COMPARATIVE ANALYSIS OF PHYSICAL DEVELOPMENT IN CHILDREN ENGAGED IN SPORTS AND PHYSICAL EDUCATION

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KEYWORDS

physical development, youth sports, health, education,children,rhythmic gymnastics, swimming

ABSTRACT

This study explores the functional characteristics of the cardiovascular and pulmonary systems in children engaged in physical education and sports. It examines how different types of physical training influence heart rate, blood pressure, oxygen uptake, lung capacity, and ECG indicators. The research highlights physiological adaptations resulting from endurance, strength, and control group, providing insights into optimizing training programs and early diagnosis of potential cardiovascular and pulmonary conditions. Recommendations include regular ECG and spirometry screenings. The findings suggest that early engagement in structured physical activity significantly improves cardiovascular efficiency, pulmonary function and overall health

I. INTRODUCTION

Physical development is a critical aspect of a child's overall well-being and is influenced by various factors, including genetics, nutrition, and physical activity. Engaging in sports and structured physical education programs has been widely recognized as a key determinant of healthy physical and psychological growth. Numerous studies have demonstrated that children who actively participate in sports exhibit improved motor skills, stronger bones and muscles, enhanced cardiovascular endurance, and better mental resilience compared to their less active peers. One of the most significant benefits of physical activity in children is its contribution to maintaining a healthy weight. Childhood obesity has emerged as a global health challenge, with sedentary lifestyles and poor dietary habits contributing to its rise. Regular engagement in sports helps regulate body weight, prevent metabolic disorders, and promote overall fitness. Additionally, physical activity has been linked to improved cognitive function, with children participating in sports often displaying higher academic performance, better attention spans, and superior social skills.

In recent years, Uzbekistan has implemented comprehensive measures to create all necessary conditions for the development of physical education and sports, promoting a healthy lifestyle among citizens, especially young people, and ensuring the country's worthy representation on the international sports arena. This study aims to analyze the impact of these efforts on children's physical development and evaluate the benefits of structured sports programs.

II. MATERIALS AND METHODS

The objective of the investigation was to assess how physical activity and sports affect kids' development and growth. The object of the study were 517 young athletes from specialized children's and youth sports schools of the districts of Tashkent city and the Gymnastics Federation of the Republic of Uzbekistan. he age of the examined children ranged from 7 to 16 years among children engaged

in physical education in a comprehensive school, boys and girls, respectively. A total of 517 young athletes were examined, including 230 boys (IV group) and 145 girls (II group) engaged in swimming, 142 girls (I group) engaged in rhythmic gymnastics, and 305 students (153 girls - III group and 152 boys - V group) engaged in physical education in accordance with the school curriculum. All children were offered a questionnaire of psychological and emotional state. Of these, 248 young athletes (120 children involved in swimming and 128 in rhythmic gymnastics) and 120 children involved in physical education in comprehensive schools were tested for physical development and cardiorespiratory function. All athletes were students of children's and youth sports schools The age of the examined children ranged from 7 to 16 years among children engaged in physical education in a comprehensive school, boys and girls.

To identify the distinctions between people involved in sports and those in regular physical education, the study sought to investigate important anthropometric variables, such as height, weight, and body mass index (BMI). Measurements and Data Gathering

Height Measurement: A stadiometer was used to measure height in centimeters (cm).

Weight Measurement: A calibrated digital scale was used to measure weight in kilograms (kg).

BMI Calculation: The formula BMI = weight (kg) / [height (m)]^2 was used to calculate BMI.

To determine group differences, tests for statistical significance (like ANOVA and t-tests) were used to examine the gathered data. Statistics were deemed significant when p-values were within the range of 0.05.

III. RESULTS AND DISCUSSION

The positive effects of physical activity have been scientifically proven. Physical activity positively affects cardiorespiratory and muscular endurance, bone development, cardiometabolism improvement, and weight status. Modern research indicates that many of these health benefits persist into adulthood. Furthermore, increasing evidence suggests that physical activity positively influences cognitive development and prosocial behavior.

