Iran J Public Health, Vol. 45, No.8, Aug 2016, pp.1012-1019

Original Article

Estimation of the Change of Ovarian Cancer Incidence in Kazakhstan: Component Analysis of Its Dynamics with the Consideration of Ethnic Features

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(Received 11 Jan 2016; accepted 15 Jun 2016)

Abstract

Background: We examined epidemiological aspects of dynamic changes in incidence of ovarian cancer in women of Kazakh and Russian nationalities in Kazakhstan.

Methods: The material of investigation was primary data on registered patients with malignant ovarian tumors in the whole country. The study was conducted during the period of 1999-2009. Evaluation of changes in ovarian cancer incidence in the female population of Kazakhstan was performed using component analysis.

Results: The number of patients with ovarian cancer in the whole country is increasing. This increase is due to several major reasons, including population growth (all females – Δ_P=+22.1%, females of Kazakh nationality – Δ_P=+46.0% and females of Russian nationality – Δ_P=−259.3%), changes in the age structure (all females – Δ_A=+32.7%, females of Kazakh nationality – Δ_A=+27.1 and females of Russian nationality – Δ_A=+130.8),and changes in risks of developing the disease (all females – Δ_R=+36.0%, females of Kazakh nationality – Δ_R=+13.1% and females of Russian nationality – Δ_R=+246.8%).

Conclusion: This investigation was the first epidemiological study of dynamics of ovarian cancer by component analysis in women of Kazakh and Russian nationalities in Kazakhstan. Implementation of the results of the study is recommended in management of anti-cancer activities for ovarian cancer.

Keywords: Ovarian cancer, Incidence, Ethnic groups, Component analysis

Introduction

Even though cases of ovarian cancer do not occur frequently, this disorder does not take the leading position in the structure of cancer pathology. However, it remains to be one of the unsolved problems of the medicine. According to the estimates of the International Agency of Cancer Research there are nearly 239,000 of new cases of ovarian cancer registered annually in the world, and the standard incidence index equals to 6.1 per 100,000 of population (1). At the same time, the increasing number of ovarian cancer patients has been increasing in many countries in the last decades. Poor prognosis of the disease, despite the advances in diagnosis and treatment, causes a major medical and public health concern (2-4).

Epidemiological studies of ovarian cancer conducted recently in Kazakhstan (5, 6) show that the dynamics of incidence indexes are raising, though the component analysis particularly, the one taking into consideration ethnic characteristics, has never been conducted. Component analysis of the dynamics of malignant tumors in Kazakhstan has been performed generally in all localizations (7), with the cancer of the esophagus (8) and malignant tumors of the CNS (9).

The study of the dynamics of malignant tumors is essential for planning and management of drug treatment for policy-makers. During this process difficult questions might occur. For example, to what extent the increase in incidence is associated with aging of the population, and to what extent - to an increased risk of developing the disease due to the emergence of new or intensification of existing epidemiological factors. Undoubtedly, identification and solution of such problems over the study period in this population are necessary, unless significant changes in registration and the quality of diagnosis could have occurred (10).

Growth of incidence of the ovarian cancer is the result of accumulation of elements of complex combinations of different component structures. Investigation of changes in the incidence of ovarian cancer in dynamics represents scientific and practical interest, especially with the component analysis. Performance of such analysis for the study of individual components of the change in incidence, influencing its level, will allow oncology service management to identify the factors leading to the occurrence of ovarian cancer, and to organize targeted cancer control.

The aim of the study was to perform component analysis of the dynamics of incidence of ovarian cancer of the female population of Kazakhstan from 1999 to 2009 taking into account their ethnic background.

Methods

The major source of the information on the incidence of the ovarian cancer was primary data on registered patients with malignant tumors in the whole country. The data of the Committee of Statistics of the Ministry of National Economy of the Republic of Kazakhstan on the female population was also used as the source of information (11).

