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EPIDEMIOLOGIC EVALUATION OF THYROID DISEASES MORBIDITY OF UKRAINIAN ADULT POPULATION FROM 2000 TO 2013

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Background. *The diseases of thyroid gland have been attracting considerable attention in recent decades. This is partly due to the fact that thyroid gland reacts actively to geochemical state and pollution of the environment with industrial and agricultural waste products with the subsequent incidence of certain pathological processes.*

The objective *of the research was to analyze the morbidity of adult population of Ukraine for thyroid gland diseases in the period from 2000 to 2013.*

Methods. *The methods of empirical and theoretical research of scientific information: analysis, synthesis, induction, deduction and systematization, as well as epidemiological and statistical methods were used. Using the Microsoft Office Excel (2007) and IBM SPSS StatisticsBase v.22 program the correlation and regression analyzes were conducted.*

Results. *From 2000 to 2013, high levels of adult population endocrinopathies, thyroid in general and diffuse goiter of varying degrees, general and primary morbidity were registered in the western and northern regions of Ukraine, low – in the central, eastern and southern regions. Statistically significant ($p<0.001$) positive correlation between the level of prevalence and the level of incidence of endocrine pathology, diseases of thyroid gland as a whole, as well as individual nosology was detected.*

Conclusions. *Regional peculiarities of the levels and dynamics of changes in the incidence rates of thyroid morbidity among adult population of Ukraine can be related to the urgent environmental factors for each region. This factor requires further study to develop effective methods of prophylaxis and defense.*

KEY WORDS: **morbidity; thyroid gland; adult population.**

Introduction

The diseases of thyroid gland have been attracting considerable attention in recent decades. In the structure of endocrine pathology prevalence in Ukraine they are the first: on average 44 %, and in the endemic with iodine deficiency western regions – up to 70 % [1]. This is partly due to the fact that thyroid gland reacts actively to geochemical state and pollution of the environment with industrial and agricultural waste products with the subsequent occurrence of certain pathological processes [2]. In the structure of endocrinological pathology, different types of goiter are the largest share [3, 4]. Minimizing thyroid dysfunction rates is an important task for most countries of the world, since, according to the WHO publications, nearly 2 billion planet's inhabitants are at risk for thyroid diseases, including iodine-dependent diseases [4, 5].

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The objective of the research was to analyze the morbidity of adult population of Ukraine for thyroid gland diseases in the period from 2000 to 2013.

Methods

The object of our research was the level and the dynamics of endocrine system (Class IV, E00-E90 according to the International Diseases Classification of the Tenth Revision) and thyroid gland (E00-E07) general morbidity (prevalence[1]) and primary morbidity (incidence[2]) of adult population in 24 regions of Ukraine, the Crimea as well as Kyiv and Sevastopil cities, in the period from 2000 to 2013.

The sources of information were the reports of the Endocrinology Service of Ukraine 'The main indices of the activity of the endocrinology service of Ukraine...' for the period of 8 years: 2000, 2004, 2005, 2006, 2009, 2010, 2011 and 2013 [7–14], according to which the evaluation of general endocrinology morbidity, incidence of diffuse nontoxic goiter degree I, diffuse non-

1 The term recommended by WHO.
2 The term recommended by WHO.

toxic goiter degree II–III, nodule goiter, hypothyroidism, thyrotoxicosis, thyroiditis and thyroid cancer (II class of neoplasm, C73) was carried out. The spreadsheet was developed in Microsoft Office Excel (2007).

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

For the analysis of changes in the level of general and primary thyroid disease, the average absolute increase (AI), which characterizes the average annual increase rate, increase rate (AIR,%) and increase rate (IR,%), were evaluated. The estimation of the basic (relative to the level of the initial year) and the chain (relative to the level of the previous year) indices were carried out.

Using the Microsoft Office Excel (2007) and IBM SPSS StatisticsBase v.22 program correlation (with Pearson correlation coefficient – r) and regression analyzes to estimate the dynamics of population morbidity over a fourteen-year period, the ranking of investigated administrative territories (AT) of Ukraine according to the levels of prevalence and incidence for 2000–2013 years and the rate of their increase, the identification of the relationship between the incidence rate of individual thyroid diseases and the relationship between the levels and the rate of morbidity index increase according to the calculation of the Spearman rank correlation coefficient (r_s), were conducted

Results

The current WHO statistics prove that the pathology of endocrine system takes the third place after cardiovascular and cancerous diseases in the structure of the overall morbidity and causes of mortality in most countries of the world and it continues to increase [1]. A similar situation is evidenced in Ukraine also, where the increase in the number of patients with various endocrinopathies in the period from 2005 to 2010 amounted to 9.85 % [14].