Regular and systematic physical exercise leads to structural and functional changes in the body's systems, characterized by various physiological effects. To study this, we conducted research to assess anthropometric and physiometric indicators that reliably reflect the impact of physical activity across different types of engagements – both school physical education programs and organized sports. A detailed dynamic analysis of the growth and weight of study participants was carried out based on their levels of physical activity (Table 1.1). The first aspect of physical development analyzed in this study was the height progression of children aged 7 to 15 years.

Table 1.1

Dynamic Growth Indicator by Age

Category	7 years	8 years	9 years	10 years	11 years	12 years	13 years	14 years	15 years
Group I	128.6 ±5.7	133.4 ±5.6	141.8 ±4.5	146.8 ±6.1	151.9 ±3.8	156.5 ±7.4	159.6 ±8.0	163.1 ±7.3	169.5 ±7.9
Group II	126.1 ±8.3	130.7 ±4.5	135.9 ±5.1	140.5 ±7.6	145.9 ±5.2	147.4 ±3.8	154.1 ±5.2	160.3 ±5.9	163.7 ±6.1
Group III	127.9 ±5.2	132.4 ±3.8	140.1 ±5.2	146.2 ±4.9	151.3 ±5.2	153.8 ±4.7	157.2 ±5.4	163.3 ±6.3	168.2 ±7.0
Group IV	121.9 ±3.8	128.5 ±4.4	136.6 ±4.2	142.1 ±4.7	147.6 ±5.0	152.4 ±5.2	157.2 ±6.2	162.2 ±6.5	165.4 ±7.3
Group V	120.6 ±5.0	127.9 ±7.1	132.4 ±3.9	137.8 ±5.3	144.5 ±8.3	152.9 ±4.5	152.9 ±5.1	157.1 ±5.7	161.5 ±6.9

An analysis of growth indicators among study participants aged 7 to 15 years did not reveal any growth deficits, either among athletes or among children and adolescents not engaged in sports. However, a clear difference was recorded between the growth of participants in groups I, II, and III (athletes) and groups I and V (non-athletes). Among girls engaged in sports (groups II and III), average growth rates from ages 7 to 15 were 5.5% – 8.0% higher than in the group of girls not involved in sports clubs (group V). Among boys (group I, athletes), growth rates were 4.5% higher compared to boys not engaged in sports (group IV). (Table 1.2)

Table 1.2

Dynamic weight indicator by age

Category	7 years	8 years	9 years	10 years	11 years	12 years	13 years	14 years	15 years
Group I	21.8 ±3.2	25.6 ±3.3	29.4 ±5.2	33.9 ±5.4	35.6 ±5.0	43.9 ±5.0	50.4 ±5.1	55.9 ±5.0	60.2 ±7.3
Group II	22.5 ±3.3	25.5 ±3.8	28.5 ±5.4	34.1 ±5.6	35.0 ±5.0	44.0 ±5.1	47.3 ±5.2	52.0 ±5.3	55.7 ±7.0
Group III	22.4 ±3.4	25.9 ±3.8	28.1 ±5.3	31.8 ±5.5	35.1 ±5.1	42.6 ±5.2	50.2 ±5.3	55.7 ±5.5	60.5 ±7.2
Group IV	23.5 ±3.5	27.9 ±3.7	32.4 ±5.3	37.9 ±5.7	40.1 ±5.3	46.6 ±5.4	50.5 ±5.5	55.9 ±5.7	60.2 ±7.3
Group V	21.8 ±3.2	25.6 ±3.6	29.4 ±5.3	33.5 ±5.5	35.0 ±5.1	43.9 ±5.2	50.4 ±5.3	55.9 ±5.3	60.2 ±7.3

An analysis of body weight indicators The research on participants aged 7 to 15 showed that boys in group IV (non-athletes) had overweight issues. Comparing body weight data indicated that athletes of both sexes (groups I, II, III) generally maintained more ideal weight levels than non-athletes (groups III and V). Anthropometric measurements were analyzed and contrasted with WHO guidelines for child growth and development. (Table 1.3)

