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ANALYSIS OF THE DYNAMICS OF ENDOCRINE PATHOLOGY IN THE POPULATION ON THE INTENSIVELY PESTICIZED TERRITORY

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Abstract:

Analysis of ESD incidence rate (endocrine system diseases, metabolic disturbances and disorders) in child population aged 0-14 years of the Republic of Tatarstan showed that in the period from 1993-2012 there was observed a gradual increase: primary - from 9.9 to 16.2, and prevalence - from 24.3 to 40.4 cases per 1,000 children of relevant age. But the averages in the country have been drawn from 20-50-fold difference between the 45 municipalities. In many municipalities with minor fluctuations, the level of child morbidity has not changed (Kukmorsky, Nurlatsky district), in other districts there was a trend to decline (Almetyevsk from 7.1 to 1.6 cases per 1,000 children). But there are districts where the analyzed period was accompanied by a sharp rise in the primary ESD incidence (Bugulminsky) from 4.53 to 43.5 cases per 1,000 children. Cluster analysis of primary ESD incidence in children for the period of five years (2006-2010) has assigned Bugulminsky district to the cluster with the highest incidence, and Almetyevsk - to low. We have conducted a comparative analysis of the ESD incidence and the public health forming factors in Bugulminsky and Almetyevsky districts. The test districts are located in the south-east of the Republic of Tatarstan, which produces up to 91% of oil in the country. And all the previous studies in the region had been devoted to the influence of the basic industry (oil-producing) on the health of the population. Neither evaluation of agricultural factors nor their relationship to the population morbidity has been studied. Both districts have the largest share of the land area for industry, transport, energy - 3.51% (Almetyevsky) and 3.27% (Bugulminsky); the share of arable agricultural land is 68.1% and 73.0%, respectively, the population density is 80.3 persons/km² and 79.7 persons/km², respectively, and is above the republican average (55 persons/km²).

Keywords: Endocrine system diseases, pesticides, glyphosate.

1. Introduction

According to the Federal State Statistics Service of the Russian Federation, the incidence of endocrine system diseases has increased by more than 2 times over the past 14 years [3]. And an important role in the formation of this pathology can belong to "endocrine destructors" - chemicals that damage the endocrine system. According to WHO and UNEP experts, about 800 chemicals are known or suspected of ability to interact with hormones. The "endocrine destructors" list includes natural chemicals and their synthetic varieties, found in pesticides, plastics etc. [6]. The use of pesticides at the present stage of agriculture development prevents the loss of plant products up to 30-50% of the crop, providing 7-billion world population with food [5]. Bringing some benefit in increasing the yield of crops, the pesticides, anyhow, have a negative impact on the health of the population. Due to the intervention in the humoral exchange mechanisms and the ability to influence the immune competent systems as biologically active substances the pesticides pose hazard to health not only during acute but also during chronic exposure to their low concentrations [4].

Studies conducted in Belgorod region indicate an increase in the incidence of diabetes mellitus in adults upon their exposure to high and average pesticide consumption in the amount of 0.6-1.8 kg/ha [1]. The US scientists found from the results of research in 1996 that the DDT pesticide derivatives inhibit the synthesis androgenic hormones, leading to delay in growth and development of male sex organs in alligators [6].

To date, one of the most globally popular herbicide is glyphosate, which is the main active substance of almost third of all agents used to control weeds [2].

The negative impact of this herbicide on the organs and systems of biological species cannot be excluded. Thus, French and Italian researchers have concluded that glyphosate contained in the compound herbicide agents intended for agricultural purposes at concentrations below the officially established safety limits may cause severe hormone-dependent breast disorders, liver and kidney in rats [8]. Glyphosate not only plays the role of a carcinogen, but also the substance that causes a variety of endocrine diseases [7].

