RESEARCH ARTICLE

Cancer Incidence and Mortality Data in Aktobe, West Kazakhstan, 2000-2010

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Abstract

The article provides an assessment of the dynamics of cancer incidence and mortality in the territory of Aktobe city for the period 2000-2010. The most common cancers were found in the lungs, stomach, esophagus and breast throughout the period, with slight increase in colon cancer and decrease in esophageal cancer being apparent. In an attempt to cast light on effects of environmental pollution, the authors also compared data on total emissions of chemicals into the air. While preliminary, the findings provide a basic picture of cancer burden in this industrialised city in Kazakhstan which should be followed up by more comprehensive monitoring.

Keywords: Cancer statistics - incidence - mortality - Aktobe, Kazakhstan - environment - pollution

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Introduction

Analysis of cancer incidence, structure and morbidity in different human populations living in different conditions gives a lot of information to determine the causes of cancer and the factors contributing to its appearance. Review studies of cancer incidence in Central Asia are of particular interest as the cancer incidence depends on a variety of factors including medical, geographical, and social living conditions, the nature and specificity of employment, and ethnic characteristics (Moore et al., 2010; Moore et al., 2011). The natural climatic conditions and industrial development of Kazakhstan, as well as the socio-economic conditions of living and ethnic structure of the population determine the specificity and peculiarities of cancer pathology (Igissinov et al., 2011; 2013a; 2013b; 2014; Bilyalova et al., 2012; Akshulakov et al., 2014).

Identifying the relationships between environmental factors and health of the population is now of paramount importance for public health. Oncopathology is a socially significant indicator of ecological trouble on urbanized territories. The formation of technogenic chrome biogeochemical province on the territory of Aktobe city (Gogua et al., 2003; Igissinov et al., 2012; Mamyrbayev et al., 2012a; 2012b; Uzbekov et al., 2014) has actualized the study of indicators of cancer incidence and mortality from cancer among residents of an urbanized city.

Materials and Methods

All epidemiological studies were conducted in the territory of Aktobe, a regional center of the Republic of Kazakhstan. It hosts the country's largest mining and metallurgical enterprises that extract and process chromium ore, for example.

Epidemiological analysis of cancer incidence and mortality from cancer per 100 thousand capita was conducted from 2000 to 2010 based on the statistical data received from the Statistics Department and extracted from the account forms f # 7, f 030-u, f 025-u, f 090-u, and f # 35. The disease list was prepared based on the "Handbook of International Statistical Classification of Diseases, Injuries and Causes of Death Tenth Revision".

Figures on the total emission of chemicals into the air were taken from "2-TP-Air" forms of the Environmental Department. The conditional index of chemical pollution of atmospheric air (P) was calculated by formula:

$$\sqrt{\sum_{i=1}^{n} K_i^2}$$

Where: P-the conditional index of chemical pollution of atmospheric air; $\Sigma\kappa_i^2$-the sum of the rates of excess of the maximum permissible concentrations of substances of different hazard categories normalized to the hazard category III.

The pollution of atmospheric air was measured by the integrated air pollution index (API_5) calculated for five substances with the highest standardized MPC values taking into account the hazard category of those substances.

Results

Table 1 provides the results of cancer incidence study in Aktobe. In the studied periods, the highest incidence of pathology was noted in bronchopulmonary system,

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Table 3. Cancer Incidence (per 100,000 inhabitants) by Body Site for Aktobe, 2000-2010