Table 1.3

Comparative Analysis of Indicators Among Study Participants

Indices	Girls 7-11 (gymnastics)	Girls 7-11 (school)	Girls 12-14 (gymnastics)	Girls 12-14 (school)	Girls 15-16 (gymnastics)	Girls 15-16 (school)
BMI	15.7±0.55	15.86±0.25	16.50±0.48	16.84±0.26	18.30±0.59	19.30±0.50***
Erisman Index	1.50±1.4	2.50±1.05	3.80±1.02	2.47±0.8	4.82±0.16**	-
Index Livi	37.0±5.5	33.0±3.5	46.0±4.1	32.0±5.0	47.10±5.1***	-
Index Pine	41.0±4.0	37.0±3.5	50.0±3.6	42.0±5.0	53.5±5.7***	-
Vervek Harmony Index	1.4±0.08	1.05±0.05	0.95±0.03	0.98±0.07	0.93±0.06**	-

* Significantly different compared to gymnastic boys (*-P<0.05; **-P<0.01; ***-P<0.001).

One of the key indicators of harmonious development is the Body Mass Index (BMI) relative to age. The average BMI in all groups remained within WHO's standard norms. A decrease in BMI below -1 SD indicates protein-energy malnutrition, with severe cases below -3 SD classified as wasting. Conversely, a BMI increase above +1 SD suggests being overweight, with severe cases above +3 SD categorized as obesity. Individual analysis revealed that 2.1% of girls engaged in school physical

education had signs of mild protein-energy deficiency, whereas among girls involved in sports, this figure was only 0.6%. Overweight prevalence was 1.5% among the school physical education group.

This comparison showed links between age and participation in sports. Before age 11, the physical condition of girls in school gym classes differed considerably from that of girls in specialized sports. For instance, at age 7, girls in rhythmic gymnastics had more weight, but their weight decreased as they advanced in sports. By age 12, these differences became greater, with gymnasts being notably lighter than those in swimming ($p<0.05$) and regular physical education ($p<0.05$). The opposite trend was seen in height changes. From age 12 onwards, the height of girls engaged in sports exceeded that of those in general physical education, with differences becoming statistically significant by age 18 ($p<0.01$). (Table 1.4)

Table 1.4

Comparative Analysis of Anthropometric Indicators Among Study Participants

Indicators	Girls 7-11 (Gymnastics)	Girls 7-11 (School)	Girls 12-14 (Gymnastics)	Girls 12-14 (School)	Girls 15-16 (Gymnastics)	Girls 15-16 (School)
Weight (kg)	24.0±0.44	24.1±0.74	35.7±0.87	32.4±0.95*	45.4±1.1	48.6±1.8
Height (cm)	124.3±0.90	123.7±1.3	145.5±0.9	139.8±1.4*	156.6±1.3	158.5±1.6
Sitting Height (cm)	64.9±0.47	59.8±0.60**	79.1±1.6	76.1±1.8	81.5±0.67	82.0±1.7
WHI	15.3±0.18	15.5±0.25	16.8±0.30	16.4±0.26	18.5±0.42	19.3±0.59
Chest Circumference (cm)	62.2±0.53	61.5±0.42	70.3±0.90	64.2±3.0**	81.5±0.67	82.5±0.86
Inhalation (cm)	64.6±0.54	63.9±0.43	74.0±0.95	69.8±1.1**	88.1±0.75	89.3±1.1
Exhalation (cm)	59.2±0.52	59.0±0.45	66.7±0.89	63.0±1.3**	75.8±0.87	77.3±1.2**
Left Hand Strength (kg)	13.4±0.63	11.8±0.56*	14.6±0.83	12.0±0.67*	16.3±1.1	17.3±1.2**
Right Hand Strength (kg)	14.2±0.75	12.5±0.67*	15.7±0.79	13.5±0.72*	17.9±1.0	19.2±1.3**
Lower Back Strength (kg)	18.3±1.8	15.7±1.4*	22.4±2.1	19.3±1.9*	27.6±2.5	31.3±3.1**
Vital Capacity (ml)	1083±92.8	862.6±177***	1443±107	1186±143**	1946±133	1733.9±178**

*Statistically significant compared to gymnastics values (*P<0.05; **P<0.01; ***P<0.001).