It has been established that in the period from 2000 to 2013, the overall endocrinology incidence (prevalence of endocrinopathies) of adult population in 16 regions of Ukraine, the Crimea, Kyiv and Sevastopil increased, as evidenced by the statistically significant coefficients of the Pearson correlation pair ($r>r_{tabl}$; r_{tabl}=0.707 at n=8, p=0.05). Regarding the primary incidence of endocrine system diseases, in the period of monitoring, a positive correlation was established only in 6 regions, another one (Cherkasy) proved a tendency to increase ($r>r_{tabl}$; r_{tabl}=0.629 at n=8, p=0.1). At the same time, the largest AIR and IR of both general and primary morbidity were observed in Zaporizhia region (IR 137.1 and 118.6 % respectively), Kyiv (113.3 and 33.8 %), Mykolaiv (102.7 and 55.8 %), Kharkiv (100.7 and 64.8 %), and Poltava (100.1 and 57.4 %) regions (respectively, 1, 2, 3, 4 and 5 rank positions for IR of general morbidity and 1, 5 , 4, 2 and 3 – IR of primary morbidity).

Significant ($p<0.05$) decrease of the total endocrinological morbidity that correlated with the year was observed only in three regions: Volyn (administrative center is Lutsk), Sumy and Chernihiv. In the other (five) regions the statistically significant correlation between the prevalence of endocrine pathology and the year was not proved. Regarding the primary morbidity, a statistically significant inverse correlation relationship was established in 8 regions (including Volyn, Sumy and Chernihiv); in another one (Kirovohrad, administrative center Kropyvnytskyi) and Crimea regions there was a tendency to index decrease ($0.05<p<0.1$). In the other (10) investigated AT, the level of primary morbidity did not significantly change during 14 study years ($p>0.1$).

In general, between the IR of the general and IR of the primary incidence of endocrine system diseases in the period from 2000 to 2013 there was a significant positive correlation (r_s=0.916; $r_{s\ tabl}$=0.597 at n=27, p=0.001). The same correlation was found between the levels of prevalence and incidence of endocrine pathology (r_s=0.841).

In general, in the period from 2000 to 2013, the highest levels of both indices of endocrine disease were reported in Vinnytsia region and the regions of Western Ukraine: Zakarpattia (administrative center is Uzhgorod), Rivne, Volyn (Table. 1). Primary morbidity was high also in Ivano-Frankivsk, Ternopil and Khmelnitsky regions, and prevalence – in the northern regions (Kyiv, Chernihiv and Sumy regions). It should be noted that these areas have the highest incidence of diffuse goiter of varying degrees; in the northern regions of nodular goiter and thyroid cancer as well.

The seven last ranked places according to both indices of endocrine system diseases incidence were occupied by the eastern (Luhansk), southern (Zaporizhia, Kherson), central (Poltava) regions and Sevastopil. Primary morbidity was also low in Donetsk and Odesa regions, and prevalence – in Kirovohrad and Mykolaiv. The

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Table 1. Ranking of administrative territories according to the levels of thyroid general (GM) and primary (PM) morbidity of adult population during the period of 2000–2013