Retrospective study (1999-2009) incidence rates were calculated according to generally accepted methods of health statistics (12, 13) and are represented by 100,000 ($^{0}/_{0000}$) of the corresponding female population. The study was approved by the local Ethical Committee and administrative permission was obtained from JSC «Astana Medical University». The information may be shared for research purposes only if a requesting organization provides the data security and under takes all the necessary actions in making unable the identity of respondents, in concordance with the Principles of the World Medical Association (WMA) Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects, adopted by the 18th WMA General Assembly in Helsinki, Finland, in June 1964.

The dynamics of the ovarian cancer in the female population of Kazakhstan was studied based on the guidelines of Dvoyrin and Axel (10). This method of analysis allows segmentation of growth of the number of the diseased belonging to the same population, but at different time. There are seven different components of growth of the number of patients. The first three components are related to the changes in population number, age structure of population, and the combined influence of these factors. The fourth component is determined only by the change of the risk index of the malignant ovarian tumor and the other three components are related to the risk associated with the population growth, changes in its age structure and the resulting effect of all three factors. Many researchers understand the term «a disease risk» as the whole complex of reasons that can lead to increase, reduction or stabilization of morbidity indexes. Therefore, the increase of the disease risk corresponds to the last four components.

The component method used for analysis of the dynamics of the number of ovarian cancer patients was performed on cases that occurred from 1999 to 2009 among the entire female population, including females of Kazakh and Russian nationalities, as the studied ethnic groups still take a leading position in both the number of the female population and among the ovarian cancer patients.

Mathematical calculations for component analysis of morbidity dynamics for malignant tumor ovarian in population of Kazakhstan were produced using Microsoft Excel program and are presented in the relevant tables.

The following symbols and abbreviations were

used in this article: P_{ij} – the incidence of ovarian cancer at certain age in the *i*- th and in the j-th years, N_{ij} – population size at certain age in the *i*-th to *j*-th years, P_j and N_j – crude incidence rate and the total population size in the j-th year respectively, *j*=1 – the start year of observation , *j*=2 – the final year of observation , $\frac{N_{ij}}{N_j} = S_{ij}$ – the proportion of patients aged *i* in the total population size in the *j*-th year, ASP – the age structure of the population, SI – structural indexes, RP – risk of progressing, NOC – the number of ovarian cancer cases, PN – population number, ENI – the expected number of infected.

Results

Demographic change of the population is one of the most important epidemiological factors that influence the occurrence of cancers in the population, in particular ovarian cancer in women. Thus, the number of total female population of the country over the study period (1999-2009) increased from 7 752 100 (1999) up to 8 185 900 (2009), while the number of women of Kazakh nationality increased and population of Russian women decreased (Fig. 1).

The age structure of the female population has changed over this period in the individual age groups (Fig. 2). Thus, the proportion of women increased in general population for the 50-59 age group (3.2%) and 70 years and older (0.6%) years, Kazakh women aged 40-49 (+2.9%), 50-59 (+2.2%), 60-69 (+0.5%) and in Russian women aged 50-59 (+3.8%) and 70 years and older (+1.4%).

The results of the component analysis of the dynamics in the number of ovarian cancer patients in all Kazakh and Russian female population of Kazakhstan since 1999 to 2009 is presented in Tables 1 and 2.

