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RESEARCH ARTICLE

Factors Affecting Thyroid Volume and the Incidence of Nodules With Goiter School-Aged Children

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ABSTRACT

Objective: This study aimed to analyze the associations between age, sex, anthropometric factors, and thyroid volume as well as to determine the prevalence of goiter and thyroid nodules in school children.

Methods: This study included schools governed by the Ministry of Education in Van province. Sonographic evaluations of thyroid glands were conducted in children aged 6–17 years, and measurements of weight, height, waist circumference, hip circumference, and skinfold thickness were obtained from the participants.

Results: A total of 2284 school children were included in the study. The median age of the participants was 11.08 years. It was observed that thyroid volume exhibited a positive correlation with age, body surface area, body mass index, height, weight, waist circumference, hip circumference, triceps skinfold thickness, and subscapular skinfold thickness ($p < 0.008$). When assessing the association between age and goiter prevalence based on World Health Organization parameters, 10.2% of children and adolescents developed goiter, and 0.8% of these cases also had a nodule. Among girls, the rates were 9.4% and 1% for goiter and nodules, respectively, whereas among boys, the rates were 11.3% and 0.7%, respectively.

Conclusions: Thyroid volume was affected by age, weight, subcutaneous tissue thickness, waist circumference, and BSA. Goiter remains a serious public health problem among school-age children in Van province.

Keywords: Anthropometry, Child; Goiter, Nodule, Thyroid

INTRODUCTION

Thyroid diseases are common endocrine disorders in children and adolescents. Iodine deficiency disorder (IDD) is a common public health issue, as it is the primary cause of preventable mental retardation and permanent brain damage in fetuses, infants, and children (1,2). However, iron, selenium, vitamin A, and zinc may interact with iodine and thyroid function (3). It has been demonstrated that protein-energy malnutrition (PEM) is a contributing factor to endemic goiter in children (4,5). Although international public health efforts have proven highly effective over the past several decades, nearly one-third of children worldwide remain at risk of iodine deficiency (6). Despite the Health Ministry's initiation of a national program that includes iodized salt standardization and its widespread use and the implementation of legislation mandating the iodization of household salt in 1998 in Turkey, endemic goiter and iodine deficiency continue to pose significant public health concerns (7,8). The prevention and control of iodine deficiency are ongoing; however, no new iodination studies have been conducted in our region since then. Therefore, a comprehensive iodination program is planned to be implemented by reviewing existing programs in Van province. Although urinary iodine concentration (UIC) can adequately assess a population's iodine nutrition, it does not provide conclusive information about an individual's iodine levels. Conversely, thyroid volume (Tvol) is an indicator of individual iodine status.

Ultrasonographic examination of the thyroid gland provides precise information on thyroid volume (Tvol), making it the most reliable method for thyroid volume assessment. Tvol is correlated with age, sex, and body surface area (BSA) (9).

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However, different studies have highlighted various influencing factors, leading to ongoing debate. Although urinary iodine concentration (UIC) effectively assesses the iodine nutritional status of a population, it does not reflect individual iodine levels. Conversely, Tvol indicates an individual's iodine status but is also subject to confounding factors. Childhood thyroid nodules though rare, have a significant malignancy rate of up to 25%.

There is a scarcity of epidemiological studies on thyroid nodules among pediatric patients. No study has been conducted on factors influencing thyroid volume, goiter, and nodule prevalence in school-age children using ultrasound in this region of Turkey. For the aforementioned reasons, we aimed to investigate the associations among age, gender, anthropometric measurements (weight, height, waist circumference, hip circumference, and skinfold thickness), thyroid volume, and the prevalence of goiter and thyroid nodules among school-age children.

MATERIALS AND METHODS

The study was approved by the Ethical Committee of Van Yüzüncü Yıl University **(Decision No: 25, Date: 05.09.2013)**. Only participants who provided a written informed consent document, which was approved by their parents and school guardian, were included in the study.

The study included state schools in both rural and urban areas. Written and verbal information was provided to 5000 students, and consent forms were sent to their home addresses to obtain parental consent.