Regions	Administrative territory	Ranks															
		Endocrine system diseases (ESD)		Diffuse goiter of I degree (DG-I)		Diffuse goiter of II-III degrees (DG-II+III)		Nodular goiter (NG)		Thyroid cancer (TC)		Hypothyroidism (HT)		Thyrotoxicosis (TT)		Thyroiditis (TD)	
		ЗЗ	ПЗ	ЗЗ	ПЗ	ЗЗ	ПЗ	ЗЗ	ПЗ	ЗЗ	ПЗ	ЗЗ	ПЗ	ЗЗ	ПЗ	ЗЗ	ПЗ
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Western	Volyn	2**	5**	1**	2**	4**	4**	12	16	27''	25''	10	24''	17	18	25''	26''
	Zakarpattia	3**	1**	2**	3**	1**	1**	20	27''	25''	27''	14	13	2**	3**	24''	24''
	Ivano-Frankivsk	8	4**	7**	4**	17	17	18	23''	26''	26''	1**	8	4**	4**	22''	20
	Lviv	11	12	6**	6**	14	16	24''	22''	17	15	16	18	8	21''	14	14
	Rivne	5**	2**	4**	1**	2**	2**	14	14	23''	21''	22''	19	16	10	23''	22''
	Ternopil	12	6**	13	5**	10	13	19	25''	22''	22''	19	21''	15	19	27''	27''
	Khmelnitsky	9	7**	14	10	11	8	8	12	18	20	6**	4*	1**	1**	17	12
	Chernivtsi	10	8	12	12	5**	6**	22''	19	11	24''	25''	23''	10	26''	12	18
Northern	Zhytomyr	15	16	11	13	9	9	7**	13	15	12	24''	26''	13	16	19	23''
	Kyiv	4**	15	3**	11	3**	3**	2**	3**	2**	2**	8	10	21''	17	6**	4**
	Sumy	7**	9	10	9	7**	5**	4**	5**	8	4**	17	15	6**	12	7**	9
	Chernihiv	6**	19	5**	14	6**	15	3**	4**	6**	6**	21''	20	7**	13	9	10
	The city of Kyiv	16	17	21''	20	15	12	1**	1**	1**	1**	2**	1**	24''	7**	1**	1**
Central	Vinnytsia	1**	3**	8	7**	8	11	5**	2**	4**	7**	5**	5**	5**	15	8	7,5**
	Dnipropetrovsk	17	18	16	16	12	10	13	8	7**	9	4**	2**	9	6**	5**	6**
	Kirovohrad	21''	13	15	15	24''	19	21''	20	19	16	26''	27''	20	27''	13	15
	Poltava	22''	24''	18	21''	19	24''	9	6**	13	11	18	14	14	8	15	13
	Cherkasy	13	10	20	18	13	7**	10	10	12	10	11	12	12	2**	21''	19
Eastern	Donetsk	19	21''	22''	23''	21''	22''	11	9	9	13	3**	3**	3**	5**	2**	3**
	Luhansk	27''	26''	23''	22''	20	18	27''	21''	24''	23''	27''	25''	25''	14	26''	25''
	Kharkiv	18	14	17	17	16	14	25''	15	16	19	13	6**	27''	24''	3**	2**
Southern	Zaporizhia	26''	26''	24''	24''	26''	25''	16	11	10	88	23''	17	19	11	11	5**
	Mykolaiv	24''	20	19	19	22''	21''	26''	18	21''		7**	9	26''	23''	10	11

Continuation of table 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Southern	Odesa	20	23''	26''	27''	25''	26''	23''	26''	14	14	15	16	11	25''	20	17
	Kherson	23''	22''	25''	26''	18	23''	6**	7**	3**	3**	9	11	22''	20	4**	7,5**
	Crimea	14	11	9	8	23''	20	15	17	20	17	12	7**	18	9	18	16
	Sevastopil	25''	27''	27''	25''	27''	27''	14	24''	5**	5**	20	22''	23''	21''	16	21''

*Note.** – the highest levels of morbidity, '' – the lowest levels of morbidity.*

Table 2. Correlation between the levels of thyroid general (GM) and primary (PM) morbidity of adult population of Ukraine during the period of 2000–2013.

