HYGIENIC ASSESSMENT OF THE EFFECTS OF PESTICIDES APPLICATION ON ADULT POPULATION MORBIDITY WITH THYROID GLAND DISEASES

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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 adult 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, Odesa and Mykolaiv regions. Sufficiently high levels of pesticide application were in the Kyiv, Kherson regions, Crimea, Zaporizhia, Kirovograd and Cherkasy regions.

Conclusion. The probability of the active chemical plant protection products usage effect on the level of prevalence and incidence of thyroid cancer, various types of goiter,

hypothyroidism, thyrotoxicosis and thyroiditis in the central and southern regions was determined. Are regions with well-developed agricultural production.

Key words: morbidity, thyroid gland, pesticides, application rate.

Introduction. Most researchers attribute an increase in the number of thyroid cancer patients with Chernobyl disaster [1, 2], and various goiter types – with habitat on endemic territories according to iodine concentration in soil [3, 4]. But among the main causes of nodular goiter are not only the low iodine content in water and food, but also the lack of other essential elements, the use of some medical products, the impact of radionuclides and heavy metals; diffuse goiter – infections, the use of goitrogenic products, the impact of pesticides; hypothyroidism – reduction of iodine in food and the use of drugs that violate its assimilation; thyroid cancer – ionizing radiation [5].

It is also 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, etc. [6, 7]. Therefore, the presence of their residual amounts in plants may affect the level of thyroid gland pathology.

It is known that the content of residual amounts of pesticides in the environment and, first of all, in food products, as a rule, correlates with their application rates [8]. In general, there is a tendency in Ukraine to increase the pesticides application. So, if in 1999 the total volume of pesticides application was 11 417 tons, in 2013 this value already reached 32 304 tons [9]. It was established that the use of formulations for pre-sowing seed treatment decreased by 37,3% between 1999 and 2013, but at the same time the fungicides application increased by 65,5 %, insecto-acaricides – by 243, 3 %, herbicides – by 281,0 % [9].

The purpose of the work was to analyze the influence of pesticide application on the Ukrainian adult 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 adult 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.

Conducted: 1. Ranking of studied regions according to the levels of primary and general morbidity of the adult 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.

2. Ranking of studied regions by application volume of whole chemical plant protection products, as well as separately herbicides, fungicides and insecticides.

3. 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.

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

Results and discussion. 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.

Thus, the highest incidence of thyroid cancer and nodular goiter was found in Kyiv, Vinnytsya, Kherson, Chernihiv and Sumy regions (Fig. 1). A rather high level was observed in the Dnipropetrovsk, Poltava, Donetsk, Cherkasy, Zaporizhzhia and Zhytomyr regions. Analyzing the possible causes of this situation, we can assume that high rates of thyroid cancer and 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 Dnipropetrovsk, Donetsk and Zaporizhzhya 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, Kherson, Poltava and Cherkasy regions.

The maximum incidence of diffuse goiter is observed predominantly in western (Zakarpattia, Rivne, Volyn, Chernivtsi, Ternopil, Lviv, Ivano-Frankivsk) and northern (Kyiv, Sumy, Chernihiv, Zhytomyr) regions (Figure 2), where there is an unsatisfactory microelement composition of the environmental objects [3, 4]. Significant levels of this pathology have also been registered in the Vinnytsia, Khmelnytsky and Dnipropetrovsk regions, which do not belong to the iodine-endemic regions.

High levels of thyroiditis are recorded in industrially developed Kharkiv, Donetsk, Dnipropetrovsk, and Zaporizhzhya regions (Fig. 3); in the northern region, affected by the Chernobyl accident (Kiev, Sumy, Chernihiv oblasts), as well as in Kherson, Vinnytsia and Mykolaiv regions, where the impact on the human body of the environment with radionuclides, heavy metals and other industrial toxicants is not too powerful.

Taking into account intensive use of agricultural chemicals in recent years, it could be assumed that the development of diffuse and nodule goiters, thyroiditis, etc. in the Vinnitsa,

Kherson, Poltava, Cherkasy, Mykolaiv 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 [5, 6, 7, 12].

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. 4). 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. Herbicide application rates were highest also in the Poltava, Dnipropetrovsk, Kharkiv, Cherkassy, Khmelnytsky and Kirovograd regions; fungicides – in the Crimea, Odessa, Vinnytsia, Khmelnytsky, Kherson, Cherkasy and Mykolaiv regions; insecticides – in Mykolayiv, Zhytomyr, Kherson, Cherkasy, Dnipropetrovsk regions and Crimea (Figure 4).

It can be assumed that high rates of application volumes both pesticides in general and their individual groups are associated with high adult morbidity rates for thyroid cancer and nodular goiter in the Vinnytsia, Kherson and Cherkassy regions; on diffuse goiter – in the Vinnytsia, Khmelnytsky, Dnipropetrovsk regions, thyroiditis – in Kherson, Vinnitsa, and Mykolaiv 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 (Table 1). 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. As already mentioned above, pesticides lead to hypertrophy of the thyroid gland as a result of increased its hormones metabolism in liver, which, with prolonged exposure, can lead to the development of the aforementioned diseases [6]. Another mechanism of their action is possible, namely the development of tyrosinaemia as a result of certain enzymes activity inhibition [7]. In addition, the uncontrolled effect of chemical plant protection products can lead to a general decrease in the resistance or allergenicity of the organism [13, 14]. In view of this, the connections we discovered (Table I) need further detailed study.