Table 1: Component analysis of ovarian cancer incidence growth in Kazakhstan

Age, years *(i)*	ASP ($Sij = \frac{N_{ij}}{N_j}$)		Growth of SI $(S_{i2}-S_{i1})$ (3)-(2)	Ovarian cancer incidence, $^0/_{0000}$		Growth of incidence			
	1999 (S_{i1})	2009 (S_{i2})		1999 (P_{i1})	2009 (P_{i2})	general $(P_{i2}-P_{i1})$ (6)-(5)	considering the changes ASP (4)×(5)	RP (2)×(7)	ASP and RP (4)×(7)
1	2	3	4	5	6	7	8	9	10
All female population									
<30	0.5150	0.4890	−0.0260	1.20	1.17	−0.03	−0.031	−0.014	+0.001
30-39	0.1520	0.1420	−0.0100	4.75	5.59	+0.84	−0.048	+0.128	−0.008
40-49	0.1282	0.1369	+0.0087	13.49	14.99	+1.5	+0.117	+0.193	+0.013
50-59	0.0773	0.1093	+0.0320	26.71	29.29	+2.6	+0.855	+0.199	+0.083
60-69	0.0707	0.0600	−0.0107	30.47	30.75	+0.3	−0.326	+0.020	−0.003
≥70	0.0568	0.0629	+0.0061	27.46	32.44	+5.0	+0.168	+0.283	+0.030
Total	$\sum S_{i1}$=1.0	$\sum S_{i2}$=1.0		P_1=8.85	P_2=10.51	+1.66	$\sum=\Delta_B$=+0.73	$\sum=\Delta_P$=+0.81	$\sum=\Delta_{BP}$=+0.12
Kazakh females									
<30	0.6013	0.5587	−0.0426	1.32	0.95	−0.37	−0.056	−0.225	+0.016
30-39	0.1645	0.1530	−0.0115	3.77	3.71	−0.06	−0.043	−0.010	+0.001
40-49	0.1088	0.1379	+0.0291	12.78	13.50	+0.7	+0.372	+0.079	+0.021
50-59	0.0563	0.0779	+0.0216	24.24	28.41	+4.2	+0.524	+0.235	+0.090
60-69	0.0385	0.0438	+0.0053	27.68	24.60	−3.1	+0.147	−0.119	−0.016
≥70	0.0306	0.0287	−0.0019	17.81	33.42	+15.6	−0.034	+0.478	−0.030
Total	$\sum S_{i1}$=1.0	$\sum S_{i2}$=1.0		P_1=5.78	P_2=7.21	+1.43	$\sum=\Delta_B$=+0.91	$\sum=\Delta_P$=+0.44	$\sum=\Delta_{BP}$=+0.08
Russian females									
<30	0.4024	0.3770	−0.0254	1.43	1.79	+0.36	−0.036	+0.144	−0.009
30-39	0.1337	0.1244	−0.0093	4.60	11.60	+7.00	−0.043	+0.936	−0.065
40-49	0.1567	0.1500	−0.0067	16.76	17.00	+0.2	−0.112	+0.038	−0.002
50-59	0.1042	0.1421	+0.0379	29.95	39.62	+9.7	+1.135	+1.007	+0.366
60-69	0.1104	0.1002	−0.0102	37.20	34.11	−3.1	+0.379	−0.341	+0.031
≥70	0.0926	0.1063	+0.0137	37.23	39.84	+2.6	+0.510	+0.242	+0.036
Total	$\sum S_{i1}$=1.0	$\sum S_{i2}$=1.0		P_1=14.49	P_2=17.95	+3.46	$\sum=\Delta_B$=+1.07	$\sum=\Delta_P$=+2.03	$\sum=\Delta_{BP}$=+0.36

