

Hygienic Assessment of the Development of Secondary Sexual Characteristics of Boys, Aged 10-17

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Abstract In this article, boys aged 10 to 17 years old who were involved in martial arts (main group) and not involved in sports (control group) were examined in the Tashkent Youth Sports School; a total of 1901 children were examined. The level of puberty and development of secondary sexual characteristics of these boys was assessed. When comparing boys of the main and control groups, it was found that the development index of the first secondary signs corresponded to 9 years 9 months in the main group and 9 years 11 months in the control group.

Keywords Sport, Teenage boys, Sexual development, Secondary sexual characteristics

1. Introduction

Sexual development is the process of maturation of the hypothalamic-pituitary-gonadal system (HPGS), characterized by the appearance of secondary sexual characteristics and the production of mature germ cells, as well as the formation of physical, functional and psychological processes in the child's body. Currently, puberty for children of the European population in 95% of cases occurs in the age range from 8 to 13 years in girls and from 9 to 14 years in boys.

Puberty is considered very important in the physiological, psychological, moral and social development of a person, and it is during this period that the formation of all morphological and functional structures of the body is completed. One of the tasks of preventive medicine is to identify early deviations in the growth and development of children with different levels of motor activity (Hassan et al., 2023; Kamilova R.T., Tillaeva S.O., 2021). Pubertal development is considered an important time interval in a person's life and secondary sexual characteristics are assessed (Hassan, 2019; Baytrak O.A., Meshcheryakov V.V., Girsh Y.V., 2021). The physical and sexual development of children is subject to fluctuations depending on social, environmental, geographical, climatic and many other factors, as well as on the level of urbanization [Hassan, 2020; Berezin I.I., Gavryushin M.Yu., 2014; Ramadan et al., 2020].

Physical activity is a powerful activator for the endocrine and cardiovascular systems of a growing organism, stimulating growth and puberty, and promoting metabolic processes (Hassan et al., 2019; Kalyuzhny E.A. 2015; Arafaa et al., 2018). Under normal conditions, physical development and puberty

always proceed in parallel and are interconnected. Puberty begins with the appearance of so-called secondary sexual characteristics: pigmentation of the external genitalia, pubic and axillary hair growth, etc. At the same time, girls enter puberty approximately 2 years earlier than boys and subsequently mature faster too (<https://studfile.net/preview/2997267/page:4/>).

Considering the above, we set ourselves the goal of studying the sexual development of teenage boys.

2. Material and Methods

The study included children and adolescents belonging to the Uzbek and Russian mentality, aged from 10 to 17 years. The research was conducted by athletes (main group) engaged in individual wrestling in 11 children and youth sports schools (youth sports schools) located in 10 districts of Tashkent (Bektemir, Yashnabad, Yakkasaray, Yunusabad, Mirzo Ulugbek, Almazar, Shaykhontakhtur, Mirabad and Chilanazar) and carried out among children (control group) studying in 5 secondary schools (GS) (122, 218, 294, 205, 195), located in 4 districts (Chilanazar, Mirabad, Yunusabad, Mirzo-Ulugbek). A total of 1965 boys were enrolled (of which 982 were the main group, 983 were the control group).

Study of secondary sexual characteristics of the Tanner scale using somatometry and somatoscopy. To measure the sexual development of adolescent children, we assessed the Tanner scale. Determined by sex formula indicators: for boys P, Ax, V, La, Fa. This indicator means P - development of pubic hair; Ah - development of hair in the armpit; V - degree of voice mutation; La - development of the Adam's apple; Fa - development of facial hair. Additional questions included the rate of growth of the testicles (scrotum), the growth of the mammary gland and visible changes in the

scrotum were assessed using palpation methods, the dimensions of the penis (diameter and length) were measured using a zero cm ruler and calipers. We noted wet dreams using survey methods. For research a unified questionnaire on sexual development was developed, based on the Tanner scale indicators.

The developed questionnaires were approved by the Scientific Council of the Research Institute of Sanitation, Hygiene and Occupational Diseases of the Ministry of Health of the Republic of Uzbekistan by protocol No. 2 of February 23, 2021. Children and adolescents from the study and control groups of each respondent were ensured confidentiality and were selected on the basis of voluntary consent.

