

## Endemic goiter – the consequence of the deficiency of iodine and selenium in the environment

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**Objective:** to identify the relationship between the concentration of trace elements of selenium and iodine in the objects of the Dagestan biosphere (soil, water sources, plants) and the incidence of endemic goiter of the population of the Republic, which will serve as a scientific basis for clarifying the ecological etiology of this human pathology and more targeted planning of preventive measures by health authorities.

**Materials and methods.** Investigated soils, vegetation, natural water Kizlyar, Rutul, Tlyaratin districts of Dagestan. 5-6 key soil sections were laid on each type of soil. For the analysis of vegetation, the accounting plant sites with the size of 10x10 m (100 m<sup>2</sup>) were laid. The study of the chemical composition of the waters was conducted by the route of the expedition surveys. Water samples were taken in the summer months in vessels with a volume of 2 liters. Iodine and selenium content were determined in the samples. Iodine level was determined by microchemical method, selenium – fluorometrically.

**Results.** The incidence of endemic goiter for 13 years increased in a number of: Kizlyar, Tlyarata, Rutul districts, on average per 1000 population, in the studied areas, was for 2002-2013: in Kizlyar district – 20.1, with a fluctuation of 15 to 25.2; in Rutul district – 37.48 with a fluctuation of 31.6 - 49; in Tlyarata district – 33.85 at a scale of 29.1-40.4. It is noted that the level of iodine and selenium content in soils, plants and water sources of the studied areas differs markedly. Moreover, the lower the content of iodine and selenium in the objects of study, the higher the incidence of endemic goiter. This pattern is confirmed by a significant negative correlation ( $r = -0.87$ ) of iodine and selenium concentrations in the objects of the Dagestan biosphere and the incidence of endemic goiter in the population.

**Conclusion.** The conducted research, indicating the correlation of iodine deficiency and selenium and the incidence of endemic goiter of the population, will help to study the ecological etiology of iodine deficiency diseases in the country.

**For citation:** Yakhyaev M.A., Salikhov Sh.K., Ataev M.G., Tagirova Z.G., Kurbanova Z.V. Endemic goiter - the consequence of the deficiency of iodine and selenium in the environment. *Ecological Medicine* 2019;2(1):62-67. DOI: 10.34662/2588-0489.2019.2.1.62-67.

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Translated from *Ecologicheskaya medicina* 2019. Vol. 2, N 1, pp. 66-71.

Translated by Kakvaeva S.B.

**Keywords:** goiter, soil, plant, water, iodine, selenium.

**M**etabolic changes and the emergence of endemic diseases under the influence of environmental factors is an important problem of geochemical ecology. The value of the chemical composition of the medium is due to the fact that biophilic elements, in particular microelements, are part of vitamins, hormones, enzymes and other biologically active compounds or take part in their synthesis. In this regard, metabolism without disturbances in the organism of plants, animals, and humans is possible only with an optimal level of biophilic elements in the soil and water sources. Such geochemical living conditions have historically developed in the chernozem zone. In other biogeochemical zones and provinces, either a deficiency, or an excess of trace elements, is observed, which leads to a change in biogeochemical food chains and thereby affects the metabolism in the body [7].

In the body, trace elements take part in vital processes: changes in blood parameters, protein synthesis from amino acids, redox reactions involving enzymes, development and growth of tissues and organs, free radical oxidation. A change in the content of one microelement entails an interconnected change in the concentration of others, in the body there is a metabolic disorder, manifested in a change in the activity of enzymes, a violation of the synthesis of amino acids, proteins, hormones, modification of blood counts and As a result, it leads to a particular human disease [10].

Of great importance are iodine deficiency diseases caused by metabolic disorders in the body, which are based on iodine deficiency, as well as other macro- and microelements in the biosphere. They, as a rule, are caused by adverse changes in the geochemical situation in biogeocenoses. With a lack of the trace element iodine in soil, water, and food, its content in the body decreases, which causes a decrease in thyroid function and ultimately leads to a weakening of protein metabolism and a decrease in oxidative processes. Long-term iodine deficiency in the body leads to a decrease in the synthesis of thyroid hormones, compensatory reactions occur in the form of increased secretion of the thy-

roid-tropic hormone of the pituitary gland, which causes hyperplasia of the thyroid gland and its increase. Iodine deficiency in the body is accompanied by a violation of protein, fat, carbohydrate and mineral metabolism, a slowdown in growth and development, a decrease in the function of reproduction, processes inherent in hypothyroidism occur. Over time, there is a violation of glycoprotein metabolism, the accumulation of mucin in the tissues, the appearance of myxedema. Endemic goiter causes the progression of such diseases as anemia, arterial hypertension, coronary heart disease, immune deficiency, atherosclerosis, leads to an increase in infant mortality, and a decrease in the level of intellectual development of the population [4].

