RESEARCH ARTICLE

Features of Malignancy Prevalence among Children in the Aral Sea Region

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Abstract

Objective: A study of primary cancer morbidity among children and subsequent calculation of average annual incidence were carried out for boys and girls, and young men and women in Kazakhstan. **Methods:** The investigated population lived in three areas of the Aral Sea region: designated catastrophe (Aral, Kazalt, Shalkar regions), crisis (Zhalagash, Karmakshy, Shiely regions), pre-crisis (Irgiz, Arys, Ulytau regions). Zhanaarka region of Karaganda oblast was applied as a control. Parameters were retrospective analyzed for the 10 years from 2004 to 2013. **Result:** The results indicate that indices of children cancer morbidity were slightly higher in the Aral Sea region than in the control district, but they were comparable with similar data from studies in other regions. In all areas of the Aral Sea region, except for Ulytau, primary cancer morbidity exceeded the control level by 1.3-2.7 times (4.7%000). Hematological malignancies, including solid tumors - tumors of musculoskeletal system and skin, digestive system, brain and central nervous system predominated. Stress levels in zones of the Aral Sea region were slightly higher in the crisis zone than in the catastrophe zone that can be explained by the phenomenon of wave-like dynamics of disease growth risk. Gender differences in characteristics of malignancy formation were not more pronounced in the studied region. **Conclusion:** Indices of children cancer are slightly higher in the Aral Sea region than in the control area of Kazakhstan, but they are comparable to results for other regions.

Keywords: Cancer morbidity- Aral sea region- environment- gender differences- children- adolescents

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Introduction

Environmental catastrophe in the Aral Sea region associated with the desiccation of the Aral Sea has led to significant climate and geographical changes and deterioration of living conditions of local population. Due to anatomical and physiological characteristics, the child's body is most sensitive to the adverse effects of natural and social environment. According to several studies (Alnazarova, 2009; Tussupbekova et al., 2014) conducted in the Aral Sea region, there are very high rates of general and infant morbidity, low life expectancy; increased extragenital pathology of women due to the growth of socially significant diseases (anemia, tuberculosis, diseases of the genitourinary system, hypertensive disorders, pathology of pregnancy, childbirth and postnatal period). Children have lower anthropometric data compared with children from other regions in Kazakhstan, there is a high infant mortality rate; increase in the number of diseases of endocrine, nervous, digestive and urinary systems (Alnazarova, 2009).

Age peculiarities of esophagus, lungs, stomach, lacteal gland, womb neck and thyroid body cancer at the Aral Sea region of Kazakhstan have been identified (Igissinov et al., 2011). The ecologically clean area of the Aral region tends to decrease in malignancies of esophagus, lungs and stomach (Igissinov et al., 2011). There are virtually no works on incidence of the malignancies among children of the region. Harmful ecological environment and the impact of radiation factor (Chimitdorzhiyeva, 2013; Abdurakhmanov et al., 2015) leads to rejuvenation and increase of oncological diseases among children, teenagers and adults, which is caused by chemical compositions and increased radiation level. Considering the global ecological changes of the Aral region, it is deemed especially important to study the incidence of malignancies among children.

Materials and Methods

Study of primary cancer morbidity among children and subsequent calculation of average annual incidence

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rates of malignancy was carried out among boys and girls, young men and women. Investigated population lived in three regions of the Aral Sea region: catastrophe (Aral, Kazaly, Shalkar regions), crisis (Zhalagash, Karmakshy, Shiely regions), pre-crisis (Irgiz, Arys, Ulytau regions). Zhanaarka region was as a control region of Karaganda oblast. Retrospective of analyzed parameters was 10 years from 2004 to 2013.

Official data according to a report of a Regional Oncology Center of malignancy diseases (Form 7) were information sources on newly diagnosed cancer patients. The study included statistical materials (Form 7, 35, form 030-y-025 y 090-y) "Indices of Oncology Service of the Republic of Kazakhstan" and reports of Regional Oncology Center "Analysis of Annual Statistical Forms of Condition of Oncology Service Areas".

Retrospective study using descriptive and analytical methods of modern epidemiology were used as a main method in the study of malignancy prevalence. The incidence is calculated for 100,000 of corresponding population. Extensive, crude, age-based and equated indicators of disease incidence were calculated: annual average values (P), average error (m), confidence interval (95%) were also estimated.

