RESEARCH ARTICLE

Component Analysis of Esophageal Cancer Incidence in Kazakhstan

S Igissinov[1,2], N Igissinov[2,3,4], MA Moore[5], S Kozhakhmetov[2,4], G Igissinova[1,2], S Sarsenova[4], G Aldiyarova[4], Z Bilyalova[2], K Zhabagin[6], Z Manambayeva[6]

Abstract

Esophageal cancer (EC) incidence rates in Kazakhstan were assessed by component analysis based on primary registered cases in 2001-2010. It was found that despite an apparent general decrease in the number of EC patients in Kazakhstan, a potential increase should be evaluated, due to changes in aging as well as the increase in population. Some problems of EC patients' registration were broached with an emphasis on the importance of the expected absolute number and reasons for undercounting in the country. Based on these, ways of improving the recording and registration of such patients in the country were suggested.

Keywords: Component analysis - esophageal cancer - incidence data - prevalence data - Kazakhstan

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Introduction

Epidemiological studies of esophageal cancer (EC) of the last three decades indicate that there have been significant changes in incidence. EC in the structure of all malignant neoplasms is 3% and on the sixth place, among the gastrointestinal tract tumors is on the third place after the stomach and colon cancers. Geographic variability and heterogeneity of EC incidence rate are linked to various exogenous and endogenous factors, including the ethnic composition of the population. In this case, the incidence of EC differs in different regions of the globe. The regions with a high EC incidence include Northern China and Northern Iran, where the rates is more than $100.0^0/_{0000}$. In the U.S. African Americans, get sick four times more often than other Americans do as a whole. In other countries, the incidence of EC varies widely.

There is a particularly high EC incidence area – the so-called Asian cancer belt, which extends from the south shore of the Caspian Sea to North China in the east, including Northern Iran, Central Asia, Afghanistan, and parts of Siberia and Mongolia. The incidence in Iran, south-central regions of the former Soviet Union, Afghanistan, Mongolia and northwest China is 10 times higher than in other countries. Annually 160 cases the esophageal cancer per 100,000 population in Iran, in other countries including North America, Europe, and Japan – from four to eight cases (Zambon, 2000; Yankin, 2003; Bosetti et al., 2008; Krutilina, 2008; Davydov et al., 2009; Ferlay et al., 2010; Zhao et al., 2012).

In Russia, EC accounted for 3.0% of all malignant neoplasms and ranked 14th place in 2006, the standardized rate (world standard) of incidence rate was $6.7^0/_{0000}$, men – $6.6^0/_{0000}$, and for women – $1.1^0/_{0000}$, it was investigated significant regional differences in the incidence. Thus, the highest incidence was found – in Yakutia and Tuva, the average – in Buryatia, Karelia, Komi, Kalmykia, Tatarstan, Bashkortostan, Sakhalin, Kamchatka and Chelyabinsk regions and the lowest – in the central and south of the European part of the Russian Federation. Among men, the highest rate in Yakutia. The incidence of EC in Muinak district of Karakalpakstan (Uzbekistan) is $126.0^0/_{0000}$ for men and $150.0^0/_{0000}$ for women (Davydov et al., 2009). Analyzing the map of world spreading of EC, it can be divided into five levels of incidence: to $3.4^0/_{0000}$ – low, from 3.4-$6.8^0/_{0000}$ – moderate, ranging from 6.8-$10.2^0/_{0000}$ – the average, 10.2-$13.6^0/_{0000}$ – high and from $13.6^0/_{0000}$ and up – maximum. The highest incidence of EC in men from 9.3-$28.1^0/_{0000}$ was observed in Ethiopia, China, Mongolia, Fiji Islands, Kazakhstan, Turkmenistan, Iran, Myanmar, Azerbaijan, Uruguay, France, Hungary, the UK, Argentina, and Slovakia. In women the highest incidence of 10.0-$19.6^0/_{0000}$ was observed in Mongolia, Iran, Turkmenistan, China, Sri Lanka, Uganda, Kazakhstan, Kenya, Fiji, Ethiopia and Qatar (Ferlay et al., 2010). Overview of EC in the world did not reveal any pattern related to the geographical and economic situation of these countries.

