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Normal values of Thyroid Ultrasound Volume of School Children in non-iodine deficiency area Abomey Calavi in Benin

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Abstract

According to WHO, the school-age children are more vulnerable to disorders caused by iodine deficiency (IDD). The prevalence of goiter in this age is an indicator of the severity of these disorders in a population. Assessing the prevalence in a moderately iodine-deficient area is more reliable by measurement of thyroid ultrasound volume (TUV) than palpation method. This study aims to define the upper limits of normal TUV which can be referenced in school children aged 06 to 12 years of Abomey-Calavi. A coastal city apparently without iodine deficiency and the most populous of Atlantic Department in southern Benin. Inclusion criteria were formulated. Children were selected at random in a cluster of 09 schools. For each of them, urinary iodine was measured, anthropometric parameters (age, sex, height, weight) were recorded and ultrasound explorations were performed to calculate TUV. The normal upper limits are the 97th percentiles of TUV calculated firstly according to age and sex and the other based on sex and body surface area (BSA). Study population includes 134 schoolchildren, 68 girls (50.70%) and 66 males (49.3%). The urinary iodine was between 100 µg / l and 300µg / l in 93.3% of children and 300 and 400 µg / l for others. In girls, 97th percentiles of TUV were respectively by age categories (06 to 12) years: 1.99 ml; 2.71 ml; 2.06 ml; 2.54 ml; 4.70 ml; 3.81 ml; 5.22 ml. For boys, respectively: 1.82 ml ; 2.11 ml ; 2.19 ml ; 2.80 ml ; 3.06 ml ; 4.6 ml ; 3.9 ml. TUV were normal in 91.04% of children. According to BSA, 97th percentiles of TUV for girls were: 2.04 ml; 3.86 ml; 2.05 ml; 3.63 ml, 4.7 ml, 5.25 ml, 3.88 ml, 4.38 ml, in boys nc; nc; 1.19 ml; 2.89 ml; 3.52 ml; 3.93 ml; 4.22 ml; 4.83 ml; nc (nc = not considered). The TUV were normal in 88.06% of schoolchildren. Upper limits of normal TUV values obtained wee fairly consistent and could serve as references for the interpretation of survey and monitoring data obtained by ultrasound in school children.

Keywords: Normal values, thyroid ultrasound volume, iodine deficiency, schoolchildren, abomey-Calavi

Introduction

According to WHO, the schoolchildren are more vulnerable to iodine deficiency disorders (IDD). Thus, the prevalence of goiter in this age is a fairly reliable indicator of the severity of these disorders in a population[1]. Assessing the prevalence in a moderately iodine-deficient area is more reliable by measurement of thyroid ultrasound volume (TUV) than palpation method[2-5]. In such areas, palpation method has a very low sensitivity and specificity[6]. Palpation increases the risk of overestimating goiter prevalence and interobserver variability is high[7].

However, the application of the ultrasound method requires some precautions. Indeed, in the context of epidemiological investigation, detecting and monitoring IDD requires referential TUV data unfortunately vary from one country to another[5,8,9]. Each country must therefore, establish its own referential standards of TUV to better assess IDD in the population. Our study aim to determine the upper limits of normal TUV basis on sex, age and body surface area among schoolchildren in Abomey-Calavi, a coastal city apparently without iodine deficiency and the most populous of Atlantic Department in southern Benin.

Material and Methods

Our study population includes children of both sexes aged 06 to 12 years selected at random in a cluster of 09 primary schools in Abomey-Calavi. For each of them, urinary iodine was measured, anthropometric parameters (age, sex, height, weight) were recorded and ultrasound explorations were performed to calculate TUV.

Determination of urinary iodine: Urine samples were taken in the morning at 08 o'clock. The iodine concentration was measured at the Research Unit Ecotoxicology and Quality Study (UREQ) at Polytechnic School of Abomey-calavi through Sandell-Kolthoff method[10]. This assay was used to verify the iodine status of our population in order to certify its non-iodine deficiency.

Anthropometric data: Age and Sex: Age was determined by year from the birth certificate or school record. Sex was recorded on the survey sheet for each child.