Site	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Lip	1.6	0.7	1.5	1.1	1.0	1.0	1.6	1.3	1.3	1.4	1.3
Tongue, oral cavity, pharynx	1.9	1.3	5.6	4.7	3.1	2.2	3.4	3.2	2.9	3.2	3.1
Esophagus	13.2	9.7	14.9	15.3	14.4	9.3	14.6	13.6	12.5	13.6	13.2
Stomach	13.2	11.6	19.4	13.2	20.5	11.0	17.3	18.2	15.5	17.0	16.9
Colon	5.5	5.4	6.5	7.1	3.8	4.3	6.7	6.9	6.0	6.5	6.5
Rectum	2.1	2.4	3.7	3.1	3.5	3.7	5.9	6.0	5.2	5.7	5.6
Liver	4.4	5.7	6.1	6.8	5.6	3.3	5.2	5.5	4.7	5.1	5.1
Pancreas	4.1	3.5	3.9	3.5	3.4	2.7	4.3	3.9	3.6	3.9	3.8
Larynx	2.1	1.3	2.2	2.9	2.5	1.0	1.6	1.9	1.5	1.7	1.7
Trachea, bronchus, lungs	26.2	13.9	22.8	21.6	23.2	13.6	21.5	22.6	19.2	21.1	21.0
Bones, articular carts	1.8	1.6	1.5	1.4	1.5	0.5	1.0	1.2	0.9	1.0	1.0
Connective and other tissues	2.2	1.4	1.9	1.0	2.4	1.1	1.7	1.9	1.6	1.7	1.7
Skin melanoma	1.0	0.4	0.3	0.5	0.9	0.7	0.5	0.7	0.6	0.6	0.6
Other skin neoplasms	10.8	7.1	10.7	12.5	16.2	6.7	10.6	11.4	9.6	10.5	10.5
Breast cancer	12.7	11.6	16.4	16.1	17.2	10.0	15.7	16.3	14.0	15.3	15.2
Cervix uteri	6.5	4.7	6.3	6.5	7.9	5.4	8.4	7.9	7.2	7.8	7.6
Corpus uteri	4.2	3.6	3.9	3.1	4.0	3.1	4.9	4.4	4.1	4.5	4.3
Ovary	4.6	5.0	5.2	4.6	5.5	3.3	5.2	5.6	4.7	5.2	5.2
Prostate	1.2	0.8	1.0	1.1	0.9	0.5	0.7	1.2	0.8	0.9	1.0
Testicular	0	0.9	0.5	1.1	0.6	0	0.4	0	0.4	0.4	0.4
Penis	0.1	0	0	0.1	0	0	0.1	0	0.1	0.1	0.1
Kidney	4.3	3.9	3.7	4.0	3.5	2.1	3.3	2.9	2.8	3.0	2.9
Bladder	4.1	2.8	3.0	2.6	3.8	1.9	3.0	2.6	2.5	2.7	2.6
Thyroid	1.4	1.8	1.5	1.4	1.0	1.1	1.7	1.5	1.4	1.5	1.5
Lymphatic and hematopoietic tissue	8.4	5.3	8.1	8.0	6.7	3.0	4.7	5.2	4.3	4.7	4.7
Lymph sarcomas, clasmocytic lymphomas	1.0	1.4	1.2	1.0	1.5	1.1	1.4	1.5	1.3	1.4	1.4
Hodgkin disease	1.4	1.2	1.3	1.1	1.0	1.1	1.0	1.2	1.1	1.1	1.1
Other hematological malignancies	0.9	1.2	0.6	0.8	0.4	0.9	1.1	1.2	1.1	1.1	1.1
Acute lymphoid malignancies	1.2	1.6	1.9	1.7	0.9	1.5	1.7	1.8	1.7	1.7	1.7
Other lymphoid malignancies	1.0	0.9	0.6	0.8	1.0	0.7	0.9	1.1	0.9	1.0	1.0
Acute myeloid leukemia	1.0	1.1	0.6	0.5	0.9	0.8	0.7	0.9	0.8	0.8	0.8
Other leukemia	1.4	0.2	0	0.4	0.9	0	1.1	0.8	1.0	1.0	0.9
Others	7.4	5.7	21.9	7.3	6.7	7.6	4.8	6.8	6.4	6.0	6.4
Total:	152.9	119.7	178.7	156.9	166.4	105.2	156.7	161.2	141.7	153.2	151.9