On the epidemiology of the disease is influenced by ethnographic features of the indigenous population living in these areas, because a higher incidence in males than females is typical (Moore et al., 2009; Igissinov et al., 2012a).

*[1]Kazakh National Medical University named after SD Asfendiyarov, Almaty, [2]Central Asia Cancer Institute, [3]Research Institute of Traumatology and Orthopedics, [4]Astana Medical University, Astana, Kazakhstan, [5]APJCP Editorial Office, Bangkok, Thailand, [6]State Medical University of Semey, Semey, Kazakhstan *For correspondence: nurbek_igisinov@mail.ru, n.igissinov@gmail.com*

Decrease of EC in the structure of malignant neoplasm is observed in most of the CIS countries. The Ukraine has the EC incidence in men – $5.3^0/_{0000}$ and women – $0.4^0/_{0000}$. The maximum incidence – in men from 7.3-$9.1^0/_{0000}$ was observed in Kiev, Kirovograd, Chernigov and Vinnitsa regions and the minimum – $3.2^0/_{0000}$ was registered in Ivano-Frankovsk and Kherson regions (Fedorenko et al., 2012). In Belarus, for the past ten years, the incidence of EC remains moderate to strong tendency to increase. From 1998-2007 overall standardized incidence rates increased from 2.7-$3.1^0/_{0000}$ (Malkevich, 2009). The highest incidence of EC is registered in Kazakhstan, the incidence in 1999 was $36.4\pm2.5^0/_{0000}$, and in 2009 it decreased to $17.6\pm1.7^0/_{0000}$ (Igissinov, 2012), then reached to $9.8^0/_{0000}$ (2006) and $8.1^0/_{0000}$ in 2010. Earlier in epidemiological studies in the Soviet Union it was found that the frequency of EC in some regions and among different ethnic groups of the multinational country differed by more than 200 times (Cancer Epidemiology in the CMEA countries, 1979).

The authors of most listed above studies consider that the major risk factors of EC in the population, living in Europe and North America, are smoking and excessive alcohol consumption. However, in populations with a high incidence living in Asia, the etiology of EC is unknown. A number of studies conducted in China, Iran, Central Asia, found that the high risk of EC associated with inadequate intake of food rich in vitamins. In addition, a possible risk factor of EC in these regions is excessive consumption of hot tea, opium, marinated and pickled vegetables and food, which is often due to improper storage, fungi production, including carcinogenic (aflatoxin), and cancer-causing nitrosamines (Moore et al., 2010a; 2010b). They can be in a variety of foods, as well as endogenously formed from precursors (nitrites and amines). Risk is increased in those who use tobacco only, opium only, and in those who use both tobacco and opium (Nasrollahzadeh et al., 2008). However, the possible association of EC to demographic factors is not carried out by the component analysis and based on it such criterion, as an operational undercounting of the cancer services is unknown.

In our previous studies (Igissinov, 2012; 2012b), we have emphasized that for the planning and management of cancer services, the changes of malignant tumors and some isolated forms of cancer in the dynamics in certain territories should be assessed what is valuable for public health and researchers, involved in the cancer epidemiology. The goal of this article is to characterize the sources of cancer patients' information and the factors that determine its completeness and accuracy, as well as the technique of statistical evaluation of the Kazakhstani population incidence of the esophagus malignant tumors in dynamics by the component analysis. There was no the component analysis of the EC incidence done in Kazakhstan until the present. The introduction of this type of analysis for the study of isolated components' changes in the incidence of EC affecting its level, the organizers of the cancer service will identify causal factors and conduct a targeted cancer control in the studied areas of Kazakhstan. By knowing of this analysis method the heads of oncology service of the selected areas can properly assess the changing dynamics of the EC incidence, as one of the leading indicators of cancer care to the population and determine the status of the registration and the quality of diagnosis.

Materials and Methods

The main source of information for studying the dynamics of the EC incidence and regional characteristics were the data on new cases, which are filled with "notice" (form № 090/U), which constitutes the basis of a data bank "cancer registry" of the Kazakh Research Institute of Oncology and Radiology.

