

## Research Article

# Diffuse Nontoxic Goiter in Children and Its Impact on Dental Pathology

Oksana Hodovanets<sup>\*</sup>, Tetiana Kitsak, Oleksandr Vitkovskyj**Abstract**

**The objective** of the research was to assess the thyroid status of children with diffuse nontoxic goiter and its effect on dental pathology depending on age.

**Materials and methods.** Clinical observation of 226 children at the age of 12-15 years was conducted. To analyze their thyroid status, serum levels of total thyroxine, free thyroxine, total triiodothyronine, and thyroid stimulating hormone were determined using enzyme immunoassay. The following thyroid indices were calculated for the integral estimation of the functional state of the pituitary-thyroid system: the peripheral inversion index (total triiodothyronine/total thyroxine), the integral index (total triiodothyronine + total thyroxine/thyroid stimulating hormone) and the indices of thyroid stimulating hormone/total triiodothyronine and thyroid stimulating hormone/total thyroxine. Their dental status was determined by means of standard indices recommended by the World Health Organization.

**Conclusions.** In children with euthyroid enlargement of the thyroid gland, there were detected changes in the thyroid status within the reference range. According to the direction of changes in the most indices, dysthyroidism is characterized by the reduced thyroid function that can affect metabolic processes in the body, including the dentofacial system, as evidenced by significantly worse indices of the intensity of damage to hard dental tissues and periodontal tissues in children with diffuse nontoxic goiter.

**Keywords**

children; diffuse nontoxic goiter; dental caries; dental tartar

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## Problem statement and analysis of the recent research

Endocrine pathology is one of the leading causes of morbidity in the general population. In childhood, a clear increase in the number of endocrine diseases with age is observed. According to official statistics, among endocrine diseases of children and adolescents in Ukraine, diffuse goiter is ranked first accounting for 56.7% of all cases. Especially high prevalence and incidence rates of diffuse nontoxic goiter (DNG) are recorded among children population of the northwestern regions of our country [3, 4].

According to literature data, the prevalence of endemic goiter among the population positively correlates with the prevalence and intensity of dental caries affecting hard dental tissues, as well as periodontal diseases, that is due to natural fluoride-iodine deficiency [1, 5, 6].

**The objective** of the research was to assess the thyroid status of children with DNG and its effect on dental pathology depending on age.

## 1. Materials and methods

The thyroid status was analyzed through the determination of serum levels of total thyroxine ( $T_4$ ), free thyroxine ( $FT_4$ ),

total triiodothyronine ( $T_3$ ), and thyroid stimulating hormone (TSH) using enzyme immunoassay by means of diagnostic ELISA kit (DRG International, Inc., USA). The following thyroid indices were calculated for the integral estimation of the functional state of the pituitary-thyroid system: the peripheral inversion index ( $T_3/T_4$ ), the integral index ( $T_3+T_4/TSH$ ) and the indices of  $TSH/T_3$  and  $TSH/T_4$ . These indices were studied in somatically healthy children and children with DNG (grades I-II) at the age of 12 and 15 years (226 individuals).

Their dental status was determined by means of standard indices recommended by the World Health Organization. Statistical data processing was performed by the method of variation statistics using the Student's t-test.

## 2. Results and discussion

The results showed that the indices of the thyroid status were within the reference range in all observation groups thereby confirming euthyroid status. However, some fluctuations in hormone levels were detected while comparing the obtained results in children with DNG with the data of apparently healthy children, which indicated the risk of thyroid disorders in the future.

The average values of thyroid hormone serum levels in children of all observation groups are given in Table 1, 2;

they show that in all patients with DNG, there was observed a significant increase in TSH level as compared to control data. This indicator mostly increased in 12-year-old girls: from  $1.46 \pm 0.10$  mIU/l in the comparison group to  $2.21 \pm 0.22$  mIU/l in children with co-existent thyroid pathology. It might be due to hormonal changes in the female body.

In children with DNG, namely 15-year-old girls and 12-year-old boys, a significant increase in T3 concentration was found as well. However, the level of total and free T4 in all children at the age of 12 years was the same. In older age group, T4 decreased significantly among boys ( $106.32 \pm 9.89$  nmol/l - the control group,  $95.37 \pm 8.44$  nmol/l - children with DNG) and girls ( $125.37 \pm 13.08$  nmol/l - the control group,  $102.91 \pm 10.53$  nmol/l - children with DNG). The free hormone fraction remained unchanged.

The analysis of the thyroid indices showed that in girls suffering from DNG, more significant changes in the functional status of the pituitary-thyroid system were found as compared to boys. This is evidenced by the following data: the integral index decreased by 35% in 12-year-old female patients and by 45% in 15-year-old girls; the peripheral inversion index increased almost twice in adolescents and TSH/T3 index decreased by 42% in younger age group as compared to the control group.

Hormone profile in boys with concomitant DNG was characterized by a decrease in the integral index by 25% at the age of 12 years and by 31% at the age of 15 years while maintaining other thyroid indices at the control level.