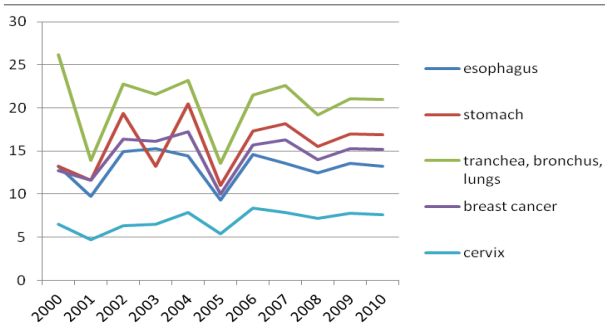

Figure 1. Incidences of the Leading forms of Cancer

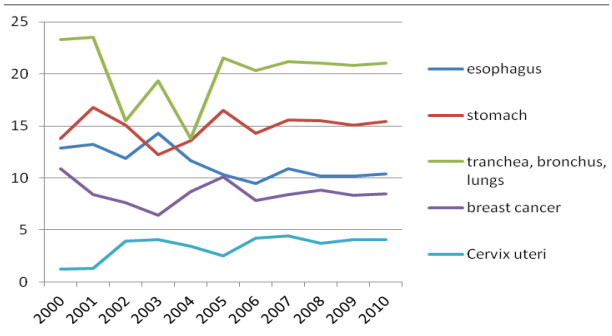

Figure 2. Mortality from the Leading Forms of Cancer

breast, stomach, and esophagus (Figure 1), followed by oncological diseases of female genital organs (cervix uteri, corpus uteri, and ovary). We also noted a relatively high incidence of cancer of lymph and blood-forming tissue, malignant tumors in bronchopulmonary system, breast cancer and cancer of esophagus. Incidence of stomach cancer, oncopathology of rectum, tongue, oral cavity, and pharynx has increased during 2006 - 2010. At the same time, incidence of cancer of lymphatic and hematopoietic tissue has decreased still remaining quiet high.

In all the studied periods, the structure of cancer mortality was headed by diseases of trachea, bronchus, lung, stomach, esophagus, breast cancer, and leukemia, as well as rectum, liver, and gall bladder (Table 2). The highest mortality was in 2000, 2001, and 2005, with a decrease from 2007 to 2010 (Figure 2). Despite the spread of incidence and mortality in certain years, generalized incidence of cancer and mortality rates remained stable.

Generalized data on the total emissions of chemicals into the air (see Table 3) showed no reduction in technogenic emissions in the analyzed period (2005-2012). Figures of pollutant emissions from stationary and mobile sources reflected the growth of gross pollutant emissions from 2003 to 2012 (Figure 3).