Weight: schoolchildren were weighed using a mechanical scale brand CAMRY iso 9001:2008 witch limit of detection ranging between 0 and 120kg. Before any measurement, each child had discarded his shoes and any compromising object and dressed in a negligible weight jacket.

Size: The size (in cm) was taken in a static position in the same terms as weight, using a tape stuck against a vertical board.

Body surface area (BSA) in m^2: DUBOIS formula was used to estimation BSA.

$BSA= W^{0,425} \times S^{0,725} \times 71,84 \times 10^{-4}$ [11].

W=Weight; S=Size.

Ultrasound data: The thyroid ultrasound was performed in real time in schools. A portable ultrasound SIEMENS with a 7.5 MHz linear probe was used. All measurements were performed by one and only one investigator, specialist in thyroid ultrasound. To measure thyroid volume, longitudinal and transversal sections had been made to determine the thickness (t) in centimeters, the breadth (b) and length (L) of each thyroid lobe. Thyroid lobe volume (VL) in cm^3 was calculated from the formula:
$VL = t \times b \times L \times (0.479)$[12].

Isthmus volume had been neglected. TUV was therefore the total obtained by adding the volume of two lobes. TUV were calculated firstly according to age and sex, on the other based on sex and BSA. The normal upper limits used are 97th percentiles of TUV as recommended by WHO and ICCIDD[13] adapted by Zimmermann[14].

Statistical Analysis: Epi Info 3.5.3 French and Microsoft Excel 2007[15,16] were used for Data Processing. Statistics related to the mean, median, standard deviation, the minimale, maximum and 97th percentile were used to analyze the dimensions.

Results and Discussion

134 schoolchildren aged 06 to 12 years, 68 girls (50.70%) and 66 males (49.3%) were included in this study. The sex ratio was 1.03. The youngest was a girl while the oldest was a boy. Table 1 shows the frequency distribution of urinary iodine concentrations. Almost all schoolchildren (93.30%) had a urinary iodine levels between 100 and 300µg/l, while the other (6.70%) have a rate between 300 and 400 µg/l, indicating an excess of iodine.

Table-1
Distribution of schoolchildren according to the urinary iodine levels

Urinary iodine (µg/l)	Number	Frequency
100-200	62	46,30
200-300	63	47,00
300-400	9	6,70
Total	134	100

Tables 2 and 3 present respectively, comparisons of normal upper limits of TUV in terms of age, sex with international standards. Abomey is not a known endemic goiter area. The median urinary iodine 210µg/l confirms that the area is not iodine deficiency. However, the prevalence of goiter detected, is respectively 8.96% and 11.94%, by age and sex, sex and body surface area. In the group of girls, the 97th percentile of TUV by age varies from 1.99 to 5.22 ml (table 2); in males from 1.82 to 4.01ml (table 3). Based on body surface, TUV varies in girls group from 2.04 to 4.38 ml (table 4); in boys due to low staffing problem, we considered BSA between 0.8 and 1.3 m^2. Therefore in this part of BSA, the 97th percentile of TUV varies from 1.19 to 4.83 ml (table 5).

Table-2
Comparison of upper limits of normal (T function age) girls with international standards

Age	P^{50} Zimmermann[22]	P^{50} ThyroMobil west Africa[23]	P^{50} Current study	P^{97} Zimmermann[22]	P^{97} ThyroMobil west Africa[23]	P^{97} Current study
6ans	1,57	1,9	1,44	3284	3,4	1,99
7 ans	1,81	2,2	2,09	3,26	3,5	2,71
8 ans	2,08	2,2	1,82	3,76	3,6	2,06
9 ans	2,40	2,3	1,56	4,32	3,6	2,54
10 ans	2,76	2,4	2,94	4,98	3,7	4,70
11 ans	3,17	3,2	3,24	5,73	4,5	3,81
12 ans	3,65	3,3	3,49	6,59	7,6	5,22

Table-3
Comparison of normal upper limits of VET (age based) boys with international standards

