

RESEARCH ARTICLE

Epidemiological Evaluation of Laryngeal Cancer Incidence in Kazakhstan for The Years 1999-2009

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Abstract

The purpose was to provide a descriptive epidemiological assessment of the incidence of cancer of the larynx in Kazakhstan and spatial evaluation with gender characteristics. This retrospective study covered all new cases of laryngeal cancer in 11 years (1999-2009). The total number was 4,967 cases, 4,535 (91.3%) in males and 432 (8.7%) in women, with a ratio of 10.5:1. The higher incidence in men compared to women was evident in all age groups, the differences being statistically significant ($p < 0.05$). At the same time revealed a unimodal growth with age, peaking at 70 years and older both sexes. In the dynamics, incidence rates of laryngeal cancer demonstrated a tendency to decrease, in women ($T = -6.7\%$) this being more pronounced than in men ($T = -3.3\%$). Levels were determined to produce cartograms of cancer of the larynx for male and female populations, clear geographical variation being evidenced. The data are discussed with reference to possible risk factors.

Keywords: Laryngeal cancer - incidence - gender - age - cartogram

Asian Pacific J Cancer Prev, 14 (6), 3969-3974

Introduction

Malignant tumors occur in men and women in all the age groups. Patterns of morbidity and mortality from cancer is different for each gender and age, that, first of all, determined by the physiological characteristics of the organism and exposure to modifiable risk factors (Jemal et al., 2011; Shin et al., 2012; Jung et al., 2012).

The incidence of cancer of the larynx also has statistical differences according to age and sex (Wunsch, 2004; de Souza et al., 2011), geographical features of the place of residence (Dykhno et al., 2002; Saurina et al., 2010), social class and the living standards of the studied group of population (Vassileiou et al., 2012) and a number of other external factors (Wong et al., 1993; Grant, 2012; Romanowicz-Makowska et al., 2012). In Kazakhstan, it has already been shown that there is geographical variation in incidences of breast (Bilyalova et al., 2012), esophageal (Igissinov S et al., 2012; 2013), and cervical cancer (Igissinov N et al., 2012), with changes over time (Igissinov et al., 2011).

Laryngeal cancer is extremely rare in women (Licitra et al., 2003; Ellis et al., 2012). So according to the International Agency for Research on Cancer in 2008, there were 150,677 cases of cancer of the larynx, of

whom 129,651 (86%) cases in men and 21,026 (14%) in women. In this case, the standardized (world standard) incidence of laryngeal cancer /100.000 was among the whole population 2.2, in males 4.1 and in females (Ferlay et al., 2010).

The highest incidence rates (crude rate) have been registered in more developed countries of the world and the lowest in the developing countries. The high incidence among male population (>9 per 100 thousand population) are registered in Spain (Zaragoza), France (Calvados), Belarus, Brazil (Sao Paulo), and in African-Americans in the United States, low (<3) in Asia and Africa. In Russia, the incidence of laryngeal cancer is not high, in women figure does not exceed 1.

The main etiological factor in the development of laryngeal cancer is tobacco (Hashibe et al., 2007; Anantharaman et al., 2011; Ramroth et al., 2011; Sharma et al., 2011). It has been estimated that 87% of laryngeal cancer cases in Central Europe are attributable to tobacco, with 75% and 12% due to current and past smoking, respectively (Hashibe et al., 2007). Both increasing duration and intensity of smoking are important (Ramroth et al., 2011) and involuntary smoking exposure is also a factor (Lee et al., 2008). Smokeless chewing tobacco, however, does not appear to be of significance (Sapkota

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et al., 2007).

Excessive consumption of alcohol, particularly alcoholic beverages increases the risk of cancer in sites like the larynx (Islami et al., 2010; Tavani et al., 2012). In one study approximately 39% of cases appeared attributable to the interaction between alcohol and tobacco (Hashibe et al., 2007). In another, the population attributable risk of tobacco and alcohol for upper aerodigestive tract cancer hypopharyngeal/laryngeal cancer was 85% (Anantharaman et al., 2011).