Chest volume (CV) was within normal ranges for all groups. Starting at age 9, girls in rhythmic gymnastics showed significantly lower CV compared to the other groups ($p<0.05$). Until age 15, girls in swimming had higher CV than those in the comparison groups. By age 15, girls in school physical education had a CV of 87.5±4.3 cm, which was 2.8 cm greater than young swimmers ($p<0.05$) and 5.3 cm greater than rhythmic gymnasts ($p<0.01$).

When we consider these sports, both positively influenced girls' growth, however, rhythmic gymnastics seemed to foster the most well-rounded development. Examining anthropometric data for boys, those in swimming showed body mass indicators within the "-1SD – median" and "median and +1SD" ranges across all age groups. (Table 1.5)

Table 1.5

Comparative Analysis of Indicators Among Study Participants

Indicators	Girls 7-11 (Swimming)	Girls 7-11 (School)	Girls 12-14 (Swimming)	Girls 12-14 (School)	Girls 15-16 (Swimming)	Girls 15-16 (School)
Weight	27,1±1,1	24,1±0,74*	46,4±1,0	32,4±0,95***	51,3±0,95	48,6±1,8
Height	129,4±1,8	123,7±1,3*	159,0±1,3	139,8±1,4***	164,5±0,98	158,5±1,6**
Sitting Height	55,6±1,4	59,8±0,60*	53,8±1,7	76,1±1,8***	67,1±2,0	82,5±0,86***
BMI	15,8±0,24	15,5±0,25	18,8±0,35	16,4±0,26***	19,0±0,39	19,3±0,59
Chest Circumference	69,2±0,83	61,5+0,42***	80,9+0,92	64,23+0,89***	87,5±0,97	82,5±0,86**
Inhalation	71,6±0,89	63,9±0,43***	83,7±1,1	67,8±0,91***	90,9±1,1	79,5±1,3***
Exhalation	66,7±0,78	59,9±0,45***	78,1±1,0	62,1±0,87***	84,8±1,2	74,0±1,2***
Left Hand Strength	14,5±0,31	12,9±0,63*	13,7±0,37	13,4±0,53	14,0±0,52	21,3±1,7***
Right Hand Strength	17,9±0,30	14,2±0,68***	17,8±0,35	15,2±0,49***	17,7±0,51	25,1±1,8**
Back Muscle Strength	35,2±0,94	23,1±0,76***	41,5±1,0	29,2±0,69***	38,3±2,0	33,7±1,2*
Vital Capacity of Lungs	1231,0±65,6	862,6±17,7***	2439,2±37,2	1410,4±38,2***	2530,0±46,5	1721,7±49,3***

A slightly different picture is noted in the growth indicators of boys involved in physical education in the school curriculum: the average growth rate of boys participating in sports aged 12 to 16 years is within "from 1 to -2so". Individual analysis showed that growth retardation was observed in 3.2% of cases in a group of boys involved in physical education, and among boys involved in sports, respectively, at 0.2%. (Table 1.6)

Table 1.6

Comparative Analysis of Anthropometric Indicators Among Study Participants

Indicators	Boys 7-11 (Swimming)	Boys 7-11 (School)	Boys 12-14 (Swimming)	Boys 12-14 (School)	Boys 15-16 (Swimming)	Boys 15-16 (School)
Weight	28.6±0.67	25.1±0.86	40.5±0.93	35.4±0.87*	55.9±1.6	45.4±1.1***
Height	130.7±1.1	126.5±0.92*	145.8±1.0	139.1±1.4*	165.3±1.7	158.7±1.6**
Sitting Height	68.9±0.56	65.9±0.52*	76.5±0.87	79.1±1.1*	81.8±0.67	80.3±1.2
WHI	16.0±0.16	15.7±0.42	18.9±0.31*	18.1±0.38	19.5±0.42*	18.5±0.42*
Chest Circumference	66.0±0.71	63.7±0.59*	72.5±0.89	70.8±1.1*	81.5±1.1	79.8±1.4**
Inhalation	69.1±0.78	66.3±0.73*	74.2±0.92	72.1±1.1	85.2±1.3	82.5±1.7*
Exhalation	64.0±0.59	61.9±0.52*	69.8±0.81	67.9±1.0*	78.5±1.1	75.7±1.5*