The exclusion criteria were as follows:

1. Children taking glucocorticoids, dopamine, dobutamine, or antiepileptic drugs (such as phenytoin, carbamazepine, or others).
2. Those who had received amiodarone or an iodine-containing contrast agent within the prior 6 months.
3. Children with adrenocortical, renal, or other serious systemic or chronic wasting diseases.
4. Patients with a known thyroid disease or a history of thyroid disease.

Overall, 2284 students from 9 separate schools governed by the Ministry of Education in Van province were included in this study. The study team consisted of 6 persons including a radiologist, a pediatry residence and 4 healthcare professionals. They were trained in the techniques and standardization of the methods used. The team and equipment attended the school at 07:30 AM. Measurements were performed between 08:00 and 12: AM. In all participants, anthropometric measurements (weight, height, waist and hip circumference, subscapular skinfold thickness [SST], triceps skinfold thickness [TST]) and thyroid ultrasonography were performed. Individual procedures were performed by the same person throughout the study.

The date of birth, gender, and age were recorded for all students. Anthropometrics was performed before ultrasonography. Weight was measured using a NAN device (İstanbul) sensitive to 50 g. Body weight was measured without shoes, with only thin clothes on the arms parallel to the body and in the neutral position. The result seen as "kg" was taken as the result. Height was measured using a Seca stadiometer at a 90° angle to the floor according to the parameters established by Jelliffe and the World Health Organization (WHO) (10). Body mass index (BMI) was measured using the formula: weight (kg)/ Height^2 (m^2). BSA was calculated using the Du Bois formula: BSA = Weight (kg)$^{0.425}$x Height (cm)$^{0.725}$x71.84x10^{-4} (11). Waist circumference (WC) was measured using an inelastic tape measure at the level in the middle of distance between the last rib and the iliac crest (12) Hip circumference (HC) was measured at the level of highest protuberance in the gluteal region using an inelastic tape measure. The WC and HC were recorded in centimeters. Skinfold thickness was measured at the left subscapular region and left arm using a device and expressed as "mm". The clothes of the patients were removed during the measurements. Triceps and subscapular skinfold thicknesses were measured in triplicate on the left side of the body to the nearest 0.1 mm using a Harpenden caliper in accordance with the standardized techniques recommended by Lohman et al. (13). The mean of triplicate values was used in the analysis.

Thyroid volume and the presence of nodules were examined using Philips HD-11 ™ US unit with a 7.5-MHz transducer/ probe (Bothell, Washigton, USA). All measurements were performed by a single radiologist. On-screen measurements were verified by printing copies of the images, which were later measured by a second technician using handheld calipers. The nodule diameter of >5 mm was considered to indicate a true nodular appearance. In clinical practice, fine needle biopsy is not recommended for nodules smaller than 5 mm. Thus, nodules smaller than 5 mm were not evaluated by US. The volume of each lobe was calculated using the equation described by Brunn et al.: Volume of lobe = depth ×width length (cm) × 0.479. The thyroid gland volume (TTV) is the sum of the volume of each lobe. The isthmus volume was excluded. Thyroid volumes greater than the 97th percentile (WHO/ICCIDD) were considered abnormally enlarged (14,15). Thyroid size was assessed according to the WHO staging (16).

Statistical Analysis

Data were analyzed using SPSS for Windows version 13 (Statistical Package for Social Sciences). Frequency, mean, median, SD, 97th percent values with 95% confidence intervals (CIs) were measured in the entire population, in individual pediatric subgroups, and in subgroups stratified by other parameters, such as anthropometrics, thyroid volume, nodule presence rate, goiter presence frequency, and BMI. The independent sample t-test was used to compare independent groups. The correlation between thyroid volume and anthropometric measurements was determined using multiple linear regression analysis. Comparisons between subgroups were performed using the chi-square test and

Kruskal–Wallis test, and correlation analysis was performed using Spearman correlation analysis, and the threshold for statistical significance was α = 0.05. Pearson's correlation analysis was performed to examine the relationship between the independent variables.

