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## Estimation of the Thyroid Gland Volume by Means of Ultrasonography among School Children in Aktobe Area, Kazakhstan.

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### ABSTRACT

Necessity of local data for carrying out screening among children with increase in a thyroid gland. It was determined the volume of a thyroid gland by ultrasonography among school children of the Aktobe area, Kazakhstan. During the period from May to December, 2013 it was conducted the transversal research on the school children, living in oil-and-gas and pollution-free regions of Aktobe area, Kazakhstan. In total 815 schools of 7-11 year-old-children, answered of criteria of the research, were included in the research. The anthropometry was measured before ultrasonography, and then the doctor of the functional diagnostics took measurement of thyroid volume by means of the portable ultrasonic device, according to the protocols recommended of WHO (World Health Organization). Ioduria was checked at 10% of the school children chosen in a random way. Prevalence of a goitre in our sampling with use of the 97% of volume, recommended of WHO / ICCIDD (2007) made  $24,7 \pm 1,50\%$ . Distribution of a goitre in areas is made: 44,6 42,8% in the oil-and-gas area (20,4% at girls and 24,18% at boys) and 8,3% (5,6% at girls and 2,7% at boys) in the pollution-free area. The mean values of the total thyroid volume (TTV), measured by means of ultrasonography, are made in oil-and-gas areas  $4,43 \pm 1,66$  ml, in -  $2,9 \pm 1,24$  ml ( $p < 0.0001$   $p < 0.0001$ ). The difference in TTV between boys of the compared areas was statistically significant ( $p < 0.0001$ ):  $4,62 \pm 1,75$  ml against  $2,78 \pm 0,93$  ml; between girls of oil-and-gas and safe areas -  $4,23 \pm 1,53$  ml against  $3,05 \pm 1,52$  ml accordingly ( $p < 0.0001$ ). The size of a thyroid gland of school children in Aktobe area of the Western Kazakhstan is higher, than reference values, about which was reported from WHO. These data can be used for definition of the local reference during of carrying out of screening among children with increase in the thyroid gland. High prevalence of the goitre in oil-and-gas areas against the background an adequate iodine provision according to a ioduria testify that in the region possibility of formation of an endemia at the expense of the raised content of xenobiotics in a surrounding medium is not excluded, in this case products of petroleum refining and gas, and is required further studying.

**Keywords:** goitre, Aktobe area, Western Kazakhstan, oil-and-gas areas, volume of a thyroid gland, ultrasonography, children.

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## INTRODUCTION

High prevalence the iodine-deficient of diseases (IDD) and a wide range of negative consequences of an iodine-deficit are allowed to carry them to the most widespread noninfectious diseases of the person, which can be protected by means of providing the population with necessary quantity of iodine. According to WHO data, 2 billion people around the world have risk of development of IDD. Iodine deficiency, besides increase in volume of a thyroid gland, conducts to decrease in intelligence, a delay of physical and mental development, aggravates somatic pathology at children and teenagers, leads to decrease in capacity of all community subject to it and it is a global problem of public health care of the whole world [1-4].

In the territory of Aktobe area it is located the large-scale oil and gas deposit, where immediate oil-and-gas recovery is carried out that aggravates an adverse ecological situation in area and has an adverse effect on a level of health of the population, conducts to increase of the level of incidence.

For a number of years, the palpation of the thyroid gland (TG) was a standard method of determination of its sizes. Despite simplicity of realization of a palpation, sizing by means of ultrasonic investigation (ultrasonography) it is more preferable because of subjective factors, low sensitivity and specificity of a palpation. Ultrasonography is the safe, noninvasive method, allowing carrying out more precise measurement of the TG sizes, than a palpation. It has the particular importance when prevalence of a visible goitre is small [1, 5, 6]. In 2003 the international standards of volumes of a thyroid gland are established [7]. Nevertheless, the standard reference values for TG volumes in the conditions of adequate intake of iodine are a subject of discussion [8-12]. The TG sizes were estimated only according to a palpation in earlier conducted researches in Kazakhstan [13,14].

The purpose of the real work it was determination of volumes of TG by means of ultrasonography at school children aged from 7 till 11 years, living in oil-and-gas and ecologically safe regions of Aktobe area of the Republic of Kazakhstan.