Results

Comparative analysis of cancer incidence of children living in the Aral Sea region compared to the control region (Zhanaarka region) showed some differences. If average annual rate of malignancies among children was at the level 4.7%000, then this figure exceeded the control in all three areas of the Aral Sea region, in the catastrophe area in 1.9 times (9.1%000), in the crisis area in 2.4 times (11.1 to 100,000 children) in the pre-crisis area in 1.5 times (6.8 to 100,000 children). Figure 1 shows data.

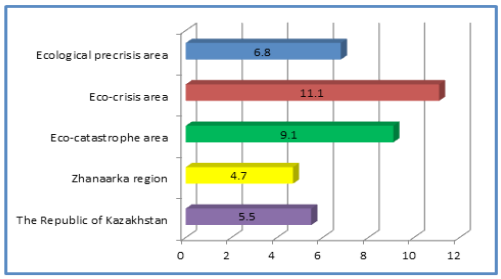

Figure 1. Average Annual Rate of Cancer Morbidity among Children in the Aral Sea Region

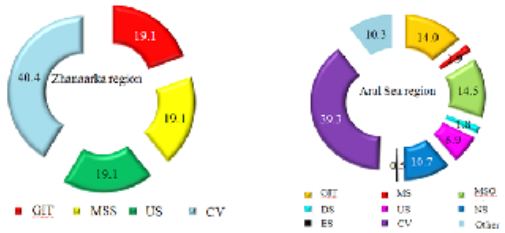

Figure 2. Structure of Primary Cancer Morbidity among Children in the Aral Sea Region (2004-2013) in Percentage Ratio

In all Aral Sea regions, except for Ulytau, primary cancer morbidity among population exceeded the control level (4.7%000) in 1.3-2.7 times. Maximum increase of the incidence observed in Shieli (12.7%000) district. Studied parameters are not critical compared with data from literature sources of neighboring countries, thus, incidence of malignancy of children in Russia was 12.5 per 100,000 children at the age of 0-17 years for the period of 2008-2012. In Ulytau district, cancer morbidity was in 2.4 times lower than in the comparison area.

Neoplasms of lymphoid and hematopoietic tissues were dominated in the structure of primary cancer morbidity among children of the region that occupied 21.6% in the Aral region to 81.3% in Irgiz district. This was followed by tumors of bone, connective tissue and skin (9.5-28.3%) and lesions of the digestive system taking 14% in average in the region (Figure 2). Solid tumors were prevalent in studied catastrophe areas (55.8%), crisis (64.7%) and pre-crisis (61.7%) except for Irgiz (18.7%), Kazaly (48.0%) and Shalkar (41%) regions.

In Aral Sea region (catastrophe, crisis and pre-crisis areas) primary cancer morbidity among child population was higher than in the control area. However, the degree of excess of this pathology is not entirely appropriate to the character of the areas. Overall morbidity in the catastrophe area was slightly lower than in the crisis area (9.1 and 11.1 cases per 100,000 children, respectively).

Only cancer of regulatory system organs among population of catastrophe areas were at the same level with the crisis area (Table 1). If we consider that some authors note undulating repeated changes in the dynamics of morbidity risk due to adaptive rearrangements of

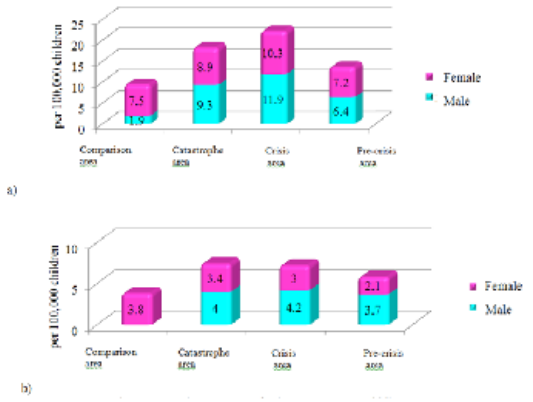

Figure 3. Gender Structure of Primary Cancer Morbidity a) in general, b) lymphoid and hematopoietic tissues of children in the Aral Sea region