RESULT

The final study cohort consisted of 2284 school children. The mean age of the subjects was 11.4±3,13 (6-17 years), and the median age was 11.08. There were 1006 (44%) boys and 1278 (56%) girls in the cohort. Table 1 presents the anthropometric and thyroid volume data of the study cohort. Thyroid volume increased with advancing age (r=0,986, p=0,000 pearson correlation), with higher volumes observed in girls than boys (p=0,700, independent t test). Thyroid volume was significantly greater in girls in age group of 12-13 years (p<0.05, p<0.01) (Table 1). Table 2 presents the median, mean, standard deviation, and 97th percentile (p) values of thyroid volume according to age and gender.

When the multiple linear regression analysis was performed between thyroid volume and anthropometrics, thyroid volume showed a positive correlation with age, BSA, BMI, height, weight, waist circumference, hip circumference, TST, and SST (Sig. (2-tailed) < 0,008) (Table 4). Table 4 presents the distribution of thyroid volumes according to BSA and sex. When thyroid volumes according to BSA were compared with regard to sex, it was seen that thyroid volume was greater in girls with BSA levels between 1.3 and 1.5 m^2 (p> 0,005, p<0.001 and p<0.010, respectively).

This ratio was 9.4% and 1% for girls and 11.3% and 0.7% for boys, respectively. There was no significant difference according to sex when all age groups were evaluated for the prevalence of goiter and nodules. However, goiter was more prevalent in girls in age group of 6-9 years age when age groups were evaluated individually (p<0.05) (Table 5).

Goiter was detected in 19.1% of boys and 11.5% of girls when the goiter prevalence according to BSA was analyzed based on the goiter limits proposed by WHO. Goiter prevalence was significantly higher in boys with BSA of 0.9-1.2 m^2 and was statistically significantly more prevalent in boys than girls (p<0.010, p<0.001, p<0.010 and p<0.010, respectively (Table 6).

DISCUSSION

Population iodine status is most commonly assessed using median urinary iodine concentrations, but goiter prevalence (determined by palpation or by ultrasound), serum thyroglobulin levels, and neonatal thyroid-stimulating hormone levels can also be used. In areas of mild-to-moderate IDDs, the sensitivity and specificity of palpation are poor (17), and measurement of thyroid volume (Tvol) by ultrasound is preferable, non-invasive, rapid (2–3 min per subject), and feasible even in remote areas by using portable equipment, and it is accepted as a standard method for measuring thyroid volume (18). In the present study, we also investigated some factors that affect thyroid volume. It was found that thyroid volume was higher in girls, although it has been reported that thyroid volume does not differ according to sex (19). There are also studies reporting higher thyroid volumes in females (20). It is obvious that the relationship between thyroid volume and gender are controversial. We think that higher thyroid volumes in age group of 12-13 years and BSA of 1.3-1.5 m^2 can be attributed to accelerated somatic growth during puberty (21).

Table 1. Shows the distribution median values of anthropometrics and thyroid volume according to sex

	n		Height (cm)		Weight (kg)		Waist C. (cm)		Hip C. (cm)		TST (cm)		SST (cm)		BMI (kg/m^2)		BSA		Right TLV (cm^3)		Left TLV (cm^3)		Total TV (cm^3)	
Age (yr)	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G
6	70	86	118	119	22	21	54	53,5	61	62	10¥	10	6*	6	22	21	0,83	0,84	2,09	2,13	2,21	2,21	4,40	4,37
7	83	103	121	122	23	23	54	55	63	63	9¥	11	5*	7	23	23	0,89	0,88	2,08	2,33	2,25	2,34	4,36	4,59
8	113	113	130	128	27	26	57	56	66	67	9¥	11	6¥	7	27	26	0,97	0,96	2,4	2,54	2,54	2,80	4,97	5,29
9	113	167	130	130	28	27	56	57	68	67	9¥	10,5	6*	8	28	27	1,02	1	2,60	2,55	2,61	2,60	5,26	5,27
10	118	138	136	139	30	30	57,5	58	70	70	9¥	10	6*	7	30	30	1,09	1,1	2,85	2,88	2,73	2,76	5,61	5,71
11	110	130	140	144	33	34,5	60	60	73	72	9¥	10	6¥	8	33	34,5	1,14	1,19	3,13	3,14	3,07	3,19	6,31	6,55
12	74	108	148	150	38	39,5	63	62	75*	78	9,5¥	10	6,5¥	8	38	39,5	1,28	1,31	3,25*	3,64	3,18	3,39	6,35*	7,01
13	81	93	152	155	40¥	46,5	60*	65	76£	83	9£	11	6£	9	40¥	46,5	1,3£	1,42	3,62¥	3,86	3,47*	3,75	7,04¥	7,92
14	81	105	158	157	46,5	49	65,5	65	81¥	85	9,5£	14	7£	10,5	46,5	49	1,44	1,46	3,95	4,10	3,82	3,92	7,77	8,22
15	51	105	162£	157	53	50	68	67	87	87	10£	14	7£	11	53	50	1,58¥	1,49	4,49	4,52	4,35	4,20	8,79	8,79
16	60	74	166£	157	55£	49	69	67	87	86	9£	12	6£	10	55¥	49	1,63£	1,47	4,73	4,88	4,56	4,37	8,98	9,33
17	51	55	164¥	157	53	53	69,5	71,5	86	89,5	9£	15	7£	12	53	53	1,57	1,51	4,65	4,72	4,61	4,64	9,65	9,76