## MATERIALS AND METHODS

It was conducted transversal research on 7-11 year-old- school-children of Aktobe area, Kazakhstan after the adoption of research by local ethical committee of the West Kazakhstan State Medical University named after Marat Ospanov (the protocol No. 06/01-7 of 05.01.2013) and receiving the written informed consent from parents or trustees before inclusion in research in the period from May to December, 2013. Work was carried out according to requirements of GCP.

Research is conducted within 30 cluster analyses of prevalence of the goitre in Aktobe area. The methodology of research corresponded to the protocols recommended from WHO on studying of an endemic goitre. It was allocated the settlements in Aktobe area, according to data of Department of statistics of area, being in oil-and-gas areas (OG) where it is immediately conducted oil-and-gas recovery. It was selected equal number of settlements from ecologically safe areas (SA) as control group by the method of a random sample, relating only to agricultural areas. The choice of schools in areas is carried out with use of the table of random numbers. It was examined the children of 3 - 4 classes of elementary school, who are constantly living in this district, by the continuous method at these schools. We have the free education accessible to all segments of the population in Kazakhstan.

The main criteria of inclusion were the prepubertal age of children (7 – 11 years), existence of the written informed consent from parents or trustees before inclusion in research. Criteria of an exception are: children with heavy somatical of heart disease, liver and kidneys, and also existence in the anamnesis of surgical interventions on a thyroid gland. The available medical records about the level of health of school children, data of medical examinations, conversations with parents, teachers and participants of research were used for detection of criteria of an exception. All demographic data (a sex, age, weight and growth) were recorded in the questionnaire. Growth and weight of children were determined by a standard methodology before research. Then the qualified doctor-functionalists carried out ultrasonography of TG according to the standard recommendations, in a recumbency with the thrown-back head. The portable ultrasonic Aloka SSD-500 device (Japan) with the sensor of 7,5 MHz was used.

The sizes of a thyroid gland and standard specifications (in ml) of thyroid volume at children were defined and estimated depending on the body surface area (BSA) and the sex according to WHO recommendations (2007) [1,7]. It is recommended to be guided by dependence on BSA in regions with a high insufficiency of protein in nutrition of the population and, shown also in a growth inhibition and poor weight. The thyroid volume (ml) was calculated by a formula Brunn (1981) [15] as the sum of product of width (W), lengths (L) and thickness (T) of each part, multiplied by a correction coefficient:  $[(W \times L \times T) \text{ on the right} + (W \times L \times T) \text{ at the left}] \times 0,479$ . The volume of a thyroid gland is equal to the volume of two of its parts. The volume of an isthmus is not considered. The surface of the area of a body is calculated on a formula Dubois and Dubois [16]:  $BSA (m^2) = (W^{0.425} \times H^{0.725}) \times 0.007184$ .

It should be noted that when using ultrasonic investigation of TG it is considered the increased (goitre), if its volume exceeds the 97% of the volume, found in the population with good in taking of iodine.

Data were analyzed by means of the SAS program, version 9.2 with use of parametrical and nonparametric methods [18]. Qualitative signs were described in the form of parts and absolute values. For the quantitative signs, having a normal distribution, the arithmetic average and a standard deviation were calculated. For the quantitative signs, having different from normal distribution, the median and extreme quartiles were calculated. The nonparametric criterion of Vilkokson (W) was applied to comparison of dependent selections. Comparison of independent selections was carried out by means of Mann Whitney (U) criterion. Statistically the values of criteria and coefficients corresponding  $p < 0,05$  were considered as the significant.

### RESULTS

815 children of Aktobe area were examined in total. The characteristic of the examined children is presented in table 1.