Data on the average population in the corresponding sex and age groups for the studied years were obtained from the official website of the Agency of the Republic of Kazakhstan on Statistics (www.stat.kz).

Dynamics of the EC incidence of Kazakhstan population was investigated using the component analysis (Dvoirin et al., 1987). This method of dynamics analysis of the EC incidence on the territory of Kazakhstan allows breaking down an increase of incidence into components related to the same population, but in different time periods. There are seven components of the EC incidence. The first three components are related to the changes in population, age structure, and the combined effect of these factors, and the 4-th component is about changes in the risk of the EC incidence rate only and the other 3 components related to a risk to get sick of EC, with population growth, changing age structure and the influence of all three factors. The term «at risk to get sick» many researchers (Starinsky, et al., 2005; Poddubnaya et al., 2007; Kudryavtsev et al., 2008) understand the full range of causes that can lead to an increase, a decrease or stabilization in the incidence. Therefore, with increased risk of disease is associated last four components.

A component method is used to analyze the dynamics of the EC incidence of Kazakhstan population from 2001 to 2010. Math component analysis of the dynamics of the stomach cancer incidence of Kazakhstan population is presented in Tables 1 and 2.

Results and Discussion

An analysis of the EC incidence in the dynamics showed a decrease of indicators, but a total increase of $T=-3.2^0/_{0000}$, and as shown in Table 1 a decrease largely depends on the changes in the risk of falling sick ($\sum=\Delta_P=-3.0^0/_{0000}$).

In Kazakhstan, the health indicators are primarily related to the demographic indicators. The dynamics of the population proportion of the Republic since 1999 (taken to 100.0%) tended to decrease until 2004, where the number has reached only the level of 1999, and then gradually started to increase and growth rate reached 8.4% in 2010 year (Figure 1).

A comparison of the age proportion of the Kazakhstan population in 2001 and 2010 is detected changes in the age groups: up to 30 years (–1.4%), 50-59 years (+3.0%) and 60-69 years (–1.5%), where the proportion in 2010 was higher than the data in 2001 (Figure 2).

Table 1. Component Analysis of the EC Incidence Increase in Kazakhstan from 2001 till 2010

		Age structure of the population		An increase of structural indicators	EC incidence		Increase of incidence			
							General	Including in connection with the change		
								Age structure of the population	Risk to get sick	Age structure of the population and risk to get sick
		2001 (S_{i1})	2010 (S_{i2})	(S_{i2}-S_{i1}) (3)-(2)	2001 (P_{i1})	2010 (P_{i2})	(P_{i2}-P_{i1}) (6)-(5)	(4)×(5)	(2)×(7)	(4)×(7)
Age	≤30	0.5334	0.5204	–0.0130	0.03	0.02	–0.002	0.000	–0.001	0.000
	30-39	0.1497	0.1471	–0.0026	0.49	0.59	0.090	–0.001	0.014	0.000
	40-49	0.1330	0.1339	0.0009	3.70	3.0	–0.700	0.003	–0.093	–0.001
	50-59	0.0727	0.1006	0.0279	21.80	15.9	–6.000	0.609	–0.433	–0.166
	60-69	0.0665	0.0506	–0.0159	65.00	48.7	–16.200	–1.033	–1.080	0.258
	≥70	0.0448	0.0473	0.0025	107.50	75.1	–32.400	0.269	–1.453	–0.081
Total		$\sum S_{i1}$=1.0	$\sum S_{i2}$=1.0		P_1=11.3	P_2=8.0	–3.2	$\sum=\Delta_B$=–0.2	$\sum=\Delta_P$=–3.0	$\sum=\Delta_{BP}$=±0