Age	P50 Zimmermann (WHO)[22]	P50 ThyroMobil West Africa[23]	P50 Current study	P97 Zimmermann (WHO)[22]	P97 ThyroMobil West Africa[23]	P97 Current study
6ans	1,60	2,0	1,21	2,91	3,1	1,82
7 ans	1,80	2,1	2,03	3,29	3,1	2,11
8 ans	2,03	2,4	1,08	3,71	3,4	2,19
9 ans	2,30	2,5	1,81	4,19	3,5	2,80
10 ans	2,29	2,6	2,57	4,73	4,3	3,09
11 ans	2,92	3,1	2,78	5,34	4,7	4,88
12 ans	3,30	3,8	2,67	6,03	6,6	4,01

Table-4
Comparison of upper limits of normal (TUV function BSA) girls with international standards

BSA	P50 Zimmermann (WHO)[22]	P50. Current study	P97 Zimmermann (WHO)[22]	P97 Current study
0,7m^2	1,46	1,81	2,56	2,04
0,8m^2	1,67	2,16	2,91	3,86
0,9m^2	1,9	1,76	3,32	2,05
1,0m^2	2,77	2,06	3,79	3,63
1,1m^2	2,47	3,19	4,32	4,70
1,2m^2	2,82	3,16	4,92	5,25
1,3m^2	3,21	3,03	5,61	3,88
1,4m^2	3,66	4,08	6,40	4,38

Table-5
Comparison of upper limits of normal (TUV function BSA) boys with international standards

BSA	P50 Zimmermann (WHO)[22]	P50 Current Study	P97 Zimmermann (WHO)[22]	P97 Current Study
0,7m^2	1,47	-	2,62	-
0,8m^2	1,66	1,42	2,95	1,19
0,9m^2	1,86	2,05	3,32	2,89
1,0m^2	2,10	2,61	3,73	3,52
1,1m^2	2,36	2,55	4,2	3,93
1,2m^2	2,65	3,14	4,73	4,22
1,3m^2	2,99	4,01	5,32	4,83
1,4m^2	3,36	-	5,98	-

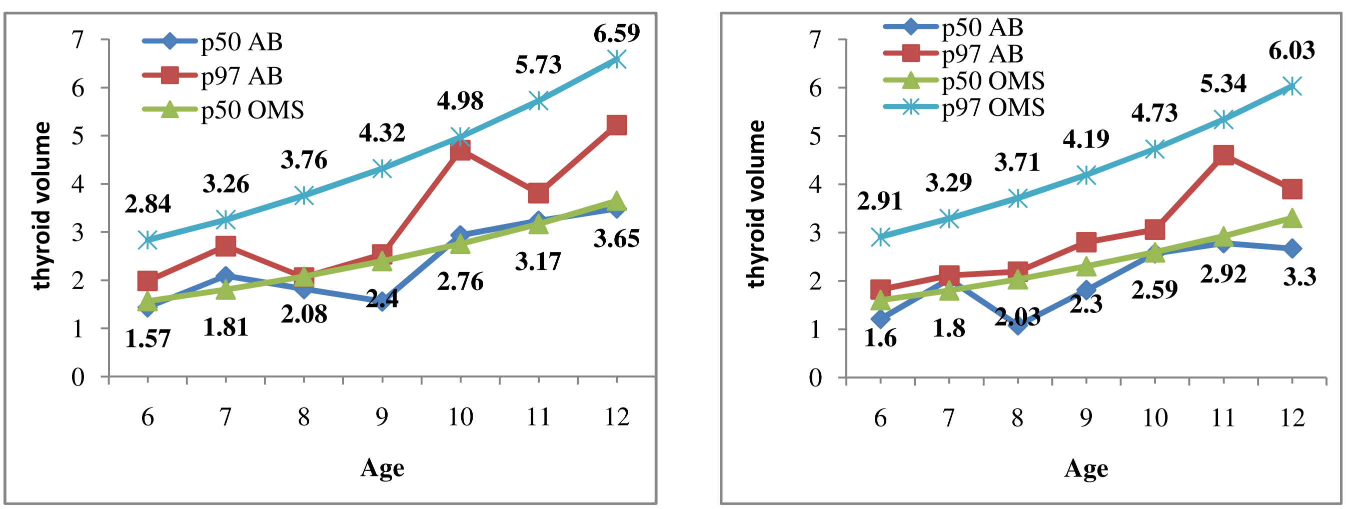

Figure-1
Comparison of TUV schoolchildren calculated according to age with the 2004 WHO reference (a: Male b: Girls)

