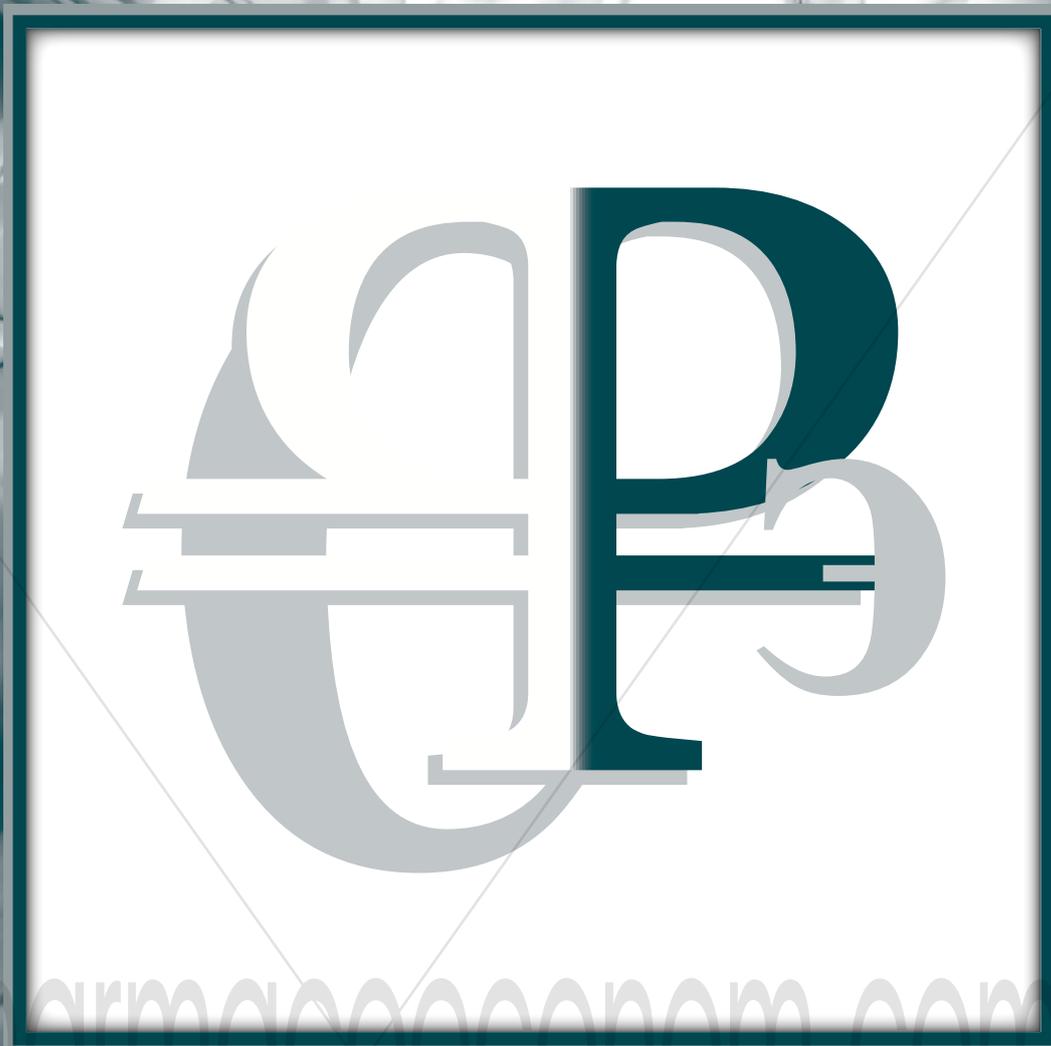


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- ❑ ВЫБОР ТЕХНОЛОГИИ СРАВНЕНИЯ ПРИ ПРОВЕДЕНИИ ФАРМАКОЭКОНОМИЧЕСКОГО АНАЛИЗА ИННОВАЦИОННЫХ ЛЕКАРСТВЕННЫХ ПРЕПАРАТОВ
- ❑ РЕЗУЛЬТАТЫ РОССИЙСКИХ ФАРМАКОЭКОНОМИЧЕСКИХ ИССЛЕДОВАНИЙ

# A COMPARATIVE PHARMACOECONOMIC ANALYSIS OF IMPACT OF ALCOHOL CONSUMPTION ON RUSSIA'S ECONOMY (2010 – 2017 DYNAMICS)

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## Abstract

This paper is devoted to assessment of economic burden of excessive alcohol consumption in Russian Federation. In the course of analysis, we gathered data about direct costs of treatment of conditions, directly or indirectly caused by excessive alcohol consumption, and indirect costs. A total burden of excessive alcohol consumption is more than 547 billion rubles, which makes up to 0,68% of Russia's GDP for the year 2015. Since 2010 the burden has decreased by nearly 100 billion rubles, and the decrease of burden in relative values from 1,98% to 0,68% of GDP, which gives the evidence of the effectiveness of the government policy in the sphere of alcohol consumption control.

