

New reference values for thyroid volume by ultrasound in Semirom, Iran: Report of a pilot study

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ABSTRACT

Background and Objective: Physical examination (inspection and palpation) has been the only available method to estimate thyroid size for many years. In areas of mild iodine deficiency, where goiters are small, ultrasonography is preferable compared to palpation for estimating thyroid volume and goiter prevalence. The proper interpretation of ultrasonography requires local reference values for thyroid volume. Our objective was to define local normal values for thyroid volume by ultrasound in school-age children in Semirom, Iran.

Methodology: One thousand eight hundred twenty eight (1828) school children were enrolled in the study. Thyroid size was estimated in each child by inspection and palpation by an expert endocrinologist and was graded according to the WHO's classification. Ninety five children were randomly selected to perform ultrasound. Age specific 97 percentiles for thyroid volume were calculated for boys and girls.

Results: The mean age was 9.12 ± 0.98 (mean \pm SD). The prevalence of goiter by palpation in 1828 school children was 36.7%. 35% of boys and 38.6% of girls were considered goitrous by palpation. The average thyroid volume was 3.46 ± 0.13 ml. In girls, the mean of thyroid volume was 3.47 ± 0.12 ml, while it was 3.45 ± 0.15 ml in boys ($p = 0.18$). The regional 97 percentile of thyroid volume by ultrasound was much lower than the WHO's reference values.

Conclusion: Similar to some other studies, the present study showed that the local reference is preferred for proper assessment and interpretation of thyroid volume, particularly in developing countries.

KEY WORDS: Thyroid volume, Ultrasound, Goiter.

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INTRODUCTION

Iodine deficiency is recognized as the major preventable public health problem worldwide.¹ Iodine deficiency disorders (IDD) cover a wide variety of clinical manifestations ranging from congenital anomalies, cretinism, deaf mutism, psychomotor defects, and severe hypothyroidism to goiter.² Goiter prevalence in school-age children (SAC) is an important indicator of IDD in a population.³ A goiter prevalence $\geq 5\%$ in SAC indicates a public health problem.¹

Physical examination (inspection and palpation) has been the only available method to estimate thyroid size for years. Since in areas of mild to moderate IDD, the sensitivity and specificity of palpation are poor⁴, ultrasonography has been

advocated as being a more reliable method than palpation to assess thyroid size⁵, and it has been recommended in epidemiological surveys.⁶ Thyroid ultrasound is non-invasive, quickly done (2-3 min per subject), and is feasible even in remote areas using portable equipment.³

Goiter is defined as thyroid volume above the 97th percentile of the reference population. Therefore normative values for thyroid volume measured by ultrasound in iodine replete school children are needed.⁷ The original references for thyroid volume that was proposed by Gutekunst et al in 1993⁸ were criticized as being too low.⁹ In 1997, the World Health Organization (WHO) and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) proposed new references for thyroid volume in SAC⁵ that were based on data from SAC in the Netherlands, Slovakia, and Austria. However subsequent reports questioned the WHO/ICCIDD references for thyroid volume in other populations, particularly in developing countries.¹⁰⁻¹²

The aim of this study was to define local normal values for thyroid volume by ultrasound in SAC in Semirom, Iran.

METHODOLOGY

One thousand eight hundred twenty eight (1828) school children were enrolled in the study. They were representative of the socio-economic and cultural status of the population who had been living in Semirom for more than five years. Written consent was obtained from all children's parents. The study was approved by the ethics committee of the Goiter Research Center affiliated to Isfahan University of Medical Sciences.

Weight and standing height were measured. Height was recorded to the nearest 0.1cm and weight was recorded to the nearest 100g. Body surface area (BSA) was calculated by the formula: $\text{weight (Kg)}^{0.425} \times \text{height (cm)}^{0.725} \times 71.84 \times 10^{-4.7}$

Thyroid size was estimated in each child, sitting upright, by inspection and palpation by an expert endocrinologist and graded according to the WHO's classification.¹³ Ninety five children were randomly selected to undergo ultrasound. Thyroid volume was determined by one out of two expert

Table-I: Thyroid size determined by inspection and palpation in school children of Semirom, Iran.

	n	Grade		
		0	1	2
Boys	989	65%	29.2%	5.8%
Girls	839	61.4%	31.7%	6.9%
All	1828	63.3%	30.4%	6.3%

radiologists with a real-time ultrasound (HLS-475M, 7.5 MHZ linear transducer, Honda, Japan). Longitudinal and transverse scans were performed allowing the measurement of the depth (d), width (w), and length (l) of each lobe. The volume of the lobe was calculated by the formula: $V \text{ (ml)} = 0.479 \times d \times w \times l \text{ (cm)}$.⁴ The thyroid volume was the sum of the volumes of both lobes. The volume of the isthmus was not calculated.