The tobacco and alcohol roles are supported by evidence from genetic studies. Sequence variants in DNA repair and cell cycle genes are significant (Hall et al., 2007), an impaired nucleotide excision repair pathway is a risk (Sliwinski et al., 2011), the GSTM1 null genotype contributes to increased laryngeal cancer risk in both Caucasians and East Asians (Xiao et al., 2013) and GSTM1 gene polymorphisms demonstrate associations, particularly in Caucasians (Kumar et al., 2011; Ying et al., 2012). Combination of polymorphisms in COX-2 or EPHX1 with high activity polymorphisms in UGT1A1, UGT1A6, or UGT1A7 showed a risk-modulating effect in head and neck carcinogenesis, especially among heavy smokers and patients with laryngeal cancer (Lacko et al., 2013). N-acetyltransferase 2 slow acetylation may contribute to a risk factor for laryngeal cancer in Asians but not in Caucasians (Ying et al., 2011). The fact that low selenium consumption could be a risk factor (Jaworska et al 2013) is in line with a role for oxidative stress.

Type of food consumed also influences laryngeal cancer development (Bradshaw et al., 2012; Tavani et al., 2012). A possible unfavorable effect of dietary patterns based on meats and animal products has been reported (Bravi et al., 2012), while conversely a prudent diet protected in Uruguay (De Stefani et al., 2013). Fried foods, high-fat and processed meats, and sweets pattern was positively associated with laryngeal cancer in the USA (Bradshaw et al., 2012). In central and Eastern Europe, dairy products and yellow/orange vegetables appear protective while preserved vegetables might entail risk (Sapkota et al., 2008). Similarly, in China, eating sauerkraut and BBQ food were found to be risk factors and regular consumption of fresh vegetables, coarse grains, eggs and milk appeared protective (Wang et al., 2011). In contrast yogurt was found to be beneficial in Japan (Kawakita et al., 2012). Consumption of Greek/Turkish coffee may promote (Vassileiou et al., 2012) but no association with caffeinated coffee drinking was found (Al-Dakkak, 2011). Regular physical exercise may reduce risk (Wang et al., 2011) but recreational physical activity was not found to exert any effect in Europe (Nicolotti et al., 2011).

Air pollution with emissions and transport industries, and water and soil with heavy metals above the maximum permissible concentrations and evolution of other exogenous and endogenous risk factors lead to an increase in illness, especially cancer pathology, and in particular cancer of the larynx (Enomoto et al., 2008; Poirier, 2012). Environmental carcinogens and materials causing irritation are well known to be aetiological factors for laryngeal cancer. Several epidemiological studies

have found that exposure to asbestos in the workplace increases the risk (Chan et al., 1988; Parnes, 1990). A study in Russia and other countries of Eastern and Central Europe, revealed an increased risk of laryngeal cancer among workers exposed to coal dust, hard metals, chlorinated solvents, as well as formaldehyde (Shangina et al., 2006). Use of coal (Sapkota et al., 2013) and silica dust exposure have also been implicated (Chen and Tsu, 2012). A similar irritation dependent mechanism might be relevant for the finding that gastrectomy for peptic ulcer disease might entail a long-term increase (Lagergren and Lindam, 2012) as does laryngopharyngeal reflux (Tae et al., 2011) but apparently not gastroesophageal reflux (Coca-Pelaz et al., 2013).

Regarding infectious disease associations, HPV infection is a risk factor, especially with high-risk type HPV-16 (Li et al., 2013) and a very high prevalence of oncogenic HPV-16 was found in a series of benign and malignant laryngeal lesions in Belgium (Duray et al., 2011). *Helicobacter pylori* can colonise the larynx and therefore might exert an influence (Siupsinskiene et al., 2013).

The study of the epidemiological features of laryngeal and geographical variation has a scientific and practical interest because it allows for monitoring for preventive measures and to assess the impact of possible causal factors of risk. This paper focuses on the descriptive epidemiologic assessment of cancer of the larynx in the republic of Kazakhstan with an especial focus on age and sex characteristics.

Materials and Methods

As a source served a data of oncology centers about new cases of laryngeal cancer (form 7), and the information of the Agency of statistics of the Republic of Kazakhstan for the years 1999-2009 taking into account the age and sex composition (www.stat.kz).

The main method used in the study of the incidence of a retrospective study using descriptive and analytical methods of oncoepidemiology. The incidence is calculated per 100,000 of the population concerned. Have been calculated extensive, crude, age and aligned incidence rates average values (P), the mean error (m), 95% confidence interval (95% CI), the average annual growth/loss (T, %) (Merkov et al., 1974; Stanton, 1999).

Results and Discussion

Over 11 years (2009-2011) in Kazakhstan were registered 4,967 new cases of cancer of the larynx, of which 4,535 (91.3%) men and 432 (8.7%) women. The ratio of male and female patients was 10.5:1 and the crude incidence rate in men ($5.7/10^5$) was higher ($p < 0.05$) than in women (0.5). Highest age-specific incidence in male and female populations were established in the older group of 70 years and over: 41.4 and 2.6.