The obtained data were subjected to statistical analysis using Microsoft Excel 2016. The survey data were processed using the variation-statistical method with the calculation of arithmetic means (M), standard deviations ($\pm d$), and average errors ($\pm m$). Differences in arithmetic means were considered significant at ($p \leq 0.05$).

3. Results

Survey data show that in the main group, isolated cases of the appearance of secondary sexual characteristics in boys, observed from 9 years 9 months of age, expressed in the appearance of hair on the pubis (P_1 -6.9%) and in the armpits (Ax_1 -2.6%), a change in voice timbre is noted (V_1 -3.5%),

an increase in thyroid cartilage (La_1 -6.9%), as well as the appearance of single facial hair (Fa_1 -6.0%), is shown in Table 1. At 16–17 years old, many boys have mature secondary sexual genitalia signs. Thus, at the age of 16-17 years, pubic hair growth P3 degree 68% and P4 degree was noted in 20% of boys, Ax hair growth 2 and 3 degrees in the axillary region - in 79%. At the same age, the initial stages of development of hair on the pubis were $P1$ -3.5%, and in the axillary region $Ax1$ - 18.5% of boys.

The same indicators were measured in control groups, as a result of which it was revealed that isolated cases of the appearance of secondary sexual characteristics in boys are observed from 9 years to 11 months of age. The appearance of hair on the pubis (P_1 - 4.3%) and in the armpits (Ax_1 - 0.9%), the appearance of single facial hair (Fa_1 - 17.2%), voice timbre (V_1 - 3.5%), is reflected in Table 2. The same indicators in 15-16-17 year old boys of the appearance of secondary sexual characteristics are much more pronounced. So, in this case, 15-year-old boys $P3$ –77.5%, 16-year-old adolescents $P3$ –87.5%, and 17-year-olds $P3$ –89.2% had 3 stages of hair growth on the pubis and in the armpits of boys from 15 to 17 years old were marked with $Ax2$ -79.34%, and $Ax3$ was noted in 17.2%. High levels of thyroid cartilage of the larynx were found in 14-year-old boys in secondary schools - 65.0%. Stage 1 facial hair was found in 10-year-old boys: $Fa1$ –17.2% and $Fa1$ –76.7% in 13-year-old boys, as well as $Fa2$ –52.7% in 17-year-old boys. The first change in voice timbre was determined in 11 year olds $V1$ –1.7%.

Table 1. Depending on the appearance of secondary signs of sexual development, in % of the number of examined male athletes

Degree of puberty		Age, years							
		10	eleven	12	13	14	15	16	17
		Number of children, persons							
		116	121	122	123	120	112	118	115
P	0	93.1	89.3	71.3	44.7	20.0	8.0	0	0
	1	4.3	9.9	23.0	30.1	27.0	15.0	4.0	3.0
	2	2.6	0.8	5.7	17.9	35.0	40.0	23.0	15.0
	3	0	0	0	6.5	18.0	34.0	68.0	68.0
	4	0	0	0	0.8	0	3.0	5.0	14.0
Ax	0	97.4	97.5	86.1	67.5	38.0	13.0	5.0	0
	1	1.7	1.7	13.9	26.0	39.0	47.0	20.0	17.0
	2	0.9	0	0	6.5	23.0	38.0	67.0	57.0
	3	0	0.8	0	0	1.0	3.0	8.0	26.0
V	0	96.6	95.9	90.2	75.6	41.0	14.0	3.0	0
	1	2.6	4.1	9.8	22.8	47.0	54.0	36.0	21.0
	2	0.9	0	0	1.6	13.0	32.0	62.0	79.0
La	0	93.1	93.4	72.1	54.5	21.0	13.0	3.0	2.0
	1	6.0	5.8	27.9	40.7	56.0	47.0	27.0	13.0
	2	0.9	0.8	0	4.9	23.0	40.0	70.0	85.0
Fa	0	94.0	93.4	82.8	61.8	36.0	18.0	7.0	6.0
	1	6.0	5.8	17.2	35.0	57.0	65.0	41.0	29.0
	2	0	0	0	3.3	8.0	17.0	52.0	55.0
	3	0	0.8	0	0	0	0	1.0	10.0