	Spearman's rank correlation coefficients														
	ESD-GM	ESD- PM	DG-I-GM	DG-I-PM	DG-II+III-GM	DG-II+III-PM	NG-GM	NG-PM	TC- GM	TC-PM	HT-GM	HT- PM	TT-GM	TT-PM	TD-GM
ESD-GM	1														
ESD-PM	0.841*	1													
DG-I-GM	0.882*	0.764*	1												
DG-I-PM	0.844*	0.906*	0.916*	1											
DG-II+III-GM	0.858*	0.692*	0.783*	0.714*	1										
DG-II+III-PM	0.797*	0.750*	0.717*	0.716*	0.920*	1									
NG-GM	0.360^	0.037	0.160	0.023	0.350^	0.265	1								
NG- PM	0.160	-0.124	0.023	-0.151	0.235	0.176	0.822*	1							
TC- GM	-0.114	-0.422''	-0.335^	-0.499*	-0.056	-0.144	0.640*	0.702*	1						
TC- PM	-0.184	-0.488*	-0.328^	-0.493*	-0.159	-0.219	0.691*	0.717*	0.911*	1					
HT- GM	0.234	0.184	0.041	0.063	0.034	0.073	0.323^	0.332^	0.194	0.156	1				
HT- PM	0.079	0.063	-0.104	-0.083	-0.060	-0.001	0.291	0.442''	0.325^	0.253	0.868*	1			
TT- GM	0.559*	0.469''	0.396''	0.409''	0.392''	0.308	0.211	0.021	-0.053	-0.169	0.223	0.183	1		
TT- PM	0.245	0.217	0.132	0.181	0.19	0.259	0.418''	0.313	-0.033	0.009	0.430''	0.507*	0.494*	1	
TD- GM	-0.163	-0.338^	-0.246	-0.408''	-0.122	-0.158	0.388''	0.672*	0.772*	0.673*	0.376^	0.545*	-0.118	-0.092	1
TD- PM	-0.153	-0.322	-0.248	-0.397''	-0.175	-0.184	0.379^	0.698*	0.701*	0.642*	0.456''	0.672*	-0.083	0.065	0.940*

*Note. Spearman's rank correlation coefficients (n =27): * – $r_{s\ tabl}$=0.487 at p=0.01; '' – $r_{s\ tabl\ n}$=0.381 at p=0.05; ^ – $r_{s\ tabl}$ =0.323 at p=0.1.*

lowest rates of diffuse goiter of different degrees are presented in Table 1.

However, it should be noted that in the regions that occupy the last ranked positions according to the levels of both morbidity indices, AIR and IR were high. On the contrary, in regions with a high morbidity, AIR and IR were low or even negative. This was confirmed by the Spearman's rank correlation coefficients, which proved a statistically significant backward correlation between the level and the IR of the total (r_s=-0.576; $r_{s\,tab}$l=0.478 at n=27, p=0.01) and the primary (r_s=-0.509, p<0.01) incidence of endocrinopathies among the population of 27 investigated AT of Ukraine.

In general, the incidence rates of adult population for endocrine diseases correlate with the prevalence and morbidity rates of diffuse goiter of various degrees (Table 2), which is explained by a high specific gravity of the latter in the structure of endocrine diseases. Thus, in Ukraine in 2010, in the structure of endocrinopathy, diffuse goiter of degrees I-III was the second (29.99 %) after diabetes mellitus (31.88 %), and the share of all thyroid gland diseases was 46.67 % [14].

In the analysis of both indices of thyroid morbidity, it was found out that during the period of investigation, the highest levels were registered in the western and northern regions of Ukraine, and the lowest ones were in the central, eastern and southern (except in the Autonomous Republic of Crimea) regions (Fig. 1). At the same time, in most of the western and northern regions during 14 years there was a decrease in both (Volyn, Lviv, Zakarpattia, Ivano-Frankivsk, Sumy oblasts), or one (Ternopil, Zhytomyr, Kyiv, Chernihiv) of the morbidity indices, while the changes in the other were insignificant (Fig. 2).

Kyiv was the exception: both indices, especially the level of general morbidity, increased; in Rivne and Chernivtsi regions the general morbidity significantly increased without significant changes in the primary one, and in Khmelnitsky region significant changes in both indices did not take place. The situation in the central, eastern and southern regions was the opposite, where in the majority of regions there was a significant increase in both (Cherkasy, Poltava, Kharkiv, Donetsk, Zaporizhia, Mykolaiv, Odesa) or one (Vinnytsia, Dnipropetrovsk, Kherson, Luhansk regions and Sevastopil) of indices with minor changes of the other. Kirovograd region and Crimea were the exceptions: the general morbidity did not