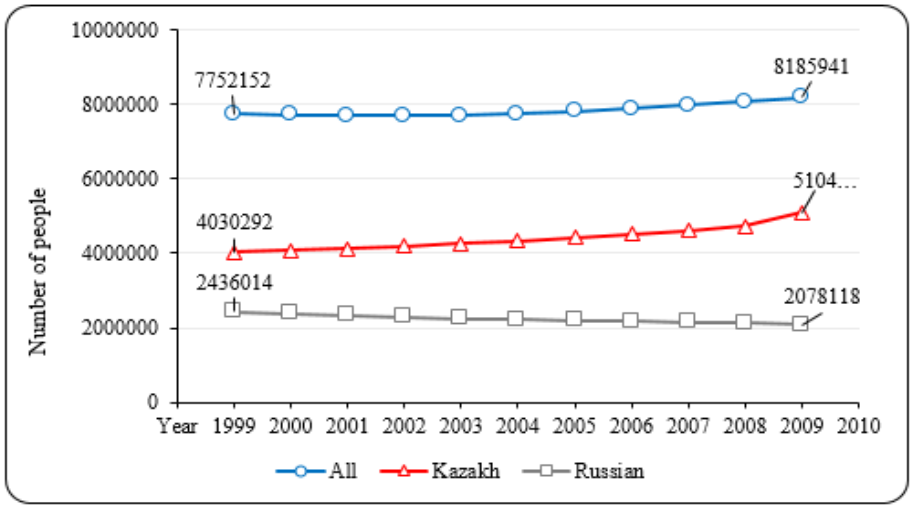

Fig. 1: Change in the size of female population of Kazakhstan for 1999-2009

Table 2: Component analysis of the dynamics of ovarian cancer incidence growth in Kazakhstan

Age, years *(i)*	NOC *(nij)*		PN *(Nij)*		Incidence, $^0/_{0000}$ Crude (*Pij*)		Incidence, $^0/_{0000}$ standardized (P_{ij}^c)		ENI in 2009 year ($P_{ij}N_{i2}10^{-5}$) (6)×(5)×10^{-5}
	1999 (*j*=1)	2009 (*j*=2)	1999 (*j*=1)	2009 (*j*=2)	1999 (*j*=1)	2009 (*j*=2)	1999 (*j*=1)	2009 (*j*=2)	
1	2	3	4	5	6	7	8	9	10
All female population									
<30	48	47	3992545	4002657	1.20	1.17		0.605	48.12
30-39	56	65	1178431	1162483	4.75	5.59		0.850	55.2
40-49	134	168	993472	1120570	13.49	14.99		1.921	151.1
50-59	160	262	599011	894458	26.71	29.29		2.263	238.9
60-69	167	151	548129	491025	30.47	30.75		2.174	149.6
≥70	121	167	440564	514748	27.46	32.44		1.844	141.4
Total	n_1=686	n_2=860	N_1=7752152	N_2=8185941	P_1=8.85	P_2=10.51	P_1^c=8.85	P_2^c=9.66	$E(n_2)$=784
Growth	$\frac{n_1-n_2}{n_1}100=+25.4$		$\frac{N_1-N_2}{N_1}100=+5.60$		$\frac{P_1-P_2}{P_1}100=+18.7$		$\frac{P_1^c-P_2^c}{P_1^c}100=+9.1$		
Kazakh females									
<30	32	27	2423355	2851763	1.32	0.95		0.866	118.70
30-39	25	29	662820	780827	3.77	3.71		0.524	77.8
40-49	56	95	438329	703716	12.78	13.50		0.734	100.9
50-59	55	113	226907	397681	24.24	28.41		0.744	160.9
60-69	43	55	155334	223607	27.68	24.60		0.725	74.5
≥70	22	49	123547	146611	17.81	33.42		0.284	25.7
Total	n_1=233	n_2=368	N_1=4030292	N_2=5104205	P_1=5.78	P_2=7.21	P_1^c=5.78	P_2^c=6.22	$E(n_2)$=341
Growth	$\frac{n_1-n_2}{n_1}100=+57.9$		$\frac{N_1-N_2}{N_1}100=+26.65$		$\frac{P_1-P_2}{P_1}100=+24.7$		$\frac{P_1^c-P_2^c}{P_1^c}100=+7.6$		
Russian females									
<30	14	14	980249	783563	1.43	1.79		0.866	118.70
30-39	15	30	325782	258533	4.60	11.60		0.524	77.8
40-49	64	53	381813	311686	16.76	17.00		0.734	100.9
50-59	76	117	253724	295339	29.95	39.62		0.744	160.9
60-69	100	71	268829	208134	37.20	34.11		0.725	74.5
≥70	84	88	225617	220865	37.23	39.84		0.284	25.7
Total	n_1=353	n_2=373	N_1=2436014	N_2=2078118	P_1=14.49	P_2=17.95	P_1^c=14.49	P_2^c=16.52	$E(n_2)$=323
Growth	$\frac{n_1-n_2}{n_1}100=+5.7$		$\frac{N_1-N_2}{N_1}100=-14.69$		$\frac{P_1-P_2}{P_1}100=+23.9$		$\frac{P_1^c-P_2^c}{P_1^c}100=+14.0$		