Table 2. Appearance of secondary signs of sexual development in examined boys (control group)

Degree of puberty		Age, years							
		10	eleven	12	13	14	15	16	17
		Number of children, persons							
		116	118	120	120	120	120	120	120
P	0	95.7	70.3	47.5	20.8	10.0	1.7	0	0
	1	4.3	29.7	41.7	36.7	20.0	4.2	0.8	0
	2	0	0	9.2	26.7	28.3	13.3	6.7	3.3
	3	0	0	1.7	15.8	40.0	77.5	87.5	89.2
	4	0	0	0	0	1.7	3.3	5.0	7.5
Ax	0	99.1	99.2	80.8	44.2	23.3	2.5	0	0
	1	0.9	0.8	19.2	47.5	51.7	34.2	6.7	2.5
	2	0	0	0	8.3	25.0	63.3	90.8	83.3
	3	0	0	0	0	0	0	3.0	14.2
V	0	100	98.3	84.2	48.3	19.2	0.8	0	0
	1	0	1.7	15.8	45.0	58.3	38.3	5.8	5.0
	2	0	0	0	6.7	22.5	60.8	94.2	95.0
La	0	100	99.2	82.5	44.2	19.2	0.8	0	0
	1	0	0.8	17.5	51.7	65.0	54.2	19.2	9.2
	2	0	0	0	4.2	15.8	45.0	80.8	90.8
Fa	0	82.8	72.0	45.8	16.7	9.2	2.5	0	0
	1	17.2	28.0	51.7	76.7	72.5	65.8	52.5	27.5
	2	0	0	2.5	6.7	17.5	30.8	46.7	56.7
	3	0	0	0	0	0.8	0.8	0.8	15.8

Table 3. Distribution of athletes depending on the rate of growth of the testicles and changes in the scrotum, (in% of the number of those examined)

Age, years	n	Sign of puberty (main group)			
		testicular growth rate		visible changes in the scrotum	
		no growth or slight growth	noticeable growth		
				+	-
10	116	85.7	4.3	7.8	92.2
eleven	121	88.4	11.6	9.1	90.9
12	122	67.3	33.7	11.5	88.5
13	123	58.5	41.5	8.1	91.9
14	120	45	54	eleven	89
15	112	39	61	eleven	89
16	118	25	75	7	93
17	115	25	75	10	90
Age, years	n	Sign of puberty (control group)			
		testicular growth rate		visible changes in the scrotum	
		no growth or slight growth	noticeable growth		
				+	-
10	116	95.0	5.0	8.6	91.4
11	118	90.0	10.0	4.2	95.8
12	120	88.3	11.7	8.3	91.7
13	120	72.5	27.5	1.7	98.3
14	120	59.2	40.8	14.2	85.8
15	120	37.5	62.5	10.8	89.2
16	120	36.7	63.3	9.2	90.8
17	120	25.0	75.0	6.7	93.3

An assessment of testicular enlargement is considered the first indicator of changes in hormonal status in the body of teenage boys. It was revealed that 11.6% of athlete 11-year-old boys had noticeable testicular growth, 75% of 16-17-year-old boys had noticeable growth, but 25% had slight testicular growth, but testicular development was observed in 10-year-old children in the control group was 1.6% less than that of the main group, and among 16-year-olds - 11.7% less, 3 tables are reflected.

Measurements of the length and diameter of the penis showed that out of 9 age groups, in the main groups, the boys' penis length grew by 4.4 cm, and in the control group - by 4 cm. The diameters of the penis in the main groups showed an average increase of 0.2 cm in each age group, but among boys who are not involved in sports, the 12-15 - year age period saw the most noticeable increase in the length (by 2.9 cm) and diameter (by 0.9 cm) of the penis, while in the period from 10 up to 12 years, the length increased by only 0.8 cm, and the diameter - by 0.2 cm, as shown in Table 4.