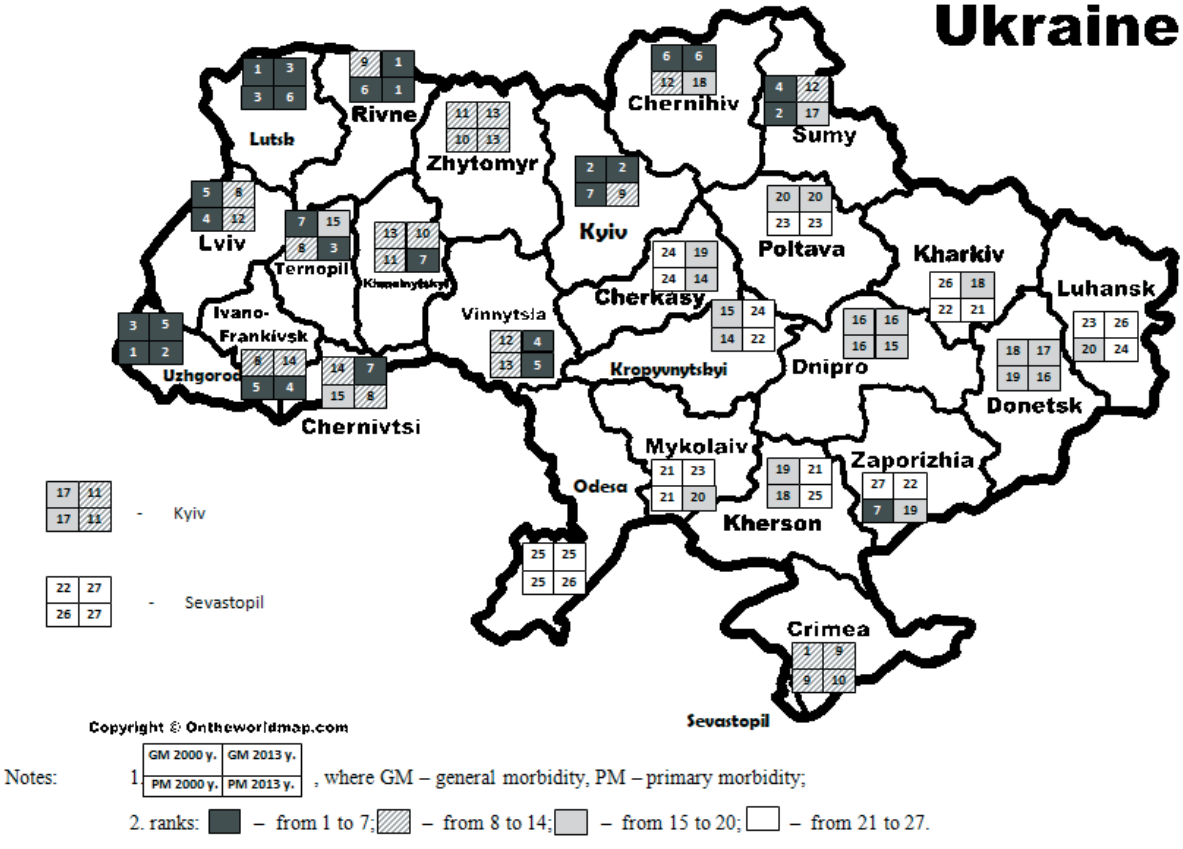


Fig. 1. Thyroid morbidity.

change significantly, and the primary one – decreased (Fig. 2).

