

## Parameters of Physical and Sexual Development at the Onset of Puberty in Boys Living in an Iodine-Deficient Region

**KG Kamalov\* and ZV Kurbanova**

*FSBEI HE "Dagestan State Medical University" of the Ministry of Health of Russia, Russia*

**\*Corresponding Author:** KG Kamalov, FSBEI HE "Dagestan State Medical University" of the Ministry of Health of Russia, Russia.

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### Abstract

**Aim:** Assessment of the degree of chronic iodine deficiency in the mountainous regions of the Republic of Dagestan in a population of boys of prepubertal age and its influence on the degree of physical and sexual development in the debut of puberty.

**Patients and Methods:** Three groups of boys aged 11 years were examined: the 1<sup>st</sup> group - residents of the mountainous district of the Republic of Dagestan. receiving prophylactic subsidies for iodine preparations (65 people); The 2<sup>nd</sup> group - residents of the mountainous district of the Republic of Dagestan who did not receive prophylactic subsidies for iodine preparations (53 people) and the 3<sup>rd</sup> group (control) - boys living in a relatively prosperous iodine region - 160 people.

**Results:** The growth rate in groups 1.2 and 3 was  $145.5 \pm 0.7$  cm.  $138.5 \pm 0.5$  cm and  $143.0 \pm 0.3$  cm, respectively. Reaching significant differences between the 1<sup>st</sup> and 2<sup>nd</sup>, as well as the 2<sup>nd</sup> and 3<sup>rd</sup> groups ( $p < 0.001$ ) and not different between the 1<sup>st</sup> and 3<sup>rd</sup> groups. By bodyweight, no significant differences were found between the 1<sup>st</sup> and 2<sup>nd</sup> groups. The frequency of endemic goiter in boys in the 2<sup>nd</sup> group was 62.5%, while in the 1<sup>st</sup> group it was 50% ( $p < 0.05$ ), and in the control group - 12.1%, which also significantly differs from the 1<sup>st</sup> and 2<sup>nd</sup> groups of the examined ( $p < 0.03$ ). The degree of development of the genitals did not significantly differ in boys of the 1<sup>st</sup> and 2<sup>nd</sup> groups ( $2.0 \pm 0.1$  and  $1.4 \pm 0.06$ , respectively,  $p = 0.5$ ). The length of the penis in boys of the 1<sup>st</sup> group was  $4.6 \pm 0.1$  cm, and of the 2<sup>nd</sup> group -  $3.2 \pm 0.2$  cm ( $p < 0.006$ ). The testicular volume in boys of the 1<sup>st</sup> and 2<sup>nd</sup> groups did not differ significantly ( $p = 0.506$ ). The degree of pubic hair growth was more pronounced in boys of the 1<sup>st</sup> group compared with the 2<sup>nd</sup> group ( $p < 0.05$ ). The level of total testosterone in boys of the 1<sup>st</sup> group was  $2.8 \pm 0.1$  ng/ml, in boys of the 2<sup>nd</sup> group -  $1.4 \pm 0.2$  ng/ml (the differences were significant,  $p < 0.01$ ).

**Conclusion:** In general, indicators characterizing physical and sexual development were comparable in boys who received preventive measures of iodine prophylaxis and in boys from an iodine-safe region, at the same time they differed from the group who did not receive iodine prophylaxis.

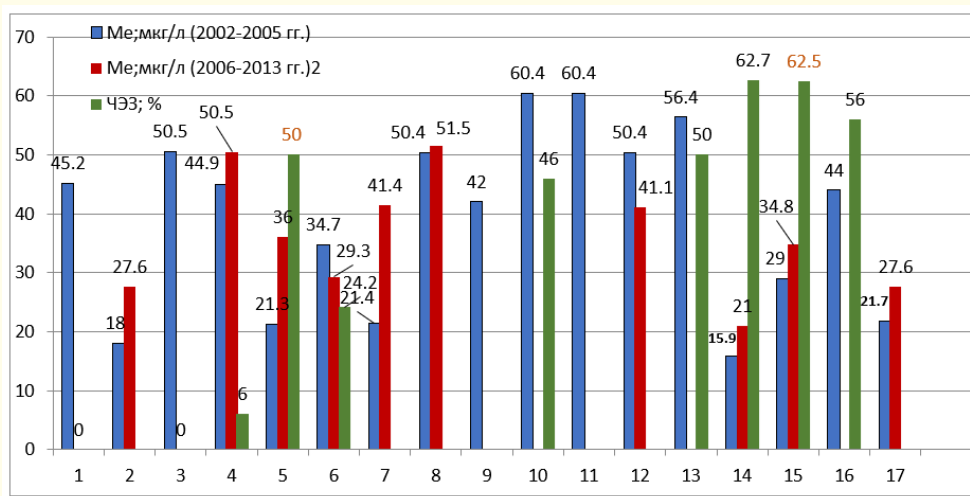
**Keywords:** *Iodine Deficiency; Boys Onset of Puberty; Prevention; Sexual Development*

