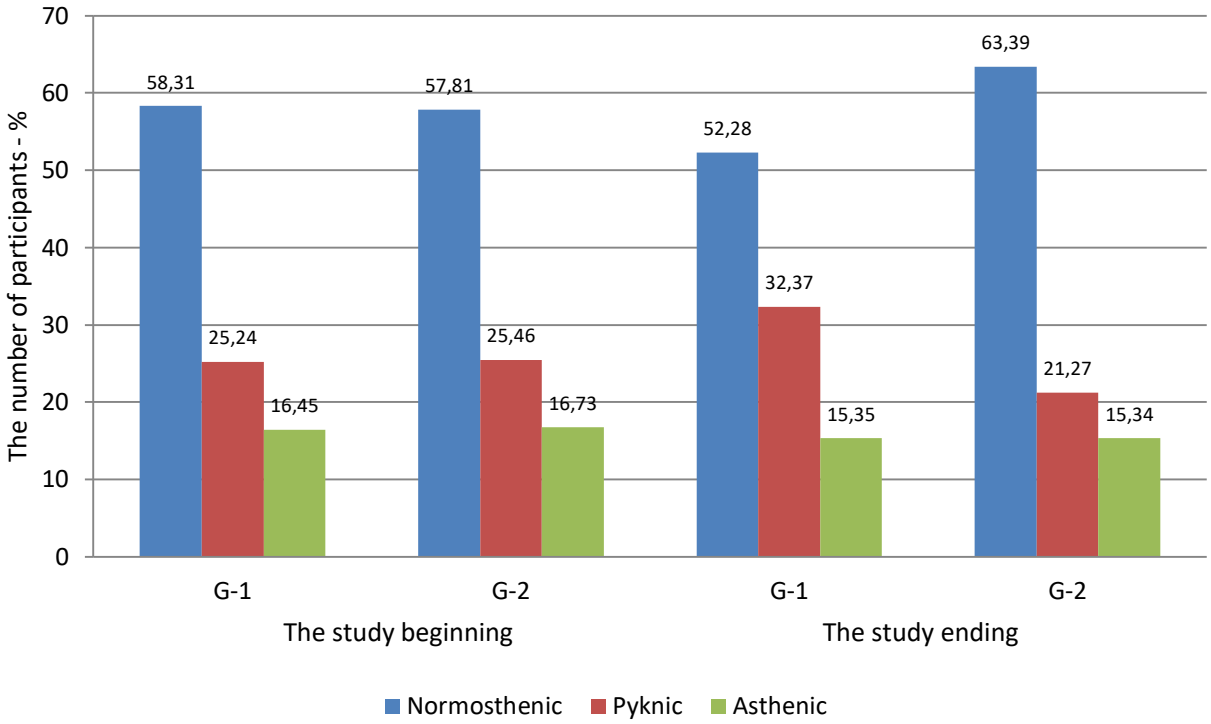

Figure 1. The dynamics of the REBI rates of the studied children.

Significant differences in the REBI values of the studied children were revealed of the study ending (June 2020). There was a significant ($p \leq 0.05$) decrease in the participants' number of normosthenic body type (from 58.31 to 52.28%) and increase in the participants' number of pyknic body type (from 25.24 to 32.37%) in group 1. A significant ($p \leq 0.05$) increase in the participants' number of normosthenic body type (from 57.81 to 63.39%) and decrease in the in the participants' number of pyknic body type (from 25.46 to 21.27%) were found in group 2. The overall number of participants of asthenic body type decreased evenly in both groups. The overall dynamics of changes in REBI values of the studied children is shown in Figure 1.

DISCUSSION

The authors acknowledge that the implementation of their recommended preschool PE program is associated with problems. There is a problem of lack or incomplete of necessary gymnastic equipment for conducting PE classes. Issues such as lack or non-availability of a gymnasium, inadequate and incomplete facilities and equipment play a significant role in fulfilling a curriculum and accomplishing the PE goals in Portugal [38], Republic of Croatia [6], Russian Federation [39, 40] and other countries. It should also be emphasized the some lack of knowledge among many preschool PE teachers about the importance of using particular PE interventions for the harmonious physique development of preschoolers. The majority of Russian preschool PE teachers do not have organizational and financial opportunities for additional training and qualitative professional development in the PE and child health care. Lack of qualified personnel has a negative impact on the PE process of preschool children in Russia today. Success of the particular kinesiological PE intervention implementation in the traditional preschool PE model in Russian Federation was found to depend on the following educational provisions: particular kinesiological PE facilitating conditions in the children's groups, sport gyms and outdoor training sites; due incentives, protocols and instruction manuals for the particular PE intervention; due training of the preschool PE teachers at workshops to help them master the best kinesiological practices and experiences [40].