The distribution of patients with laryngeal cancer in the whole country, taking into account age and sex is shown in Figure 1. A high proportion of patients (both sexes) were installed in 60-69 years (36.2%), a similar pattern

was for men (37.4%), while the high proportion of women were in the age group of 70 years and older (30.1%). The average age of patients with laryngeal cancer in the whole country among men was 61.4±0.2 years (95% CI, 61.1-61.8 years), women: 45.5±0.6 years (95% CI, 58.9-61.0 years), difference is statistically significant (p<0.05), as their 95% confidence intervals don't not overlap.

The average annual crude incidence rate of the male population of the Republic with laryngeal cancer was 5.7, and the rate of women was 11.4 times lower: 0.5±0.06, the difference being statistically significant (p<0.05). In the dynamics crude incidence rate in both men (T=-3.3%) and in women (T=-6.7%) decreased, wherein among women trends were more pronounced.

Analysis of the 95%CI indicates that between age indicators there are statistically significant differences (p<0.05), where they do not overlap, i.e., the formation of various indicators affect the causal factors (Table 2).

Next, we made cartogram of cancer of the larynx in all, male and female population according to the administrative-territorial division of the country. The cartogram laryngeal cancer incidence among all population has the same regularities described in this study, and more accurately represents the spatial distribution of laryngeal cancer for individual regions. The discrepancy between the theoretical and actual distribution of laryngeal cancer incidence for individual regions and cities are small; the Pearson criterion (χ^2) was equal to 12.7 (calculations are

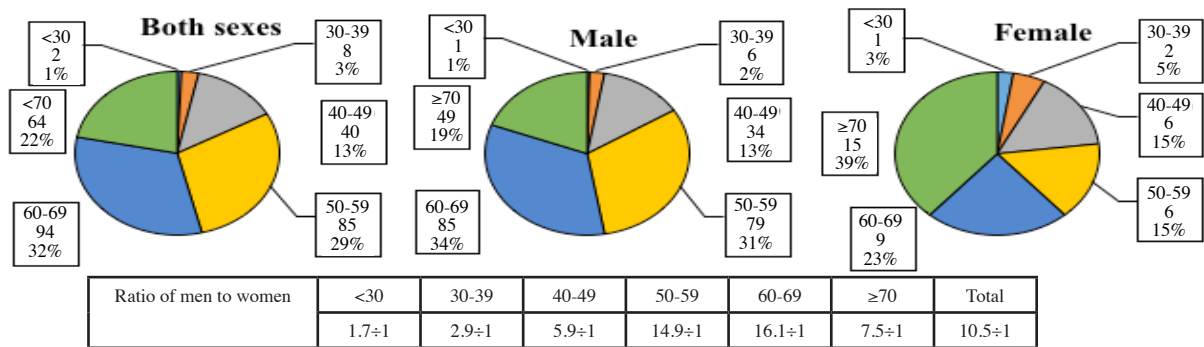


Figure 1. Distribution of Patients with Laryngeal Cancer by Age and Gender in Kazakhstan for The Years 1999-2009

Table 1. Age-Specific Indicators of Laryngeal Cancer Incidence in Kazakhstan for The Years 1999-2009

Age groups	Both sexes			Male			Female		
	Incidence, 0/0000 P±m	T, % 95%CI	T, %	Incidence, 0/0000 P±m	T, % 95%CI	T, %	Incidence, 0/0000 P±m	T, % 95%CI	T, %
<30	0.014±0.01	0.0-0.03	±0.0	0.03±0.01	0.01-0.04	-23.2	0.02±0.01	0.01-0.03	+9.7
30-39	0.31±0.14	0.03-0.58	+0.7	0.5±0.1	0.3-0.7	-17.2	0.18±0.04	0.1-0.3	+0.5
40-49	1.6±0.4	0.9-2.3	-7.9	4.4±0.5	3.5-5.3	-8.1	0.7±0.1	0.5-0.9	-8.8
50-59	6.6±1.4	3.9-9.4	-0.4	21.1±1.5	18.2-24.0	-3.5	1.2±0.2	0.8-1.6	-7.7
60-69	11.0±1.7	7.6-14.4	-3.5	40.0±2.1	36.0-44.1	-2.8	1.8±0.2	1.3-2.2	-4.3
≥70	12.1±3.4	5.4-18.8	-0.4	41.4±2.4	36.7-46.1	-2.6	2.6±0.4	1.9-3.4	-10.7
Total	1.3±0.2	1.0-1.7	-1.8	5.7±0.3	5.0-6.3	-3.3	0.5±0.1	0.4-0.6	-6.7