The result of a study on indicators of wet dreams and pubertal growth of the mammary gland showed that in the control groups of 15 to 17 year old boys, about 97% experience irregular emissions, and 2.2% regularly. At the age of 10, an increase and pigmentation of the areola were observed, and the maximum degree of gynecomastia appeared in the main group at 11, 13, 17 years old, and in the control group at 13-14 years old. In boys in the main and control groups, during a 10-year period, wet dreams appeared in 5.2%

and 2.6% of cases; the number of cases increased with age. At the age of 17, the number of boys in both groups with wet dreams increased to 61.7 and 96.7%, respectively, with 34.8% in the main group and 34.8% in the control group. group, 1.7% of young men had regular emissions. The highest rates of gynecomastia were noted among the control groups of 13 and 14 year old boys, presented in Table 5.

Cryptorchidism is one of the most common diseases in children, the frequency of unilateral cryptorchidism is 1: 150-200 boys, bilateral - 1:600 (Shkityr Z.V., 2012; Zakaria M., Azab S., El baz M., Fawaz L., Bahagat A., 2013).

It was found that children who studied for 1-3 years and 4 years or more had almost the same rate ($P > 0.05$) for changes in varicocele and cryptorchidism. When comparing the level of development of the mammary glands, it was found that the number of children studying for 4 or more years is higher ($0.8 \pm 1.09\%$) than children studying for 1-3 years. It has been shown that the growth rate of testicles in boys who have been training for 4 years or more is almost 1.7 times higher, and in terms of pollutants it is 5.6 times higher than in children who have been training for up to 3 years.

It was found that martial arts and high training loads have an effect on slowing down the rate of testicular growth ($P < 0.05-0.001$) and may have an effect on wet dreams ($P < 0.05-0.001$). The remaining indicators did not give reliable values, as shown in Table 6.

Each child was given referrals for clinical and highly specialized examinations regarding the identified abnormalities.

Table 4. Average quantities dimensional signs sexual member boys dependencies from their age, cm

Age, years	n	Dimensions sexual member (main group)					
		Length			Diameter		
		M	$\pm m$	$\pm \delta$	M	$\pm m$	$\pm \delta$
10	116	3.5	0.09	0.96	1.6	0.03	0.30
11	121	3.6	0.10	1.11	1.7	0.03	0.36
12	122	3.9	0.14	1.54	1.8	0.04	0.48
13	123	5.0	0.17	1.84	2.1	0.05	0.55
14	120	5.9	0.17	1.83	2.4	0.05	0.52
15	112	6.8	0.16	1.72	2.7	0.05	0.57
16	118	7.6	0.12	1.30	2.9	0.07	0.77
17	115	7.9	0.13	1.40	2.9	0.04	0.42
Age, years	n	Dimensions sexual member (control group)					
		Length			Diameter		
		M	$\pm m$	$\pm \delta$	M	$\pm m$	$\pm \delta$
10	116	4.0	0.07	0.80	1.7	0.03	0.30
11	118	4.2	0.08	0.89	1.7	0.03	0.31
12	120	4.8	0.12	1.35	1.9	0.04	0.46
13	120	6.2	0.17	1.77	2.3	0.04	0.48
14	120	6.9	0.14	1.58	2.6	0.05	0.52
15	120	7.7	0.11	1.23	2.8	0.03	0.36
16	120	7.7	0.11	1.23	2.8	0.03	0.35
17	120	8.0	0.13	1.41	2.9	0.05	0.58

Table 5. Grade availability gynecomastia And wet dreams, %

Sign of puberty (main group)						
Age years	n	Height dairy glands		Pollutions		
		No increase	gynecomastia	are missing	Not regular	regular
10	116	97.4	2.6	94.8	5.2	-
11	121	92.6	7.4	97.5	1.7	0.8
12	122	95.9	4.1	87.7	12.3	-
13	123	92.7	7.3	56.1	42.3	1.6
14	120	95.0	5.0	22.5	75.0	2.5
15	112	97.3	2.7	6.3	81.3	12.5
16	118	95.8	4.2	5.1	78.8	16.1
17	115	93.0	7.0	3.5	61.7	34.8
Sign of puberty (control group)						
Age, years	n	Height dairy glands		Pollutions		
		No increase	gynekomastia	Absent	Not regular	regular
10	116	96.6	3.4	97.4	2.6	-
11	118	97.5	2.5	96.6	3.4	-
12	120	95.8	4.2	76.7	23.3	-
13	120	93.3	6.7	40	60	-
14	120	93.3	6.7	16.7	82.5	0.8
15	120	96.7	3.3	3.3	95.8	0.8
16	120	97.5	2.5	1.7	95.8	2.5
17	120	95.8	4.2	1.7	96.7	1.7