Consequently, our assumption about the impact of pesticides on the incidence of Ukrainian adult population thyroid gland morbidity is confirmed by the following data. High levels of thyroid cancer and nodular thyroid goiter were detected in the Vinnytsia, Kherson, Poltava and Cherkasy regions; diffuse goiter of various degrees – in the Vinnytsia, Khmelnytsky and Dnipropetrovsk regions; thyrotoxicosis and hypothyroidism – in Khmelnytsky, Dnipropetrovsk, Vinnytsia and Cherkasy regions; thyroiditis – in Kharkiv, Dnipropetrovsk, Kherson and Vinnitsa regions; hypothyroidism and thyroiditis – in Mykolaiv region (Fig. 1, 2, 3). These regions have not been subjected to significant radioactive contamination due to the Chernobyl accident, they have the optimal microelement composition of the environmental objects, are not zones of active development of industry, except for the Dnipropetrovsk region. However, as can be seen from Fig. 4, it is in these areas the largest volumes of individual pesticides groups and the total amount of chemical plant protection products application are observed.

Kherson region is a region with well-developed agricultural production, in which the total area of agricultural land is 1969,5 thousand hectares [15], or almost 70 %. On the territory of the Vinnytsia region, the agricultural area is more than 2 million hectares [16], i.e. more than 75 %. In the Kharkiv region, the area of agricultural land is 2418,7 thousand hectares (77,0 %)

[17]. In Cherkassy region agricultural development of the land exceeds the ecologically tolerable and in recent years it remains almost unchanged: from the total area of the region (2091,6 thousand hectares) 1451,3 thousand hectares (69,4 %) are occupied by agricultural land [18].

In Dnipropetrovsk, Cherkasy and other regions of Ukraine in recent years there has been a sharp increase in the fungicides application. Thus, in 2001-2004, their application volumes ranged from 8-50 tons, while in 2010-2013 – 100-300 tons. In 2013, the rate of increase in the fungicides application in these regions amounted to about 1000-3000 %, compared with 2001. In addition, in the Dnipropetrovsk region, agricultural production is carried out on the territory of 2513,6 thousand hectares (78,7 % of the total region area) [19].

Agricultural development of the Mykolaiv region, in comparison with land funds of other regions of Ukraine, is extremely high (86,6 %). The area of agricultural land in the region exceeds 2 million hectares. In the farms of the region there are up to 200 thousand hectares of irrigated land [20].

In addition, we would like to pay attention to the fact that an increase in the incidence of thyroid disease in areas with a large number of agricultural land and, therefore, agricultural workers, is likely to be caused by a greater number of such diseases among professional contingents. After all, the whole population is protected from the negative influence of pesticides by approved in the established order values of pesticides maximum residue levels (MRL) in agricultural products. In the presence of chemical plant protection products residues in products, even at the MRL levels, there is guarantee of absence neither acute effects and chronic diseases development, nor long-term effects of exposure [21].

At the same time, workers in the agrarian sector, especially small private farms that are not under control, may not always adhere to the recommended regulations for the pesticides application and use the necessary personal protective equipment. In addition to the most

common acute poisoning, there are also data on the chronic effects of pesticides on the health of workers [22], including the thyroid gland [23]. For example, workers who have been working with dithiocarbamate pformulations for a long time showed an increase in the incidence of diffuse and nodular goiter compared with the control group from 9,2% to 55,6% [23].

Conclusions: 1. The presence of significant regional differences in the prevalence and morbidity of the Ukrainian adult population on the thyroid dysfunction in general and certain diseases of the thyroid gland, which is connected with the peculiarities of environmental pollution: significant radioactive loads in the northern and north-western regions, reduced iodine content in the soil of the western and northwest regions, high levels of industrial development and environmental pollution by industrial toxicants , has been confirmed.

2. The existence of a reliable ($p < 0,05$) correlation between the levels of morbidity of Ukrainian adult population on thyroid gland cancer, diffuse goiter of various degrees, thyroiditis and volumes of pesticides application in general, herbicides and insecticides has been shown.

3. The probability of the active chemical plant protection products usage effect on the level of prevalence and incidence of thyroid cancer, various types of goiter, hypothyroidism, thyrotoxicosis and thyroiditis in the central and southern regions (Vinnytsia, Cherkassy, Poltava, Kherson, Odessa, and Mykolayivska) was determined. Are regions with well-developed agricultural production.

Reference

1. Komissarenko I.V., Kovalenko A.Y., Larin A.S. Surgical Treatment of Thyroid Cancer in Residents of the Ukraine Exposed to Radiation, The Chernobyl accident. Thyroid abnormalities in children, congenital abnormalities and other radiation related information — the first ten years. Hiroshima-Nagasaki Peace Foundation. 1996. 81–86.

