

# HEALTH RISK ANALYSIS IN ORGANISING PUBLIC HEALTHCARE

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## ECONOMIC LOSSES DUE TO ONCOLOGIC DISEASES RELATED TO MODIFIABLE RISK FACTORS

**A.V. Kontsevaya, Yu.A. Balanova, A.O. Myrzamatova, M.B. Khudyakov, D.K. Mukaneeva, O.M. Drapkina**

National Medical Research Center for Preventive Medicine, Bld. 10, Petroverigskiy lane, Moscow, 101990, Russian Federation

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*As per data provided by the WHO, about one third of death cases due to cancer are caused by risk factors that can be modified. Also, according to data provided by several authors, 4 modifiable risk factors cause 70% of malignant neoplasm cases that could have been prevented. Malignant neoplasms occupy the 2<sup>nd</sup> rank place in mortality structure in the Russian Federation. A significant share of analyzed malignant neoplasms can potentially be prevented provided that risk factors are corrected; therefore, investments into prevention should be a core in any activity aimed at public health improvement.*

*Our goal was to evaluate economic losses that occurred due to most common oncologic diseases related to behavioral risk factors among population in Russia in 2016 (including costs borne by the public healthcare and losses in the economy).*

*Our analysis comprised direct expenses borne by the public healthcare or, in other words, money spent on oncologic diseases treatment, direct funds allocated to pay disability allowances and temporary disability payments as well as indirect losses in the economy associated with untimely deaths and disability among employable population.*

*Aggregated economic losses that occurred due to 10 most common malignant neoplasms included into our analysis amounted to 241.3 billion rubles or 0.3% of the country GDP in 2016. Direct expenses accounted for 71.7% of the total losses while GDP losses caused by untimely deaths and disability amounted to 28.3%. The highest direct expenses borne by the public healthcare were due to colorectal cancer (52 billion rubles) and cancer in the trachea, bronchial tubes, and lungs (50 billion rubles).*

*Our data indicate it is necessary to invest into oncologic diseases prevention and treatment. These investments can produce a significant economic effect in long-term period thus making for economic growth.*

**Key words:** *economic losses, risk factors, oncologic diseases, public healthcare, expenses, economic losses, direct costs, indirect costs.*

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Malignant neoplasms (MNs) take the 2<sup>nd</sup> rank place in the structure of mortality in the RF [1]. In 2017 in the RF a number of MNs cases exceeded 600 thousand for the first time [2] and the overall number of diagnosed MNs is growing each year. But at the same time as per data provided by the World Health Organization (WHO) [3], approximately one third of all death cases due to cancer are caused by 5 primary risk factors. These factors are high body mass index, fruit and vegetables consumed in insufficient quantities, low physical

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**Anna V. Kontsevaya** – Doctor of Medicine, Deputy Director (e-mail: akontsevaya@gnicpm.ru; tel.: +7 (495) 223-49-58; ORCID: <http://orcid.org/0000-0003-2062-1536>).

**Yuliya A. Balanova** – Candidate of Medical Sciences, Lead researcher, laboratory of the economic analysis of epidemiology surveys and preventive technologies Department of Epidemiology of Chronic Non-Communicable Diseases (e-mail: jbalanova@gnicpm.ru; tel.: +7 (926) 126-76-91; ORCID: <http://orcid.org/0000-0003-2062-1536>).

**Azaliya O. Myrzamatova** – Researcher of Public Health Department (e-mail: azaliya89@list.ru; tel.: +7 (966) 377-39-93; ORCID: <https://orcid.org/0000-0001-8064-7215>).

**Mikhail B. Khudyakov** – Lead Engineer of Public Health Department (e-mail: mbkh52@mail.ru; tel.: +7 (915) 104-87-56; ORCID: <http://orcid.org/0000-0002-7869-2030>).

**Dinara K. Mukaneeva** – Junior Researcher of Public Health Department (e-mail: mdksc@mail.ru; tel.: +7 (966) 642-26-34; ORCID: <http://orcid.org/0000-0003-2682-7914>).

**Oksana M. Drapkina** – Corresponding Member of the Russian Academy of Sciences, Doctor of Medicine, Professor, Director (e-mail: akontsevaya@gnicpm.ru; tel.: +7 (495) 223-49-58; ORCID: <http://orcid.org/0000-0002-4453-8430>).

activity, and alcohol intake; but the most significant factor is tobacco smoking since approximately 22% death cases due to cancer are related to it. As per data obtained by British researchers, four modifiable risk factors (obesity, smoking, excessive alcohol intake, and low physical activity) are reasons for 70% of preventable MNs such as lung cancer, rectal cancer, breast cancer, etc. [4]. At the same time it is these MNs localizations that cause high morbidity and mortality in the RF [1]. A significant share of MNs in these localizations is potentially preventable should risk factors be corrected; therefore, investments into prevention should be given specific attention when activities aimed at public health improvement are planned and implemented. Determination of economic losses caused by risk factors and related diseases is a convincing argument for authorities responsible for making decisions on investments into prevention activities [5].