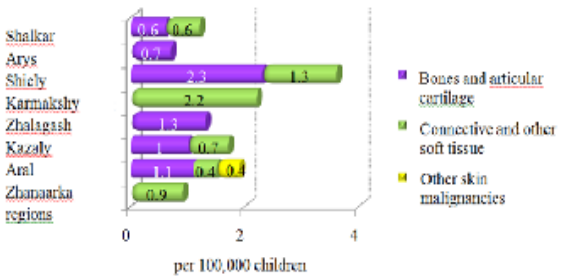

Figure 4. Structure of Primary Cancer Morbidity of MSS Organs and Skin among Children in the Aral Sea Region

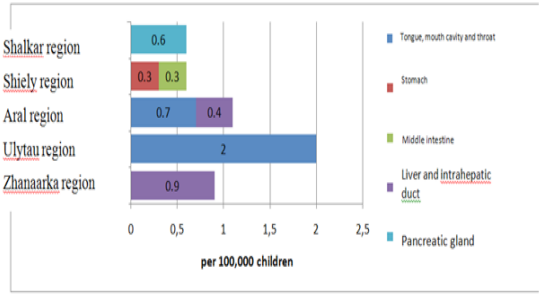

Figure 5. Structure of Primary Cancer Morbidity of the Digestive System among Children in the Aral Sea Regions

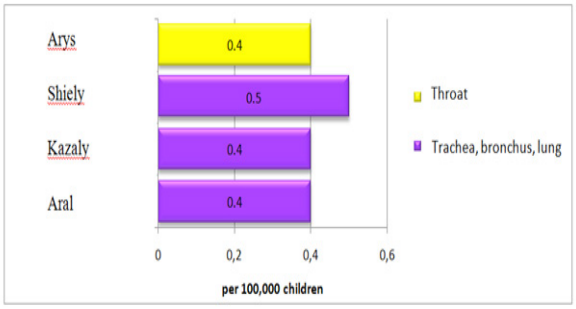

Figure 7. Structure of Primary Cancer Morbidity of Respiratory System Organs among Children in the Aral Sea Region

increased non-specific resistance state to its weakening or conditionally satisfactory adaptation with a period of 12-15 years (Prusakov et al., 2014), identified levels in the zones may be different from the available waves of decrease and increase of disease - in the catastrophe areas. Perhaps, there was a period of high resistance of the population, and in the crisis area, the period of weakening of adaptation processes that caused incidence among children.

Gender difference in primary cancer rates among children was identified in the comparison area with predominance of girls, in particular, and per dominant class of tumors of lymphoid and hematopoietic tissues (Figure 3 a, b).

Level of tumors of musculoskeletal system and skin including neoplasms of bone and articular cartilage, connective and other soft tissues and other skin neoplasms made up 0.9%000, in catastrophe and crisis areas similar levels were in 1.9 and 3.1 times, and in pre-crisis area in 1.8 times lower. Figure 4 shows a structure of primary cancer morbidity of musculoskeletal system (MSS) and skin in the Aral Sea region. Tumors of bone and articular cartilage and other skin neoplasms were not registered in Zhanaarka region during the studied period. Skin tumors are revealed only in 2009 at the girl in the Aral region. If we compare with similar data in Russia in 2013, indicators and specific weight will be slightly higher in the Aral Sea region. Thus, the specific weight of tumor of bone and articular cartilage among children up to 17 years was 5.14% in Russia, crude incidence rate per 100,000 of population -0.64, standardized (world standard) 0.64 prosantimille. In neoplasms of connective and other soft tissue, specific weight is 4.87%, morbidity 0.61%000.

As for digestive system organs, level of tumors in comparison area was higher (0.9%000) than in the zones of the Aral Sea region (0.5%000 – catastrophe area and 0.3%000- in crisis and pre-crisis areas). Figure 5 demonstrates the structure of primary cancer morbidity of the digestive system per areas of the Aral Sea region.

Tumors of mouth, esophagus, and rectum were not found in studied areas. Malignancy of digestive organs were recorded in the region in a few cases, so if you compare them with the levels of incidence of other researchers, for example, the Krasnodar Territory, indices in the Aral Sea region will be lower. Moreover, in the Krasnodar Territory the incidence of stomach malignant tumors among children up to 15 years for 2001-07 had levels of 0.53 to 1.71%000, and stomach tumor in the Aral Sea regions for the entire analyzed period was identified in 2011 at one male child in Shiely region, which accounted for 0.3%000.