## Key words

pharmacoeconomic analysis, clinical-economic analysis, pharmacoeconomics, economic burden, excessive alcohol consumption, alcoholism, binge drinking, government policy in the sphere of alcohol consumption control, direct costs, indirect costs.

## Introduction

Alcoholism is a complex medico-social problem, which affects virtually all segments of population. A total economic loss due to alcohol consumption consists not only of costs of treatment of diseases, but also of social problems connected to alcohol consumption. Alcohol abuse leads to a higher morbidity, which leads to decreased life expectancy and has a significant negative effect on demographic indicators in Russian Federation [1]. In a "Concept of government policy on decreasing excessive alcohol consumption and alcoholism prevention among the population in Russian Federation" (Government Decree #2128 on 30.12.2009) is stated, that excessive alcohol consumption is one of the main reasons of societal degradation due to the increase in crime and violence rates, increase in number of orphans and deterioration of health [1]. When compared to different countries of the same level of economic development, it can be noticed, that life expectancy in these countries is significantly higher and alcohol consumption is lower: in Russia life expectancy is 71 years (World Bank), in Turkey – 75 years, in Mexico – 77 years [38,49,50]. Annual alcohol consumption in Russia is approximately 10 litres per capita [47], in Turkey – 3.4 [51], in Mexico – 7.2[52].

Aside from a negative impact on mortality and morbidity, excessive alcohol consumption leads to the degradation of Russian society. Crime, loss of parental functions, orphanhood, fertility decline, divorces, suicides – these are the most dramatic, yet not all of the consequences of alcoholism. All these factors have a negative impact on labor productivity and as a result on GDP,

and also on Human Development Index and on quality of life in Russia in general.

The evaluation of the burden of alcoholism on the economy of Russian Federation is based on the cost of illness. The result of the evaluation is a total damage from diseases, which includes both economic and social components. This data is very important to determine policy in the sphere of healthcare and also in the global distribution of governmental resources. Economic evaluation of the outcomes of every disease is based upon theory of "human capital". It is based upon the official statistical data on the specific disease (rate of morbidity, mortality, prevalence among different age groups), which are converted into the financial equivalent. One of the doubtless advantages of this theory is an ability to estimate the labor productivity or GDP for several years, which is essential for long-term planning.

All costs can be divided into two types:

1. Direct costs
2. Indirect costs

Direct costs are costs that are associated with the medical care, e.g. cost of medicines, laboratory tests, salaries of doctors and medical staff, and also costs of the transportation to the medical facility and patient care. To analyze the economic constituent of the alcoholism burden throughout the health service, it is reasonable to use the official tariffs on specific medical services.

Following criteria were used to analyze the costs:

- cost of the ambulance trips
- cost of the completed clinical case
- period of hospitalization (for conditions without fixed costs of the completed clinical case)
- cost of the bed-day (for conditions without fixed costs of the completed clinical case)
- cost of the outpatient consultation

Direct costs of the burden of alcoholism is a sum of all costs on treatment of alcoholism in the drug dispensary and costs of treatment of clinical consequence of alcoholism.

Steps of the direct costs calculation:

Hospital treatment

1. Determine the number of ill people with specific nosology, caused by excessive alcohol consumption;
2. Determine the number of hospitalizations on every nosology, caused by excessive alcohol consumption;

3. Determine the cost of the completed clinical case;
4. Determine the length of the hospitalization (for diseases without the completed clinical case cost).

**Outpatient consultations**

1. Determine the number of patients with specific nosology caused by excessive alcohol consumption;
2. Determine the cost of outpatient consultations;
3. Calculation of costs of outpatient treatment considering the visit multiplicity.

To get the total costs we sum up the obtained values.

