Anthrop. Közl. *34;* 83–89. (1992)

THYROID VOLUME OF SCHOOLCHILDREN IN BUDAPEST AND IT'S RELATIONSHIP TO AGE, BODY HEIGHT, BODY WEIGHT, BODY SURFACE AND SEX

I. Szécsényi-Nagy, Zs. Kovács, F. Péter

Buda Children's Hospital, Budapest, Hungary

Abstract: *The clinical estimation of the thyroid size (by palpation, inspection and measurement of the neck circumference) is inaccurate and irreproducible. The main purpose of present study was to introduce US-scan for practical and accurate measurement of thyroid volume and establish a "normal range" in Budapest's schoolchildren. Comparing the data (used SPISS mathematic program) the thyroid gland's size was correlated to age, body height, body weight and body surface. A significant difference was demonstrated between the right and left lobes and an increasing total volume was found at the pubertal acceleration. This scanning method is noninvasive, inexpensive and rapid, without any discomfort to the patient. The authors suggest a subregional US screening for goiter caused by iodine deficiency in the paraendemic areas.*

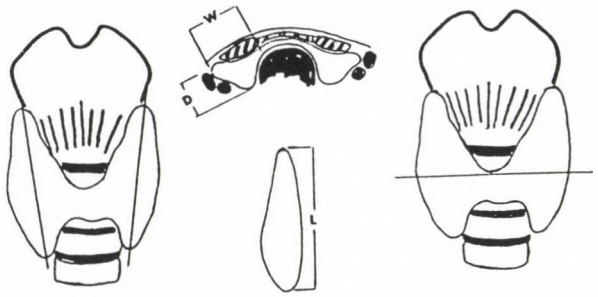
Key words: *Anthropometry; Thyroid volume; Ultrasound; Iodine deficiency.*

Introduction

The authors look for an appropriate technique for volume determination, which correlates well to the real size of *in situ* organ and which is reproducible, safe, harmless and can be repeated unlimitedly without inconveniences. The sonography (US) is such a procedure and opens a new perspective for *in vivo* anthropometry. The US together with scintiscan are preferred diagnostic methods of adult's thyroid. The US successfully delineates the thyroid's size, surveys it's echopattern and it is suitable for differentiate the solid nodular or mixed nodular from cystic lesions and the palpable intra-, from extrathyroideal disturbing objects. In certain diagnoses the evaluation and the follow-up of the thyroid volume are particularly informative during the treatment. In the last decade the US was widespread available and gave larger and larger assistance in the identification of suspicious cases (applying as screening method still symptomless cases can be discovered). In thyroid volume estimation methods based on inspection and palpation average errors (30%) were found by Tannahill and Igl (1978) in comparison with ultrasound.

Material and Method

The main purpose of the present study was the application of a practical and accurate ultrasonic scanning investigation for determining of thyroid size and establishing a "normal range" for Budapest's schoolchildren. 1380 healthy children (suburb and inside of Buda) were investigated. Sonography was performed with real-time sector scanner (TOSHIBA-SAL 38B) applied 7.5 MHz transducer and the appropriate waterbag kits. For the imaging the subjects were ordered to take a supine position with a pillow under their shoulder and neck was hyperextended. The long axis (L), the short axis (W), and the thickness (D) of each thyroid lobes were measured (*Fig. 1*). The volume of thyroid gland was determined by using the standard geometric formula for prolate ellipsoid spheroid, L x W x D x 0.523 (Brunn et al. 1981) initiated in Hungary by Gönczi et al. (1985).