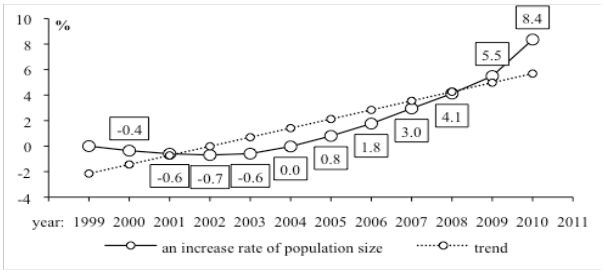

Figure 1. Dynamics of an Increase Rate of Kazakhstan Population for 1999-2010

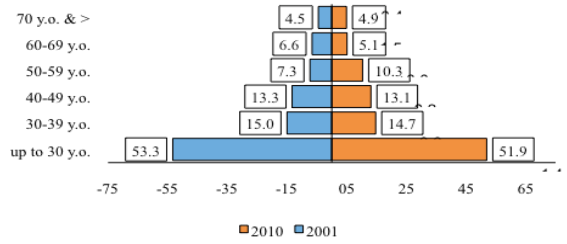

Figure 2. Changes of Proportion by Age Group in the Kazakhstan Population for 2001 and 2010

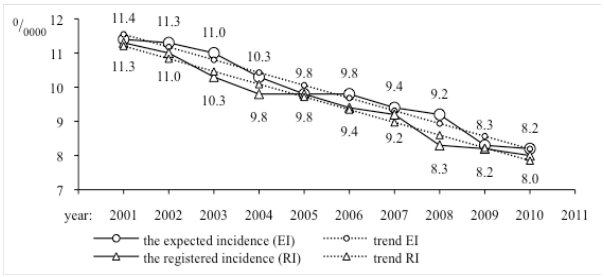

Figure 3. Dynamics of the Registered and Theoretical (expected) Incidence of the Esophageal Cancer of the Kazakhstan Population for 2001-2010

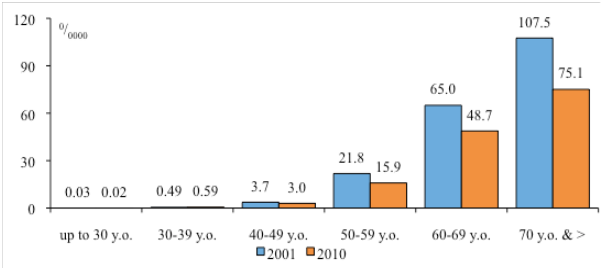

Figure 4. Age Indicators of the Esophageal Cancer Incidence in Kazakhstan for 2001 and 2010

A comparative analysis (Figure 3) between the registered and the expected incidence of EC of the Republic population indicates that they have slight differences, ranging from 0.1‰ (2001) to 0.2‰ in 2010, a decrease incidence rate in these cases were the same (T_{reg}=–3.7% and T_{exp}=–3.7%). Therefore, the frequency of EC in Kazakhstan does tend to decrease, although it is difficult to explain the reason for such decrease of EC in our country. Perhaps relative improvement of a social situation, resulting in changed eating habits, but the use of hot tea and soup are continuing.

Furthermore, the comparative analysis of the EC incidence by the age has been done for 2001-2010. In this case, revealed that with increasing age of the population grow in parallel the incidence of EC, although in 2010 in all age groups the incidence was low compare to data in 2001, and their exponential growth trends are almost identical (T_{2001}=+0.013% and T_{2010}=+0.014%) and is not correlated with each other. Consequently, age-related changes in the EC incidence are the main factors affecting the increase or decrease in the number of patients in Kazakhstan. However, despite these conditions, the number of EC got sick people in the country reduced. A paradox, instead of increasing the number of patients with EC in the country the number is reduced, and this is true, or there are certain shortcomings in the work of organizations in the cancer registration and registered cases of EC in some regions of Kazakhstan. To clarify this situation needs analysis of the absolute number of patients with EC.

Since this criterion of cancer services in the country can serve as a key indicator of the cancer care to patients with EC. The absolute number of patients registered in Kazakhstan, and its value is shown in Table 3, which shows that the absolute number of patients with EC in the Republic is reduced.

This aspect of the problem of many public health organizer are satisfied, as the number of reported cases with EC in the country are decreasing, it is evaluated as a success for the fight against this form of cancer. However, these results represent inability to apply the analytical methods of biostatistics of malignant neoplasms by the majority of public health organizers.