SST: Subscapular skin thickness; TST: Triceps skin thickness; C: Circumference; BMI: Body mass index; BSA: Body surface area; TLV: trois lobe volüme; B. boys, G: Girls, *:p<0,05; ¥:<0,01; £: p<0,001, superscript letters show comparison of each parameter in each age group with regard to gene.

Table 2. Range, mean, median, and standard deviation of thyroid gland volume according to age and gender

			Right thyroid lobe (cm_3)				Left thyroid lobe (cm_3)				Total thyroid volume (cm_3)			
Age (yr)		**N**	**mean**	**SD**	**median**	**97p**	**mean**	**SD**	**median**	**97p**	**mean**	**SD**	**median**	**97p**
6	**Boys**	70	2,23	0,68	2,09	4,06	2,38	0,80	2,21	4,58	4,62	1,40	4,40	7,99
	Girls	86	2,39	0,96	2,13	5,05	2,50	0,94	2,21	4,65	4,90	1,82	4,37	9,22
7	**Boys**	83	2,32	0,69	2,08	4,57	2,33	0,59	2,25	3,53	4,65	1,21	4,36	7,58
	Girls	103	2,48	0,99	2,33	4,81	2,52	0,86	2,34	5,10	5,01	1,75	4,59	9,92
8	**Boys**	113	2,73	1,21	2,4	6,49	2,74	1,08	2,54	4,91	5,47	2,22	4,97	10,73
	Girls	113	2,77	0,97	2,54	5,24	2,86	0,89	2,8	5,37	5,63	1,76	5,29	10,47
9	**Boys**	113	2,84	1,06	2,6	5,61	2,81	1,08	2,61	5,55	5,65	2,07	5,26	10,93
	Girls	167	2,78	1,02	2,55	5,34	2,81	0,95	2,6	5,58	2,59	1,85	5,27	10,77
10	**Boys**	118	2,97	0,92	2,85	4,86	2,86	0,77	2,73	4,54	5,83	1,58	5,61	9,12
	Girls	138	3,05	1,04	2,88	5,84	2,98	0,94	2,76	5,83	6,04	1,9	5,71	11,71
11	**Boys**	110	3,31	1,18	3,13	6,42	3,24	1,2	3,07	5,67	6,56	2,23	6,31	11,47
	Girls	130	3,43	1,34	3,14	6,05	3,41	1,1	3,19	5,61	6,84	2,32	6,55	11,52
12	**Boys**	74	3,32	1,02	3,25	5,84	3,28	0,89	3,18	5,71	6,61	1,81	6,35	11,14
	Girls	108	3,7	1,12	3,64	6,07	3,6	1,16	3,39	6,72	7,31	2,1	7,01	12,38
13	**Boys**	81	3,6	1,04	3,62	5,76	3,61	1,02	3,47	5,96	7,22	1,95	7,04	11,56
	Girls	93	4,16	1,4	3,86	7,61	4,01	1,32	3,75	6,41	8,17	2,49	7,92	13,94
14	**Boys**	81	4,11	1,34	3,95	7,49	4,00	1,16	3,82	6,69	8,12	2,36	7,77	13,35
	Girls	105	4,34	1,57	4,10	8,29	4,07	1,32	3,92	6,87	8,41	2,59	8,22	14,44
15	**Boys**	51	4,72	2,03	4,49	10,4	4,49	1,44	4,35	8,03	9,22	3,33	8,79	17,8
	Girls	105	4,6	1,71	4,52	8,54	4,43	1,65	4,2	8,65	9,04	3,18	8,79	16,60
16	**Boys**	60	4,88	2,13	4,73	10,6	4,66	1,8	4,56	9,19	9,55	3,65	8,98	17,99
	Girls	74	4,9	1,73	4,88	8,97	4,51	1,44	4,37	7,65	9,41	3,04	9,33	16,48
17	**Boys**	51	4,86	2,2	4,65	10,67	4,77	1,92	4,61	9,37	9,63	3,95	9,65	19,68
	Girls	55	4,83	1,49	4,72	7,53	4,78	1,91	4,64	10,08	9,61	3,07	9,76	16,20