$$L \cdot W \cdot D \cdot \frac{\pi}{6}$$

Fig. 1: Measurement of the thyroid's parameters and the Brunn's calculation

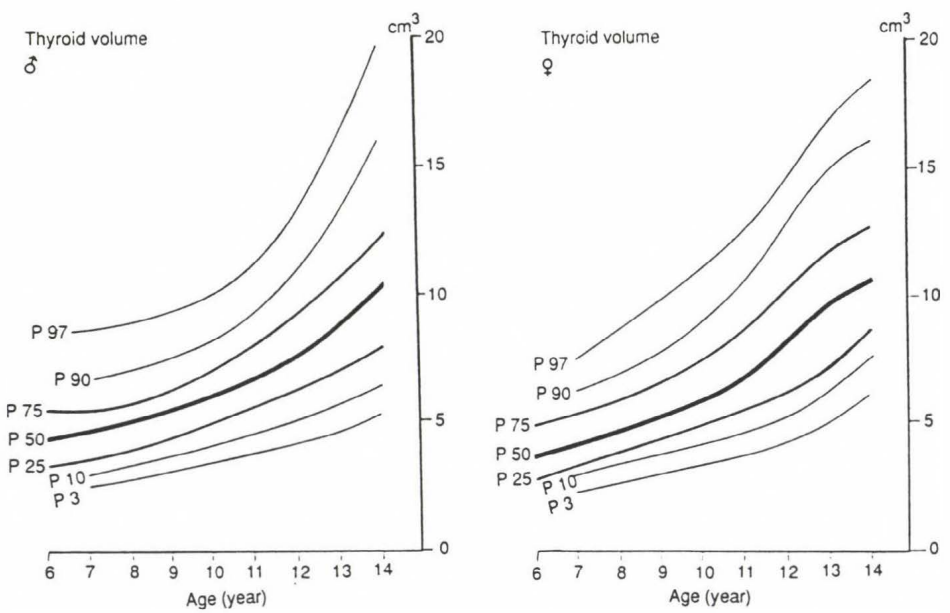


Fig. 2: Percental distribution of thyroid volumes, in boys and girls

Result and Discussion

Six parameters of thyroid and the calculated thyroid volumes were tabulated in annual arrangement, separately for girls and boys. The mean values and standard deviations were calculated. The percental distribution of thyreoid volumes was demonstrated by *Tabl. 1–2,* and *Fig. 2.* The mean volumes of Budapest's children (according to age-groups are essentially similar to the measurements of the following authors and working groups: Müller-Leisse C. *Heidelberg* (1988), Gutekunst R. *Lübeck* (1985), and to the parameters published by Zubovszky GA *Moscow* (1989). These data originate from paraendemic or exactly from endemic iodine deficient areas. In non iodine deficient area

Table 1. **Ultrasonically measured parameters of thyroid lobes in Boys and girls (mean, SD in mm)**

Age (year)	Right lobe			Left lobe		
	Width	Depth	Length	Width	Depth	Length
Boys						
6	13.2 ± 2	8.6 ± 2	35.6 ± 9	13.0 ± 2	7.2 ± 1	33.4 ± 6
7	14.3 ± 2	9.0 ± 2	38.2 ± 5	13.6 ± 2	8.3 ± 2	36.9 ± 4
8	13.5 ± 2	8.9 ± 2	40.6 ± 5	13.5 ± 2	8.0 ± 1	38.0 ± 4
9	14.2 ± 2	9.0 ± 2	42.5 ± 5	14.4 ± 2	8.2 ± 1	40.1 ± 4
10	15.4 ± 2	9.3 ± 2	44.5 ± 5	15.0 ± 2	8.5 ± 2	42.0 ± 6
12	16.2 ± 2	9.9 ± 1	48.1 ± 5	16.0 ± 2	9.3 ± 2	46.0 ± 6
13	17.0 ± 3	10.9 ± 2	50.2 ± 7	16.3 ± 3	10.0 ± 2	48.3 ± 6
14	18.1 ± 3	11.7 ± 3	51.5 ± 7	17.2 ± 3	10.6 ± 2	49.9 ± 6
Girls						
6	13.6 ± 3	8.0 ± 1	33.8 ± 4	13.6 ± 2	8.6 ± 1	30.8 ± 2
7	13.4 ± 2	8.7 ± 2	39.7 ± 5	13.5 ± 2	7.7 ± 2	37.8 ± 6
8	14.1 ± 2	9.2 ± 2	40.6 ± 5	13.8 ± 2	8.2 ± 2	38.7 ± 5
9	14.0 ± 2	9.0 ± 1	41.5 ± 5	13.9 ± 2	8.8 ± 1	40.6 ± 4
10	14.7 ± 2	9.8 ± 2	44.0 ± 6	15.1 ± 2	8.5 ± 1	42.2 ± 5
11	15.5 ± 3	10.0 ± 2	46.2 ± 5	15.0 ± 2	9.0 ± 1	45.1 ± 5
12	16.7 ± 2	10.7 ± 2	49.0 ± 5	16.7 ± 3	9.8 ± 2	47.7 ± 5
13	17.7 ± 3	11.0 ± 2	50.9 ± 6	17.2 ± 3	10.3 ± 2	49.6 ± 8
14	18.2 ± 3	11.3 ± 2	53.2 ± 7	18.3 ± 2	10.5 ± 2	52.4 ± 7