Table 2. Calculation Scheme for Determining Normal and Theoretical Distributions of Laryngeal Cancer Incidence and Pearson Criterion (χ^2)

NN	GR	CM	NoD	Vxp	d=V-x	d ²	d ² xp	t=(V-x)/σ	F(t)	TF=[(γxΣp)/σ]x F(t)	RTF, p'	p-p'	(p-p') ² /p'
(γ=20.7)	(V)	(p)											
Male Population													
1.	0.0-2.7	1.3	1	1.3	-4.7	22.5	22.5	+1.57	0.1163	1.641	2	-1	0.25
2.	2.7-5.3	4.0	7	28.0	-2.1	4.3	30.4	+0.69	0.3144	4.436	4	+3	1.48
3.	5.3-8.0	6.7	6	40.0	+0.6	0.3	2.0	-0.19	0.3918	5.528	6	+0	0.04
4.	8.0-10.7	9.3	1	9.3	+3.2	10.5	10.5	-1.07	0.2251	3.176	3	-2	1.49
5.	10.7-13.3	12.0	0	0.0	+5.9	35.0	0.0	+1.96	0.0584	0.824	1	-1	0.82
6.	13.3-16.0	14.7	1	14.7	+8.6	73.6	73.6	+2.84	0.0071	0.100	0	+1	8.08
Σp=n=16		ΣVxp=93.3		Σd ² xp=139.1		-		-		16		χ ² =12.2	
Female Population													
1.	0.0-0.3	0.2	1	0.2	-0.4	0.1	0.1	+1.04	0.2323	3.428	3	-2	1.72
2.	0.3-0.6	0.5	10	4.5	-0.1	0.0	0.0	+0.19	0.3918	5.782	6	+4	3.08
3.	0.6-0.9	0.8	4	3.0	+0.2	0.1	0.2	-0.65	0.3230	4.766	5	-1	0.12
4.	0.9-1.2	1.1	0	0.0	+0.5	0.3	0.0	-1.49	0.1315	1.940	2	-2	1.94
5.	1.2-1.5	1.4	0	0.0	+0.8	0.7	0.0	+2.34	0.0258	0.381	0	+0	0.38
6.	1.5-1.8	1.7	1	1.7	+1.1	1.3	1.3	+3.18	0.0034	0.050	0	+1	17.98
Σp=n=16		ΣVxp=9.3		Σd ² xp=1.7		-		-		16		χ ² =25.2	

*GR: grouping regions, CM: class mark, NoD: the number of districts, TF: theoretical frequency, RTF: refined theoretical frequency, 10th column is determined in a

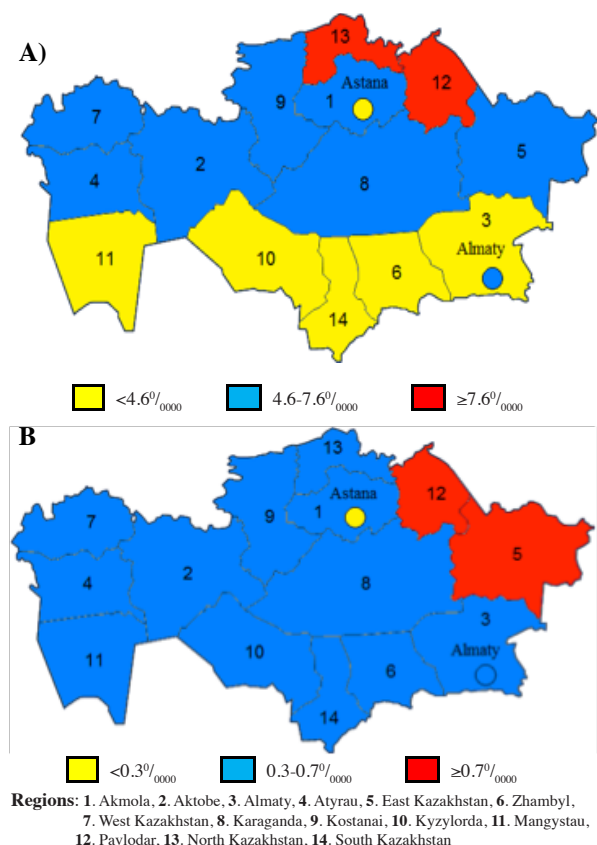


Figure 2. Cartogram of Laryngeal Cancer Incidence among the A) Male Population and B) Female Population of Kazakhstan for the Years 1999-2009

shown in Table 2 for the two sexes. Hence, the actual distribution of laryngeal cancer incidence in the regions of the Republic of Kazakhstan is close to the normal distribution.