2. Material and methods

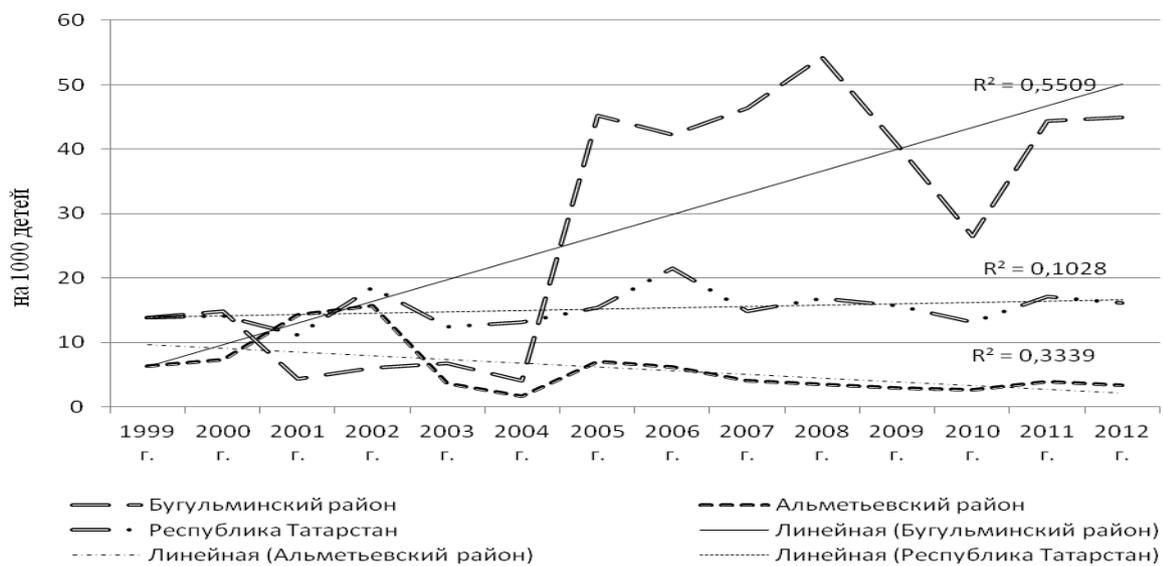
Data were collected from official statistical reporting forms, government reports, statistical book of the Ministry of Health of RT, Rospotrebnadzor in RT, FBHCI "Center for Hygiene and Epidemiology in the Republic of Tatarstan", the Ministry of Ecology and Natural Resources of RT, FSBI "Rosselkhoztsentr in RT". The collected information was processed using the descriptive statistics methods (assessment of the frequency in the studied aggregation),

multivariate statistical procedures, ordering the objects in a relatively homogeneous groups (cluster analysis), and the analysis of event dynamics (trend analysis).

The correlation between the environmental factors and the incidence rates was performed using Spearman's coefficient for the year of influence, and subject to the impact of the delay in the resulting response - with a lag. Data processing was conducted with Excel software package, STATISTICA 6.0.

3. Results and discussion

From 1999 to 2005, the primary ESD incidence among children aged 0-14 years in Bugulminsky and Almetьевsky districts differed slightly and was below the republican average, indicating the similarity of the factors forming the incidence rate in both areas (Figure 1).



Per 1,000 children

Bugulminsky district

Almetьевsky district

Republic of Tatarstan

Linear (Bugulminsky district)

Linear (Almetьевsky district)

Linear (Republic of Tatarstan)

Fig. 1. Incidence of new endocrine disease cases per 1,000 children aged 0-14 years in the Republic of Tatarstan, Almetьевsky and Bugulminsky districts (R^2 - reliability of the trend line approximation).

Since 2005, however, there was a sharp rise in primary ESD incidence among the children of Bugulminsky district from 4.0 per 1,000 persons of appropriate age in 2004 to 45.3 (2005), and the following sharp rise was observed in 2008 (54.3); an increase in the period of 1999-2012 in this district is characterized as "significant" ($R^2=0.55$). This indicates the appearance of an endocrine destructor in 2005 in Bugulminsky district, which impact repeated in 2008

with its further aggravation in the coming years. In the same period, in the Almetyevsky district, there was "moderate" decrease in ESD incidence among children ($R^2=0.33$), from 6.4 in 1999 to 3.3 in 2012, with no sharp rises or fluctuations observed in the analyzed period.

In the period of 1999-2012, there was a "significant" increase in the primary ESD incidence among the adult population (18 years and older) ($R^2=0.5$) from 3.8 (1999) to 6.3 cases (2012), but the incidence rate differences between the regions of the republic were not as significant as in children. Bugulminsky and Almetyevsky districts showed only upward trend from 3.3 to 4.0 cases, and from 6.25 to 7.2 per 1,000 population, respectively. Being more sensitive and less adapted to changing environmental factors, a child's organism is an indicator of environmental degradation, and the differences in the dynamics of ESD incidence in the studied areas prove the emergence of differences in the reasons for the pathologies occurring among the population.