### Introduction

Puberty is one of the important periods of a person's life, the pathological course of puberty can have a negative effect on the formation of the neuro-hormonal component of the copulative cycle of a future man and even reduce its reproductive potential in the future [1]. Chronic iodine deficiency is one of the unfavorable exogenous factors that affect both the mental development of the child and the further development and course of the puberty period [2-9].

**Objective and Methodology**

To assess the degree of chronic iodine deficiency in the mountainous regions of the Republic of Dagestan in a population of prepubertal boys and its effect on the degree of physical and sexual development in the debut of puberty. The study was conducted in RD, which is one of the iodine deficiency zones of the Russian Federation. The Republic of Dagestan is the southernmost region of Russia, a region of natural iodine deficiency. Oscillations of ioduria are quite variable, as shown by studies, in cities the frequency of endemic goiter was 21.7% and the median of ioduria was 46.8 µg/l [14]. In the coastal regions of the republic, the frequency of endemic goiter is 19.6%, and the median of ioduria is 56.2 µg/l. In rural areas on a flat ecological and geographical area, the frequency of endemic goiter was 28.1%, and the median of ioduria was 49.6 µg/l; in the piedmont ecological-geographical zone, the frequency of endemic goiter is 28.2%, and ioduria is 49.1 µg/l; in the mountain ecogeographic zone, the frequency of endemic goiter was 37.1%, and ioduria - 40.1 µg/L. As can be seen, in the general population of both boys and girls of pre-pubertal and puberty age, the median of ioduria was in the range of moderate iodine deficiency, and the frequency of goiter was of moderate severity. The specifics of the region - the Republic of Dagestan is that there are three ecological and geographical zones in the republic: mountain, piedmont and plain, which are characterized by different degrees of iodine deficiency and different frequency of endemic goiter.



**Figure 1:** Indicators of the median ioduria (Me; mcg/l) (blue - 2002-2005, red - 2006-2013) and the frequency of endemic goiter (%) (green - 2002-2013) in the mountain ecology and geographic area of the Republic of Dagestan (n = 1873).

№	Area	2002 - 2005	2006 - 2013
	Akušinskiy	Me = 45.2 µg/L	
	Ahvahskiy	Me = 18.0 µg/L	Me = 27.6 µg/L
	Agulskiy	Me = 50.5 µg/L	
	Botlihskiy	Me = 44.9 µg/L	Me = 50.5 µg/L
	Gergebelskiy	Me = 21.3 µg/L	Me = 36.0 µg/L
	policies	Me = 34.7 µg/L	Me = 29.3 µg/L
	Gunibskiy	Me = 21.4 µg/L	Me = 41.4 µg/L
	Levaşinskiy	Me = 50.4 µg/L	Me = 51.5 µg/L
	Şamilskiy	Me = 42.0 µg/L	
	Untsukulskiy	Me = 60.4 µg/L	
	Tsuntinskiy	Me = 60.4 µg/L	
	Çarodinskiy	Me = 50.4 µg/L	Me = 41.1 µg/L
	Dahadevskiy	Me = 56.4 µg/L	
	Kulinsky	Me = 15.8 µg/L	Me = 21.0 µg/L
	Kurahskiy	Me = 29.0 µg/L	Me = 34.8 µg/L
	Ahtinskiy	Me = 44.0 µg/L	
	Lakskiy	Me = 21.7 µg/L	Me = 27.6 µg/L