In Shieli region, they revealed a tumor of the segmented intestine at one girl in 2008. In Shalkar region, pancreatic oncology was revealed at one female child in 2007. In 2013, neoplasm of the oral cavity was revealed at one girl in Ulytau region. Two male children had malignant tumors of the oral cavity in 2007 and in 2010 in the Aral Sea regions, and in 2005 liver tumor was identified at one boy. In comparison area, one girl was diagnosed with a liver tumor in 2010.

The leading group also included the brain and central nervous system tumors, which had average levels per areas - 1.4; 1.5 and 0.5 for 100,000 children; in comparison area, diseases of this subclass for 2004-2013 were not registered. Maximum level was detected in the Aral

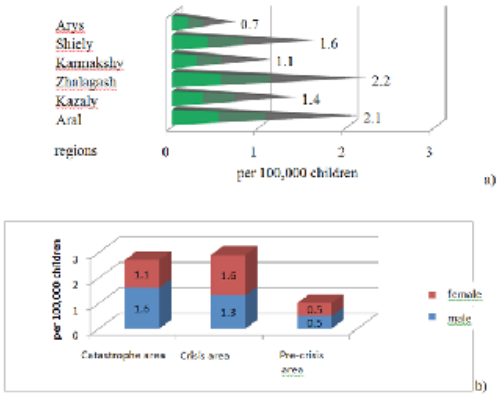

Figure 6. Gender structure of Primary Cancer Morbidity of Brain and Central Nervous System among Children in the Aral Sea Region

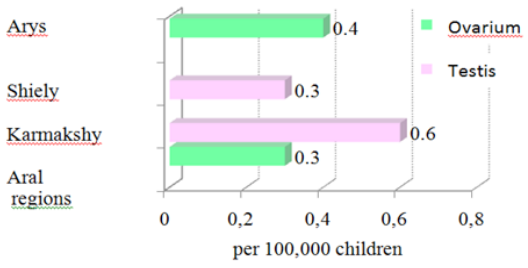

Figure 8. Structure of Primary Cancer Morbidity of Reproductive System Organs among Children in the Aral Sea Region

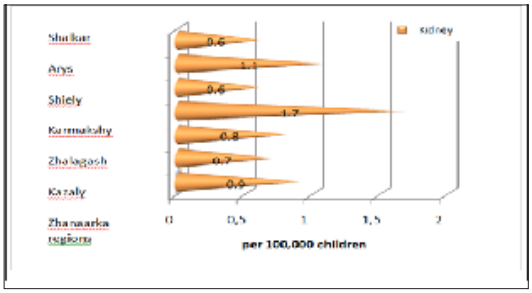

Figure 9. Primary Cancer Morbidity of Kidney among Children in the Aral Sea Region

region (2.1%000), minimum - in Arys region (0.7%000). According to the International Agency for Research on Cancer (IARC), standardized incidence rates of CNS tumors in different countries ranged from 0.42 to 3.37 cases per 100,000 children. In Kazakhstan, brain tumors among children ranked second place in the structure of oncological pathology among children and accounted for 11% for many years consistently.

In general in 2004, aligned incidence rates for the first time identified by brain tumors among children were 1.16 per 100,000 children (Dyussembekov et al., 2009). Gender differences in the brain and central nervous system tumors among children in the Aral Sea region were not identified (Figure 6, a, b).

Neoplasms of trachea, bronchus, lung were not registered during the analyzed period, in Zhanaarka region average rate is 0.3% 000 in the Aral Sea regions (in catastrophe areas - 0.3, crisis - 0.2 prosantimille, pre-crisis - 0.3 per 100,000 children). Figure 7 demonstrates the structure of primary cancer morbidity of the respiratory system per districts of the Aral Sea region.

In comparison area, tumors of the reproductive system were not registered, data was 0.1%000 in the catastrophe area and 0.3 prosantimille in crisis and pre-crisis areas. Figure 8 shows the structure of primary cancer morbidity of reproductive system organs per Aral Sea regions.

Data on malignant kidney tumors among children in the comparison area (0.9%000) was higher than the average data in the Aral Sea region (0.7%000), but lower than in some regions (Karmakshy - 1.7 per 100,000 children) (Figure 9). For comparison - incidence of kidney malignancies among children in Moscow in 2012 was equal to 0.92000 according to the world standards.