**Table 1: The characteristic of the examined children at the age of 7 – 11 years of Aktobe area, Kazakhstan**

| Main characteristics                  | Oil-and-gas areas |               |               | Ecologically safe areas |               |               |
|---------------------------------------|-------------------|---------------|---------------|-------------------------|---------------|---------------|
|                                       | boys (n=194)      | girls (n=174) | total (n=368) | boys (n=243)            | girls (n=204) | total (n=447) |
|                                       | M±SD              | M±SD          | M±SD          | M±SD                    | M±SD          | M±SD          |
| Age (years)                           | 8,39±1,08         | 8,31±0,76     | 8,35±0,94     | 8,84±0,69               | 8,72±0,67     | 8,68±0,66     |
| Body build index (kg/m <sup>2</sup> ) | 16,41±2,7         | 16,06±2,02    | 16,24±2,40    | 16,46±2,25              | 16,14±2,16    | 16,31±2,21    |
| Growth (cm)                           | 129,31±4,8        | 12,40±6,6     | 129,41±6,8    | 129,41±5,8              | 131,41±6,2    | 130,77±6,6    |
| Weight (kg)                           | 27,17±3,8         | 28,27±4,3     | 27,27±4,8     | 28,29±3,8               | 28,97±2,3     | 28,07±5,44    |
| BSA (cm <sup>2</sup> )                | 0,99 ±0,10        | 0,98 ±0,11    | 0,98 ±0,10    | 0,99 ±0,09              | 1,21 ±0,10    | 1,0±0,13      |
| TTV (ml)                              | 4,62±1,75         | 4,23±1,53     | 4,43±1,66     | 2,78±0,93               | 3,05±1,52     | 2,9±1,24      |
| Rate of goitre(%)                     | 24,18             | 20,4          | 44,6          | 2,7                     | 5,6           | 8,3           |

Note: p – reliability of distinction between indexes oil-and-gas and ecologically safe areas

The most significant criterion of the goitre endemia in research is goitre frequency. It is revealed that goitre frequency in the region averages is 42,8% according to 30 cluster analyses of prevalence of the goitre in Aktobe area in 2013. Goitre endemia of heavy case is noted in the region on the basis of the criteria of an assessment of severity of iodic deficiency, offered by WHO.

In the analysis of the obtained data it is revealed that the relative frequency of the goitre at school children in OG areas considerably exceeds indicators in ecologically SA areas, both at boys, and at girls all age groups. Prevalence of the goitre in our selection with use of the 97% of volume, recommended from WHO / ICCIDD (2007), is made 24,7±1,50% (49,8% at girls and 50,2% at boys), of them in OG regions of 44,6% (20,4% at girls and 24,18% at boys) and 8,3% (5,6% at girls and 2,7% at boys) in ecologically SA areas. The analysis of distinctions of prevalence of the goitre showed that the tireomegaliya among children was observed less in SA areas in comparison with OG areas ( $t=12,65$ ;  $p<0,001$ ) and on average on the region ( $t=16,34$ ;  $p<0,001$ ) (figure 1).

The goitre frequency from 164 children with the goitre in OG area was distributed as follows: at 89 (54,3%) boys, at 75 (45,7%) at girls, and in ecologically SA area from 37 children with the goitre, it was observed at 11 (29,7%) boys and at 26 (70,3%) girls. In the analysis of distribution of of the goitre frequency on the sex it is revealed that in OG areas ( $t=1,56$ ;  $p<0,05$ ) and on all region ( $t=3,88$ ;  $p<0,001$ ) the goitre was more often at boys, while in SA areas the goitre was met at girls ( $t=3,82$ ;  $p<0,001$ ).