The findings indicated the development of dysthyroidism in children on the background of thyroid gland hyperplasia and pointed at the need of iodine supplementation for normal thyroid hormonogenesis.

It is worth mentioning that in the comparison groups, there were changes in studied parameters by both age and gender. Significantly higher indicators of T4 were recorded in boys in early puberty ( $115.87 \pm 8.23$  nmol/l) ( $p < 0.05$ ) than in late puberty ( $106.32 \pm 9.89$  nmol/l). The levels of TSH and FT<sub>4</sub> were slightly higher, although there was no significant difference between them ( $p > 0.05$ ).

In adolescent girls, on the contrary, the levels of T<sub>4</sub> and FT<sub>4</sub> increased by 16-18% ( $p < 0.05$ ) with age. There were no differences in other indices among girls depending on age.

While comparing serum levels of thyroid hormones in boys and girls of the same age groups, significant differences between the levels of T<sub>3</sub> and T<sub>4</sub> were found in older patients ( $p < 0.05$ ). In 12-year-old children, all the studied indices were not gender-specific.

Thus, in healthy children, thyroid dys hormonogenesis with signs of sexual dimorphism was observed during puberty. However, changes in their hormonal status were less significant than in children with DNG.

Children's dental health is presented in Table 3, 4. It should be mentioned that the indices of dental caries intensity in children with DNG tended to increase with increasing severity of somatic pathology, which was confirmed by a significant

difference between the most data and the control group.

The analysis of the intensity of dental caries by gender has not revealed the difference in these indices among boys and girls. The DMF index was slightly higher in 12-year-old girls than in boys, although there was no reliable difference between all the studied criteria. This tendency was most likely due to the beginning of rapid morphological and functional development of the female body at the age of 12 years, puberty in particular – as a result, the process of secondary mineralization of dental hard tissues led to functional stress. The decrease in the amount of calcium in the enamel contributed to the development of dental caries and, consequently, increased the prevalence and intensity of dental caries in this group of children.

The assessment of periodontal state by bleeding and dental tartar is given in Table 5.

The prevalence of bleeding in DNG was high in both age groups and significantly higher as compared to somatically healthy children ( $p < 0.05$ ). Hard dental deposits were more rarely observed in children of the control group and children over 12 years old suffering from DNG. In adolescents, the average value of this index was observed. The same results were obtained while studying the intensity of damage to periodontal tissues.

### 3. Conclusions

In children with euthyroid enlargement of the thyroid gland, there were detected changes in the thyroid status within the reference range. According to the direction of changes in the most indices, dysthyroidism is characterized by the reduced thyroid function that can affect metabolic processes in the child's body, including the dentofacial system, as evidenced by significantly worse indices of the intensity of damage to hard dental tissues and periodontal tissues in children with diffuse nontoxic goiter.

### 4. Prospects for further research

The study of the impact of thyroid dys hormonogenesis on the development of dental pathology in children and the methods of its correction are promising.

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**Table 1.** Indices of the thyroid status in 12-year-old children with DNG (M±m)

Hormone level	Boys		Girls		p1	p2
	healthy children (n=25)	children with DNG (n=34)	healthy children (n=25)	children with DNG (n=32)		
TSH (mIU/l)	1.52±0.12	1.97±0.20*	1.46±0.10	2.21±0.22*	>0.05	>0.05
T <sub>4</sub> (nmol/l)	115.87±8.23	111.05±9.46	108.41±10.78	105.64±7.33	>0.05	>0.05
FT <sub>4</sub> (pmol/l)	16.12±1.34	15.89±1.25	14.56±1.45	15.83±1.38	>0.05	>0.05
T <sub>3</sub> (nmol/l)	2.89±0.16	3.54±0.25*	2.56±0.20	2.71±0.18	>0.05	<0.05
T <sub>3</sub> +T <sub>4</sub> /TSH	76.13±5.43	57.16±4.32*	75.23±4.15	51.03±2.35*	>0.05	>0.05
T <sub>3</sub> /T <sub>4</sub>	0.024±0.002	0.031±0.002	0.025±0.001	0.026±0.003	>0.05	>0.05
TSH/T <sub>3</sub>	0.49±0.05	0.58±0.04	0.55±0.04	0.79±0.06*	>0.05	<0.01
TSH/T <sub>4</sub>	0.012±0.001	0.018±0.002	0.013±0.001	0.021±0.002	>0.05	>0.05

Notes:

\* - significant difference in indices among children with DNG and the control group, p&lt;0.05;

p1 – comparison of indices among healthy boys and girls;

p2 – comparison of indices among boys and girls with DNG.