Table 6. The influence of the duration of classes and training sessions in children on sexual development, %

Visible changes in the scrotum, %					
Indicators	1-3 years	4 year and more	m1	m2	p
norm	90.6	90, 3	1.69	1.16	nd
changes (varicocele, cryptorchism)	9.4	9, 3	1.69	1.14	nd
Breast growth, %					
Indicators	1-3 years	4 year and more	m1	m2	p
no magnification	9 5	94.45	1.27	0.90	nd
gynecomastia	5.03	5, 83	1.27	0.90	nd
Testicular growth rate					
Indicators	1-3 years	4 year and more	m1	m2	p
no growth	10.40	5.55	1.77	0.90	0.05
slight increase	59.40	44.38	2.84	1.95	0.001
noticeable growth	30.20	50.08	2.66	1.96	0.001
Pollutions, %					
Indicators	1-3 years	4 year and more	m1	m2	p
none	63.09	40.06	2.80	1.92	0.001
irregular	34.90	48.69	2.76	1.96	0.001
regular	2.01	11.25	0.81	1.24	0.001

4. Discussions

St. Petersburg olimlari tomonidan olib borilgan tadqiqot ishiga kura, Armpit hair growth begins later; at the age of 12 years, 33% of the examined schoolchildren had axillarche of the 1st and 2nd degrees (V.L. Gritsinskaya, S.M. Mamedova,

I.L. Nikitina, 2018). According to the results of our research, hair growth in the armpits begins in athletes at the age of 10 - 1.7%, in schoolchildren at the same age - 0.9%.

At 14 years of age, 18.7% of boys had 0 degree of severity of secondary sexual characteristics; at 15 years of age, boys with 0 degree of severity of secondary sexual characteristics

were absent, while 68.7% had degree III of severity of hair in the armpits, and 58 on the pubis..8% of surveyed young men (Kuchma, V.R., Skoblina, N.A., Bokareva, N.A., Milushkina O.Yu., 2012). The result of our study showed that 14-year-old boys of the main group had 31.2% 0 level of development of secondary sexual characteristics, 16.2% of children in the control group and 13.2% of 15-year-old boys in the main group had a development level of 0 degree, in children of the control group - 2%. At the same age in both groups, 4.0 % had degree III hair in the armpits, and 42.4% of the examined adolescent boys had hair on the pubis.

A study conducted among Chelyabinsk adolescents showed that, from time to time, the maximum expression of secondary sexual characteristics (SCH) is characteristic of boys aged from 13 to 16 years (*Uzunova A.N., Lopatina D.A. et al., 2014*). According to the results of our study, the highest level of development of secondary sexual characteristics in boys was at the age of 12-15 years.

5. Conclusions

Thus, we can conclude that it has been established that the appearance of secondary sexual characteristics in boys, observed from 9 years 9 months of age.

Thus, in the change in voice timbre V_{1-2} -3.5% - 10 year old boys in the main groups, V_1 -1.7% in the control groups, increase in thyroid cartilage in 11 year old children of the main group La_{1-2} in 8, 3 times higher than in children of the control group, and also, the appearance of single facial hair Fa_1 among 10 year old boys of both groups was found to be 2.9 times higher in the control group.

Testicular development in 10-year-old children in the control group was 1.6% less than in the main group. 9 age groups in the main groups of boys, the length of the penis increased by 4.4 ± 0.14 cm, and in the control group - by 4 ± 0.12 cm.

It was found that in the children of the main group the level of regular emissions was 20.5 times higher than in the children of the control group. It was found that martial arts and high training loads have an effect on slowing down the rate of testicular growth ($P < 0.05-0.001$) and may have an effect on wet dreams ($P < 0.05-0.001$).

In order to correctly distribute the load during sports training, it is recommended to strictly observe the age and physical condition of each child, as well as the duration of training.

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