RESEARCH ARTICLE

# Malignant Tumors of the Central Nervous System in Kazakhstan: Component Analysis of Incidence Dynamics

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## Abstract

**The paper presents the incidence rates of malignant tumors of the central nervous system assessed by the component analysis. The data on primary registered cases of malignant tumors of the central nervous system in the country were used as the material of the study for the period from 2004 to 2011. A general trend of increase in the number of patients with malignant tumors of the central nervous system in Kazakhstan was determined and the potential of their increase was evaluated, which can be due to changes in the morbidity risk and age specifics, as well as the increase in population.**

**Keywords:** Component analysis - malignant tumors - CNS - incidence - the expected number of patients

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## Introduction

The incidence rate of malignant tumors of the central nervous system (CNS) is not so high and is not in the leading positions of the structure of cancer pathology. According to the International Agency for Research on Cancer, there are about 14 million registered malignant tumors in the world each year, and approximately 256,000 cases occur in malignant tumors of CNS, which is equal to 1,8% (Ferlay et al., 2014). However the increase in the incidence of CNS tumors is observed in many countries in recent decades, and correspondingly it is the problem of public health and medicine due to the unfavorable prognosis of the disease.

Numerous studies point to the growth of CNS malignant tumors (Helseth, 1995; Polednak, 1996; Kuratsu et al., 1997; Christensen et al., 2003; Hess et al., 2004; Lonn et al., 2004; Johannesen et al., 2004; Hoffman et al 2006; Mehrazin et al., 2006; Pirouzmand et al., 2007; Yeole, 2008; Deltour et al., 2009; Li-Xiang Ding et al., 2011; Manoharan et al., 2012; Seyed Behzad Jazayeri et al., 2013), especially among older ages (Grieg et al., 1990; Lowry et al., 1998; Kuratsu et al., 2001) and children (Smith et al., 2000; Cho et al., 2002; Wiangnon et al., 2003, McKinney, 2004; Saima Nasir et al., 2010). The results of these studies show many unresolved issues related with the epidemiology of this type of cancer.

Epidemiological studies of CNS malignancies which held in Kazakhstan (Igissinov et al., 2013) show that the dynamics of morbidity are rising, whereas no component analysis was carried out. Component analysis of the dynamics of malignant tumors in Kazakhstan has been studied as a whole for all localizations (Igissinov et al., 2012) and esophageal cancer (Igissinov et al., 2013).

Hence, this study was conducted considering that the study of the incidence of CNS malignant tumors in dynamics by the component analysis has the certain theoretical and practical significance.

## Materials and Methods

The main source of information on the incidence was the data of the cancer care facilities on primary registered cases of MT CNS in the whole country and the data of the Agency of the Republic of Kazakhstan on the dead from MT CNS. Data on the population in the corresponding age and gender groups for the studied years were obtained from the official website of the Committee on Statistics/ Ministry of National Economy of the Republic of Kazakhstan (www.stat.gov.kz).

The dynamics of the MT CNS incidence of Kazakhstan population was investigated using the component analysis guidelines of V. Dvoirin and E. Axel (Dvoirin et al., 1987). This method of dynamics analysis of the MT CNS 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 MT CNS 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 MT CNS incidence rate only. The other 3

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components related to the risk of the MT CNS incidence with population growth, changing of age structure and the influence of all three factors. Many researchers (Starinsky, et al., 2005; Poddubnaya et al., 2007; Kudryavtsev et al., 2008) understand the term «at risk to get sick» as the full range of causes that can lead to an increase, a decrease or stabilization in the incidence. Therefore, last four components associated with increased risk of disease.

The component method is used to analyze the dynamics of the MT CNS incidence of Kazakhstan population from 2004 to 2011. Mathematical calculations of the component analysis of the dynamics of the MT CNS incidence of Kazakhstan population are presented in the corresponding Tables.

## Results and Discussion

The component method of analysis of the dynamics of the MT CNS incidence of Kazakhstan population in 2004 to 2011 is given in Tables 1 and 2. Analysis of the MT CNS incidence in dynamics showed the growth of indicators, while the overall increase in 2011 compared to 2004 was T= +0.550/0000, and as shown in Table 1, the growth of indicators largely depended on the changes in the morbidity risk (Σ=ΔP= +0.530/0000).

As it was already established, trend of the MT CNS incidence in the entire population over the study period tended to increase (T= +0.9%). In this case, attention is drawn to changes in the number of patients with MT CNS, as the expected number of registered cases in the country 2011 was supposed to be about 558 patients, but in fact there were 641 new cases. Thus, based on the analysis of the dynamics of the absolute number of patients with MT CNS in the country for the years 2004-2011, we can assume that each year on the average about 20 cases of MT CNS are not recorded (see Table 3 (+88−65+101−74 +50−22+63)/7=20)). Also, these numbers would increase on average by 86 ((+ 88+23+124+50+100+78+141)/7=86) patients with a recalculation on their expected or theoretical number of patients with MT CNS, which is more than 4 times higher than the expected number of unreported cases (Table 3).