Cartogram of laryngeal cancer incidence among men has showed following groups of regions (Figure 2A): *i*) Regions with low rates (up to 4.6), South Kazakhstan (2.2), Kyzylorda (2.9), Zhambyl (3.8), Almaty (4.0) regions and Astana city (4.2). *ii*) Regions with the average rates (from 4.6 to 7.6), Aktobe (4.7), Mangystau (5.1^{0/0000}), Atyrau (5.1), Akmola (6.1), Karaganda (6.4), West Kazakhstan (6.8), Kostanai (7.2) East Kazakhstan (7.2) regions and Almaty city (6.1). *iii*) Regions with high rates (from 7.6 and above), North Kazakhstan (10.3) and Pavlodar (15.2) regions.

Cartogram of laryngeal cancer incidence among women has showed following groups of regions (Figure 2B): *i*) Regions with low rates (up to 0.3), Astana city (0.2). *ii*) Regions with the average rates (from 0.3 to 0.7), South Kazakhstan (0.3), Aktobe (0.3), Almaty city (0.3), Zhambyl (0.4), Almaty (0.4), Akmola (0.4), Karaganda (0.4), West Kazakhstan (0.4), Kostanai (0.4), Atyrau (0.5), Kyzylorda (0.6), Mangystau (0.60/0000) and North Kazakhstan (0.6) regions. *iii*) Regions with high rates (from 0.7 and above), East Kazakhstan (0.7) and Pavlodar (1.8) regions.

Therefore, the actual distribution of cancer of the larynx, especially in males seems to indicate an increase as one travels north. One possibility is that the ethnic distribution in terms of the relative proportions of Russian

and Kazakh regions vary. At the same time it appears that the major cities have relatively low rates. Clearly future work should focus on this ethnicity aspect.

This is particularly with regard to the major laryngeal risk factors, tobacco and alcohol consumption. Tobacco quit ratios are low in the former Soviet Union but desire for control and cessation support does exist (Footman et al., 2013). Smoking prevalence appears to have stabilized and may be declining in younger groups, but remains extremely high among men, especially those in lower socioeconomic groups. Large gaps exist in public understanding of the negative health effects of tobacco use, particularly in Kazakhstan (Roberts et al., 2012).

Regarding dust exposure geographical variation in Kazakhstan might be expected and this possibility deserves exploration. While HPV infection could be a risk factor, the fact that Almaty has a much higher incidence of cervical cancer than Almaty (Igissinov N et al., 2012) would suggest that other factors are in action. The prevalence of *H. pylori* infection has been reported to be almost identical among the two ethnic groups (Russians 79% and Kazakhs 80%) with a negative relation to clean water index (Nurgalieva et al (2002).

In Central Asia worse socio-economic situation, negative health behaviours (smoking and alcohol consumption) and rural residence were all associated with low levels of fruit and vegetable intake (Krull Abe et al., 2013) so that many factors are probably interacting together to determine risk of laryngeal cancer. One area of obvious interest is availability of various detrimental and advantageous factors like alcohol, tobacco and foodstuffs , as highlighted earlier for Almaty (Yim et al., 2003).

In future our results should be used for targeted anti-cancer activities of laryngeal malignancies. Further study of the incidence of laryngeal cancer taking into account a variety of exogenous and endogenous causes is a priority of our research.

References

Ahmad Kiadaliri A, Jarl J, Gavriilidis G, Gerdtham UG (2013). Alcohol drinking cessation and the risk of laryngeal and pharyngeal cancers: a systematic review and meta-analysis. *PLoS One*, **8**, e58158.

Al-Dakkak I (2011). Tea, coffee and oral cancer risk. *Evid Based Dent*, **12**, 23-4.

Anantharaman D, Marron M, Lagiou P, et al (2011). Population attributable risk of tobacco and alcohol for upper aerodigestive tract cancer. *Oral Oncol*, **47**, 725-31.

Bilyalova Z, Igissinov N, Moore M, et al (2012). Epidemiological evaluation of breast cancer in ecological areas of Kazakhstan-association with pollution emissions. *Asian Pac J Cancer Prev*, **13**, 2341-4.

