

# **HYGIENIC ASSESSMENT OF THE EFFECTS OF PESTICIDES APPLICATION ON CHILDREN POPULATION MORBIDITY WITH THYROID GLAND DISEASES**

Antonenko A.M., PhD, Vavrinevych O.P., MD, Korshun M.M., MD, Omelchuk S.T.,  
MD

Hygiene and ecology institute (head – prof. Omelchuk S.T.) of Bogomolets National  
Medical University  
Kyiv, Ukraine

**Summary.** It is proved that some groups of fungicides and herbicides are capable of affecting the thyroid gland, provoking its growth, leading to a compensatory change in the activity of the hormones synthesis. Therefore, the presence of their residual amounts in plant may affect the level of thyroid gland pathology.

**The purpose** of the work was to analyze the influence of pesticide application on the Ukrainian child population morbidity with thyroid diseases in the period from 2001 to 2014.

**Materials and methods.** The methods of empirical and theoretical research of scientific information, namely analysis, synthesis, induction, deduction and systematization, epidemiological, cartographic and statistical methods were used.

**Results and discussion.** The maximum level of thyroid pathology was found in the northern, western and northwestern regions, where the diffuse goiter dominates in the morbidity and prevalence of thyroid diseases; minimal – in the southern, eastern and south-eastern regions. It was established that the highest volumes of application of chemical plant protection products in the period 2001-2013 took place in the southern and central regions of Ukraine, namely in Poltava, Vinnitsa, Kharkiv, Dnipropetrovsk, Khmelnytsky regions. Sufficiently high levels of pesticide application were in the Kyiv, Kherson regions, Zaporizhia, Kirovograd and Cherkasy regions.

**Conclusion.** The probability of the active chemical plant protection products application effect on the level of thyroid cancer, various types of goiter, hypothyroidism, thyrotoxicosis and thyroiditis in the central and southern regions was determined. These are regions with well-developed agricultural production.

**Key words:** children, thyroid gland, morbidity, pesticides.

## **Introduction.**

In the structure of children and adolescents endocrine pathology thyroid disease according to frequency occupy the 2nd place after diabetes mellitus. Diffuse euthyroid goiter - the most common pathology of the thyroid gland among children from 0 to 14 years old [1, 2]. A similar situation with the level of this pathology and among the children's population of Poland. The high percentage of follicular carcinoma and follicular adenoma indicates that the long-term iodine deficiency in Poland may be significant in the pathogenesis of malignant transformation [3, 4].

In addition, in recent years after the Chernobyl nuclear power plant accident, a significant increase in primary incidence of thyroid cancer among the population of Ukraine and Poland under 18 years old was found [4, 5].

Reducing the prevalence of thyroid diseases, including among the children of the world, is one of the priorities of WHO specialists [6].

**The purpose** of the work was to analyze the influence of pesticide application on the Ukrainian children population morbidity with thyroid diseases in the period from 2001 to 2014.

**Materials and methods.** The object of our research was the level of morbidity of the thyroid gland diseases of Ukrainian children population during the period from 2001 to 2014, and the application volume of various pesticides groups in the specified regions during the same period.

The methods of empirical and theoretical research of scientific information, namely analysis, synthesis, induction, deduction and systematization, epidemiological, cartographic and statistical methods were used.

Reports of Endocrinology Service of Ukraine "Key Indicators of the Endocrinology Service of Ukraine ..." for 2000-2014 [10] and Attachments to the letters from the Ministry of Agrarian Policy and Food [9] were used as the sources of information.

The research was conducted in three stages. At the first stage, ranking of studied regions according to the levels of primary and general morbidity of the children population in the period of 2001-2014 for thyroid cancer, nodular goiter, diffuse nontoxic goiter of the I degree and II-II degrees, hypothyroidism, thyrotoxicosis and thyroiditis

was made. At the next – we have ranking of studied regions by application volume of whole chemical plant protection products, as well as separately herbicides, fungicides and insecticides. At finally, correlation analysis of the relationship between the levels of thyroid diseases and the volume of pesticides application with the calculation of the Spirman ranks correlation coefficient was conducted.

Statistical processing of the results was performed using the statistical suite of statistical software IBM SPSS StatisticsBase v.22.

**Results.** The analysis of morbidity in different regions showed the following pattern: the maximum level of thyroid pathology was found in the northern, western and northwestern regions, where the diffuse goiter dominates in the morbidity and prevalence of thyroid diseases; minimal – in the southern, eastern and south-eastern regions. In addition, significant regional differences in levels of prevalence and morbidity on individual nosologies have been established.

The prevalence of endocrine diseases among children (0-14 years old) has a general tendency to decrease in the investigated period (2000-2014). In most regions (15 out of 24) growth rates ranged from -18.7 to -59.9 %. Similarly, in the majority of regions (14 out of 24) a reliable correlation between the level of morbidity and death was determined ( $r > 0.7060$ ).

With regard to the prevalence of diffuse goiter of various degrees, it has, in most of cases, a significant ( $p \leq 0.05$ ), tendency to decrease in 18 regions for diffuse goiter of I degree and in 20 regions for diffuse goiter of II-III degrees.