We observed that the effects of weight, height, TST, SST, BSA, age, and weight on thyroid volume were statistically significant (Sig. (2-tailed)< 0.008) . In the study by Zou Y et al (22), the authors found a statistically significant association in linear regression analysis between thyroid volume and age, gender, BMI, and BSA, as observed in our study. A study by Duatre et al. found that thyroid volume was correlated with age and BSA in boys and girls (23). However, no study has evaluated thyroid volume and skinfold thickness together so far. Based on our results, with other studies, it was seen that thyroid volume can be affected by nutritional status.

In earlier studies about iodine deficiency in different regions of Turkey, goiter prevalence was found to be 6.9% in Konya province, 12.1% in the Agean region (2005), 47.6% in Erzurum province (2004), 1.3% in Ankara province (2009), and 34% in Antalya and Kayseri provinces (24,25). In our previous study, the prevalences of goiter and iodine deficiency prevalence was found to be 17.5 % and 64,2 % in Van province (26). These studies indicated that Turkey is a moderately iodine-deficient country despite decreasing goiter prevalence over time. In addition, regional variations are striking. According to the WHO guidelines, the goiter prevalence was 10.2% in our study. There was a decrease in the goiter prevalence by 7.5 compared with our previous study. Although goiter prevalence was detected by palpation in the first study, the ratios in the studies determining goiter prevalence by simultaneous use of US and palpation suggest that the difference of 7.3% cannot be attributed to differences in the detection technique alone.

Additionally, unlike studies that were conducted on children, we also determined the nodule presence rate in children and determined the nodule prevalence. Nodule prevalence in childhood in the US may range from 0.2% to 5.1% (27). In our country, Ruhuşen Kutlu et al. (24) assessed the prevalence of nodules in children, but only children with nodules at palpation underwent sonographic evaluation. Thus, our study is the first to evaluate nodule prevalence in healthy children in our country.

In our study, the prevalences of goiter and nodules did not differ by sex; however, the results are highly variable in

Table 3. Correlation analysis between thyroid volüme and anthropometric measurements