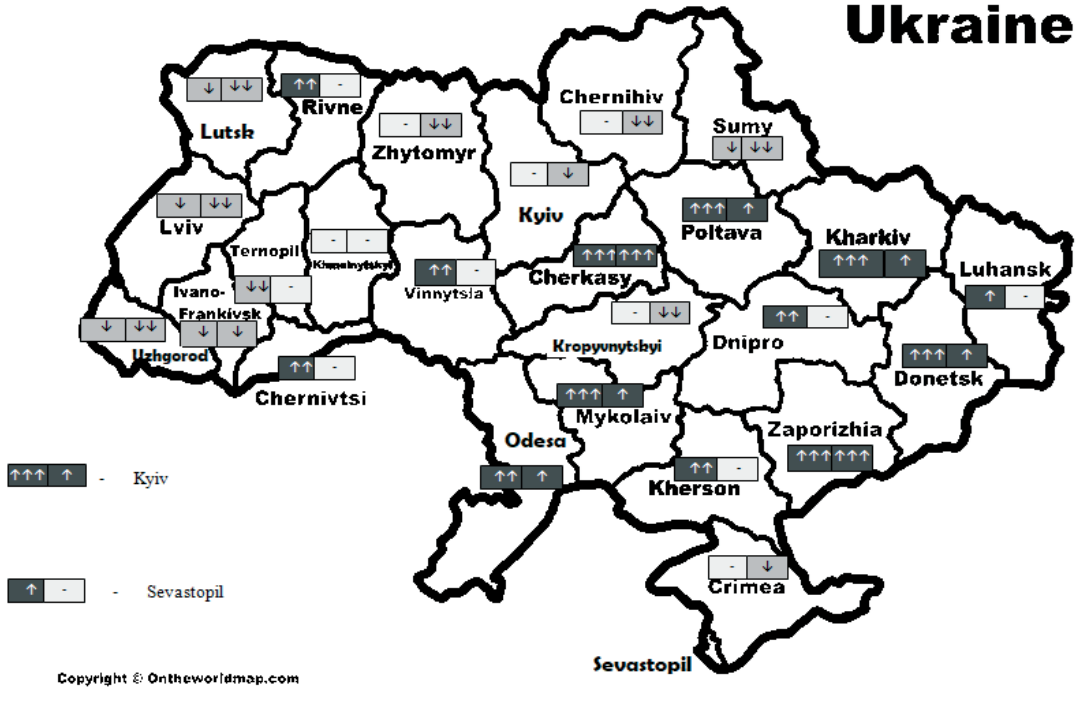
Thus, in relation to thyroid pathology, as well as in case of endocrine diseases in general, a statistically significant inverse relationship between the level and IR of the general (r_s= -0.687, p<0.001) and primary (r_s=-0.735, p<0.001) morbidity of adult population in 27 investigated AT of Ukraine was revealed.

Concerning certain nosological forms of thyroid pathology, during the period of monitoring, significant regional features were revealed both for the levels of morbidity indices and the direction of their changes in the period of study.

Thus, the levels of primary and general morbidity of diffuse goiter (DG) were the highest in the western (Zakarpattia, Rivne and Volyn regions – DG of degrees I and II–III, Chernivtsi – DG of degrees II–III, Lviv and Ivano-Frankivsk – DG of degree I) and northern (Kyiv, Sumy, Chernihiv) regions, and the lowest ones – in the eastern (Donetsk) and southern (Odesa, Zaporizhia, Kherson regions and Sevastopil) regions (Table 1).

During 14 years of the study, the general morbidity rate for diffuse goiter of degrees I (DG-I) and II–III (DG-II–III) in 11 and 6 regions respectively decreased, in 8 and 13 AT – increased, which was confirmed by statistically significant correlation coefficients. In 3 and 2 AT respectively, there was a tendency to increase (0.707>r>0.622, 0.05<p<0.1); in the rest of the AT there were no significant changes. Regarding the primary morbidity of diffuse goiter of different degrees, its level decreased in 16 AT (p<0.05), in one region – a tendency to decrease was evidenced; in the other 10 AT there were no significant changes. It should be noted that between the level and GR of both general and primary morbidity with diffuse goiter of degrees I and II–III there was a reliable inverse relationship (from r_s=-0.390 to r_s=-0.582; $r_{s\ tabl}$=0.381 at n=27 and p=0.05): the lower the level of incidence in the region, the greater the pace of its growth.

The highest levels of nodular goiter primary and general morbidity were registered in the northern regions (Kyiv city, Kyiv, Chernihiv and Sumy regions), Vinnytsia and Kherson regions (Table 1). At the same time, in those regions, as well as in Sevastopil, the highest levels of thyroid cancer morbidity incidence and prevalence were proved. The lowest levels of morbidity rates for both nodular goiter and thyroid cancers were registered in western



Notes: 1. Changes in ranges: «-» - less than ±25 %; ↑/↓ - 25-50 %; ↑↑/↓↓ - 50-100 %; ↑↑↑/↓↓↓ - more than 100%; GM | PM - general/primary morbidity.

2. ↑ – index increasing; ↓ - index decreasing; - - significant ghanges are absent.

Fig. 2. Dynamics of changes in the thyroid general and primary morbidity.

(Zakarpattia, Ivano-Frankivsk, Ternopil) and Luhansk regions; only nodular goiter – in Lviv and Odesa, only cancer – in Volyn and Rivne regions. In general, between the levels of nodular goiter primary and general morbidity, on the one hand, and cancer, on the other hand, there was a significant positive correlation (Table 2).