Table 1

Three groups of boys in the period of puberty (at the age of 11 years) were examined. The first and second groups are formed from residents of the mountainous regions of the Republic of Dagestan, belonging to iodine-deficiency zones. As can be seen from figure 1, the median iodine indices of the Gergebilsky district were 21.3 µg/L, and the frequency of ES was 50%. The median iodine of the Kurakhsky region was 29.0 µg/L, and the frequency of erectile dysfunction was 62.5%. Adolescents in the 1st group (65 boys from the Gergebilsky district) received iodine preparations during the prepubertal period for 2 - 3 years. The second group consisted of 53 boys from the Kurakhsky district who did not receive systemic iodine prophylaxis. The third, control, group (160 boys) was formed from residents of the relatively prosperous iodine towns of Kislovodsk and Zheleznovodsk. The average age of the boys in the 1<sup>st</sup> group was 11.8 ± 0.1 years, in the 2<sup>nd</sup> group - 11.6 ± 0.1 years, in the 3<sup>rd</sup> group - 11.3 ± 0.1 years. The median of ioduria in the 1<sup>st</sup> and 2<sup>nd</sup> groups was 21.3 (severe iodine deficiency) and 35.8 µg/L (moderate iodine deficiency), respectively. In the 3<sup>rd</sup> group, this indicator was 84.7 (the city of Kislovodsk) and 102.6 µg/l (the city of Zheleznovodsk) [10]. Parents of adolescents were informed about the goals and objectives of this survey.

In all three groups, anthropometric indicators (height, body weight, body mass index) were evaluated in accordance with age standards adopted in Russia [11]. Sexual development was assessed on the Marshall-Tanner scale [12]. The level of total testosterone was determined by radioimmunoassay using standard RIA test kits from Immunotech, Czech Republic. The degree of iodine deficiency was determined in areas with an allocation of clusters of children and adolescents of pre-adolescent age, with the determination of the median ioduria in the clusters examined. Directly, the degree of ioduria was carried out by the cesium-arsenite method with wet preliminary ashing of urine [13]. For the statistical analysis of the obtained data, the application M3 Exce1-2000 was used. The mean values (M), standard error of the mean (t), and median (Me) were calculated. The significance of differences in the parameters of the comparison groups was determined by the student's criterion.

## Results of the Study

Indicators of physical and sexual development of boys are presented in table 2 and 3.

Groups	Height, cm	Body weight	IMT	Goiter frequency %
1 <sup>st</sup> (n = 65)	145,5 ± 0,7	36,8 ± 0,8	17,3 ± 0,3	50,0
2 <sup>nd</sup> (n = 53)	138,5 ± 0,5	36,0 ± 0,3	17,4 ± 0,1	62,5
3 <sup>rd</sup> (n = 160)	143,0 ± 0,3	31,5 ± 0,1	16,9 ± 0,7	12,7
	p I-II < 0,001	p I-II = 0,802	p I-II = 0,703	I-II (< 0,05)
	p I-III = 0,601	p I-III < 0,002	p I-III < 0,002	I-III (< 0,003)
	p II-III < 0,006	p II-III < 0,005	p II-III < 0,001	II-III (< 0,001)

**Table 2:** Indicators of physical development of boys in the debut of puberty.

Group	G	P (body hair pubic area)	Penis length, cm	Testicular volume, ml	The level of total testosterone, ng/ml
1 <sup>st</sup> (n = 65)	2,0 ± 0,1	1,3 ± 0,1	4,6 ± 0,1	3,8 ± 0,1	2,8 ± 0,1
2 <sup>nd</sup> (n = 53)	1,6 ± 0,1	1,1 ± 0,1	3,2 ± 0,3	3,65 ± 0,3	1,4 ± 0,2
3 <sup>rd</sup> (n = 160)	1,9 ± 0,06	1,5 ± 0,05	4,3 ± 0,1	3,0 ± 0,1	2,0 ± 0,2
	p I-II < 0,01	p I-II < 0,05	p I-II < 0,001	p I-II < 0,506	p I-II < 0,001
	p I-III = 0,5	p I-III = 0,06	p I-III = 0,511	p I-III = 0,05	p I-III = 0,101
	p II-III < 0,05	p II-III < 0,02	p II-III = 0,702	p II-III < 0,05	p II-III = 0,503

**Table 3:** Indicators of sexual development of boys in the debut of puberty.

Growth rates significantly differed between the 1<sup>st</sup> and 2<sup>nd</sup> groups:  $145.5 \pm 0.7$  and  $138.5 \pm 0.5$  cm, respectively ( $p < 0.001$ ). In boys living in the territory with relative iodine-filling and their peers who underwent iodine prophylaxis, the growth rates were close to each other:  $143.0 \pm 0.3$  cm and  $145.5 \pm 0.7$  cm ( $p = 0.601$ ). Bodyweight did not differ in groups 1 and 2. The frequency of endemic goiter in boys in the 2<sup>nd</sup> group who did not undergo iodine prophylaxis was 62.5%, while in the 1<sup>st</sup> group, with iodine prophylaxis, it was significantly lower than 50% ( $p < 0.05$ ). In the iodine-rich area, the frequency of endemic goiter was 12.1%, which also significantly differs from the 1<sup>st</sup> and 2<sup>nd</sup> groups of the examined ( $p < 0.03$ ).