The mentioned trend was valid for both stationary

Table 2. Cancer Mortality Data (%) by Body Site for Aktobe, 2000-2010

Site	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Lip	2.9	2.5	-	0.3	-	-	0.7	-	0.7	0.7	-
Tongue, oral cavity, pharynx	-	3.5	5.2	4.9	3.4	1.9	1.8	1.6	1.8	1.7	1.7
Esophagus	12.9	13.2	11.9	14.3	11.7	10.3	9.5	10.9	10.2	10.2	10.4
Stomach	13.8	16.8	15.1	12.2	13.6	16.5	14.3	15.6	15.5	15.1	15.4
Colon	2.2	2.7	3.3	3.5	5.5	3.5	3.5	3.7	3.6	3.6	3.6
Rectum	4.6	4.4	2.8	3.9	3.7	3.2	4.0	4.2	3.8	4.0	4.0
Liver & gall bladder	4.4	5.1	4.2	5.7	6.4	4.8	3.5	3.9	4.1	3.8	3.9
Larynx	2.2	1.3	2.4	1.7	2.4	2.0	1.5	1.8	1.8	1.7	1.8
Trachea, bronchus, lungs	23.3	23.5	15.5	19.3	13.8	21.5	20.3	21.2	21.0	20.8	21.0
Bone, articular cartilages	-	1.0	1.4	1.6	1.8	1.1	0.6	-	0.9	0.8	0.9
Skin melanoma	0.8	0.6	0.1	0.3	0.1	0.3	0.3	0.6	0.4	0.4	0.5
Other skin neoplasms	1.0	4.1	-	-	-	0.6	1.1	-	0.9	-	-
Breast cancer	10.9	8.4	7.6	6.4	8.7	10.1	7.8	8.4	8.8	8.3	8.5
Cervix uteri	1.2	1.3	3.9	4.1	3.4	2.5	4.2	4.4	3.7	4.1	4.1
Corpus uteri	2.6	1.1	1.5	1.7	1.7	1.9	0.9	1.1	1.3	1.1	1.2
Ovary	2.3	-	2.0	2.4	2.1	2.9	4.0	3.2	3.4	3.5	3.4
Prostate	0.9	0.7	-	1.1	0.4	1.3	0.6	-	-	0.8	-
Testicular	-	0.2	-	0.2	0.3	0.3	0.6	-	0.5	0.6	0.6
Kidney	3.3	1.1	1.9	1.3	3.7	1.7	0.8	0.6	1.0	0.8	0.8
Bladder	1.5	-	1.1	1.6	0.8	1.1	0.5	-	0.8	0.7	-
CNS	0.1	0.4	0.9	0.6	0.6	0.8	1.2	-	1.0	-	1.0
Thyroid	0.6	-	0.6	0.5	0.4	1.3	0.5	-	0.9	-	0.8
Malignant lymphomas	1.7	0.2	2.0	1.6	2.8	2.3	2.5	2.7	2.5	2.6	2.6
Leukemia	5.9	5.3	3.3	4.1	3.1	2.7	2.5	3.2	2.8	2.8	2.9
Others	1.8	2.6	11.8	6.1	9.2	5.5	5.4	4.9	5.3	5.2	5.1
Total:	100.9	100	98.5	99.4	99.6	100.1	92.6	92	96.7	93.3	94.2

Table 3. Metal Emissions into the Atmosphere (kilotons annually, KTA)

Element	Period of monitoring							
	2005	2006	2007	2008	2009	2010	2011	2012
Fe	283	285	284	283	286	284	286	286
Mn	72.6	87.6	152	205	304	222	202	301
Cr+6	8664	8885	9675	6841	5737	5483	6839	5741
Cr+3	121632	196267	122705	174206	157418	122740	174228	157447
Mg	119535	141213	140020	139735	134667	131015	139740	134686
V	1.5	1.6	1.5	1.4	1.5	1.4	1.5	1.6
∑	250188.1	346739.3	272837.6	321271.5	298413.5	259745.5	321296	298462

Table 4. Air Pollution Level in the Regional Center

	Air pollution index (API5)									
Years	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
City										
Aktobe	9.6	10.1	9.7	9.5	8.5	8.6	7.6	6.9	6.4	4.2

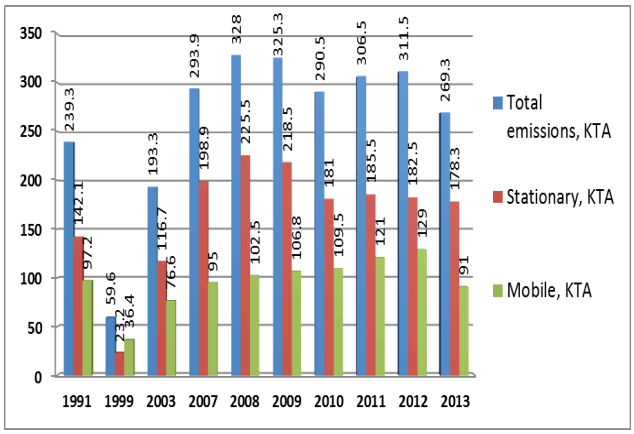

Figure 3. Dynamics of Pollutant Emissions

and mobile sources. In Aktobe, API_5 ranged from 6.4 to 10.1 (Table 4). According to the hygienic standards, API5 should not exceed 5.0. Major air pollutants in the city were sulfur dioxide, carbon monoxide, nitric oxide and dust containing trivalent, and hexavalent chromium, as well as magnesium compounds, manganese, and iron. According to the provided evidence the north-eastern edge of Aktobe hosts all the major stationary sources of air pollution (industrial area). Due to their close proximity to each other, these plants represent a single powerful core of multi-component air pollution of residential areas of the city. The urban air contains a considerable variety of chemical pollutants including a number of inorganic compounds such as heavy metals. These circumstances necessitate a detailed study of the health status of adults and children living in the city, including indicators of newly diagnosed cancer incidence, and mortality from cancer.