Table 2. **Normal volume of the thyroid gland in boys and girls (cm^3)**

Age (year)	N	Volume		Percentiles						
		Mean	± SD	3	10	25	50	75	90	97
Boys										
6	5	4.45	1.79	—	—	3.12	3.57	6.21	—	—
7	57	4.89	1.52	2.49	3.03	3.76	4.90	5.41	6.48	9.62
8	60	4.77	1.23	2.97	3.42	3.78	4.94	5.51	6.72	7.32
9	72	5.38	1.22	3.13	3.68	4.42	5.43	6.18	7.04	8.14
10	61	6.25	1.66	3.02	4.05	5.20	6.09	7.21	8.66	9.84
11	73	6.80	2.06	3.60	4.66	5.26	6.74	7.80	9.20	13.20
12	79	7.74	1.98	4.57	5.30	6.39	7.52	8.90	10.70	12.10
13	98	9.29	3.38	4.43	5.64	6.91	8.73	10.75	13.76	16.21
14	58	10.77	3.52	5.50	6.73	8.09	10.53	12.14	15.96	19.64
Girls										
6	5	3.91	1.13	—	—	2.80	3.87	5.02	—	—
7	54	4.56	1.30	2.12	3.10	3.67	4.41	5.31	6.32	7.56
8	76	5.16	1.53	2.84	3.61	4.06	4.80	6.23	7.02	8.75
9	70	5.39	1.28	3.02	3.72	4.50	5.24	6.26	7.06	7.75
10	71	6.37	2.12	3.36	4.08	4.67	6.41	7.34	8.83	12.25
11	73	7.10	2.10	3.37	4.60	5.72	6.66	8.60	10.20	11.86
12	84	8.83	2.57	5.35	6.01	6.57	8.20	10.54	12.67	14.73
13	85	10.17	3.59	4.70	6.50	7.40	10.10	12.13	15.40	17.15
14	63	11.23	3.13	6.22	7.87	8.84	10.82	12.87	16.02	18.70

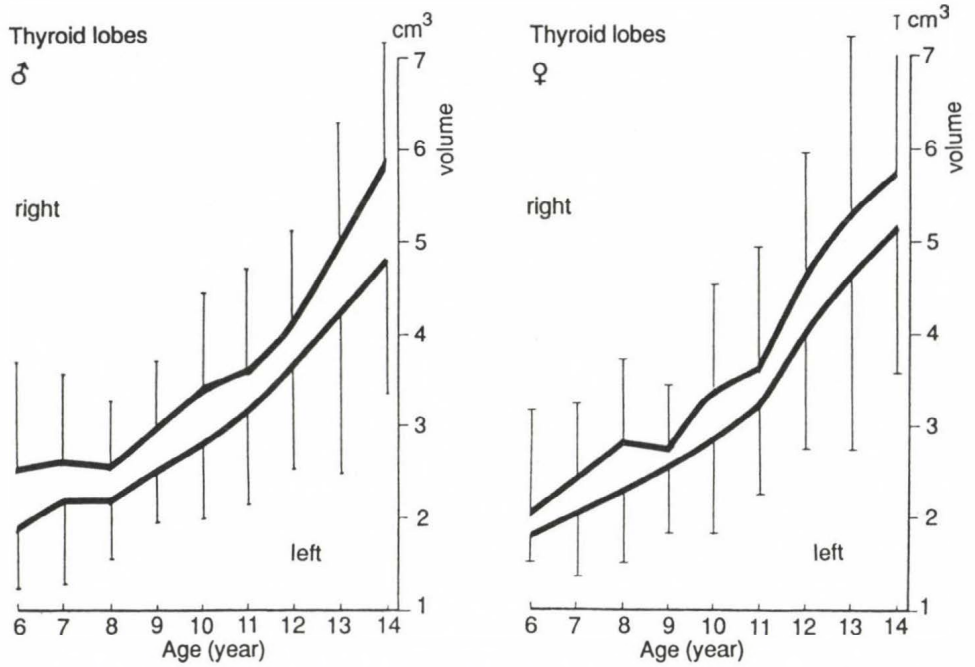


Fig. 3: The mean difference between the right and left lobes of thyroid lobes in boys and girls