As can be seen from the data table 3, indicators of the degree of development of genitalia (G) did not significantly differ in boys.

1<sup>st</sup> and 3<sup>rd</sup> groups -  $2.0 \pm 0.1$  and  $1.4 \pm 0.06$ , respectively ( $p = 0.5$ ). This indicator correlated with the length of the penis and the volume of the testicles. So, the length of the penis in boys of the 1<sup>st</sup> group was  $4.6 \pm 0.1$  cm, and of the 2<sup>nd</sup> group -  $3.2 \pm 0.2$  cm ( $p < 0.006$ ). On this basis, there was no statistically significant difference between the 1<sup>st</sup> and 3<sup>rd</sup> groups of the examined ( $p = 0.511$ ). The testicular volume in boys of the 1<sup>st</sup> and 2<sup>nd</sup> groups did not differ significantly ( $p = 0.506$ ), however, the differences in the 1<sup>st</sup> and 3<sup>rd</sup> groups of the examined were significant ( $p < 0.05$ ). The degree of pubic hair growth was more pronounced in boys of the 1<sup>st</sup> group compared with the 2<sup>nd</sup> group ( $p < 0.05$ ). The level of total testosterone in boys of the 1<sup>st</sup> group was  $2.8 \pm 0.1$  ng/ml, in boys of the 2<sup>nd</sup> group -  $1.4 \pm 0.2$  ng/ml (the differences were significant,  $p < 0.01$ ).

Previous studies have shown that RD, in accordance with the criteria assessing the severity of iodine deficiency (ICCIDD), refers to a region with moderate iodine deficiency [14]. In 29% of the regions of the mountain ecological and geographical zone, iodine deficiency was severe, and in the rest it was moderate. The frequency of endemic goiter was close to the general population of children in the Republic of Dagestan - 54.2%. Moreover, severe iodine deficiency does not always correlate with the frequency of the detection of endemic goiter. So, in the territory of severe iodine deficiency (Gergebel district), the median of ioduria was  $21.3 \mu\text{g/l}$ , and the frequency of endemic goiter was 50%. On the territory of moderate iodine deficiency (median ioduria -  $35.8 \mu\text{g/l}$ ), the frequency of endemic goiter was 62.5%. Regular and long-term prophylaxis of chronic iodine deficiency with iodine preparations, begun in the prepubertal period (7 - 8 years), as shown by our studies, improves not only the physical but also the sexual development of adolescents in the debut of puberty. This is consistent with the data of some researchers who believe that adequate thyroid function during puberty provides mainly anabolic action, or growth effect [15-17]. This information is generally close to the results of this study. Thus, growth indicators in boys who received iodine prophylaxis were statistically significantly higher than in their peers who did not receive it. It should be noted that a re-determination of ioduria in the 1<sup>st</sup> group of boys after a number of years of preventive measures, according to the Republican Endocrinology Center, showed an increase in the degree of ioduria to  $36.0 \mu\text{g/l}$  ( $p < 0.05$ ).

There are rather conflicting opinions regarding the effect of chronic iodine deficiency and thyroid function on the reproductive function of the body. So, some authors believe that iodine deficiency has a greater effect on female reproductive function [16]. Others believe that one of the causes of impaired reproductive function in the male body and delayed puberty may be thyroid pathology in puberty [18,19]. Our results show that boys who received regular iodine prophylaxis developed better not only physically, but also sexually. These changes correlated with an increase in total testosterone.

## Discussion

1. Chronic iodine deficiency in the Republic of Dagestan is characterized more often by moderate or moderately severe indicators of the frequency of endemic goiter and median ioduria, especially in the mountainous and foothill ecological and geographical zones of the Republic of Dagestan.

2. Timely measures are taken to prevent iodine deficiency in the pre-pubertal period lead to an improvement not only in physical development indicators but also improve signs of puberty starts in the population of boys of the Republic of Dagestan.
3. Levels of total testosterone are better demonstrated by boys who received iodine prophylaxis than boys who did not receive iodine prophylaxis.

### Conclusion

Thus, in areas of moderate or moderate to severe iodine deficiency, which includes the Kurakhsky and Gergebilsky districts of the Republic of Dagestan, carried out long-term and systematic preventive measures for iodine deficiency, lead to an improvement not only in anthropometric indicators but also improve the signs of the onset of sexual development in the population of boys of RD.

### Conflict of Interests

Authors declare that there is no conflict of interest.

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