Bradshaw PT, Siega-Riz AM, Campbell M, et al (2012). Associations between dietary patterns and head and neck cancer: the Carolina head and neck cancer epidemiology study. *Am J Epidemiol*, **175**, 1225-33.

Bravi F, Edefonti V, Randi G, et al (2012). Dietary patterns and upper aerodigestive tract cancers: an overview and review. *Ann Oncol*, **23**, 3024-39.

Chan CK, Gee JB (1988). Asbestos exposure and laryngeal cancer: an analysis of the epidemiologic evidence. *J Occup Med*, **30**, 23-7.

Chen M, Tse LA (2012). Laryngeal cancer and silica dust

- exposure: a systematic review and meta-analysis. *Am J Ind Med*, **55**, 669-76.
- Coca-Pelaz A, Rodrigo JP, Takes RP, et al (2013). Relationship between reflux and laryngeal cancer. *Head Neck* (in press).
- de Souza DL, Pérez MM, Curado MP (2011). Predicted incidence of oral cavity, oropharyngeal, laryngeal, and hypopharyngeal cancer in Spain and implications for cancer control. *Cancer Epidemiol*, **35**, 510-4.
- De Stefani E, Boffetta P, Correa P, et al (2013). Dietary patterns and risk of cancers of the upper aerodigestive tract: a factor analysis in Uruguay. *Nutr Cancer*, **65**, 384-9.
- Duray A, Descamps G, Arafa M, et al (2011). High incidence of high-risk HPV in benign and malignant lesions of the larynx. *Int J Oncol*, **39**, 51-9.
- Dykhno IuA, Ivanova IuD, Kas'ianov VV, et al (2002). Use of geoinformational systems for epidemiological studying malignant laryngeal neoplasms in Krasnoyarsk. *Gig Sanit*, **3**, 37-9.
- Ellis L, Rachet B, Birchall M, Coleman MP (2012). Trends and inequalities in laryngeal cancer survival in men and women: England and Wales 1991-2006. *Oral Oncol*, **48**, 284-9.
- Enomoto M, Tierney WJ, Nozaki K (2008). Risk of human health by particulate matter as a source of air pollution-comparison with tobacco smoking. *J Toxicol Sci*, **33**, 251-67.
- Ferlay J, Shin HR, Bray F, et al (2010). GLOBOCAN 2008 v1.2, Cancer Incidence and Mortality Worldwide: IARC CancerBase No. 10 [Internet]. Lyon, France: International Agency for Research on Cancer; 2010. Available from: <http://globocan.iarc.fr>, accessed on 01.07.2013.
- Footman K, Roberts B, Stickley A, et al (2013). Smoking cessation and desire to stop smoking in nine countries of the former Soviet Union. *Nicotine Tob Res* (in press)
- Grant WB (2012). Role of solar UVB irradiance and smoking in cancer as inferred from cancer incidence rates by occupation in Nordic countries. *Dermatoendocrinol*, **4**, 203-11.
- Griffiths H, Molony NC (2003). Does asbestos cause laryngeal cancer? *Clin Otolaryngol Allied Sci*, **28**, 177-82.
- Hall J, Hashibe M, Boffetta P, et al (2007). The association of sequence variants in DNA repair and cell cycle genes with cancers of the upper aerodigestive tract. *Carcinogenesis*, **28**, 665-71.
- Hashibe M, Boffetta P, Zaridze D, et al (2007). Contribution of tobacco and alcohol to the high rates of squamous cell carcinoma of the supraglottis and glottis in Central Europe. *Am J Epidemiol*, **165**, 814-20.
- Igissinov N, Igissinov S, Moore MA, et al (2011a). Trends of prevalent cancer incidences in the Aral-Syr Darya ecological area of Kazakhstan. *Asian Pac J Cancer Prev*, **12**, 2299-303.
- Igissinov S, Igissinov N, Moore MA, et al (2013). Component analysis of esophageal cancer incidence in Kazakhstan. *Asian Pac J Cancer Prev*, **14**, 1945-9.
- Igissinov S, Igissinov N, Moore MA, Kalieva Z, Kozhakhmetov S (2012). Epidemiology of esophageal cancer in Kazakhstan. *Asian Pac J Cancer Prev*, **13**, 833-6.
- Igissinov N, Nuralina I, Igissinova G, et al (2012). Epidemiological aspects of morbidity and mortality from cervical cancer in Kazakhstan. *Asian Pac J Cancer Prev*, **13**, 2345-8.
- Igissinov N, Tereshkevich D, Moore MA, et al (2011b). Age characteristics of incidences of prevalent cancers in the Aral Sea area of Kazakhstan. *Asian Pac J Cancer Prev*, **12**, 2295-7.