Thyroid cancer was detected only in the catastrophe area (0.1%000) in the Aral Sea region. Other localization of malignancy were identified in the comparison area, in the Aral Sea region data were equal to 0.8 prosantimille in catastrophe area, 1.5 - in the crisis area and 1.3 per 100,000 children in pre-crisis area.

Discussion

The results indicate that indices of cancer incidence among children were slightly higher in the Aral Sea region than in the control area, but they were at an acceptable level compared with similar data from studies in other regions. The structure of cancer morbidity was dominated by hematological malignancies, including solid tumors - tumors of the musculoskeletal system

Table 1. Structure of Primary Cancer Morbidity of Children in the Aral Sea Region with Intensive Accumulation of Average Annual Levels per Grades

	Comparison area	Catastrophe area	Crisis area	Pre-crisis area
GIT	0.9	0.5	0.3	0.3
MS	0	0.3	0.2	0.3
MSS	0.9	1.7	2.8	0.5
DS	0	0.1	0.3	0.3
US	0.9	0.4	1	0.8
NS, ES, CV	1.9	5.2	5	3.4
Other	0	0.8	1.5	1.3

and skin, digestive system, brain and central nervous system. Stress levels in the Aral Sea region were slightly higher in the crisis zone area than in the catastrophe area that can be explained by the phenomenon of wave-like dynamics of disease growth risk. Gender differences in characteristics of malignant formations in the test region were not observed compared with the control area.

Currently, incidence of tumors among children is increasing around the world. In developed countries, malignancy neoplasms are the second cause of child mortality, in the USA the proportion of tumors in the infant mortality rate is 12.3%. The differences of children malignancies related to sex and ethnicity were also identified (Musselman et al., 2014). In developing countries, such as India, percentage of child mortality due to malignancy is below 3.38%, but they identified trends of growth indices (Bhattacharyya et al., 2014). Malignancies among children in the first year of life have particular epidemiological, diagnostic features, differences in risk factors, prognosis and biological behavior of tumors in other age groups. The incidence among children of the first year of life has significant geographical variation, the index ranges from 7.5 to 27 per 100,000 babies, which is undoubtedly connected with regional capabilities for the timely detection of this pathology. In countries with a high level of diagnostic efficiency, the peak of child morbidity falls in the first year of life. According to USA and German researchers, neuroblastoma of adrenal gland and retroperitoneal space is more than 30% of the tumors among infants. Tumors of kidney and liver in the first year of life have the highest age-specific incidence rates accounting for about 10% and 3%, respectively (Smith et al., 2009).

Cancer is a kind of eco-indicator pathology, highly informative and socially important indicator of health of general population. Among factors that have a direct, indirect or mediate impact on the dynamics and structure of morbidity neoplasms one should include both environmental factors, among which there are natural, natural-anthropogenic as well as socio-economic and demographic factors. Anthropogenic factors have a decisive influence on cancer morbidity, which is manifested in decrease in adaptive capacity of the organism (Mamyrbaev, 2012; Liang, 2015; Kawaguchi et al., 2016).

Inconsistency of methods of epidemiological study

of malignant neoplasms with conditions in which human populations live often lead to wrong conclusions about the causes of disease and ineffectiveness of the proposed measures to prevent it. Methodology of system research of cancerogenic situation created prospects for the existing features of the reasons under influence of multifactorial complex of environmental conditions of cancer morbidity environment and way of life. Carcinogenicity study can be based on static and dynamic models. Dynamic models - the basis for development of cancer disease prognosis. The methodology of system research and management of situation causing cancer opens new perspectives in dealing with prevention of malignant neoplasms (AIRTUM Working Group et al., 2013; Contreras et al., 2016).

The problem of population health research and identification of its regional differences due to multidimensionality has an interdisciplinary character (Moore, 2014). Approaches and methods of analysis in environmental epidemiology continue to be modified and integrated with sociological, hygienic data to optimally reflect current situation in the municipalities and to be a basis in creation of sustainable development programs. In relation to data it is important to develop further efforts to analyze the epidemiology of tumors among children that will serve as a basis for effective prevention and improvement of care to cancer patients.

1. Indices of children cancer morbidity were slightly higher in the Aral Sea region than in the control area, but they were at an acceptable level compared with similar data from studies in other regions

2. In all areas of the Aral Sea region, except for Ulytau, primary cancer morbidity among population exceeded the control level in 1.3-2.7 times (4.7%000).

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