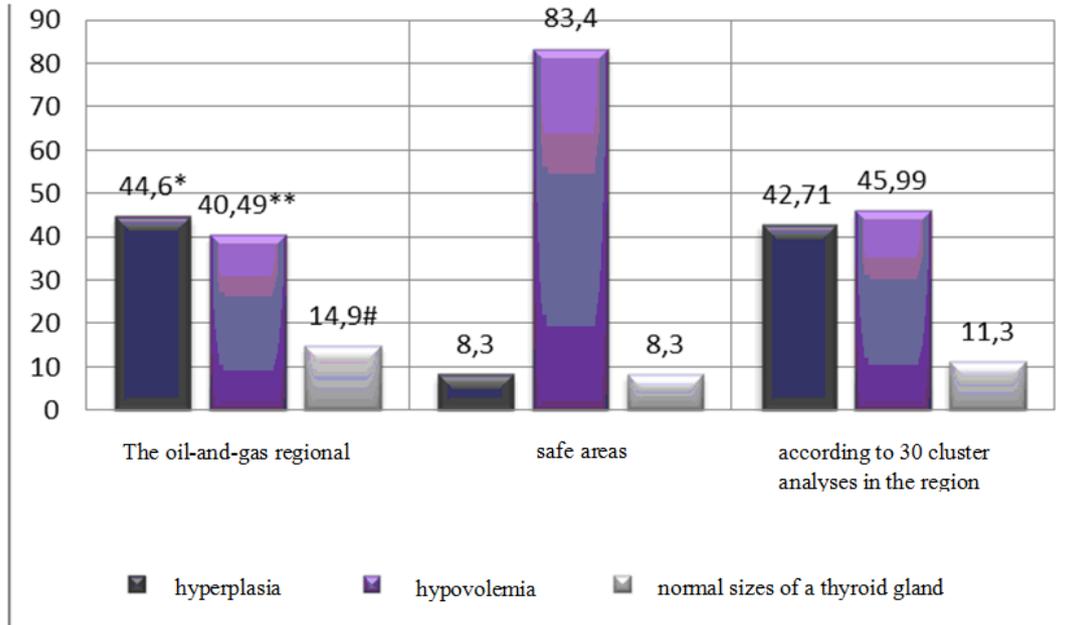


Figure 1: The sizes of a thyroid gland of children in the region according to ultrasonography (%).

Signs of a hypovolemia are found at 522 children, from them in the oil-and-gas area at 149 school children, the safe area at 373.

The average volume of the thyroid gland, measured by means of ultrasonography is made in oil-and-gas areas  $4,43 \pm 1,66$  ml, in the safe region of  $2,9 \pm 1,24$  ml. The difference in volume of the thyroid gland statistically is significant  $p<0.0001$ . The average volume of the thyroid gland at boys is equal in the oil-and-gas area  $4,62 \pm 1,75$  ml, at girls  $4,23 \pm 1,53$  ml; in ecologically safe area boys of  $2,78 \pm 0,93$  ml, at girls have  $3,05 \pm 1,52$  ml respectively. The difference in volume of the thyroid gland between boys of the compared areas statistically was significant ( $p<0.0001$ ):  $4,62 \pm 1,75$  ml against  $2,78 \pm 0,93$  ml; between girls of oil-and-gas and safe areas  $4,23 \pm 1,53$  ml against  $3,05 \pm 1,52$  ml respectively ( $p<0.0001$ ).

Mean value of volume of the thyroid gland does not correlate participants with age ( $r = - 0,02875$ ), but poorly correlates with body build index ( $r= 0,2$  ;  $p<0.0001$ ).

These medians and the 95% of volume of the thyroid gland on the sex and age in the studied areas are presented in tables 2, 3.

Table 2: Comparison of a median and the 95% of volume of a thyroid gland on age, the area at boys of the Aktobe area.

| Age (y) | Oil and gas region (n=194) |             |          | Safe region (n=243) |             |          |
|---------|----------------------------|-------------|----------|---------------------|-------------|----------|
|         | n                          | Median (ml) | 95% (ml) | n                   | Median (ml) | 95% (ml) |
| 7       | 32                         | 3,99        | 7,66     | 2                   | 3,18        | 3,38     |
| 8       | 59                         | 4,6         | 8,75     | 76                  | 2,56        | 4,27     |
| 9       | 79                         | 4,02        | 8,39     | 122                 | 2,64        | 4,46     |
| 10      | 23                         | 4,47        | 7,5      | 40                  | 2,89        | 5,49     |
| 11      | -                          | -           | -        | 3                   | 2,70        | 3,29     |

**Table 3. Comparison of a median and the 95% of volume of a thyroid gland on age, the area at girls of Aktobe area.**

| Age (y) | Oil and gas region (n=174) |             |          | Safe region (n=204) |             |          |
|---------|----------------------------|-------------|----------|---------------------|-------------|----------|
|         | n                          | Median (ml) | 95% (ml) | n                   | Median (ml) | 95% (ml) |
| 7       | 24                         | 3,63        | 5,60     | -                   | -           |          |
| 8       | 65                         | 4,36        | 7,65     | 86                  | 2,78        | 4,7      |
| 9       | 74                         | 3,80        | 6,48     | 95                  | 2,72        | 5,63     |
| 10      | 11                         | 4,5         | 6,78     | 22                  | 2,8         | 6,23     |
| 11      | -                          | -           |          | 1                   | -           |          |

In general, by results of the researches the ioduria median at 81 children is made 193,9±86,1 mkg/l that points to adequate providing the population of these areas with the iodine.