Economic losses caused by MNs are being examined in the EU, both overall and in separate countries, the USA [6–8], Canada, and some other states. Estimation of economic damage caused by MNs is a bit complicated due to difficulties related to taking into account all the components in such damage and estimating costs on treatment, both in our country and abroad. Methodical issues related to estimating economic burdens caused by MNs, first of all, estimating direct costs, are described in the work by V.I. Ignatyeva [9]. There have been several research works performed in the RF that focused on estimating economic losses caused by certain MNs [10–18], but they were accomplished in different time periods and are based on different methodological approaches; though some of them were accomplished as per similar procedures by the same authors [9, 14, 16, 18].

**Our research goal** was to estimate economic losses that occurred due to main oncologic diseases related to behavioral risk factors among population in Russia in 2016 (including costs borne by the public healthcare system and indirect economic losses).

**Data and methods.** Our analysis included several oncologic diseases that were

authentically related to behavioral risk factors and caused high morbidity and mortality among population in Russia (Table 1). They are lung cancer; breast cancer; stomach cancer; pancreas cancer; kidney cancer; cervical cancer; ovarian cancer; prostate cancer; rectal cancer [19–24].

Table 1  
Oncologic diseases included into the analysis

Oncologic disease	ICD-10 code	Number of cases in 2016 [1]	
		New	Overall
Stomach cancer	C16	37,135	139,800
Rectal cancer	C18–C21	69,500	357,050
Liver cancer and intrahepatic biliary ductules cancer	C22	8,320	7,829
Pancreas cancer	C25	18,517	18,511
Trachea, bronchial tubes, or lung cancer	C33, C34	60,467	137,381
Breast cancer	C50	69,095	642,720
Cervical cancer	C53	17,212	177,876
Ovarian cancer	C56	14,017	108,188
Prostate cancer	C61	38,371	202,604
Kidney cancer	C64	23,908	159,427

Our analysis included direct costs borne by the public healthcare on treating oncologic diseases; direct costs on permanent disability and temporary disability payments; indirect costs occurring in the economy and related to untimely deaths and permanent disability among employable population.

Data on direct costs borne by the public healthcare in 2016 were determined on the basis of previous research on a cost of each disease in the analyzed group (Table 2). Basing on literature data on expenses spent on treating patients suffering from oncologic pathologies, we recalculated direct costs borne in 2016. Costs borne by the public healthcare and related to pancreas cancer are not included into the calculations due to absence of relevant data in the domestic research works.

To reduce data obtained for different years to a level relevant for 2016, we adjusted direct medical costs according to actual inflation.

Table 2  
Sources of relevant data for analyzing direct medical costs on MNs borne in 2016 and related to modifiable risk factors

Oncologic disease	ICD-10 code	Year of the analysis	Direct medical costs per 1 patient a year (rubles)	Source
Stomach cancer	C16	2013	262,216	[10]
Rectal cancer	C18–C21	2010	395,175	[11]
Liver cancer and intra-hepatic biliary ductules cancer	C22	2008	446,252	[12]
Pancreas cancer	C25	No data in domestic research works		
Trachea, bronchial tubes, or lung cancer	C33, C34	2009	1,202,675	[13]
Breast cancer	C50	2014	40,275	[14]
Cervical cancer	C53	2008	122,500	[15]
Ovarian cancer	C56	2009	15,460	[16]
Prostate cancer	C61	2009	10,758	[17]
Kidney cancer	C64	2009	34,455	[18]

Calculations were performed as per the following formula:

$$\text{COST}_{\text{dmc16}} = \text{COST}_{\text{dmc0}} * \text{In}_0 * \text{In}_1 * \dots * \text{In}_{16}, \quad (1)$$

where

$\text{COST}_{\text{dmc16}}$  are reduced direct medical costs in 2016;

$\text{COST}_{\text{dmc0}}$  are direct medical costs at the moment research was performed;

$\text{In}_0$  is growth rate for consumer prices indexes (CPI) in the RF in the year in which direct medical costs were analyzed;

$\text{In}_1$  and  $\text{In}_{16}$  are CPI growth rates over years up to 2016.