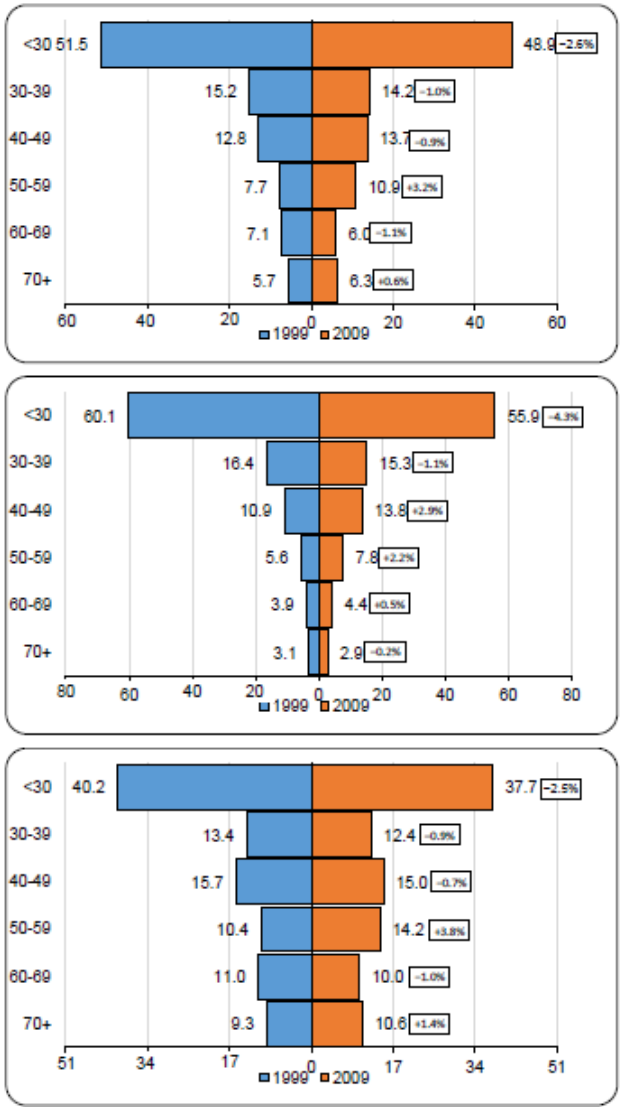

Fig. 2: The change in age structure of the female population (A – total, B – Kazakh, C – Russian) in Kazakhstan for 1999 to 2009 (%)

The analysis of morbidity of the ovarian cancer in dynamics showed the growth of indexes, with the total increase in 2009 compared to 1999 caused by the changes in the age structure of the population, the disease risk and the combined influence of the age structure and the disease risk. At the same time, the growth of indexes among Russian female population is mainly caused by the changes associated with risk of infection ($\sum=\Delta_P=+0.81$ и $+2.03$ respectively), and for Kazakh females it is mostly caused by changes in the age structure of the population ($\sum=\Delta_B=+0.91$).

The internationally recognized epidemiological patterns say that with the population growth and the changes in its age structure the number of patients should grow as well. These patterns are also observed in our country.

It can be concluded from the researches that in general the dynamics of the number of patients with ovarian cancer for the entire female population of Kazakhstan can be caused by the following factors (Table 3).