- Islami F, Tramacere I, Rota M, et al (2010). Alcohol drinking and laryngeal cancer: overall and dose-risk relation—a systematic review and meta-analysis. *Oral Oncol*, **46**, 802-10.
- Jaworska K, Gupta S, Durda K, et al (2013). A low selenium level is associated with lung and laryngeal cancers. *PLoS One*, **8**, e59051.
- Jemal A, Bray F, Center MM, et al (2011). Global cancer statistics. *CA Cancer J Clin*, **61**, 69-90.
- Jung KW, Park S, Shin A, et al (2012). Do female cancer patients display better survival rates compared with males? Analysis of the Korean National Registry data, 2005-2009. *PLoS One*, **7**, 52457.
- Kawakita D, Sato F, Hosono S, et al (2012). Inverse association between yoghurt intake and upper aerodigestive tract cancer risk in a Japanese population. *Eur J Cancer Prev*, **21**, 453-9.
- Krull Abe S, Stickley A, Roberts B, et al (2013). Changing patterns of fruit and vegetable intake in countries of the former Soviet Union. *Public Health Nutr*, **23**, 1-9.
- Kumar V, Murthy AK, Suresh KP (2011). Glutathione S-transferase M1 and T1 status and the risk of laryngeal cancer: a meta-analysis. *Asian Pac J Cancer Prev*, **12**, 2221-6.
- Lacko M, Voogd AC, Roelofs HM, et al (2013). Combined effect of genetic polymorphisms in phase I and II biotransformation enzymes on head and neck cancer risk. *Head Neck*, **35**, 858-67.
- Lagergren J, Lindam A (2012). Increased risk of laryngeal and pharyngeal cancer after gastrectomy for ulcer disease in a population-based cohort study. *Br J Cancer*, **106**, 1342-5.
- Lee YC, Boffetta P, Sturgis EM, et al (2008). Involuntary smoking and head and neck cancer risk: pooled analysis in the International Head and Neck Cancer Epidemiology Consortium. *Cancer Epidemiol Biomarkers Prev*, **17**, 1974-81.
- Li X, Gao L, Li H, et al (2013). Human papillomavirus infection and laryngeal cancer risk: a systematic review and meta-analysis. *J Infect Dis*, **207**, 479-88.
- Licitra L, Bernier J, Grandi C, et al (2003). Cancer of the larynx. *Crit Rev Oncol Hematol*, **47**, 65-80.
- Merkov AM, Polyakov LE (1974). Sanitary statistics. Leningrad, 384.
- Ndiaye C, Alemany L, Diop Y, et al (2013). The role of human papillomavirus in head and neck cancer in Senegal. *Infect Agent Cancer*, **8**, 14.
- Nicolotti N, Chuang SC, Cadoni G, et al (2011). Recreational physical activity and risk of head and neck cancer: a pooled analysis within the international head and neck cancer epidemiology (INHANCE) Consortium. *Eur J Epidemiol*, **26**, 619-28.
- Nurgalieva ZZ, Malaty HM, Graham DY, et al (2002). *Helicobacter pylori* infection in Kazakhstan: effect of water source and household hygiene. *Am J Trop Med Hyg*, **67**, 201-6.
- Parnes SM (1990). Asbestos and cancer of the larynx: is there a relationship? *Laryngoscope*, **100**, 254-61.
- Poirier MC (2012). Chemical-induced DNA damage and human cancer risk. *Discov Med*, **14**, 283-8.
- Ramroth H, Dietz A, Becher H (2011). Intensity and inhalation of smoking in the aetiology of laryngeal cancer. *Int J Environ Res Public Health*, **8**, 976-84.
- Roberts B, Gilmore A, Stickley A, et al (2012a). Changes in smoking prevalence in 8 countries of the former Soviet Union between 2001 and 2010. *Am J Public Health*, **102**, 1320-8.
- Roberts B, Stickley A, Gilmore AB, et al (2012b). Knowledge of the health impacts of smoking and public attitudes towards tobacco control in the former Soviet Union. *Tob Control*. (in press).
- Romanowicz-Makowska H, Smolarz B, Gajęcka M, et al (2012). Polymorphism of the DNA repair genes RAD51 and XRCC2 in smoking- and drinking-related laryngeal cancer in a Polish population. *Arch Med Sci*, **8**, 1065-75.
- Saurina C, Saez M, Marcos-Gragera R, et al (2010). Effects