Costs borne by the public healthcare per 1 patient in 2016 calculated according to the above procedure were multiplied by a number

of people who suffered from an analyzed oncologic disease in 2016 (Table 1).

To calculate number of people with disability as per a specific nosology, we multiplied an overall number of people who were recognized as being disabled for the first time as per data provided by the Rosstat in 2016 [25] by a share of this specific MN in the overall number of the first diagnosed MNs with the given localization (Report Form No. 7 “Data on malignant neoplasms in 2016). When determining a disability group, we took into account stages of MN: Stage IV meant a person had the 1<sup>st</sup> disability group (the highest payments); Stage III, the 2<sup>nd</sup> disability group; Stages I and II, the 3<sup>rd</sup> disability group accordingly. When calculating annual economic losses related to disability payments, we took 6 months as it was an average period during which patients received such payments and average disability payment granted for disabled people by the RF State Pension Fund in 2016 [26].

To calculate a number of days of temporary disability (TD) and a number of people with it as per a specific nosology, we took data from the Statistic Report Form No. 16-td issued in 2016.

Indirect costs (economic losses) included costs of products that were not manufactured as a lost contribution into the country GDP due to untimely deaths and disability among employable population.

Mortality was analyzed basing on data provided by the WHO and data on MNs-related mortality provided by the Herzen’s National Medical Research Center for Radiology” of the RF Public Healthcare Ministry [1]. To calculate potential years of life that were lost, we multiplied an absolute number in a specific age group by a number of years that a person failed to live to reach 72 years of age in each specific age group. Losses related to untimely deaths among employable population included non-manufactured GDP due to years of life in a relevant age group that were lost due to deaths caused by MNs taking into account employment rates. Future losses were calculated with the use of ‘net present value’ with 3% discounting.

GDP losses due to disability were determined according to the following procedure: first, we calculated a number of people with persistent disability in each disability group taking into account employment rates; then a calculated number of disabled people among employable population was multiplied by GDP net present value per capita.

Data were statistically analyzed with Microsoft Excel 10.0.

**Results and discussion.** To determine economic losses related to MNs, we calculated the following parameters: number of deaths among people younger than 72; potential years of life lost before a person reached 72 years of age; number of days during which a person was temporarily disabled; number of temporary disability cases (Table 3).

Table 3

Number of deaths, lost years of life, duration and number of temporary disability cases related to MNs in 2016

MN	Number of deaths	Years lost before age of 72	Temporary disability duration (in days)	Number of temporary disability cases
Stomach cancer	16,341	106,058	607,616	17,134
Rectal cancer	18,690	112,533	1,137,183	32,067
Liver cancer and intrahepatic biliary ductules cancer	5,514	35,928	136,135	3,839
Pancreas cancer	10,470	66,338	302,982	8,544
Trachea, bronchial tubes, or lung cancer	34,619	205,530	989,382	27,899
Breast cancer	14,204	104,565	1,130,556	31,880
Cervical cancer	5,174	53,600	281,629	7,941
Ovarian cancer	5,150	37,925	229,351	6,467
Prostate cancer	4,831	22,233	627,840	17,704
Kidney cancer	5,394	32,888	391,191	11,031

Trachea, bronchial tubes and lung cancer caused the greatest number of overall deaths (34 thousand); a number of lost years of life was also the greatest for this nosology (205 thousand). Rectal cancer, stomach cancer, and breast cancer also caused a signifi-

cant number of deaths and lost years. Cervical cancer caused a relatively low number of deaths (5 thousand) but a related number of lost years of life was rather great (53 thousand) due to people dying from this cancer at a relatively young age. Temporary disability was the longest in case of breast cancer, rectal cancer, and cancer in the trachea, bronchial tubes and lungs (approximately 1 million days for each nosology).

Economic losses caused by MNs included into the analysis are given in Table 4. The greatest direct costs borne by the public healthcare were caused by rectal cancer (52 billion rubles) and trachea, bronchial tubes and lung cancer (50 billion rubles). Breast cancer caused substantially lower costs (20 billion rubles) as direct costs on treating 1 breast cancer case taken from initial data were substantially lower than costs on treating rectal cancer or lung cancer (Table 2). Overall direct costs also turned out to be the greatest for rectal cancer and trachea, bronchial tubes and lung cancer (56 and 54 billion rubles accordingly).