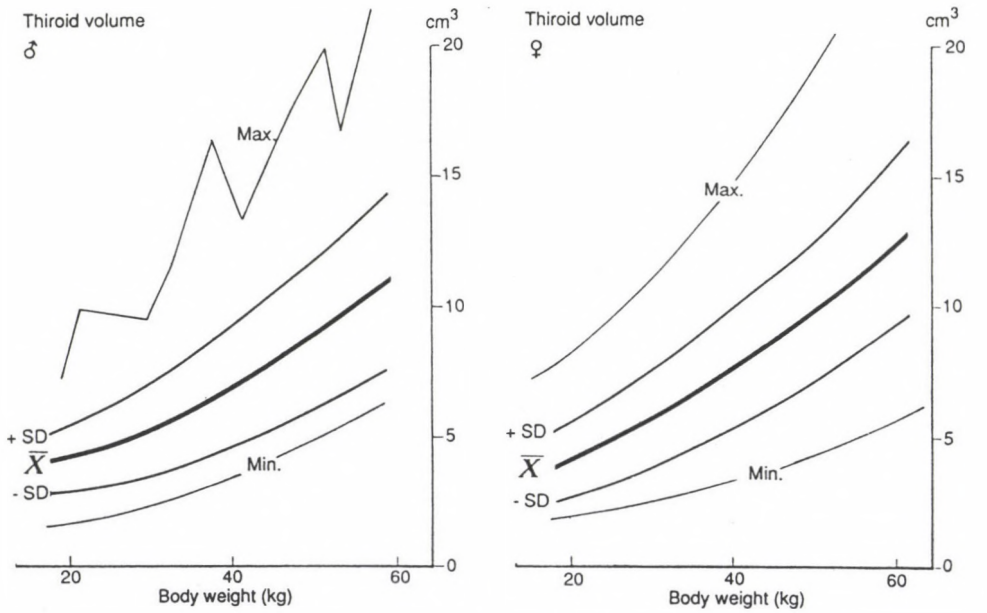


Fig. 4: Relation between the thyroid volume and the body weight, in boys and girls

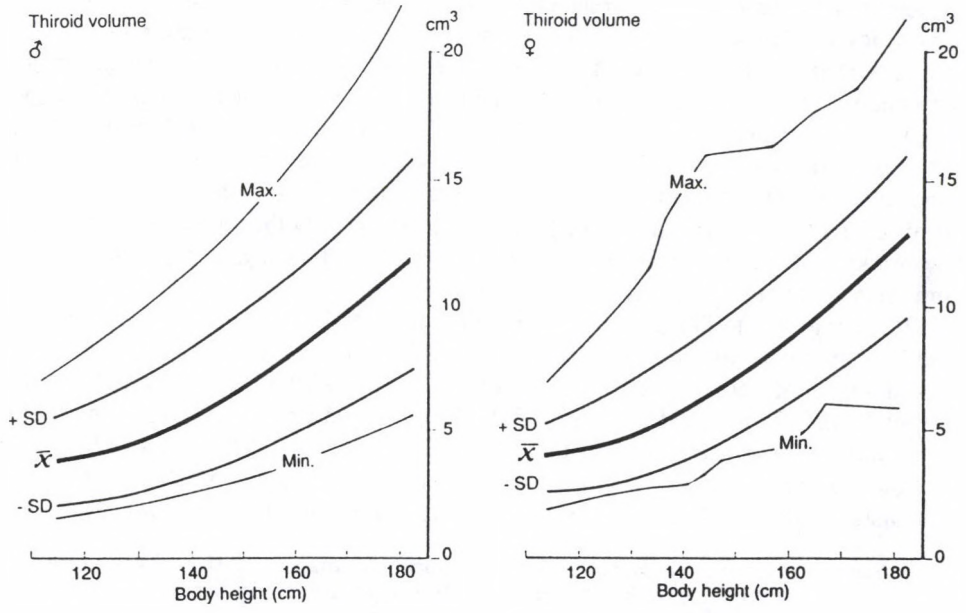


Fig. 5: Relation between the thyroid volume and the body height, in boys and girls