Statistical analysis was performed using SPSS for windows ver. 11. The logarithmic transformation was used to normalize the distribution of thyroid volume. Kolmogorov- Smirnov test was applied to check normality before linear regression was done. Correlation and multiple regression analysis were used to examine the association between thyroid volume and age, sex, and anthropometric measurements. The 97th percentile (P97) volumes were computed from P97 of the standard normal distribution.

RESULTS

The frequency distribution of goiter is given in Table-I. The prevalence of goiter by palpation in 1828 school children was 36.7%. Thyroid ultrasound was performed in 95 school children (49 boys and 46 girls). The mean age was 9.12 ± 0.98 (mean \pm standard deviation). The mean of thyroid volume was 3.46 ± 0.13 ml. In girls, the mean of thyroid volume was 3.47 ± 0.12 ml, while it was 3.45 ± 0.15 ml in boys ($p = 0.18$).

Local normal values for thyroid size were assessed as a function of age/gender. The upper limit of normality for thyroid volume as a function of age/gender was defined by the 97th percentile. The mean, median, and P97 of thyroid volume that were normalized for age/gender are given in Table-II.

The goiter prevalence was estimated by ultrasound derived reference values for thyroid volume as a function of age/gender in school children was 3.16%. When the WHO/ICCIDD's ultrasound thyroid volume references for age/gender⁹ were considered, none of the subjects had goiter.

Using local ultrasound thyroid volume references for age/gender as gold standard, the sensitivity

Table-II: The mean, median, and 97th percentile (P97) of thyroid volume (ml) by age and gender in school children of Semirom, Iran.

Age	Boys			Girls		
	Mean	Median	P97	Mean	Median	P97
8	3.39	3.38	3.57	3.40	3.44	3.57
9	3.41	3.42	3.58	3.47	3.48	3.61
10	3.54	3.47	3.86	3.54	3.54	3.78
11	3.68	3.68	3.70	3.55	3.47	3.80

and specificity of thyroid palpation were 100% and 70.65%, respectively. The positive and negative predictive values were respectively assessed as 10% and 100%. A total of 27 (28.42%) children that were classified as goitrous by palpation had normal thyroid volume by ultrasound (false positive). False negative of the determination of goiter by palpation was 0%. Positive correlations between thyroid volume and BSA ($r = 0.55$, $p < 0.001$) and age ($r = 0.49$, $p < 0.001$) were found in this study.

DISCUSSION

The WHO classification of goiter by inspection and palpation are suitable for measuring goiter prevalence in areas of moderate to severe iodine deficiency with a high proportion of large goiter. In areas of mild iodine deficiency like Semirom¹⁴, where goiters are small, ultrasonography is clearly preferable compared to palpation for estimating thyroid volume and goiter prevalence.¹⁵

Correct interpretation of ultrasonography results depends upon availability of a valid reference.⁷ Recently, many studies advocate that the local references were more accurate and preferred for proper assessment and interpretation of thyroid volume, particularly in developing countries.¹⁰⁻¹²

In this study there was no significant difference in thyroid volumes between boys and girls and this is in agreement with other studies.¹⁰⁻¹² The median of thyroid volumes of the children in our study was comparable with those by Azizi et al⁷ and Delange et al.⁹ The P97 of thyroid volumes of the children in this study are much smaller than those reported by Gutekunst et al⁸, Delange et al⁹, Foo et al¹⁰, Xu et al¹¹, Azizi et al^{7,12} and Burgi et al.¹⁶

The probable factors that accounted for the differences between our thyroid volume values and others include genetic, environmental and methodological factors such as inclusion of isthmus in thyroid volume estimation, participant's position, type of transducer/instrument, and ultrasound practical experience of the operators. This study was carried out on a small sample of population of Semirom school children. However, the findings of this study justify another study with larger sample size.

In conclusion, like some other studies, the present study supported this fact that the local reference values for thyroid volume should be used to estimate the prevalence of goiter in different regions.

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