Lung cancer caused the highest GDP losses due to untimely deaths (18.5 billion rubles), and it was practically two times higher than losses caused by rectal cancer (10 billion rubles). Untimely deaths caused by stomach cancer and breast cancer also resulted in significant GDP losses (9 billion rubles and 8 billion rubles accordingly).

Overall costs borne by the public healthcare in 2016 on treating 10 analyzed MNs related to modifiable risk factors amounted to 152 billion rubles; overall direct costs taking into account permanent and temporary disability payments were equal to 173 billion rubles.

Overall GDP losses related to 10 MNs amounted to 65.7 billion rubles; GDP losses caused by disability amounted to 2.6 billion rubles.

Total economic losses caused by 10 MNs included into our analysis amounted to 241.3 billion rubles or 0.3% RF GDP in 2016.

In 2016 in the RF the greatest economic losses were caused by malignant neoplasms in

Table 4

## Economic losses due to oncologic diseases caused by modifiable risk factors in the Russian Federation in 2016 (million rubles)

Disease	ICD-10 code	Direct medical costs	Temporary disability payments	Permanent disability payments	Total direct costs	GDP losses due to disability	GDP losses due to untimely deaths	Total GDP losses	Total costs and losses
Stomach cancer	C16	11,140.0	733.3	1,264.1	13,137.5	282.9	8,926.4	9,209.4	22,346.9
Rectal cancer	C18–C21	52,173.7	1,372.4	2,488.4	56,034.5	454.9	10,064.3	10,519.2	66,553.7
Liver cancer and intrahepatic biliary ductules cancer	C22	5,656.5	164.3	366.2	6,186.9	106.7	3,016.6	3,123.3	9,310.3
Pancreas cancer	C25	–	365.7	881.7	1,247.3	230.8	5,684.9	5,915.8	7,163.1
Trachea, bronchial tubes and lung cancer	C33, C34	50,626.6	1,194.1	2,487.2	54,307.8	628.7	18,564.6	19,193.3	73,501.2
Breast cancer	C50	20,903.9	1,364.4	2,541.0	24,809.3	314.5	7,950.7	8,265.3	33,074.6
Cervical cancer	C53	4,362.8	339.9	618.2	5,320.9	85.8	3,160.6	3,246.3	8,567.2
Ovarian cancer	C56	1,049.2	276.8	493.3	1,819.2	126.8	2,886.5	3,013.2	4,832.3
Prostate cancer	C61	5,431.4	757.7	1,394.9	7,584.2	233.2	2,491.2	2,724.4	10,308.5
Kidney cancer	C64	1,146.9	472.1	985.9	2,604.8	126.7	2,908.1	3,034.7	5,639.6
Total		152,491.0	7,040.7	13,520.9	173,052.5	2,591.0	65,653.9	68,244.9	241,297.4

the trachea, bronchial tubes and lungs (73.5 billion rubles); rectal cancer took the 2<sup>nd</sup> rank place (66.5 billion rubles); breast cancer took the 3<sup>rd</sup> rank place (33.1 billion rubles) (Figure 1).

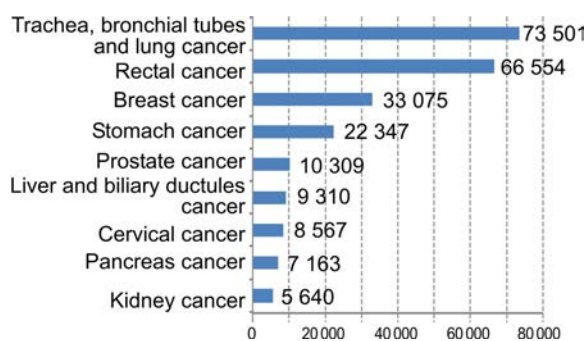


Figure 1. Economic losses due to MNs caused by modifiable risk factors (million rubles)

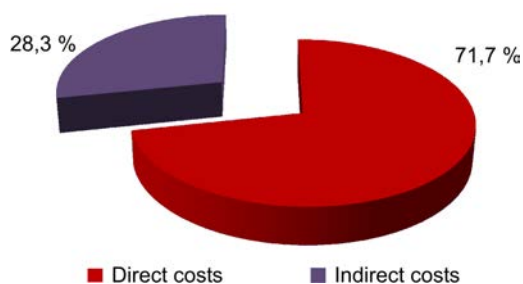


Figure 2. Structure of economic losses due to oncologic diseases caused by modifiable risk factors in 2016

Figure 2 shows the structure of economic losses due to 10 MNs caused by modifiable risk factors; thus, direct costs accounted for 71.7% of the total losses whereas GDP losses due to untimely deaths and disability accounted for 28.3%.