Researchers [8, 14] point out that in addition to iodine, the incidence of endemic goiter is also influenced by other macro- and microelements - iron, magnesium, selenium, zinc, cobalt, copper, manganese, chromium, and lead. Thus, the cause of endemic goiter is a natural polyelement imbalance.

The trace element iodine is needed as a building block from which the main thyroid hormones are formed - triiodothyronine (T3) and tetraiodothyronine (T4). However, the trace element iodine is not absorbed in the absence of selenium.

In the development of thyroid dysfunction, the role of the trace element selenium is very important. Selenium activates deiodinases in the thyroid gland, kidneys, liver, pituitary gland and thereby promotes the conversion of T4 to T3 [13]. A deficiency of selenium causes a disruption in the functioning of the antioxidant defense system, which is carried out due to selenium proteins, and thus contributes to the effect of free radicals on lipophilic membranes, leading to the development of atrophy of fibrosis and thyroid gland [15]. Since all chemical elements enter the body from the environment, it is necessary to know its biogeochemical parameters. An assessment of the foci of endemic goiter distribution indicates that the disease most often occurs in ecosystems located in mountainous regions, where the landscape contributes to the removal of the iodine microelement

from soils with melt and rainwater, in biogeocenoses with sandy, acidic soils and their analogues.

Purpose: to study the relationship of selenium and iodine concentration in the Dagestan ecosystem with the incidence of goiter among the population of the republic, which will serve as a scientific basis for clarifying the etiology of endemic goiter and more targeted planning by health authorities of preventive measures.

### Material and methods

The location of various types of soils and the modification of their properties in the lowland and mountainous conditions of Dagestan is subject to horizontal and vertical zoning. When passing from the plain to the foothills, an arid-foothill, humid-foothill zonality is formed, which reflects the influence of the mountainous terrain [6].

Thus, the soils of Dagestan are characterized by an exceptional variety both in properties and in terms of spatial distribution, which leads to different contents of macro- and microelements in them, the imbalance of which leads to the incidence of the population [1, 11, 12].

The natural conditions of Dagestan are distinguished by complex paleogeography, a peculiarity of geological-geomorphological and climatic conditions, which led to increased biological and landscape diversity, different contents of macro- and microelements in plants [9].

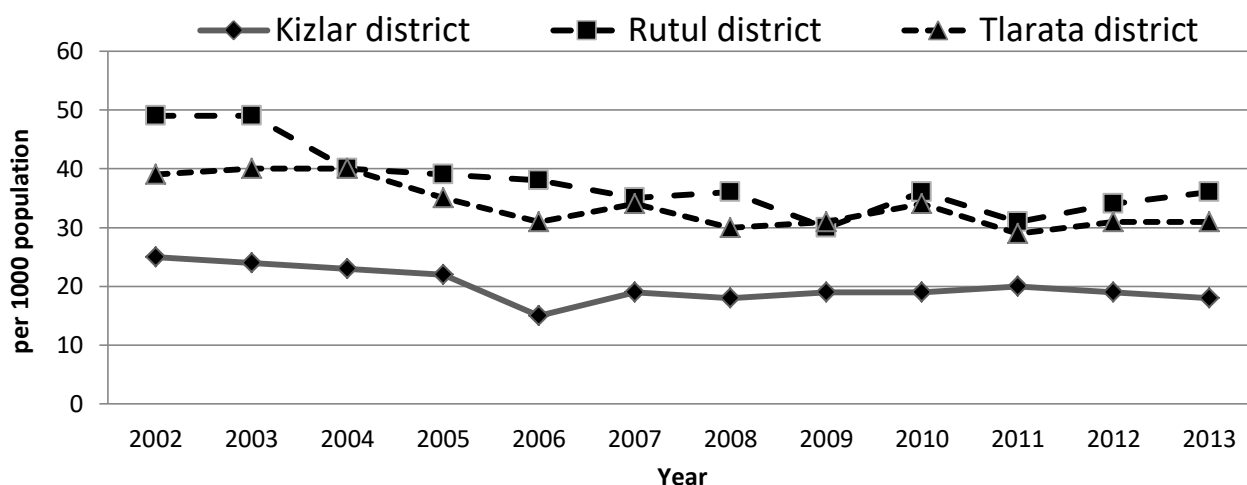
The development of the river network of Dagestan is determined by the topography and climatic conditions. According to the data of [2], river waters have different mineral composition, due to the variegation of the soil cover and various environmental conditions of their confinement.