Croatian scientists investigated the changes of body size and composition of preschoolers aged 5-6 years during of five years. In the studied girls there were no significant changes in height, weight

and BMI, while again fatness (body fat) was significantly enlarged (from 15.50% to 19.44%) [13]. Similar body fat rates of studied girls were found in our study beginning. A reducing of body fat percentage in participants (G-2) was found in our study ending (up to 18.68%). Polish experts to examine comprehensive associations between body composition and objectively measured levels of PA in a large sample of preschool children aged from 5 to 6 years. The results showed that in the total sample of preschoolers aged from 5 to 6 years, a level of MVPA below the WHO recommendation (at least 60 min of MVPA per day) was significantly associated with higher content of body fat and lower content of muscle mass. However, in girls, these relationships occurred but were not statistically significant [17]. There were significant ($p \leq 0.05$) differences in muscle mass rates between of participants' group (in favor of girls who used a particular (SUBE) PE intervention) in our study ending. May conclusion, a particular (SUBE) PE intervention has a significant impact on changing the body composition of preschool girls. However, this conclusion should be taken with some caution, since preschool girls show, due to early maturity, earlier changes (fat decrease) toward an integrated child's body [41].

Lithuanian and Ukrainian scientists presented BMI data for girls of similar age who practice standard PE programs. BMI indicators (15.55) at the Lithuanian girls were in the normal range [28]. BMI data (17.68) of Ukrainian girls exceeded the WHO normal range and were characterized by overweight [20]. Girls (G-1), practiced standard PE programs in our study also had overweight in the study ending. BMI data for girls (G-1) – 17.38. BMI indicators of girls (G-2) were normal range (16.74) in the study period. The results indicate a positive effect of organizing PE classes method (SUBE) proposed by the authors. This positive effect is associated with BMI maintaining of preschool children in the normal range.

Spanish and Chilean experts note, that the relationship between physical fitness and BMI is inconsistent in preschool children. The improvements of physical fitness performance and its association with PA could be important for the health of children, particularly in obesity prevention [15]. A positive association between BMI values and PE program preschool girls' was found in our study. The G-2 group that used the upper body and shoulder girdle development PE program showed significantly better results of BMI and harmonious physique development.

Ukrainian experts indicate that the number of children with disharmonious development, detected by excess body weight was 39.9% on average, whereas 13.5% of the subjects were with insufficient body weight [22]. The number of pyknic body type children is characterized by excess body weight accounted for 25.24% (G-1) and 25.46% (G-2) in our study beginning. The number of asthenic body type children is characterized by insufficient body weight accounted for 16.45% (G-1) and 16.73% (G-2). The study revealed a significant increase in the number of children (G-1) with a pyknic body type and excess body weight up to 32.37%. This indicator in children (G-2) was 21.27%. The percentage of asthenic body type children decreased to 15.35% (G-1) and 15.34% (G-2).

Spanish scientists have proposed a program of intensive PA for preschool and primary school children. The intervention consisted of 3 days per week of vigorous-intensity PA (relay races, sprints, running, skipping rope and competitive games), 15 minutes per day, during 12 weeks and significant improvements were obtained except for BMI. BMI data of children (17.48) exceeded the normal values for this age [12]. Russian experts have proposed a program of intensive (70-80% of 170 bpm) PA for preschool children. The intervention consisted of 3 days per week of vigorous-intensity PA, 18 minutes per day, during 34 weeks. Scientists received significant improvement of physical fitness and motor abilities of children except for BMI [42]. The positive BMI dynamics was obtained in children (G-2) who practiced particular PE program in our study. It should be noted that the authors did not using high-intensity PA intervention in children's PE sessions. We can conclude that the author's PE program for preschool children is highly effective in preventive of obesity risk.

Estonian experts show, that weight-status and PA level were associated with physical fitness level of preschool children. The differences in physical fitness based more upon weight status than PA participation among 6-7-years old children [9]. We did not specifically compare the participants' physical fitness indicators because of recent scientific research there were no significant differences in PA or weight status between preschool children with high, medium, or low fundamental movement skills mastery, and fundamental movement skills are considered independent of physical fitness and physical features, such as weight and height of preschool children [43]. However there was a

significant ($p \leq 0.05$) difference in BMI values between participants in our study. May conclusion, a significant impact of a particular PE program on the body weight and BMI of preschool children.

Any conclusions made in the present study have some limitations. These limitations associated with chronological age and low number of participants. There was no difference between groups for chronological age, height, body weight and body type in the study beginning. In spite of being homogeneous in terms of chronological age, investigated 5-6 years old children were still in the process of growth and maturation and that could have interfered with their perceived exertion and recovery measures after PE classes. PE teachers, who had significant experience practice of PE with preschoolers, teaching PE training for participants and corrected exertion.

CONCLUSIONS

Scientists and PE professionals pay attention to the need for high-quality methodological content of PE practice for harmonious physical development of preschool children. The lack or low quality of PE practice negatively affects of physique, physical development and motor skills of children. Inferior quality of preschool PE programs is associated with incomplete of necessary gymnastic equipment and incomplete knowledge of PE teachers. In particular there is a lack of quality PE programs for preschoolers in the Russian Federation that has a negative impact on harmonious physique development of children. PE programs related to the purposeful development of the shoulder girdle, upper limbs and motor skills contributes to the process of harmonious physique development of preschool girls (aged 5-6). The total amount of such PA sessions should be at least 40-50% of the total PE time in preschool children. A highly positive effect of harmonious physique development, increase in bone and muscle mass percentage in body composition, control of body weight and BMI dynamics in preschool girls (aged 5-6), who used this PE program was found in the study. Preschool PE teachers can use the author's particular (SUBE) PE intervention protocol in the traditional preschool PE model. The authors also recommend that parents of preschoolers use the protocol of a particular (SUBE) PE intervention in the home playtimes and indoor physical activities with children every day.

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