Oncologic diseases cause substantial losses borne by public healthcare systems in different countries all over the world. Our analysis revealed that total economic losses caused by 10 MNs included into the research amounted to 241.3 billion rubles or 0.3% RF GDP in 2016. Expenses borne by the public healthcare accounted for the biggest part of these losses (more than 70%). It differs from the results obtained via analyzing economic losses caused by cardiovascular diseases in 2016: the analysis was performed as per a similar procedure and it revealed that indirect economic losses prevailed in that case, primarily due to untimely deaths [27]. When compared, economic losses in the RF caused by oncologic diseases turned out to be smaller than those caused by cardiovascular diseases. However, one should take into account that our analysis didn't include all oncologic diseases; it focused only on those caused by modifiable risk factors of chronic non-communicable diseases. In its turn, mortal-

ity due to oncologic diseases is lower and high morbidity occurs among older people and it determines not so significant losses due to employable population being disabled permanently or temporarily.

In the EU overall expenses on MNs amounted to 126 billion euro in 2009; 51 billion euro or 40% were direct expenses borne by public healthcare systems; losses due to untimely deaths amounted to 42.6 billion euro; losses due to temporary disability, 9.43 billion euro; expenses on so called “informal relatives’ help”, 32.2 billion euro [6]. Our research examined costs as per other components, besides, a significant share of indirect costs in the EU could be due to high GDP in European countries.

In 2012 in Canada 7.5 billion dollars were spent by public healthcare solely on treating oncologic diseases [28].

In Russia in 2016 malignant neoplasms in the trachea, bronchial tubes and lungs accounted for the highest economic losses among all the examined MNs; the 2<sup>nd</sup> place belonged to rectal cancer; the 3<sup>rd</sup> place, breast cancer. Lung cancer also caused the greatest economic losses in the EU (15% out of expenses on all MNs), breast cancer (12%) and rectal cancer (10%) followed. Therefore, relative economic burdens related to MNs with various localizations turned out to be quite similar.

There was a research work performed in Canada that focused on estimating economic losses due to MNs caused by such risk factors as smoking, obesity, low physical activity, and excessive alcohol intake [29], and it is similar to approaches adopted in the present work as we assessed losses due to not all MNs but only the most significant ones and caused by modifiable risk factors. In Canada economic losses due to MNs caused by such risk factors amounted to 9.6 billion dollars, including 1.7 billion dollars direct costs and 8.0 indirect ones; that is, structure of economic losses turned out to be different from that described in the present work. It can also be due to high GDP in Canada. It was also stated in the same research that a decrease in risk factors prevalence would allow prevent-

ing 13.2% MNs and reduce economic losses by 1.3 billion dollars a year.

When economic losses due to MNs are calculated, actual damage, as a rule, tends to be underestimated thanks to several factors. Thus, for example, not only a patient loses his or her productivity but the same goes for his or her family members as they have to quit job or take some time off to take care of a sick relative. Our research didn’t cover such issues due to absence of any data. Immaterial losses related to pain and anxiety, social limitations and poorer life quality are also very difficult for estimating; therefore they are hardly ever included into any calculations [7]. So, the present work also has certain limitations as economic losses due to MNs caused by modifiable risk factors are underestimated thanks to absence of data on certain components and impossibility to include them into any analysis. Besides, though most components in losses were calculated as per a unified procedure (indirect GDP losses, permanent and temporary disability payments), direct expenses borne by the public healthcare were calculated basing on results obtained via previous research works that could differ both methodologically and as per time periods and it could exert significant influence on their results.

Nevertheless, it is the first research work accomplished in the RF that focused on estimating economic losses due to 10 MNs with different localizations caused by modifiable risk factors over a calendar year. These data can give grounds for planning investments into preventing and treating the analyzed MNs in order to reduce burdens occurring due to oncologic diseases. It is economic arguments that are the most significant for authorities responsible for decision-making and selecting activities aimed at improving population health and determining investment volumes. Besides, calculation results can be applied for determining economic losses caused by risk factors related to the given MNs.

**Conclusion.** Total economic losses caused by the analyzed MNs amounted to 241.3 billion

rubles and it was equal to 0.3% RF GDP in 2016. Direct expenses borne by the public healthcare prevailed in the structure of losses (more than 70%) and they were primarily caused by rectal cancer (52 billion rubles) and trachea, bronchial tubes and lung cancer (50 billion rubles). The obtained data determine the necessity to invest into preventing and treating oncologic

diseases. Such investments can result in significant economic effects in a long-term period thus making for the economic growth.

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