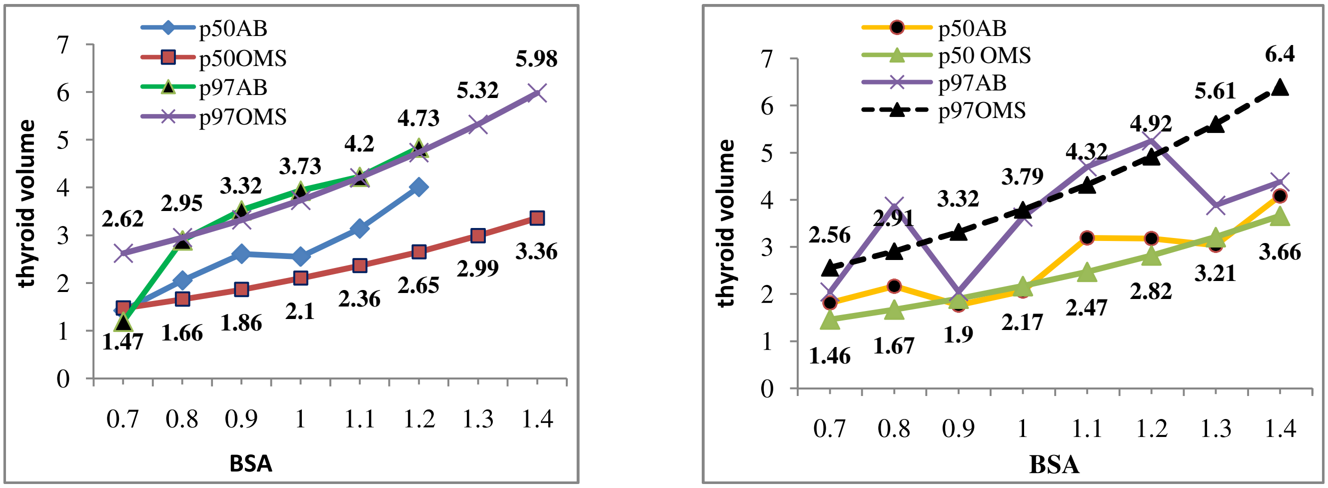

Figure-2
Comparison of TUV schoolchildren calculated based on body surface with the WHO 2004 reference (a: Male b: Girls)

Discussion: This study has verified the iodine status and determined normal values of TUV in schoolchildren. The different data are used to assess locally, the effectiveness of battle against IDD through universal salt iodization strategy and extension of the consumption of iodized salt initiated by the government and its partners at household level[17].

The urinary iodine reflects the consumption standby of iodide level. Thus, the severity of IDD is evaluated based on the median of urinary iodine[18]. The median urinary iodine level in our sample is 210µg/l and any child has a lower rate to 100 µg/l. This shows that the schoolchildren of this community do not suffer from a dietary iodine deficiency. However, a total of nine (09) schoolchildren (6.7%) had a urinary iodine levels above 300 mg/l, which reflects an excess of iodine consumption whose consequence is the effect of Wolff –Chaikoff[19]. The prevalence of goiter sonographically determined by the two sets of thresholds (age, sex) and (SC, sex) are 8.96% and 11.94% respectively. These different rates of persistence quite surprising goiters direct us to several tracks.

First, we suspect that due to the mobility of schoolchildren, some of them may immigrate an endemic area to recover sharply in Abomey-Calavi**.**

Now a day, Abomey-Calavi is as we know the new dorm cited which receives every year many transferred children to other schools for various reasons.

Under these conditions, the daily iodine intake in the new locality *(Abomey*-Calavi) will quickly improve urinary iodine levels but have a fairly significant effect on the thyroid volume. This confirms published results in 2001 by WHO and UNICEF indicated that normalization of TUV may be several years after the correction of dietary iodine deficiency[1].