The maximum incidence of diffuse goiter is observed predominantly in western (Zakarpattia, Rivne, Volyn, Chernivtsi, Ternopil, Lviv, Ivano-Frankivsk) and northern (Rovne, Kyiv, Chernihiv, Zhytomyr) regions (Figure 1), where there is an unsatisfactory microelement composition of the environmental objects [8, 9]. The same situation with iodine deficiency was observed in some Poland regions, for example Lower Silesia [4]. Significant levels of this pathology have also been registered in the Vinnytsia, Khmelnytsky regions, which do not belong to the iodine-endemic regions.

There was no clear tendency to change the prevalence of nodular goiter during the study period. In part of regions (15), there was a significant decrease in the general incidence of nodular goiter, in other regions – its growth.

Thus, the highest incidence of thyroid nodular goiter was found in Kyiv, Vinnytsya, Cherkasy, Volyn, Chernihiv and Sumy regions. A rather high level was observed in the Luhansk, Poltava, Khmelnytskyi and Zhytomyr regions. Analyzing the possible causes of this situation, we can assume that high rates of thyroid nodular goiter in the northern region (Kyiv, Chernihiv, Sumy, Zhytomyr) are related to the impact of ionizing radiation on the population as a result of the Chernobyl accident; in the Luhansk region – with significant pollution of the environment by industrial emissions, including heavy metals, which play an essential role in the development of thyroid gland pathology [11]. But both of these factors are not leading in the formation of pollution in the Vinnytsia, Poltava and Cherkasy regions.

The prevalence of hypothyroidism has a distinctly tendency ( $p \leq 0.05$ ) to increase the level with a clear correlation of changes with the year of observation ( $r > 0.7060$ ). It should be noted that in most cases the rate of growth of this pathology was higher than 100 %.

In the majority of Ukraine regions, a general tendency to decrease in the prevalence of thyrotoxicosis was noted, although a strong correlation and significant differences were practically not detected (only in 9 regions). This may be due to a low overall prevalence of thyrotoxicosis among children (0.9-10.7 cases per 100 thousand children in 2000 and 0.7-5.4 – in 2013).

Thyroiditis is a much more common pathology among the child population than nodular goiter, hypothyroidism and thyrotoxicosis, but less common than diffuse goiter of various degrees. In the majority of regions (15) there was a decrease in the overall incidence of thyroiditis, but a strong correlation was found in only 8 cases.

High levels of thyroiditis are recorded in industrially developed Kropyvnytskii, Zaporizhzhya regions; in the northern region, affected by the Chernobyl accident (Kyiv, Sumy, Chernihiv regions), as well as in Kherson, Vinnytsia regions, where the impact on the human body of the environment with radionuclides, heavy metals and other industrial toxicants is not too powerful.

Thyroid cancer is also one of the not common pathologies for childhood. The level of primary morbidity varies from 0.33 to 1.83 cases per 100 thousand children. The highest incidence of thyroid cancer was found in Kyiv, Vinnytsya, Cherkasy, Volyn,

Chernihiv, Chernivtsi and Sumy regions. A rather high level was observed in the Donetsk, Dnipropetrovsk, Poltava, Rivne and Zhytomyr regions. Analyzing the possible causes of this situation, we can assume that high rates of thyroid nodular goiter in the northern region (Kyiv, Chernihiv, Sumy, Zhytomyr) are related to the impact of ionizing radiation on the population as a result of the Chernobyl accident; in the Donetsk, Dnipropetrovsk regions – with significant pollution of the environment by industrial emissions, including heavy metals, which play an essential role in the development of thyroid gland pathology [11]. But both of these factors are not leading in the formation of pollution in the Vinnytsia, Chernivtsi, Poltava and Cherkasy regions.

**Discussion.** A significant increase in primary morbidity among the children was observed immediately after the accident at the Chernobyl Nuclear Power Plant, due to the significant release of short-lived radioactive iodine isotopes that settled on grass pastures for cattle and from there into cow's milk. The use of such milk by children on the background of general iodine deficiency, characteristic for the western regions of Ukraine, has led to a significant increase in the level of primary thyroid cancer [5].

Taking into account intensive application of agricultural chemicals in recent years, it could be assumed that the development of diffuse and nodule goiters, thyroiditis, etc. in the Vinnitsa, Chernivtsi, Poltava, Cherkasy regions with a developed agricultural sector of the economy is associated with the introduction into the human body of pesticides that affect the function of the thyroid gland [12-15].

To test this hypothesis, we examined the application volumes of pesticides in the studied regions and compared them with the levels of thyroid pathology.

It was established that the highest volumes of application of chemical plant protection products in the period 2001-2013 took place in the southern and central regions of Ukraine, namely in Poltava, Vinnitsa, Kharkiv, Dnipropetrovsk, Khmelnytsky, Odesa and Mykolaiv regions (Fig. 2). Sufficiently high levels of pesticide application were in the Kyiv, Kherson regions, Crimea, Zaporizhia, Kirovograd and Cherkasy regions. In addition, the Vinnytsia region fell into the top five in application volumes of all three groups of pesticides – herbicides, fungicides and insecticides.