The total increase in the absolute number of patients overall (all nationalities) equals the sum of components: $n_2-n_1=+38+57+3+63+4+9+0=$ $=+174$ or $+25.4\%$ in comparison with the primary number of patients ($174\div686\times100=25.4\%$). At the same time, the components of the growth in the percentage at the primary level are equal for the whole female population:

$$\underbrace{+5.6\%+8.3\%+0.5\%}_{+14.4\%}+\underbrace{9.1\%+0.5\%+1.3\%+0.1\%}_{+11.0\%}=+25.4\%$$

The overall increase for Kazakh female population equals to: $n_2-n_1=+62+37+10+18+5+3+1=$ $=+135$ or $+57.9\%$ compared to 1999 ($135\div233\times100=57.9\%$), the components were:

$$\underbrace{+26.6\%+15.7\%+4.2\%}_{+46.5\%}+\underbrace{7.6\%+2.0\%+1.4\%+0.4\%}_{+11.4\%}=+57.9\%$$

The overall increase for Russian female population equals to: $n_2-n_1=-52+26-4+49-7+9-1=$ $=+20$ or $+5.7\%$ compared to the original number of patients ($20\div353\times100=5.7\%$). According to that, the components of growth in percent of the initial level were equal to:

$$\underbrace{-14.7\%+7.4\%-1.1\%}_{-8.4\%}\underbrace{-2.1\%+14.0\%+2.5\%-0.4\%}_{+14.0\%}=+5.7\%$$

Table 3: Components of increase in the number of cases of ovarian cancer in Kazakhstan

Components of growth in the number of cases due to:	All female population			Kazakh females			Russian females		
	AN	% growth		AN	% growth		AN	% growth	
		к (n_2-n_1)	к n_1		к (n_2-n_1)	к n_1		к (n_2-n_1)	к n_1
1. Growth PN $\Delta_P = \frac{N_1 - N_2}{N_1} n_1$	+38	+22.1	+5.6	+62	+46.0	+26.6	−52	−259.3	−14.7
2. Changes ASP $\Delta_A = \frac{N_1}{N_2}(E(n_2) - n_1 - \Delta_P)$	+57	+32.7	+8.3	+37	+27.1	+15.7	+26	+130.8	+7.4
3. Combined effect of changes in PN and ASP $\Delta_{PA} = \frac{N_2 - N_1}{N_1} \Delta_A$	+3	+1.8	+0.5	+10	+7.2	+4.2	−4	−19.2	−1.1
		∑=+56.6	**∑=+14.4**		**∑=+80.3**	**∑=+46.5**		**∑=−147.7**	**∑=−8.4**
4. Change of RP $\Delta_R = N_1(P_2^c - P_1^c) \times 10^{-5}$	+63	+36.0	+9.1	+18	+13.1	+7.6	+49	+246.8	+14.0
5. Combined effect of changes of RP and PN $\Delta_{RA} = \frac{N_2 - N_1}{N_1} \Delta_R$	+4	+2.0	+0.5	+5	+3.5	+2.0	−7	−36.3	−2.1
6. Combined effect of changes of RP and ASP $\Delta_{RA} = \frac{N_2 - N_1}{N_1} \Delta_R$	+9	+5.1	+1.3	+3	+2.4	+1.4	+9	+43.6	+2.5
7. Combined effect of the changes RP, PN and ASP $\Delta_{PAR} = \frac{N_1}{N_2}\left(n_2 - n_1 - \sum_{x=1}^{5} \Delta\right)$	0	+0.3	+0.1	+1	+0.6	+0.4	−1	−6.4	−0.4
		∑=+43.4	**∑=+11.0**		**∑=+19.7**	**∑=+11.4**		**∑=+247.7**	**∑=+14.0**
Total	**+174**	**∑=+100.0**	**∑=+25.4**	**∑=+135**	**∑=+100.0**	**∑=+57.9**	**∑=+20**	**∑=+100.0**	**∑=+5.6**