2. Vozianov O.F., Bebeshko V.H., Bazyka D.A. [Medical consequences of the accident at the Chernobyl nuclear power plant]. 2007. 800 p.

3. Pyrohova V.H., Kravchenko V.I. [Dynamics of diseases of the thyroid gland caused by iodine deficiency in the population of the Transcarpathian region]. Naukovyy visnyk Uzhhorods'koho universytetu. 2011; 3 (42); 132-139.

4. Karachentsev Yu.I., Tymchenko A.M., Kozakov O.V. [Modern tendencies of endocrine morbidity of the population and prospects of development of endocrinology service]. Zdorov"ya Ukrayiny [Content last modified 2016]. – Mode of assess: http://health-ua.com/article/110.html.

5. Sarne D. Effects of the environment, chemicals and drugs on thyroid function, Thyroid disease manager. 2010. 54.

6. Antonenko A.M., Korshun M.M., Milokhov D.S. [Features of the mechanism of action of inhibitors of succinate dehydrogenase on the body of warm-blooded animals and humans]. Suchasni problemy toksykolohiyi, kharchovoyi ta khimichnoyi bezpeky. 2015; 4 (72): 23–29.

7. Antonenko A.M., Blagaia A.V., Vavrinevych O.P. [et al.] Mechanism of action of 4-hydroxyphenylpyruvate dioxygenase inhibitor herbicide on homoterm animals and humans. Journal of Pre-Clinical and Clinical Research. 2015; 9(2): 148–153.

8. Lunev M. I. [Pesticides and protection of agrophytocenoses]. Moscow: Kolos, 1992. 269 p.

9. [Use of plant protection products by agricultural producers in Ukraine in ... .. years]. – Letter of the Ministry of Agrarian Policy of Ukraine dated February 24, 2005 No. 156-05-02 / 56, supplemented by 15.02.2011 № 37-156-10/2217, 22.03.2012 № 37-156-10/451322, 14.03.2013 № 37-156-10/4513.

10. [Report of the Endocrinology Service of Ukraine "Key Indicators of the Endocrinology Service of Ukraine for ..... Year"]. Academy of Medical Sciences of Ukraine and the Ministry of Health of Ukraine, DU "Institute of Endocrinology and Metabolism named after them. VP Commissioner of NAMS of Ukraine ". 2000, 2004, 2006, 2007, 2010, 2011, 2012, 2013, 2014. – 31 p.

11. Antonenko A.M., Korshun M.M. [Environmental factors as risk factors for thyroid gland pathology (first report)]. Dovkillya i zdorov"ya. 2016; 3 (79): 74–79.

12. Stavnichenko P.V., Antonenko A.M., Bardov V.H. [et al.] [Hygienic estimation of assortment changes and volumes of use of fungicides in agriculture of Ukraine]. Ukrayins'kyy zhurnal z problem medytsyny pratsi. 2016; 4 (49): 32–36.

13. Balan H.M., Ivanova A.Y., Ivanova S.Y. [et al.] [Acute and chronic intoxication with pesticides, estimation of the intensity of implemented occupational risk and forecasting the nature of the course]. II Congress of Toxicologists of Ukraine, Kyiv. 2004: 147–149.

14. Zimba O.O. [Xenobiotics - toxicants: etiological stimuli of nodular polyarthritis]. Sovremennye problemy toksikologii. 2011; 5: 193–194.

15. Kherson region. Economy of the region. Agroindustrial complex / Kherson Chamber of Commerce and Industry [Content last modified 2015]. – Mode of assess: http://www.tpp.ks.ua/khersonskij-region/ekonomika-regionu.html.

16. Vinnitsa region [Content last modified 2014]. – Mode of assess: http://uk.wikipedia.org/wiki/Вінницька_область.

17. Status of land resources and soils in the Kharkiv region (regional report) [Content last modified 2014]. – Mode of assess: http://5ka.at.ua/load/ekologija/stan_zemelnikh_resursiv_ta_gruntiv_u_kharkivskij_oblasti_regionalna_dopovid/18-1-0-10815.

18. State of land resources and soils in Cherkasy region (regional report) [Content last modified 2014]. – Mode of assess: http://5ka.at.ua/load/ekologija/stan_zemelnikh_resursiv_ta_runtiv_u_cherkaskij_oblasti_regionalna_dopovid/18-1-0-10876.

19. Dnipropetrovsk region [Content last modified 2014]. – Mode of assess: http://www.experts.in.ua/regions/detail.php?ID=4316.

20. Mykolaiv region [Content last modified 2014]. – Mode of assess: http://www.experts.in.ua/regions/detail.php?ID=4338.

21. Methodological guidance on the hygienic assessment of new pesticides № 4263-87. Kyiv: Ministry of health, 1988. – 210 p.

22. Occupational Health: recognizing and preventing work-related disease and injury / Ed. by Barry S. Levy; David H. Wegman – 4th ed. Philadelphia: Lippincott Williams & Wilkins. 2000. – 842 p.

23. Khubaveshki S., Lozanov B., Atanasova I. [et al.] [Long-term effects of dithiocarbamate pesticides on the thyroid gland]. Endokrinologiya. 1996; 4: 34–39.

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