Based on calculation results of the integrated indicator of ecological condition by 12 factors in 1993 in the Republic of Tatarstan, both Almetyevsky and Bugulminsky districts were assigned to the same group with "severe" environmental situation. In 2012, a factor analysis identified the environmental quality in Bugulminsky district as "optimal", and in Almetyevsky - as "insufficient", the anthropogenic impact index in Almetyevsky district increased and was 0.609, and in Bugulminsky - 0.179. And if in 1990s years the ecological situation in the two districts was similar and acute, then, by 2012, Almetyevsky district was classified as environmentally unfavorable based on volumes of atmospheric and unit-area emissions, the discharge of sewage, and sanitary-chemical indicators of drinking water, while Bugulminsky district was classified as relatively favorable. But in all cases, the evaluation did not consider pesticide indicators in the districts, though both districts intensively maintain agricultural activities in addition to oil production.

The situation with the use of pesticides developed as follows: by 1999, the Republic of Tatarstan had the lowest rate of pesticidal performance (processed area, consumption volumes, territorial pesticide load) among all the analyzed years. The pesticide-treated area in Almetyevsky district this year was greater than in Bugulminsky (39.2 and 25.9 thous. ha, respectively), but in the following years the latter district had gradual increase up to 70.3 thousand. ha, while the first district had tendency to decrease (up to 25 thous. ha). Bugulminsky district had also increase in the annual consumption of pesticides from 14.7 to 41.5 tons (1999-2012), TPL (territorial pesticide load) from 0.3 kg/ha to 0.6 kg/ha; in Almetyevsky district, the consumption rate decreased from 31.4 to 9.5 tons, TPL decreased from 0.54

kg/ha to 0.1 kg/ha. Generally in the Republic of Tatarstan, there was an increase in the pesticide treated area, consumption volume, and territorial pesticide load in the same period.

There were also certain changes in the structure of pesticides. By 1999, the proportion of herbicides used in RT was 63.9%, and then was gradually increasing and reached 73.2% by 2012. In Bugulminsky district, this figure was 84.5% by 2012, and in Almetyevsky - the proportion of herbicides for the whole analyzed period was lower by 2012 and amounted to 64.8%. The range of used products also changed in terms of chemical structure: in the studied period, the Republic of Tatarstan for many years had been using predominantly the 2,4-D-based agents, which amounted to 62.7% by 2002, however, decreased to 11% by 2012. In parallel with this, during these years the republic intensified consumption of glyphosate agents, which share among herbicides increased from 1.1% (2002) to 21.5% (2012) with its maximum level in 2011 (26.5%). In 2002-2003, no differences in the range of the applied pesticides was observed both in Almetyevsky and Bugulminsky districts, but, since 2005, Bugulminsky district started using glyphosate (0.3 tons), and after two-year interval, the herbicide application volumes increased, reaching 59.8% of all herbicides (20.885 t) by 2012. In Almetyevsky district, glyphosate pesticides were used only in 2010, and their share was 14.2% (1.5 t). Unlike Bugulminsky district, Almetyevsky district had no absolute leader in the consumption of the said agent throughout the entire analyzed period (1999-2012). Thus, by 2012, there were clear differences between the districts in the purpose and chemical structure of pesticides. The analysis of the environmental and hygienic situation in both regions shows that since 1999, the public health forming factors in the districts started varying. On the background of more favorable environmental situation and simultaneous increase in pesticide rates in Bugulminsky district, there was an increased incidence of endocrine system diseases in children, while Almetyevsky district had a quite opposite situation. The correlation analysis of primary morbidity of the child population of both districts with the main pesticide indicators showed a high level of its relationship with the pesticide treated area (0.73; $p < 0.004$) in Bugulminsky district, with the maintained relationship in case of 1-year lag (0.5 $p < 0.04$). In Almetyevsky district, no relationship with these indicators was revealed. No relation between ESD incidence and pesticide indicators was also revealed among the child population of the republic. However, unlike the child population, a significant dependence of primary ESD incidence on pesticide treated area of arable land (0.83; $p < 0.0001$ with a lag of 2 years), on gross consumption of pesticides (0.79; $p < 0.001$ with a lag of 3 years), and on the volume of herbicides used (0.67; $p < 0.01$) was revealed in adults. Analysis of the structure of ESD incidence among the adult population of the republic showed the prevalence of diabetes mellitus, which share increased from 29.2% to

44.5% over the last decade. It is noteworthy, that the correlation analysis of the nosology and the main pesticide indicators reveals a strong relation between the incidence of diabetes among the adult population of the country and the treated area of arable land; the Spearman correlation coefficient - 0.8 ($p < 0.01$). A similar analysis for Almetyevsky and Bugulminsky districts cannot be conducted because of the small number of annual cases.

Summary: Thus, the results of the study support the impact of pesticides, including glyphosate agents, on the endocrine system of humans and raise the need for more detailed study of the contribution of individual agents to the formation of this nosology.

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