1. Growth population number Δ_P=+22.1% (Kazakh – Δ_P=+46.1, Russian – Δ_P=−259.3%);
2. Changes in the Age Structure of the population Δ_A=+32.7% (Kazakh – Δ_A=+15.7%, Russian – Δ_A=+130.8%).
3. Combined effect of changes in population number and its age structure Δ_{PA}=+1.8% (Kazakh – Δ_{PA}=+7.2%, Russian – Δ_{PA}=−19.2%).
4. Change of infection risk Δ_R=+36.0% (Kazakh – Δ_R=+13.1%, Russian – Δ_R=+246.8%).
5. Combined effect of changes in the disease risk and population number Δ_{PR}=+2.0% (Kazakh – Δ_{PR}=+3.5%, Russian – Δ_{PR}=−36.3%).
6. Combined effect of changes in the disease risk and age structure of the population Δ_{AR}=+5.1% (Kazakh – Δ_{AR}=+3.5%, Russian – Δ_{AR}=−36.3%).
7. Combined effect of the changes in the disease risk of the population and its age structure Δ_{PAR}=+0.3% (Kazakh – Δ_{PAR}=+0.6%, Russian – Δ_{PAR}=−6.4%).

Discussion

Thus, ovarian cancer in Kazakhstan is characterized by the increase in the number of patients due to the changes in total number and the structure of the population (for the entire female population +14.4% of the total growth of +25.4%; for Kazakh female population +46.5 of the total growth +57.9% and for Russian female population −8.4% of the total growth of +5.6%). The actual growth of ovarian cancer cases is significant and is equal to +9.1% for the whole population, +7.6% for Kazakh women and +14.0% for Russian women.

The components are grouped into 3 classes, one of which represents different kinds of changes in the population (Δ_P+Δ_A+Δ_{PA}), the second one shows only the growth of disease risk (Δ_R) and the third – the relationship between these factors (Δ_{PR}+Δ_{AR}+Δ_{PAR}). Therefore, to characterize the cumulative effect of changes in population or the disease risk the components of the 1st and 2nd

class the effect of influence of the 3rd class components should be added:

1. $(\Delta_P+\Delta_A+\Delta_{PA})+(\Delta_{PR}+\Delta_{AR}+\Delta_{PAR})$
2. $\Delta_R+(\Delta_{PR}+\Delta_{AR}+\Delta_{PAR})$

If the overall increase in the number of ovarian cancer patients for the female population (174) is taken as 100%, the increase associated with the disease risk is +43,4% ((+9.1+0.5+1.3+0.1)÷÷25.4×100) and with «pure» risk growth it equals to +36.0%. For Kazakh women the growing number of the disease risk (135=100%) will be +19.7% ((+7.6+2.0+1.4+0.4)÷57.9×100), and with «pure» increased risk of +13.1%, respectively, and for Russian women (20=100%) the growth of ovarian cancer risk will be 247.7% ((+14.0−2.1+2.5−0.4)÷5.6×100), and with «pure» increased risk +246.8%.

Various component structures in ovarian cancer at different times or in different groups of the female population at the same time period may provide important information for the construction of epidemiological hypotheses about possible causal role of environmental factors.

Thus, the number of patients with ovarian cancer in the whole country is increasing. The growth is mainly caused by population growth, the combined effect of changes in population number and its age structure, the changes if infection risks, the combined effect of changes in the infection risks and age structure of the population. The results of the component analysis of the dynamics of ovarian cancer infections in Kazakhstan are recommended to use when planning anti-cancer activities of ovarian cancer.

Conclusion

The number of patients with ovarian cancer has been steadily increasing in the Republic of Kazakhstan. It was found that the increase in the number of patients with this malignant disease is caused mainly by the change in the total number and age structure of the population, and their combined action, as well as the increase of risk of developing the disease due to the emergence of new or intensification of existing epidemiological risk factors. The results of the component analysis of the dynamics of ovarian cancer cases in Kazakhstan are recommended to use when planning anti-cancer activities of ovarian cancer.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

The authors(s) declare that they have no competing interests.

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