**Table 2.** Indices of the thyroid status in 15-year-old children with DNG (M±m)

Hormone level	Boys		Girls		p1	p2
	healthy children (n=25)	children with DNG (n=30)	healthy children (n=25)	children with DNG (n=33)		
TSH (mIU/l)	1.41±0.11	1.86±0.20*	1.39±0.15	2.09±0.30*	>0.05	>0.05
T <sub>4</sub> (nmol/l)	106.32±9.89	95.37±8.44*	125.37±13.08	102.91±10.53*	<0.01	>0.05
FT <sub>4</sub> (pmol/l)	15.04±1.47	16.64±1.52	17.25±1.33	18.43±1.54	>0.05	<0.05
T <sub>3</sub> (nmol/l)	3.22±0.34	3.87±0.26	2.43±0.21	3.38±0.27*	<0.05	>0.05
T <sub>3</sub> +T <sub>4</sub> /TSH	81.69±7.12	52.35±4.84*	92.94±6.25	51.85±4.35*	<0.05	>0.05
T <sub>3</sub> /T <sub>4</sub>	0.034±0.004	0.042±0.003	0.018±0.002	0.035±0.003*	<0.05	>0.05
TSH/T <sub>4</sub>	0.43±0.04	0.48±0.03	0.57±0.05	0.63±0.05	<0.05	<0.05
TSH/T <sub>4</sub>	0.013±0.002	0.019±0.002	0.011±0.001	0.022±0.003	>0.05	>0.05

Notes:

\* - significant difference in indices among children with DNG and the control group, p&lt;0.05;

p1 – comparison of indices among healthy boys and girls;

p2 – comparison of indices among boys and girls with DNG.

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**Table 3.** Indices of dental caries intensity in children under the age of 12 years, M±m

Groups	Subgroups by gender	Caries intensity DMF <sub>T</sub>	DMF <sub>T</sub>		
			D	M	F
Control group	together	2.83±0.14	1.45±0.05	1.34±0.11	0.04±0.002
	boys	2.64±0.15	1.36±0.09	1.25±0.09	0.03±0.001
	girls	3.02±0.20	1.54±0.12	1.43±0.13	0.05±0.005
DNG, grade Ia	together	3.05±0.19	1.62±0.14	1.35±0.12	0.08±0.009
	boys	2.87±0.11	1.53±0.11	1.27±0.09	0.07±0.007
	girls	3.23±0.31	1.71±0.16	1.43±0.15	0.09±0.005
DNG, grade Ib	together	3.48 ± 0.25*	1.92±0.20	1.42±0.08	0.14±0.02*
	boys	3.28±0.15*	1.83±0.17	1.36±0.12	0.09±0.01
	girls	3.69±0.20*	2.01±0.16*	1.48±0.11	0.20±0.008*
DNG, grade II	together	4.58± 0.37*	2.01±0.38*	2.06±0.17*	0.51±0.03*
	boys	4.43±0.25*	1.89±0.15*	1.97±0.13*	0.57±0.05*
	girls	4.73±0.51*	2.13±0.17*	2.15±0.20*	0.45±0.01*

Notes:

DMF<sub>T</sub> - index of dental caries experience based upon the number of decayed, missing (extracted), and filled permanent teeth;

\* - significant difference between the indices and the control group, p&lt;0.05.

**Table 4.** Indices of dental caries intensity in children at the age of 15 years, M±m

Groups	Subgroups by gender	Caries intensity DMF <sub>T</sub>	DMF <sub>T</sub>		
			D	M	F
Control group	together	4.95±0.23	2.97±0.20	1.83±0.12	0.15±0.01
	boys	4.89±0.25	3.08±0.33	1.65±0.02	0.16±0.02
	girls	5.01±0.20	2.86±0.15	2.01±0.01	0.14±0.01
DNG, grade Ia	together	6.28±0.41*	3.87±0.25*	2.13±0.18	0.28±0.01
	boys	6.34±0.52*	3.64±0.32	2.45±0.20*	0.25±0.03
	girls	6.22±0.48*	4.10±0.15*	1.81±0.16	0.31±0.02*
DNG, grade Ib	together	7.03±0.54*	4.28±0.30*	2.43±0.15	0.32±0.01*
	boys	7.13±0.25*	4.49±0.35*	2.29±0.31	0.35±0.02*
	girls	6.93±0.56*	4.07±0.28*	2.57±0.24	0.29±0.01
DNG, grade II	together	7.51±0.63*	4.58±0.20*	2.35±0.17*	0.58±0.05*
	boys	7.52±0.51*	4.64±0.51*	2.34±0.25*	0.54±0.04*
	girls	7.50±0.45*	4.52±0.15*	2.36±0.24	0.62±0.05*

Notes:

\* - significant difference between the indices and the control group, p&lt;0.05.

**Table 5.** Prevalence of bleeding and dental tartar in children

Age	Group	Bleeding, %	Dental tartar, %
12 years old	Control group	48.0%	18.0%
	DNG	77.33% *	37.33% *
	DNG, grade Ia	72.0% *	30.0% *
	DNG, grade Ib	76.0% *	36.0% *
	DNG, grade II	84.0% *	46.0% *
15 years old	Control group	70.0%	48.0%
	DNG	95.86% *	72.41% *
	DNG, grade Ia	90.0% *	64.0% *
	DNG, grade Ib	98.0% *	70.0% *
	DNG, grade II	100% *	84.44% *

Notes:

\* - significant difference between the indices and the control group,  $p < 0.05$ .