Regarding the dynamics, in the study period, the nodular goiter general morbidity in 25 of 27 AT increased, which was confirmed by a statistically significant positive correlation coefficient; in Zhytomyr region there was a tendency to increase ($0.707>r>0.622$, $0.05<p<0.1$) and only in Volyn region the index decreased ($r=-0.902$; $p<0.01$). Nodular goiter primary morbidity increased in 22 AT ($r>0.707$, $p<0.05$); in three – it did not change significantly, remaining steadily high in Kyiv and Sumy regions; and in Volyn and Zhytomyr – decreased ($r=-0.908$, $p<0.01$ and -0.748, $p<0.05$, respectively).

Regarding the overall incidence of thyroid cancer, in general in the period of 2000–2013 there was no statistically significant relationship in the period of monitoring between 25 out of 27 AT ($p>0.05$), only in Kyiv region the increase ($r=0.784$, $p<0.05$) took place, while in Chernivtsi – the decrease ($r=-0.716$, $p<0.05$) of the index.

The primary incidence of thyroid cancer in the period of investigation increased in 15 regions and the Crimea Autonomous Republic ($r>0.707$, $p<0.05$), while in 4 regions (Rivne, Zhytomyr, Kropyvnytskyi, and Odesa), there was a tendency to increase ($0.707>r>0.622$, $0.05<p<0.1$), in the rest of the AT the relationship between the level of the indices and the year of monitoring was not detected ($p>0.05$).

The highest levels of both indices of the incidence of adult thyroiditis in Ukraine were registered in Kyiv city, Kharkiv, Donetsk, Kyiv, Dnipropetrovsk and Kherson regions, and the lowest – in Ternopil, Volyn, Luhansk, Zakarpattia and Rivne regions (Table 1). In general, both thyroiditis morbidity indices correlated with the incidence of thyroid cancer, nodular goiter and hypothyroidism (Table 2).

During the study period, the overall incidence of thyroiditis, hypothyroidism and thyrotoxicosis increased in most (24, 20 and 26, respectively) of the studied AT, which was confirmed by a statistically significant positive coefficient of correlation. Regarding the primary morbidity of thyroiditis, hypothyroidism and thyrotoxicosis, the indices increased in 13, 17 and 11 respectively.

Discussion

The regional peculiarities of the levels and dynamics of changes in the incidence rates of the thyroid morbidity among adult population of Ukraine can be related to the priority environmental factors for each region. It is established that the western and northern regions of Ukraine are different from the rest of the low natural content in the soil of iodine. The northern (Kyiv, Chernihiv, Zhytomyr, Rivne) and Cherkasy regions are significantly contaminated by radioactive substances, including radioactive iodine isotopes (predominantly I-131), as a result of the Chernobyl accident. In the eastern region, Dnipropetrovsk and Zaporizhia regions, powerful industrial centers are concentrated, in which relatively high levels of environmental pollution by industrial toxicants, including heavy metals, are registered. The central and southern regions have developed agricultural production, which today widely uses chemical protection products for plants. The study of the environmental factors influence on the Ukrainian adult population thyroid morbidity will be a topical issue of our further research.

Conclusions

In the period from 2000 to 2013, high levels of adult population endocrinopathies, thyroid glands in general and diffuse goiter of varying degrees, general and primary morbidity have been recorded in the western and northern regions of Ukraine, low – in the central, eastern and southern regions.

Statistically significant ($p<0.001$) positive correlation between the level of prevalence and the level of incidence of endocrine pathology, diseases of thyroid gland as a whole, as well as individual nosology has been detected.

It has been established that endocrine diseases incidence rates of adult population correlate ($p<0.01$) with the prevalence and morbidity rates of diffuse goiter of various degrees, which is explained by a high specific gravity of the latter in the structure of endocrine diseases in general and thyroid pathology, in particular.

The factors that cause development of various diseases of thyroid gland as well as regional peculiarities of their development require further study to develop effective methods of protection and prevention.

** Kropyvnytskyi is a city in central Ukraine, and is the administrative center of the Kirovohrad Oblast. Between 1939 and 2016 it was called Kirovohrad.*

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