### DISCUSSION

The problem of deficiency of the iodine was solved in Kazakhstan after implementation of the national program of iodination of salt [19,20,21] and goitre frequency was considerably decreased. Nevertheless, the frequency of the goitre is still high among school children in Aktobe area, Kazakhstan [22-24].

In the real research, we presented the volume of a thyroid gland measured by means of ultrasonography at 7-11 year-old-children living in oil-and-gas and ecologically safe regions of Aktobe area, Kazakhstan. In our research data of volume of the thyroid gland are submitted in compliance by sex and BSA. We compared the volume of the thyroid gland, weight, growth, Body build index, BSA at school children of two rural areas but differing on ecological wellbeing. As far as we know, it is the first research in which the volume of the thyroid gland was measured, using the ultrasonography at school children of Aktobe area. We measured average and 95% of volume of the thyroid gland for the different sex and age. In the real research average and the 95% of volume of gland of children of Aktobe area were above the corresponding references reported from WHO as normative values [7]. Our results are coordinated with the research conducted in Egypt [25].

Mean value of volume of the thyroid gland in all age groups was more in the oil-and-gas area, than in safe. In our research it was noted statistically significant excess of volume of the thyroid gland in the oil-and-gas area at boys (4,62±1,75 ml in comparison with 4,23±1,53ml), than at girls that are coordinated with the data obtained by the Iranian researchers [26]. However, in the pollution-free area the volume of a thyroid gland at boys was less, than at girls (2,78±0,93 ml and 3,05±1,52 ml respectively).

Our research had some restrictions. Not all age groups were presented equally. The main part of selection was presented by 8-9 summer school children. We made calculation of thyroid volume depending on the sex and BSA, and we did not carry out comparison of volume of the thyroid gland depending on age. As the researches was shown, the volume of the thyroid gland, calculated on BSA, is more, than on age.

It was revealed essential distinctions at the assessment of volume of the thyroid gland at school children on various criteria by other researchers [28]. Nevertheless, it is recommended to use the criteria based on the body surface area as it is allowed to estimate individual constitutional characteristics of a child development [9].

Average values of body height, weight, Body build index, BSA were higher in the pollution-free area, in comparison with the oil-and-gas area that is quite explainable.

Mean value of volume of the thyroid gland in our research does not correlate participants with age. Between Body build index and average volume of the thyroid gland it is noted a weak correlation, as well as in the research Kaloumenou I with coauthors [27].

The relative frequency of the goitre at school children in the oil-and-gas area considerably exceeds the indicators in ecologically safe area, both at boys, and at girls of all age groups. By the epidemiological criteria, determined by the World Health Organization (WHO) and the International council for control of ID (ICCID), an

index of the common frequency of the goitre among school children 6-12 year-old-children is equal or exceeding 5%, and it is testified about existence of a problem of iodine deficiency. Studying of the obtained data is showed, that high prevalence of the goitre is noted not only in OG areas (44,6%), which exceeds a sporadic incidence almost by 10 times and corresponds to the goitre endemia of heavy case, but also in SA areas, where by criteria of WHO (5%), it is noted the endemia of mild case (8,3%).

Aktobe area refers to the region with a sufficient iodine provision on the ioduria median. However, goitre frequency in the region is high. According to researches it is known that the increase in a thyroid gland after introduction of programs for use of iodinated salt can be remained till four years. In Kazakhstan the share of the households, consuming iodinated salt reaches 92%, the median of the ioduria makes 235,9 + 166,8 mkg/l by results of the national research conducted by Academy of a nutrition in 2006 [19,21].

Resulting all above, it is possible to draw a conclusion that a microelement imbalance, features of the nutrition, struma-genetic effect of xenobiotics, promote the high frequency of the goitre, despite the held preventive events at persons who are living long time in the residential territories with the expressed anthropogenic pollution.

### CONCLUSIONS

The size of the thyroid gland of school children in the Aktobe area of the Republic of Kazakhstan is higher, than reference values, about which it was reported from WHO. These data can be used for detection of the local reference at the implementation of screening among children with increase of the thyroid gland. High prevalence of the goitre in oil-and-gas areas against an adequate iodine provision according to a ioduria data is testified, that it is not excluded the possibility of formation of an endemia at the expense of the raised content of xenobiotics in a surrounding medium of the region, and in this case products of petroleum refining and gas, and also it is required further studying.

Conflict of interests: authors declare that there is no conflict of interests concerning the publication of this document.

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