Analysis of the dynamics of the registered patients of EC shows that the absolute number in 2008 was 1,286 people, or on 1,274 patients less than in 1989, and in 2010 compare to 2008 new cases of EC increased on

Table 2. Component Analysis of the Esophageal Cancer Incidence in Dynamics in Kazakhstan from 2001 till 2010

Age (i)	No. of getting sick (n_{ij})		Population size (N_{ij})		Incidence indicators Rough (P_{ij})		Standardized (P^c_{ij})		The expected no. of getting sick patient in 2010y. ($P_{ij}N_{i2}10^{-5}$) (6)×(5)×10^{-5}	$N1/N2$ (4)÷(5)	%increase $\kappa(n_2-n_1)$ $100\Delta/(n2-n1)$	κn_1 $100\Delta/n1$
	2001 (j=1)	2010 (j=2)	2001 (j=1)	2010 (j=2)	2001 (j=1)	2010 (j=2)	2001 (j=1)	2010 (j=2)				
1	2	3	4	5	6	7	8	9	10	11	12	13
00-29	2	2	7929718	8433469	0.03	0.02		0.013	2.13			
30-39	11	14	2224886	2384326	0.50	0.60		0.088	11.80			
40-49	73	65	1976807	2169146	3.70	3.00		0.398	80.10			
50-59	236	259	1080306	1629972	21.80	15.90		1.155	356.10			
60-69	642	400	987912	820519	65.00	48.70		3.240	533.20			
70+	716	576	665981	767185	107.50	75.10		3.364	824.80			
Total	n_1	n_2	N_1	N_2	P_1	P_2	P^c_1	P^c_2	$E(n_2)$	0.917		
	1,680	1,316	14865610	16204617	11.3	8.1	11.3	8.3	1,808			
	$[(n_1-n_2)/n_1]$x100		$[(N_1-N_2)/N_1]$x100		$[(P_1-P_2)/P_1]$x100			$[(P^c_1-P^c_2)/P^c_1]$x100				
	-21.7		9.0		-28.1			-26.9				

Components of an increase of getting sick due to:

1. Population growth	$\Delta_H=[(N_1-N_2)/N_1]$xn_1=151	–41.6		+9.0	
2. Changes in the age structure of the population	$\Delta_B=(N_1/N_2)[E(n_2)-n_1-\Delta_H]$=–21	+5.8	–35.2	–1.3	+7.6
3. Combined effect of changes in population size and age structure	$\Delta_{HB}=[(N_2-N_1)/N_1]x\Delta_B$=–2	+0.5		–0.1	
4. Changes in the risk to get sick	$\Delta_P=N_1(P^c_2-P^c_1)\times10^{-5}$=–453	+124.3		–26.9	
5. Combined effect of changes in the risk of getting sick. and population	$\Delta_{HB}=[(N_2-N_1)/N_1]x\Delta_P$=–41	+11.2		–2.4	
6. Combined effect of changes in the risk of getting sick and age structures	$\Delta_{BP}=(N_1/N_2)[(n_2-n_1-\sum_{x=1}^{5}\Delta)]$=1	-0.3	+135.2	+0.1	+29.3
7. Combined effect of the changes in the risk of getting sick. a population size and its age structure	$\Delta_{HBP}=[(N_2-N_1)/N_1]x\Delta_{BP}$=0	±0.0		±0.0	
Total	n_2-n_1=-364	100		–21.7	

Table 3. Absolute Number of EC and its Meaning in Kazakhstan

Esophageal cancer	1989	1996	2001	2008	2010
Registered patients (X_r)	2,560	1,922	1,680	1,286	1,316
Increase or decrease in the absolute number compared to previous year	–	–638	–242	–394	30
Increase (decrease) in the absolute number compared to 1989	–	–638	–880	–1274	–1244
Growth (increase) rate compare to previous year (%)	–	–24.9	–12.6	–23.5	2.3
Growth (increase) rate compare to 1989 (%)	–	–24.9	–34.4	–49.8	–48.6
Population size (thousand)	14,955	16,539	14,866	15,572	15,999
Expected number (X_{ex}) compared to 1989	2,560	2,831	2,545	2,666	2,739
Difference between the expected and registered absolute number (X_{ex}-X_r)	–	–909	–865	–1,380	–1,423
Registered incidence	17.1	11.6	11.3	8.3	8.2