			Right thyroid lobe (cm_3)				Left thyroid lobe (cm_3)				Total thyroid volume (cm_3)			
BSA (m^2)		**N**	**mean**	**SD**	**median**	**97p**	**mean**	**SD**	**median**	**97p**	**mean**	**SD**	**median**	**97p**
0,7	**Boys**	45	2,08	0,88	1,86	5,84	2,06	0,71	1,89	5,03	3,98	0,90	3,79	6,88
	Girls	72	1,93	0,58	1,87	2,89	2,06	0,76	2,03	3,38	4,00	1,27	3,85	5,99
0.8	**Boys**	115	2,25	0,58	2,12	3,53	2,35	0,57	2,32	3,54	4,61	0,98	4,39	7,01
	Girls	150	2,24	0,57	2,14	3,59	2,32	0,52	2,21	3,53	4,57	1,00	4,42	7,01
0.9	**Boys**	154	2,41	0,61	2,36	3,63	2,47	0,61	2,39	4,07	4,89	1,10	4,84	7,46
	Girls	158	2,45	0,60	2,39	4,03	2,49	0,57	2,44	3,82	4,95	1,04	4,81	7,32
1.0	**Boys**	158	2,67	0,59	2,65	4,26	2,72	0,65	2,62	4,06	5,39	1,14	5,26	8,15
	Girls	144	2,77	0,87	2,61	5,25	2,82	0,72	2,72	4,69	5,60	1,47	5,44	9,95
1.1	**Boys**	112	2,89	0,73	2,84	4,44	2,93	0,61	2,88	4,18	5,82*	1,21	5,76	8,54
	Girls	112	3,04	0,65	2,95	4,57	3,09	0,68	2,98	4,63	6,14	1,11	6,11	8,62
1.2	**Boys**	82	3,40	0,84	3,38	5,37	3,32	0,84	3,36	5,49	6,73	1,57	6,75	10,06
	Girls	106	3,48	0,86	3,38	5,57	3,31	0,87	3,14	5,58	6,80	1,61	6,37	10,88
1.3	**Boys**	66	3,70	0,87	3,62	5,97	3,51*	0,84	3,47	4,95	7,22	1,50	6,81	11,05
	Girls	113	3,86	1,02	3,68	5,80	3,95	1,26	3,75	6,14	7,81	2,02	7,23	12,15
1.4	**Boys**	62	3,84	0,87	3,64£	6,22	3,74	0,88	3,57£	6,04	7,58	1,56	7,18£	12,26
	Girls	183	4,56	1,38	4,23	7,88	4,34	1,32	4,01	7,41	8,90	2,50	8,31	15,26
1.5	**Boys**	62	4,61	1,25	4,24*	7,80	4,21	1,17	4,07¥	6,80	8,82	2,17	8,07¥	13,76
	Girls	140	5,02	1,37	4,94	8,00	4,59	1,17	4,50	7,19	9,61	2,26	9,30	15,83
1.6	**Boys**	72	5,23	1,44	4,97	8,86	5,03	1,37	4,93	8,81	10,27	2,61	10,01	17,71
	Girls	75	5,29	1,67	4,94	8,77	5,00	1,60	4,82	8,74	10,30	2,93	9,97	15,55
1.7	**Boys**	78	6,15	2,19	5,58	12,42	5,74	1,65	5,60	9,49	11,89	3,56	11,19	20,54
	Girls	25	5,12	1,64	4,98	8,98	4,99	1,64	4,94	7,96	10,11	3,11	9,65	16,50

*:p<0,05; ¥:<0,01; £: p<0,001, superscript letters indicate the comparison of each parameter in each BSA group about gender.

Table 4. Range, mean, median, and standard deviation of the thyroid gland volume for BSA

Variable	Right TLV Correlation	Left TLV Correlation	TTV Correlation
Age	0.565	0.548	0.580
Gender	0.058	0.055	0.059
BSA	0.788	0.760	0.807
BMI	0.789	0.763	0.809
Height	0.770	0.741	0.787
Weight	0.789	0.763	0.809
Waist c.	0.672	0.648	0.688
Hip c.	0.764	0.737	0.783
TST	0.258	0.243	0.261
SST	0.419	0.407	0.432

SST: Subscapular skin thickness; TST: Triceps skin thickness; C: Circumference; BMI: Body mass index; BSA: Body surface area; TLV: thyroid lobe volume, B. Boys, G: Girls, TLV: Thyroid lobe volume; TTV: Total thyroid volume

studies evaluating the relationship between goiter prevalence and sex (8,24,28). In our study, no reasonable explanation could be made for the higher prevalence of goiter in girls aged 6-9 years.

In many studies, no association between thyroid volume and urinary iodine deficiency was observed (29,30). On the other hand, thyroid volume can change according to sex, BSA, age, and ethnic origin (24-27). However, a limited number of studies have determined the upper limits of the thyroid gland when evaluating thyroid volume in children in Turkey. The thyroid volumes of our children were greater than those presented by the World Health Organization (16). In the present study, we would determine the degree of ID more accurately and could use the values obtained as normal reference values for assessments of thyroid volume in children without ID by stratifying children with or without ID if we were able to use UIE in addition to thyroid sonography. Nevertheless, we think that reference values in our study can be helpful until more ideal percentile curves are created, as iodine deficiency is still endemic in our country.