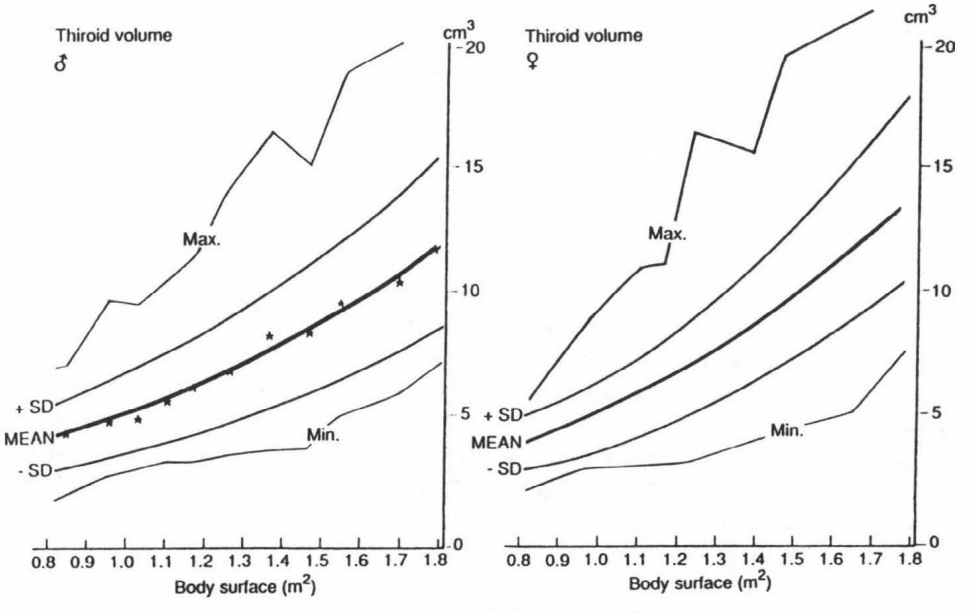


Fig. 6: Relation between the thyroid size and the body surface, in boys and girls

in Sweden (Ivarsson et al. 1989) the identical age-groups have half as large thyroid volumes than those of Hungarian children. In comparison the distribution of goiter frequency in Hungary (1950–1990) and the regional iodine concentration of dringking water put the question in a peculair light. The frequency of iodine deficient goiter in its tendency is being moderated in numerous county, while in other area of Hungary it stagnates or is being deteriorated (see Zala or Heves and Győr-Sopron-Moson countys). The causal relation between the iodine deficiency and the goiter is wiedly known. Nearly one half of the Hungarian population gets less than 10 μg/l iodine by drinking water and further 30% get not more than 25 μg/l iodine. Consequently the iodine supplementation by drinking water is insufficient all over the country. This lays a great stress on the importance of iodine prophylaxis in the general health.

We should like to illustrate with *Fig. 3* that the right lobe is significantly larger than the left (the mean difference is 0.5 cm^3 in girls and boys alike). Müller–Leisse (1988) found bigger difference i.e. 0.8 cm^3, while Ueda (1990) didn't observe inequality. Around puberty the great diversity of the body weight and body height, motive the reference of these parameters in thyroid investigation (*Fig. 4* and *5*). On *Fig. 6* the thyroid size related to body surface was estimated. The best correlation (by Pearson calculation) was found between thyroid volume and body surface area (*Table 3*).

Table 3. **Correlation between the ultrasonically measured thyroid volume and the age, body weight, body height and body surface**

Thyroid volume		age	Body weight	Body height	Body surface
Boys					
	r =	0.6301	0.6610	0.6820	0.6861
	n =	563	563	563	563
	p =	0.000	0.000	0.000	0.000
Girls					
	r =	0.6907	0.7133	0.7175	0.7342
	n =	578	578	578	578
	p =	0.000	0.000	0.000	0.000

On screening the 1380 children by US examination the following appeared alterations: 5 children had clinically unambiguos goiter stadium II.–III., in further 41 cases the thyroids exceeded the percentile 97 on our tabulation, 3 children had cystic lesions and in cases of 4 children Hashimoto's thyroiditis was revealed. That calls attention to relative frequency of these disorders in schoolage. The authors have no doubt that the integration method suggested by Rasmussen and Hjorth (1974) and a new self-acting US scanner projected by Yokoyama et al. (1986) will revolutioniez the thyroid volumetric proceeding.