Discussion

It was established that in the territory of Aktobe city the incidence of cancer was relatively high, and primarily on the part of bronchopulmonary system, breast cancer,

stomach, and esophagus. High levels of oncological pathology were identified on the part of female genital organs, lymphatic and hematopoietic tissue. The authors identified features of the dynamics and spread of cancer incidence in the studied period. The mortality from cancer largely depends on the structure of cancer incidence. At the same time, we observed an emerging trend of reduced mortality from cancer.

As is well known, primary cancer registration is the basis for the development of programs to combat cancer (WHO, UICC). Though Globocan provides worldwide data (Globocan, 2012), in many cases these figures indicate just the general picture without details. Therefore, the study of "rough" and standardized rates of cancer incidence and mortality from cancer seems relevant especially when these indicators are linked to a complex of factors of the environment and socio-economic living conditions of the population, geographic and ethnic characteristics of the study groups. Many researchers highlight the negative impact of air pollution on the emergence and development of malignant tumors (Chimitdorzhiyeva and Kremenetsky, 2008; Crouse et al., 2010; Cambra et al., 2011).

Specific environmental polluters in Aktobe included such highly toxic chemicals as chromium compounds (Cr^{+3}, Cr) known to have strong long-term effects including mutagenic and carcinogenic action (Blockin and Zubov, 1974; Bigaliyev , 1977; Tushnyakova and Likhacheva, 1979; Tushnyakova et al., 1979; Sarto et al., 1982; Elias et al., 1983; Snow and Xu, 1989; Kutikhin et al., 2012). At that, the intensity of the pollution in the city was different varied with the city district and its proximity to the industrial area.

Monitoring of quality of air, water, and soil allows to quantitatively and qualitatively assess the impact of the environment on public health and to calculate the environmental risks. The assessment made in Aktobe has identified the highest danger from the inhalation of chromium, formaldehyde, sulfur dioxide, and hydrogen sulfide; as well as from the oral (alimentary) admission of chromium, boron, fluoride and nitrates (Ibrayev et al., 2006). At that, the total hazard index (HI) during inhalation of chemicals in an environmentally disadvantaged area of the city was twice higher than in the areas with enough clean environments. In Aktobe, they also observed the growth of primary total morbidity of population and increase in the incidence of respiratory diseases, endocrine diseases, neoplasms, diseases of the circulatory system. At the same time, against the general increase of morbidity, there was a decrease in the incidence of digestive disorders, skin diseases, injuries, and poisonings. Causes of adult mortality were headed by cardiovascular diseases, the second place was hold by the mortality from injury and poisoning, the third - from tumors, the fourth - the mortality from diseases of the digestive system, and the fifth - infectious and parasitic diseases (Mamyrbayev et al., 2010). Rates of disability, their dynamics, structure, and causes, provided important information not only about the effectiveness of therapeutic and preventive measures and the level of working capacity examination, but also about the state of the environment. It was found that the 1st category of disability in Aktobe was three times more often assigned to working-age population than to the pensioners; the 2nd category of disability was assigned to that population group 10 times more often than to the pensioners; and the 3rd category of disability-18 times more often (Mamyrbayev et al., 2010).

In the structure of medical entities causing disability, the 1st rank was hold by diseases of the circulatory system, the 2nd - by cardiovascular diseases, the 3rd-by injury and poisoning, the 4th-by tumors, the 5th-by diseases of the musculoskeletal system, the 6th - diseases of the eye and its appendages, and the 7th-by TB.

The results of our own studies and the literature data show that the regional specific features influence the degree of expression of many risk factors related to the possibility of cancer. The adverse ecological background contributes to poor health of the urban population, the growth of cancer and mortality rates. General morbidity, its incidence and disability rates are also positively related to the environmental degradation. All the above requires urgent adoption of a set of measures for prevention, screening, early detection, and timely treatment of oncological diseases.

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