Left Hand Strength	12.9±0.76	10.9±0.59*	15.0±0.82	13.8±0.89*	19.5±1.1	17.3±1.5*
Right Hand Strength	15.0±0.26	12.9±0.59*	18.2±0.81	16.6±0.42**	21.1±1.4	19.5±1.7*
Back Muscle Strength	30.0±1.73	25.3±0.64*	36.7±2.1*	32.7±1.0*	37.5±1.7	35.9±1.3
Vital Capacity of Lungs	1301.6±29.2	1189.3±38.3***	2024.6±42.3	1765.8±52.9*	2496.3±93.1	1938.7±49.3***

Significant compared to gymnastic data. (- P<0.05; **- P<0.01; ***- P<0.001).

The chest volume (CV) in all groups corresponded to normal values and from 9 years of age was significantly higher in young swimmers (p<0.01).

Additional markers of physical growth also match the findings. For example, protein-energy malnutrition, spanning various levels, was found more frequently in children participating in physical education versus boys involved in sports (only 1.8%). Overweight boys in physical education comprised 2.6%, while no young athletes in sports were overweight. In comparison, sports supported a more balanced physical development in boys.

Analysis also showed that anthropometric measurements varied with the length of sports training. Prior to sports school, boys' and girls' physical development aligned with WHO standards in 78.0% and 84.0% of cases, respectively. In both groups, 4.0% were in the "-1SD and -2SD" range, with a few below -2SD. Meanwhile, 8.0% and 12.0% were in the "+1SD and +2SD" range, some surpassing +2SD.

After three years of training, 12.0% of 6-10 year-old girls had physical development levels within the "-1SD – median" and "median – +1SD" range, a 4.0% increase from before rhythmic gymnastics. In 80.0% of cases, indicators remained normal, while 8.0% were in the low range. Among 11-16 year-old girls, 4.0% showed a high level of physical development, 80.0% were normal, and 16.0% were low.

In this study group, a downward trend in height was observed in 12.0% of girls. Whereas, 4.0% of athletes in the 6-10 age group showed an increase in height. The comparison group mostly exhibited normal physical development both before and after the study (70.0% and 80.0%, respectively), which was 8.0% higher than in the initial primary observation groups. Among 8.0% of girls, measurements were in the 70-87th percentile, which was 8.0% lower than three years earlier, 4.0% lower than the first primary group, and 8.0% higher than the second primary observation group. Girls in rhythmic gymnastics were three times more likely to have above-average physical development compared to their non-sporting peers. Meanwhile, girls not in rhythmic gymnastics were twice as likely to have below-average physical development compared to those who trained.

Prior to sports school, disharmony in physical development affected 34.0% of girls in the first group, 20.0% in the second, and 46.0% in the comparison group, as per outpatient records. The main reasons for this were mild overweight (8.0%, 4.0%, and 20.0%, respectively, p<0.05) or underweight (8.0%, 12.0%, and 0, respectively, p<0.05).

Following three years of consistent sports training, neither the first nor the second group of girls exhibited any cases of overweight. Instead, they saw a higher incidence of moderate underweight (12.0% and 16.0%). Conversely, girls in the comparison group showed a higher prevalence of overweight (24.0%) compared to underweight (4.0%, p<0.05).

IV. CONCLUSION

Research on growth, using both snapshots in time and tracking over time, showed that the control group of children aged 11-16 grew 18.5 cm. The first group grew 12.0 cm, and the second group grew 16.0 cm. The most significant height gain occurred in the 11-16 age range, particularly during puberty, when girls typically have growth spurts. However, since physical activity in this sport may restrict height gain, girls not involved in sports tended to be taller than those who were.

Controlled physical activity affects physical development. Gymnasts displayed a more balanced development compared to their non-athletic counterparts, who frequently showed imbalances, most notably excessive body weight.

In conclusion, based on the data on physical development, participating in sports supports the balanced growth and development of children of all ages and genders. Nevertheless, the proper nutrition for young athletes requires close attention, given observations of protein-energy deficits and excessive weight. Proper nutrition is essential in the health aspects of youth sports training.

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