Summary

The ultrasonic investigation as anthropometric method was adopted. The thyroid results were tabulated annually in age groups into percent distributions separately of both sexes. The increasing thyroid volume has been confirmed with increasing age. In

femals the thyroid size preceedes that of the males at the age of 8–10 years, and the range of standard deviation expands at the age of 10, one year before the boys. Significant correlation has been demonstrated between thyroid volume and age, body weight, body height and body surface in both sexes. The difference between the "normal" thyroid volumes registered on several geographical areas is explicable with variations of iodine intake, altered genetic background or different alimentation factors. The acceleration at puberty was revealed in growth of thyroid glands. Because of the wide variation of body weight and body height in these age-groups it looks reasonable to refer the thyroid volume to the above mentioned parameters. The US thyroid volumetry may give assistance at the proper time to recognize the subregional disturbances of iodine supply and attracts our attention to the higher frequency of thyroid disorders in adolescence.

*

Paper presented at the Conference of the Pediatric-Anthropological Subsection of the Anthropological Section, Hungarian Biological Society, Debrecen, Hungary, May 1992. — Received 7 October, 1992.

References

Brunn J, Block U, Ruf G, Bos I, Kunze WP, Scriba PC (1981) Volumetrie der Schilddrüsenlappen mittels Real-time Sonographie. — *Dtsch. Med. Wochensch., 106;* 1338—1340.

Gönczi J, Szabolcs I, Szilágyi G, Bohár L, Göblyös P (1985) Stellung und Wert der Ultrasonographie bei der Untersuchung von Schilddrüsenkrankheiten. — *Röntgenblatter, 38;* 233—237.

Gutekunst R, Smolarek H, Scriba PC (1985) Strumaepidemiologie IV: Schilddrüsenvolumina bei deutschen und schwedischen Schulkindern. — *Dtsch. Med. Wochensch., 110;* 50—54.

Hegedűs L, Perrild H, Poulsen LR, Andersen JR (1983) The determination of thyroid volume by ultrasound and its relationship to body weight, age and sex in normal subjects. — *J. Clin. Endocrinol. Metab., 56;* 260—263.

Igl W, Lukas P, Leisner B, Fink U (1981) Sonographische Volumenbestimmung der Schilddrüse Vergleich mit anderen Methoden. — *Nuklearmedizin, 20;* 64—71.

Ivarsson SA, Persson PH, Ericsson UB (1989) Thyroid gland volume as measured by ultrasonography in healthy children and adolescents in non-iodine deficient area. — *Acta. Paediatr. Scand., 78;* 633—634.

Müller-Leisse C, Tröger J, Khabirpour F, Pöckler C (1988) Schilddrüsenvolumen–Normalwerte. — *Dtsch. Med. Wochenschr., 113;* 1872—1875.

Olbricht T, Schmitka T, Mellinghoff U, Benker G (1983) Sonographische Bestimmung von Schilddrüsenvolumina bei Schilddrüsengesunden. — *Dtsch. Med. Wochensch., 108;* 1355—1358.

Rasmussen SN, Hjorth L (1974) Determination of thyroid volumen by ultrasonic scanning. — *J. Clin. Ultrasound, 2;* 143—147.

Tannahill AJ, Hooper MJ, England M, Ferriss JB (1978) Measurement of thyroid size by ultrasound, palpation and scintiscan. — *Clin. Endocrinol.,* (Oxf) 8; 483—486.

Ueda D (1990) Normal volume of the thyreoid gland in children. — *J. Clin. Ultrasound, 18;* 455—462.

Zubovsky GA, Tararukhina OV (1989) Ultrasound scanning of the child's thyroid. — *Med. Radiol. Mosk., 34;* 7—11.

Mailing address: Dr I. Szécsényi-Nagy
Buda Children's Hospital
Budapest II., Cserje u. 14.
P.O.Box 14
H–1277 Budapest
Hungary