It can be assumed that high rates of application volumes both pesticides in general and their individual groups are associated with high children morbidity rates for thyroid

cancer and nodular goiter in the Vinnytsia, Chernivtsi and Cherkassy regions; on diffuse goiter – in the Vinnytsia, Khmelnytsky regions, thyroiditis – in Vinnitsa, Khmelnytsky regions.

In addition to comparing the incidence of thyroid disease and pesticides application volumes, we have conducted a correlation analysis between the values of these indices by regions. There was a significant correlation ( $p < 0.05$ ) between the levels of thyroid cancer, diffuse goiter of various degrees and thyroiditis, and the all pesticides application volumes in general, herbicides and insecticides.

It should be noted that the exposure of child's body with pesticides is not likely to be related to the consumption of agricultural products, as the level of residues of their active substances in plants is strictly regulated and controlled. However, pesticides are well penetrated to milk of breastfeeding mothers. In addition, children living in rural areas may come into contact with components of pesticide formulations crawling around the land near treated areas [16, 17].

In view of this, the connections we discovered need further detailed study.

### **Conclusions:**

1. It has been established that in the majority of cases (62.5%) the overall endocrine morbidity among the children's population of Ukraine in the period from 2000 to 2014 has a significant ( $p < 0.05$ ) tendency to decrease. The disease of the thyroid gland in the structure of the general endocrinological morbidity of the child population, as well as the adult, occupy one of the leading places. Diffuse goiter is the most common pathology among the child population of Ukraine in the study period.

2. In recent years, there has been a tendency towards a significant decrease in the level of both general and primary thyroid cancer incidence among 0-14 year olds, as opposed to the incidence rates of this pathology for 10 years after the Chernobyl nuclear power plant accident.

3. The existence of a reliable ( $p < 0.05$ ) correlation between the levels of morbidity of Ukrainian child population on thyroid gland cancer, diffuse goiter of various degrees, thyroiditis and volumes of pesticides application has been shown.

4. The probability of the active chemical plant protection products usage effect on the level of thyroid cancer, various types of goiter, hypothyroidism, thyrotoxicosis and

thyroiditis in the central and southern regions (for example, Vinnytsia, Cherkassy, Poltava, Chernivtsi, Khmelnytsky) was determined. Are regions with well-developed agricultural production.

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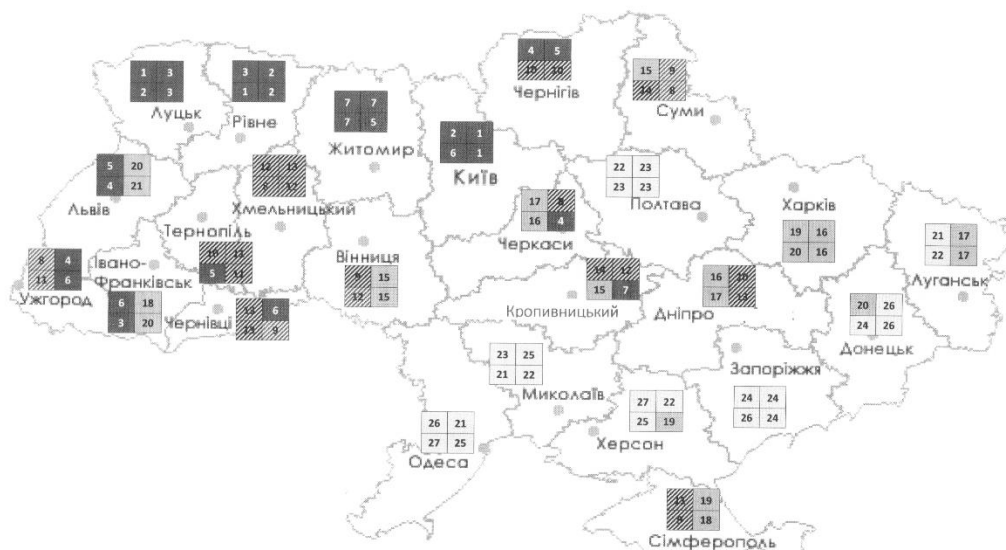
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Notes: 1. 

DG I GM	DG II-III GM
DG I PM	DG II-III PM

, where DG – diffuse goiter, I or II-III grade, GM – general morbidity, PM – primary morbidity;  
2. ranks: 

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 – from 1 to 7 (100-75 %); 

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 – 8-14 (75-50 %); 

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 – 15-20 (50-25 %); 

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 – 21-27 (25-0 %).

Figure 1. – Levels of morbidity of the child population of Ukraine on diffuse goiter of various degrees



Notes: 1. 

P	F
II	I

, P – application volumes of all pesticides in general; F – application volumes of fungicides; II – application volumes of herbicides; I – application volumes of insecticides;  
2. ranks: 

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 – from 1 to 7 (100-75 %); 

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 – 8-13 (75-50 %); 

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 – 14-19 (50-25 %); 

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 – 20-25 (25-0 %).

Figure 2. – Volumes of different groups of pesticides application on the territory of Ukraine