Then, we must also fear the adverse effects of goitrogenic foods on the incorporation of iodine in thyroid gland. An investigation is needed to assess the toxicity of the foods consumed by our schoolchildren. There are foods that contain substances that prevent use of iodine in the body. These substances are divided into three groups: the flavonoids in soybeans decreased intestinal absorption of thyroxin; thioglucosides contained in cruciferous (cabbage, turnip) and cyanoglucosides whose main source is cassava. The cyanoglucosides contain cyanide which is converted in gastrointestinal tract into thiocyanate, a potent inhibitor of the uptake of iodine in the thyroid gland.

The link of TUV in relation to sex parameter shows that girls the thyroid volume is comparable to girls than boys (p = 0.095). These results confirm those found by other authors who have worked in areas where iodine intake is adequate[8,20,21]. Our 50th and 97th percentiles of TUV were compared with WHO references adapted by Zimmermann[22] and Thyromobil coastal cities, Cotonou (Benin) and Lomé (Togo)[23]. Depending on age, our data are slightly lower than international standards both sexes. We must recognize that international standards were published in 2004, in the final phase of the battle against IDD in different countries explored. We can therefore assume that, almost ten years after the fight, TUV had time to undergo regression was significant.

The reconciliation of TUV in relation to gender parameter shows that the thyroid volume is comparable to girls than boys (p=0.095). These results confirm those found by other authors who have worked in areas where iodine intake is adequate[8,20,21]. Our 50th and 97th percentiles of TUV were compared with the 2004 WHO references adapted by Zimmermann[22] and Thyromobil coastal cities Cotonou (Benin) and Lomé (Togo)[23]. Depending on age, our data are slightly lower than international standards data for both sexes. We must recognize that international standards data were published in 2004, during the final phase of the fight against IDD in different countries explored. We can therefore assume that, almost ten years after this fight, thyroid volume had time to undergo a significant regression.

Conclusion

The fight against disorders caused by iodine deficiency requires a permanent and increased surveillance. Under these conditions, the data from our study will be quite obvious utility. Indeed, the normal upper limits of the VET obtained values are fairly consistent and can serve as references for the interpretation of survey and monitoring data obtained by ultrasound in schoolchildren. This study should therefore be generalized to all of our schoolchildren in order to lead to the establishment of national standards of TUV depending on the recommendations of who and UNICEF.

References

1. *WHO; UNICEF; ICCIDD,* Assessment of iodine deficiency disorders and monitoring their elimination. A guide for programme managers. Geneva*, WHO/NHD*/**01, 1,** 107 **(2001)**

2. *WHO; UNICEF; ICCIDD,* Indicators for assessing iodine deficiency disorders and their control through salt iodization. Geneva*: WHO***,** (WHO/NUT/94.6.) **(1994)**

3. Tapsoba T.L., Ouédraogo T.B., Nacro B., O. Diallo O. and Niampa M. Mensurations échographiques de la thyroïde chez des enfants de zéro à 15 ans de la ville de Ouagadougou, *Med. Nucl*., **32(11),** 573-579 **(2008)**

4. Marwaha R.K., Tandon N., Ashraf G.M., Ganguly S.K., Batra A., Aggarwal R., Kalaivani Mani, and Singh S., Ultrasound evaluation of thyroid size: A large nationwide study of schoolchildren in India, *Nat. Med. J. India,* **21,** 69–74 **(2008)**

5. Zimmermann M.B., Hess S.Y., Molinari L., De Benoist B., Delange F., Braverman L.E., Fujieda K., Ito Y., Jooste P.L., Moosa K., Pearce E.N., Pretell E.A. and Shishiba Y., New reference values for thyroid volume by ultrasound in iodine sufficient schoolchildren: a World Health Organization/Nutrition for Health and Development Iodine Deficiency Study Group Report, *Am. J. Clin. Nutr*., **79,** 231–7 **(2004)**