We have analyzed the soils, vegetation, natural waters of the Kizlyar, Rutul, Tlyarata districts of Dagestan.

Taking into account the area of soil contours on each soil type, 5–6 key soil sections were laid. After cameral processing, the content of trace elements of iodine and selenium was determined in the samples. For the analysis of vegetation, accounting plots of 10x10 m (100 m<sup>2</sup>) in size were laid. The study of the chemical composition of the waters was carried out by route expeditionary surveys. Water samples were taken in the summer months in vessels of 2 liters. The iodine level in the objects of the biosphere of Dagestan was determined by the microchemical method [3], selenium - fluorometrically [5]. The analysis results were statistically processed using the Microsoft Excel computer program.

### Results and discussion

The incidence of endemic goiter according to the Ministry of Health of the Republic of Dagestan, in the administrative regions: Kizlyar (lowland Dagestan); Rutul (southern mountain Dagestan); Tlyarata (northern mountainous Dagestan), markedly different (figure).



Picture. The incidence of endemic goiter in the Republic of Dagestan (per 1000 population).

On average, the incidence of endemic goiter in the studied areas was 2002–2013 per 1000 population: in the Kizlyar district - 20.1, with fluctuations from 15 to 25.2; in the Rutul district - 37.48 with a fluctuation of 31.6 - 49; in Tlyarata district - 33.85 with a range of 29.1-40.4.

Thus, the incidence rate of the population of the regions examined by us, both by

years and on average over 13 years, increased in the series: Kizlyar → Tlyarata → Rutul.

Soils, vegetation, water sources of the indicated regions of the republic were examined for the content of trace elements — iodine and selenium (Table 1).

**Table 1. The content of iodine and selenium in the objects of the biosphere of Dagestan**

Object of study	Administrative district		
	Kizlyar	Rutul	Tlyarata
<b>Iodine</b>			
Soil, mg / kg	2,4	1,64	2,1
Plants, mg / kg	0,4	0,15	0,2
Water sources, mg / L	2,8	2,0	2,3
<b>Selenium</b>			
Soil, mg / kg	2,16	0,08	1,16
Plants, mg / kg	0,03	0,009	0,023
Water sources, mg / L	1,7	1,14	1,4

From the obtained data it is seen that the level of iodine and selenium content in the soils, plants and water sources of the Kizlyar, Rutul and Tlyarata districts is noticeably different. Moreover, the lower the content of iodine and selenium in the objects of study, the higher the incidence of endemic goiter of the population.

This regularity is confirmed by a significant negative correlation of the concentration of iodine and selenium in the objects of the biosphere of Dagestan with the incidence of endemic goiter of the population of the studied administrative regions (Table 2).

**Table 2. The correlation coefficient between the incidence of endemic goiter and the content of iodine and selenium in the objects of the biosphere of Dagestan (Kizlyar, Rutul, Tlyarata administrative districts)**

Object of study: endemic goiter	Correlation coefficient
iodine in soils: endemic goiter	-0,90
iodine in plants: endemic goiter	-0,99
iodine in water: endemic goiter	-0,98
selenium in soils: endemic goiter	-0,94
selenium in plants: endemic goiter	-0,87
selenium in water: endemic goiter	-0,96

### Conclusion

The content of trace elements in food is largely determined by the geochemical conditions of the area. In modern conditions, the population of developed countries is characterized by the inclusion in the diet of food products, a large proportion of which is grown far from the consumption area, which eliminates the circumstances

that contribute to the influence on the person of the geochemical conditions of the area. The imbalance of trace elements in the surrounding biogeochemical environment through water and food products is reflected in the balance of trace elements in the human body. The study of endemic goiter from the standpoint of understanding its causes will make it possible to find more

effective ways to prevent it and contribute to the knowledge of the pathogenesis of the disease associated with the imbalance of trace elements.

Studies that indicate a correlation between iodine deficiency and selenium deficiency and the incidence of endemic goiter in the population will help to study the etiology of iodine-deficient diseases in the republic and the scientific approach in planning preventive measures to eradicate them.

### Funding and Conflict of Interest Information

The authors declare no apparent and potential conflicts of interest related to the publication of this article.

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