Limitations

1. The study was conducted in a single region.
2. There is a possibility that differences in personal experience may become prominent during radiological evaluations.

Table 5. Comparison of the frequency of goiter and nodule presence according to sex and age

Yaş	Boys Goiter (n %)	Boys' nodula (n %)	Boys' long axis of the nodule (mm)	Girls Goiter (n %)	Girls Nodula (n %)	Girls Long axis of the nodule (mm)
6	13 (18.6)*	0 (0)**	-	28 (32.6)	1 (1.2)	7.5
7	16 (19.3)**	0 (0)**	-	22 (21.4)	0 (0)	-
8	24 (21.2)**	1 (0.9)**	10	17 (15)	0 (0)	-
9	19 (16.8)*	0 (0)**	-	15 (9.0)	0 (0)	-
10	13 (11)**	1 (0.8)**	6	7 (5.1)	2 (1.4)	6, 4
11	11 (10)**	1 (0.9)**	5	13 (10)	1 (0.8)	9
12	5 (6.8)**	0 (0)**	-	4 (3.7)	0 (0)	-
13	1 (1.2)***	0 (0)**	-	4 (4.3)	0 (0)	-
14	2 (2.5)**	0 (0)**	-	3 (2.9)	1 (1)	6
15	1 (2.0)**	1 (2.0)**	11	4 (3.8)	4 (3.8)	5.5, 6, 7, 7
16	5 (8.2)**	1 (1.6)**	7	2 (2.7)	3 (4.1)	5, 6, 6
17	3 (5.9)**	1 (2.0)**	5	1 (1.8)	1 (1.8)	14
Total	117 (11.3)**	7 (0.7)**	-	120 (9.4)	13 (1)	-

Significant at 5% level, ** Significant at 1% level, *** Significant at 0.1% level*: superscripted letters show p values obtained from the comparison of the frequency of goiter and nodule presence between genders.

Table 6. Comparison of the frequency of goiter according to sex and BSA

BSA	Boys Goiter (n %)	Girls Goiter (n %)
0.8	44 (38.3)**	53 (35.3)
0.9	46 (29.9) ¥	25 (15.8)
1	39 (24.7) £	11 (7.6)
1.1	17 (15.2) ¥	5 (4.5)
1.2	15 (18.3) ¥	5 (4.7)
1.3	8 (12.1) **	9 (8)
1.4	3 (4.9)**	21 (11.5)
1.5	5 (8.1)**	10 (7.1)
1.6	4 (5.6)**	7 (9.3)
1.7	11 (14.1)**	1(4.5)
Total	192 (19.1) £	147 (11.5)

** Significant at 1% level (¥ Boys, £ Girls)
p<0,001; *: p<0,05; **: p>0,05, superscripts letter shows p values obtained from the comparison of the frequency of goiter and nodule presence between genders.

CONCLUSION

Thyroid volume was influenced by age, weight, subcutaneous tissue thickness, waist circumference, and body surface area (BSA). Goiter remains a significant public health concern among school-aged children in Van Province. Furthermore, it is important to emphasize the need for additional studies to establish reference values for normal thyroid volume in children with adequate iodine levels. This study was limited to a single region; thus, it should be supported by larger, multicentric studies encompassing diverse regions.

Ethics Committee Approval: This study was approved by the Ethical Committee of Van Yüzüncü Yıl University (Decision No: 25, Date: 05.09.2013).

Informed Consent: Written consent was obtained from the participants.

Peer Review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study- S.K., M.D., A.Y.; Data Acquisition- S.K., M.D., A.Y.; Data Analysis/Interpretation- S.K., M.D., A.Y., S.K.; Drafting Manuscript- S.K., M.D., A.Y., S.K.; Critical Revision of Manuscript- S.K., S.K.; Final Approval and Accountability- S.K., M.D., A.Y., S.K.

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