6. Zimmermann M.B., Saad A., Hess S.Y., Torresani T. and Chaouki N., Thyroid ultrasound compared with world health organization 1960 and 1994 palpation criteria for determination of goiter prevalence in regions of mild and severe iodine deficiency, *Eur. J. Endocrinol*., **143,** 727–31 **(2000)**

7. Tonglet R., Bourdoux P., Dramaix M., Hennart P. and Ermans A., Interobserver variation in the assessment of thyroid enlargement: a pitfall in surveys of the prevalence of endemic goiter, *Food Nutr Bull,* **15,** 64–70 **(1994)**

8. Xu F., Sullivan K., Houston R., Zhao J., May W. and Maberly G., Thyroid volumes in US and Bangladeshi schoolchildren: comparison with European schoolchildren, *Eur. J. Endocrinol*., **140,** 498–504 **(1999)**

9. Seker S. and Tag I., Determination of Thyroid Volume and Its Relation with Isthmus Thickness, *Eur J Gen Med*, **7(2)***,* 125-129 **(2010)**

10. Dunn J.T., Crutchfield H.E., Gutekunst R. and Dunn A.D., Methods for Measuring Iodine in Urine, *International Council for Control of Iodine Deficiency Disorders,* **(1993)**

11. Dubois D. and Dubois E.F., Clinical colorimetry, Tenth paper, A formula to estimate the approximate surface area if height and weight be known, *Archives of International Medicine,* **17,** 863-871 **(1916)**

12. Brunn J., Block U., Ruf G., Bos I., Kunze W.P. and Scriba P.C., Volumetric analysis of thyroid lobes by real-time ultrasound, *Deutsche Medizinische Wochenschrift,* **(106-41),** 1338–1340 **(1981)**

13. WHO, ICCIDD, Recommended normative values for thyroid volume in children aged 6 15 years, *Bull. WHO,* **75,** 95-97 **(1997)**

14. Zimmermann M.B., Molinari L., Spehl M., Weidinger-Toth J., Podoba J., Hess S. and Delange F., Towards a consensus on reference values of thyroid volume in iodine replete schoolchildren results of workshop on interobserver and interequipment variation in sonographic measurement of thyroid volume, *Euro. J. Endo*., **144,** 213-20 **(2001)**

15. Ancelle T., Statistique épidémiologie, *2e édition, Paris : Maloine,* 300 **(2006)**

16. Schwartz D., Statistique médicale et biologie, *5e édition, Paris : Flammarion,* 125 **(1985)**

17. Snu Benin, Bilan Commun de Pays. Système des Nations Unies au Bénin **(2002)**

18. OMS, Série sur les micronutriments : Indicateurs d'évaluation des troubles dus à la carence en iode et de la lutte contre ces troubles par l'iodation du sel. Genève, *WHO/NUTm* **(94.6), 5**0 **(1994)**

19. Roti E.; Degli Uberti E., Iodine excess and hyperthyroidism, *Thyroid*., **(11),** 493–500 **(2001)**

20. Aghini-Lombardi F., Antonangeli L., Pinchera A., Leoli F., Rago T. and Bartolomei A., Effect of iodized salt on thyroid volume of children living in an area previously characterized by moderate iodine deficiency, *Journal of Clinical Endocrinology and Metabolism,* **82,** 1136–1139 **(1997)**

21. Ivarsson S.A., Persson P.H. and Ericsson U.B., Thyroid gland volume as measured by ultrasonography in healthy children and adolescents in non-iodine deficient area, *Acta Paediatrica Scandinavica,* **(78),** 633-634 **(1989)**

22. Zimmermann M.B., Hess S.Y., Molinari L., de Benoist B.; Delange F. and Braverman L.E., New reference values for thyroid volume by ultrasound in iodine sufficient schoolchildren: a World Health Organization/Nutrition for Health and Development Iodine Deficiency Study Group Report, *Am. J. Clin. Nutr*., **79, 231-7 (2004)**

23. Ntambwekibambe T., Acakpo A., Ouedraogo A. and Salami M., Evaluation rapide des troubles dus à la carence en iode : le projet Thyromobil dans six pays d'Afrique de l'Ouest, *Nutrition Third World Brussels,* 51-62 **(2004)**