Such epidemiological patterns according to which population growth and changes in the age structure are lead to the simultaneous increase of the number of patients are recognized worldwide. And these patterns are observed in our country too.

The research allows us to conclude that changes in the dynamics of the number of patients with MT CNS in Kazakhstan can generally be related to the following factors (Table 2):

*i)* Population growth ΔH= +35.4%.

*ii)* Changes in the age structure of the population ΔB= +5.5%.

*iii)* Combined effect of changes in population size and age structure ΔHB= +0.5%.

*iv)* Changes in the risk of getting sick P= + 56.6%.

*v)* Combined effect of changes in the risk of getting sick and population ΔHP= +5.6%.

*vi)* Combined effect of changes in the risk of getting sick and age structures ΔVR=-3.3%.

*vii)* Combined effect of the changes in the risk of getting sick, the population and its age structure ΔHBP= −0,3%.

The total increase in the absolute number of cases is equal to the sum of the components: $n_2$-$n_1$=50+8+80+1+8-5-1= +141 or+28.2% related to the initial number of patients (141÷500×100=28.2%).

Accordingly, the components of the growth in percentage of the initial level will be equal to:

A) (10.0%+1.5%+0.2%+16.0%)= 11.7%
B) (16.0%+1.6%–0.9%–0.1%)= 16.6%
(A+B) (11.7%+16.6%)= 28.2%

Thus, MT CNS in Kazakhstan is characterized by growth in the number of cases due to changes in total population and its structure (+11.7% of the total growth, which is equal to +28.2%). There is high potential of real increase in the number of cases (+16.0%).

Components are categorized into three classes, one of

**Table 1. The Component Analysis of the CNS Cancer Incidence Increase in Kazakhstan from 2004 Till 2011**

| Age (*i*) | Age structure of the population ($Sij=N_{ij}÷N_j$) | | | CNS cancer incidence | | | Increase of incidence: including in connection with the change | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2004 ($S_{i1}$) | 2011 ($S_{i2}$) | An increase of structural indicators ($S_{i2}$-$S_{i1}$) (3)-(2) | 2004 ($P_{i1}$) | 2011 ($P_{i2}$) | general ($P_{i2}$-$P_{i1}$) (6)-(5) | age structure of the population (4)×(5) | a risk to get sick (2)×(7) | age structure of the population and a risk to get sick (4)×(7) |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| <30 | 0.5240 | 0.5189 | −0.0051 | 1.4 | 1.7 | +0.3 | −0.007 | 0.137 | -0.001 |
| 30-39 | 0.1454 | 0.1469 | +0.0015 | 3.2 | 3.6 | +0.4 | +0.005 | 0.056 | 0.001 |
| 40-49 | 0.1404 | 0.1314 | −0.0090 | 4.7 | 5.2 | +0.6 | −0.042 | 0.079 | -0.005 |
| 50-59 | 0.0827 | 0.1034 | +0.0207 | 9.5 | 9.0 | −0.5 | +0.196 | -0.038 | -0.010 |
| 60-69 | 0.0640 | 0.0510 | −0.0130 | 8.9 | 11.3 | +2.4 | −0.116 | 0.157 | -0.032 |
| 70+ | 0.0435 | 0.0484 | +0.0049 | 3.2 | 6.5 | +3.3 | +0.016 | 0.144 | 0.016 |
| Total | $\sum S_{i1}$=1.0 | $\sum S_{i2}$=1.0 | | $P_1$=3.34 | $P_2$=3.90 | +0.55 | $\Sigma=\Delta_B$=+0.05 | $\Sigma=\Delta_P$=+0.53 | $\Sigma=\Delta_{BP}$=−0.03 |

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

| Age ($i$) | Number of getting sick ($nij$) | | Population size ($Nij$) | | Incidence indicators: rough ($Pij$) | | Incidence indicators: standardized ($P^c_{ij}$) | | The expected number of getting sick patient in 2011 y. | $\frac{N_1}{N_2}$ | % increase: κ ($n_2$-$n_1$) | κ $n_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2004 (j=1) | 2011 (j=2) | 2004 (j=1) | 2011 (j=2) | 2004 (j=1) | 2011 (j=2) | 2004 (j=1) | 2011 (j=2) | $(P_{ij}N_{i2}10^{-5})$ $(6)\times(5)\times10^{-5}$ | (4)÷(5) | 100Δ ($n_2$-$n_1$ ) | 100Δ $n_1$ |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| <30 | 109 | 141 | 7834884 | 8532380 | 1.4 | 1.7 | | 0.866 | 118.70 | | | |
| 30-39 | 70 | 87 | 2173592 | 2414914 | 3.2 | 3.6 | | 0.524 | 77.8 | | | |
| 40-49 | 98 | 113 | 2099052 | 2160918 | 4.7 | 5.2 | | 0.734 | 100.9 | | | |
| 50-59 | 117 | 153 | 1236499 | 1699941 | 9.5 | 9.0 | | 0.744 | 160.9 | | | |
| 60-69 | 85 | 95 | 956249 | 837946 | 8.9 | 11.3 | | 0.725 | 74.5 | | | |
| 70+ | 21 | 52 | 650924 | 795860 | 3.2 | 6.5 | | 0.284 | 25.7 | | | |
| Total | $n_1$=500 | $n_2$=641 | $N_1$=14951200 | $N_2$=16441959 | $P_1$=3.34 | $P_2$=3.90 | $P^C_1$=3.34 | $P^C_2$=3.88 | E($n_2$)=558 | 0.909 | | |
| | [($n_1$-$n_2$)÷$n_1$]100= +28.2 | | [($N_1$-$N_2$)÷$N_1$]100= +10.0 | | [($P_1$-$P_2$)÷$P_1$]100= +16.6 | | [($P^C_1$-$P^C_2$)÷$P^C_1$]100= +16.0 | | | | | |