30 people i.e., on 2.3%, but compare to the data in 1989 decreased on 48.6%. Therefore, based on the analysis of the dynamics of the absolute number of the EC patients studied for four years (1996, 2001, 2008, 2010), we can assume that each year on the average about 311 cases of EC are not recorded (see tab. (638+242+394–30)/4=311). Also, these numbers would increase on average on 1009 ((638+880+1274+1244)/4=1009) patients with a re-calculation of the theoretical or expected number of EC, which is 3.2 times higher than the expected number of unregistered patients. Such difference in the absolute number of reported cases of EC compared with the expected patients, mainly related to such criteria of oncology service as an operational underestimation of malignant tumors in the country.

Worldwide such epidemiological patterns according to which the growth in population and changes in its age structure and at the same time an increasing in the number of malignant tumors are recognized. However, these principles are not observed in our country, since the causes of a decrease in the absolute number of the EC patients is not identified and analyzed by the component analysis of the disease dynamics in specific areas and for the whole country. The research allows us to conclude that changes in the dynamics of the number of patients with EC in Kazakhstan generally may be associated with the following components of the population (Table 2):

Consequently, the increase in the number of patients with EC in Kazakhstan may be due to the risk of getting sick with changes of age structure in the population, as well as the combined effect of changes in the risk to get sick and the population size.

On the basis of the component analysis of the dynamics of the EC incidence in Kazakhstan for 2001-2010, it can be said that the decrease in the number of patients is mainly due to underestimation of cancer patients, such as: 1) Undercounting of new EC identified in nearby foreign countries (Russia, China, Uzbekistan, Kyrgyzstan, etc.), since it «notice» report form is not filled; 2) Treated patients with EC from abroad, do not go to territory

Oncology Center, and their registration occur only after their death at the departments registry office; 3) All diagnostic centers (public, private) do not fill «Notice» registration form in case of EC diagnosis; 4) In private clinics of the country in the diagnosis of EC, as well as patients after treated also don't fill the required user forms; 5) Most medical organizations do not provide reports on cancer, they are not responsible for this issue, as in the new order from 12.08.2011, in general regulation of paragraph 1, are only the objectives, functions, legal and organizational basis of cancer care to the Republic of Kazakhstan population at state organizations. 6) Oncology Centers do not always fill the «Notice» after the EC patient death, which have been registered in the department of the registrar; 7) Pathoanatomical service of the Republic, issuing certificate of the patient death: indicates the cause of death and did not indicate a primary diagnosis – EC also between oncological clinics and these organizations communication is almost absent.

To improve the recording and registration of the EC patients in the Republic we should: 1) Fill out the (Notice) not only on the disease, identified in patients coming for the medical care in the hospitals of the Ministry of Health, but other departmental organization; 2) Fill out the (Notice) on the EC patients identified with periodic checkups, medical examination of the population with chronic diseases, the examination in hospitals during surgery, when medical examination at diagnosis, at autopsy; 3) To provide a full awareness of the EC patients supplemented by (Notice), filled at unregistered cancer institutions. Data about them can be obtained in the verification of information about died patients with EC, held on the account, when they were alive, the death certificate in statistical offices, providing that unrecorded patients who died not only on the underlying disease, and other causes; 4) Identifying unreported cases - is a reconciliation of registered by dispensary EC, discharged from the medical institutions overall network and specialized agencies at all levels (the statistical history of departures from the hospital, form № 066/u).

Thus, the number of patients with EC, falling globally, including Kazakhstan, and the need to take into account that the reason for the general decrease of EC until the present is not fully understood, but according to the most researchers associated with an improvement of character of diet and the social conditions of the population after the Great Patriotic War. While the increase in the EC patients in the country can be attributed to changes in risk getting sick, and the age of the population. Despite this trend of EC in general in our country, there is a certain underestimation of them associated with the undercounting of cancer services in some regions of Kazakhstan.

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