- of deprivation on the geographical variability of larynx cancer incidence in men, Girona (Spain) 1994-2004. *Cancer Epidemiol*, **34**, 109-15.
- Sepetliev D (1968). Statistical Methods in Medical Research. Moscow: Meditsina, 420.
- Sapkota A, Gajalakshmi V, Jetly DH, et al (2007). Smokeless tobacco and increased risk of hypopharyngeal and laryngeal cancers: a multicentric case-control study from India. *Int J Cancer*, **121**, 1793-8.
- Sapkota A, Hsu CC, Zaridze D, et al (2008). Dietary risk factors for squamous cell carcinoma of the upper aerodigestive tract in central and eastern Europe. *Cancer Causes Control*, **19**, 1161-70.
- Sapkota A, Zaridze D, Szeszenia-Dabrowska N, et al (2013). Indoor air pollution from solid fuels and risk of upper aerodigestive tract cancers in central and eastern Europe. *Environ Res*, **120**, 90-5.
- Shangina O, Brennan P, Szeszenia-Dabrowska N, et al (2006). Occupational exposure and laryngeal and hypopharyngeal cancer risk in central and eastern Europe. *Am J Epidemiol*, **164**, 367-75.
- Sharma MK, Gour N, Pandey A, Wallia D (2011). Epidemiological study of risk factors for oral, laryngeal and esophageal cancers at a tertiary care hospital in India. *Asian Pac J Cancer Prev*, **12**, 1215-8.
- Shin H-R, Marie Clem C, Vargese C (2012). Cancer control in the asia pacific region: current status and concerns. *Jpn J Clin Oncol*, **42**, 867-81.
- Siupsinskiene N, Jurgutaviciute V, Katutiene I, et al (2013). *Helicobacter pylori* infection in laryngeal diseases. *Eur Arch Otorhinolaryngol*, **270**, 2283-8.
- Sliwinski T, Markiewicz L, Rusin P, et al (2011). Impaired nucleotide excision repair pathway as a possible factor in pathogenesis of head and neck cancer. *Mutat Res*, **716**, 51-8.
- Stanton G (1999). Medicobiological statistics. Moscow, 460.
- Tae K, Jin BJ, Ji YB, et al (2011). The role of laryngopharyngeal reflux as a risk factor in laryngeal cancer: a preliminary report. *Clin Exp Otorhinolaryngol*, **4**, 101-4.
- Tavani A, Malerba S, Pelucchi C, et al (2012). Dietary folates and cancer risk in a network of case-control studies. *Ann Oncol*, **23**, 2737-42.
- Vassileiou A, Vlastarakos PV, Kandiloros D, et al (2012). Laryngeal cancer: smoking is not the only risk factor. *B-ENT*, **8**, 273-8.
- Wang C, Li Q, Wang Y, et al (2011). Case-control study on risk factors of laryngeal cancer in Heilongjiang province. *Lin Chung Er Bi Yan Hou Tou Jing Wai Ke Za Zhi*, **25**, 1117-9 (in Chinese).
- Wong O, Foliart DE (1993). Epidemiological factors of cancer in Louisiana. *J Environ Pathol Toxicol Oncol*, **12**, 171-83.
- Wünsch Filho V (2004). The epidemiology of laryngeal cancer in Brazil. *Sao Paulo Med J*, **122**, 188-94.
- www.stat.kz – The Republic of Kazakhstan statistic agency official web site.
- Xiao H, Li M, Tian L, et al (2013). Quantitative assessment of the association between GSTM1 null genotype and laryngeal cancer risk. *Eur Arch Otorhinolaryngol*, **270**, 615-22.
- Yim A, Humphries D, Abuova G (2003). Food, alcohol and cigarette availability and consumption in Almaty, Kazakstan: results and appraisal of a rapid assessment. *Public Health Nutr*, **6**, 791-800.
- Ying XJ, Dong P, Shen B, et al (2011). Possible association of NAT2 polymorphism with laryngeal cancer risk: an evidence-based meta-analysis. *J Cancer Res Clin Oncol*, **137**, 1661-7.
- Ying XJ, Dong P, Shen B, et al (2012). Glutathione S-transferase M1 gene polymorphism and laryngeal cancer risk: a meta-analysis. *PLoS One*, **7**, 42826.