| Components of an increase of getting sick due to: | | | | | |
|---|---|---|---|---|---|
| 1. Population growth | $D_H$= [($N_1$-$N_2$)÷$N_1$]$n_1$= +50 | +35.4 | +25.3 | +10.0 | +11.7 |
| 2. Changes in the age structure of the population | $D_B$= ($N_1$÷$N_2$)[E ($n_2$)-$n_1$-$D_H$]= +8 | +5.5 | | +1.5 | |
| 3. Combined effect of changes in population size and age structure | $\Delta_{HB}$= [($N_2$-$N_1$)÷$N_1$]$\Delta_B$= +1 | +0.5 | | +0.2 | |
| 4. Changes in the risk to get sick | $\Delta_P$= [$N_1$($P^C_1$-$P^C_2$)]$10^{-5}$= +80 | +56.6 | +74.7 | +16.0 | +16.6 |
| 5. Combined effect of changes in the risk of getting sick. and population | $\Delta_{HB}$= [($N_2$-$N_1$)÷$N_1$]$\Delta_{5P}$= +8 | +5.6 | | +1.6 | |
| 6. Combined effect of changes in the risk of getting sick and age structures | $\Delta_{BP}$= $N_1$÷$N_2$ ($n_2$-$n_1$-$\sum_{x=1}$ Δ)= -5 | –3.3 | | –0.9 | |
| 7. Combined effect of the changes in the risk of getting sick. a population size and its age structure | $\Delta_{HBP}$= [($N_2$-$N_1$)÷$N_1$] $\Delta_{BP}$= -1 | –0.3 | | –0.1 | |
| Total | **$n_2$-$n_1$=+141** | | **100.0** | | **+28.2** |

**Table 3. Absolute Number of CNS Cancer and its Meaning in Kazakhstan**

| CNS cancer | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|
| Registered patients ($X_r$) | 500 | 588 | 523 | 624 | 550 | 600 | 578 | 641 |
| Increase or decrease in the absolute number compared to previous year | – | +88 | –65 | +101 | –74 | +50 | –22 | +63 |
| Increase (decrease) in the absolute number compared to 2004 | – | +88 | +23 | +124 | +50 | +100 | +78 | +141 |
| Growth (increase) rate compare to previous year (%) | – | +17.6 | –11.1 | +19.3 | –11.9 | +9.1 | –3.7 | +10.9 |
| Growth (increase) rate compare to 2004 (%) | – | +17.6 | +4.6 | +24.8 | +10.0 | +20.0 | +15.6 | +28.2 |
| Population size (thousand) | 14,951 | 15,075 | 15,219 | 15,397 | 15,572 | 15,777 | 16,205 | 16,442 |
| Expected number ($X_{ex}$) compared to 2004 | 500 | 504 | 509 | 515 | 521 | 528 | 542 | 550 |
| Difference between the expected and registered absolute number ($X_{ex}$–$X_r$) | – | 84 | 14 | 109 | 29 | 72 | 36 | 91 |

which reflects a different kind of changes in the population (ΔH+ΔB+ΔHB), the second relates to increase of the risk of getting sick only (△P), and the third presents the relationship between these factors (ΔHR+ΔBR+ΔHBR). Therefore, in order to characterize the cumulative effect of changes in the population or the risk of getting sick to the components of the 1st and 2nd classes, there should be added the effect of the 3rd class components' impact:

*i)* (ΔH+ΔB+ΔHB)+(ΔHR+ΔBR+ΔHBR)

*ii)* △P+(ΔHR+ΔBR+ΔHBR)

If the total increase in the number of cases of MT CNS (141) consider as 100%, the increase which is in anyway associated with the risk of the disease progression will be +58.6% [(+16.0+1.6-0.9-0.1)÷28.2×100], and with the "clear" increase of risk+56.6%.

Different componential structures of MT CNS at different periods of time or in different population groups in the same periods of time may provide important information for the formation of epidemiological hypotheses about the possible causal role of environmental factors.

Thus, the number of patients with MT CNS in Kazakhstan is increasing. The increase is associated with the population growth, the combined effect of changes in population and its age structure, changes in the risk of getting sick, the combined effect of changes in the risk of getting sick and the age structure of the population. The results of the component analysis of dynamics of the MT CNS incidence in Kazakhstan are recommended to use in planning the anticancer activities due to MT CNS.

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