Calculations were done using these formulas:

Hospital treatment

$$N(z) = N * K(h)$$

$N(z)$  – number of patients with this condition in hospital;  $N$  – total Russian Federation population;  $K(h)$  – hospitalization rate per 1000 people.

$$N(alc) = N(z) * K(p)$$

$N(alc)$  – number of people with this condition with alcoholism in hospitals;  $K(p)$  – coefficient of prevalence of disease among alcoholics.

$$C = N(alc) * P(fcc)$$

$C$  – cost of hospital treatment;  $P(fcc)$  – cost of one completed clinical case.

$$C(amb) = N(alc) * P(amb)$$

$C(amb)$  – total costs of ambulance trips;  $P(amb)$  – cost of one ambulance trip;

Outpatient treatment

$$N(p) = N * K(p)$$

$N(p)$  – number of patients with this disease.

$$N(p, alc) = N(p) * K(p)$$

$N(p, alc)$  – number of patients with alcoholism with this disease

$$N(oc) = N(p, alc) * S(m)$$

$N(oc)$  – number of outpatient consultations;  $S(m)$  – multiplicity of outpatient consultations per 1 patient.

$$C(t. o. c.) = N(oc) * P(o.c.)$$

$C(t. o. c.)$  – total costs of outpatient consultations;  $P(o.c.)$  – cost of one outpatient consultations

Indirect costs are caused by the decrease in labor productivity due to alcoholism, alcohol-related mortality, treatment of complications, associated with the excessive alcohol consumption.

Incidents, that lead to indirect costs, include alcohol-related road accidents and drownings, alcohol intoxication, mortality due to alcohol-related diseases, fires, orphan care and detention of prisoners.

We calculated the indirect costs using the following formula:

$$C(ind) = N * LP \text{ or } \% \text{ of GDP}$$

$C(ind.)$  – indirect costs,  $N$  – number of cases,  $LP$  – labor productivity, % of GDP – share of Russian GDP equivalent to the damage done.

The total economic damage ( $T$ ) is calculated as the sum of direct and indirect costs:

$$T = C(dir) + C(indir)$$

**Calculations**

At first, we calculated the direct costs.

*Cost of treatment in narcological dispensaries*

According to a report issued by the Institute of Narcology – a branch of the FGBU “FITsPN im. VP Serbsky” of the Ministry of Health of Russia – in 2016, 585,778 patients were admitted to the narcological dispensaries, of which 89,624 (15.3%) with alcoholic psychosis, 383 099 (65.4%) with alcoholism,

symptoms of acute intoxication – 40 419 (6.9%). In total, the fraction of people with alcoholic disorders in the total number of hospitalized patients was 87.6% [2]. One completed case of treatment of alcoholic psychosis according to the MMI (mandatory medical insurance) tariffs costs 35,667 rubles, one completed case of alcohol dependence syndrome costs 49,933.8 rubles, and one completed case of acute intoxication costs 17,384 rubles [3,8]. The average ambulance service in the country costs 1819.50 rubles [5].

According to the formula (4), the cost of ambulance trips for hospitalization to a narcological hospital was calculated:

$$C(amb) = 513\,141 * 1819.50 \text{ rubles} = 933,661,869 \text{ rubles.}$$

According to the formula (3), the cost of inpatient treatment of alcoholic psychosis was calculated:

$$C(\text{alcoholic psych.}) = 89,624 * 35,667 \text{ rubles} = 3,196,619,208 \text{ rubles.}$$

According to the formula (3), the cost of in-patient treatment of the alcohol dependence syndrome was calculated:

$$C(\text{alc. dep. syndr}) = 383\,099 * 49\,933.8 \text{ rubles} = 19\,129\,588\,846 \text{ rubles.}$$

According to the formula (3), the cost of inpatient treatment of the acute consequences of alcohol intoxication was calculated:

$$C(\text{acute poisoning}) = 40\,419 * 17,384 \text{ rubles} = 720,812,236 \text{ rubles.}$$

Adding up all the costs of inpatient care in narcological dispensaries results in a total amount of

$$C(\text{narc. disp. total}) = 3\,196\,619\,208 + 19\,129\,588\,846 + 720\,812\,236 = 23\,047\,020\,290 \text{ rubles.}$$

*Expenditures for outpatient narcological treatment*

According to the Serbsky State Scientific Center for Social and Forensic Psychiatry of the Ministry of Health of Russia – for 2016 the total number of people applying for narcological help was 2 080 340 people [2]. The average weighted cost of outpatient admission according to the MMI tariffs is 385 rubles [4,11].

According to the formula (8), the cost of outpatient narcological care was calculated:

$$C(amb. narc.) = 2\,080\,340 * 385 \text{ rubles} = 801\,846\,250 \text{ rubles.}$$

The total cost of inpatient and outpatient care is 24,782,528,409 rubles.

**The cost of the treatment of clinical consequences of alcoholism, i.e. direct costs**

*Diseases of the liver*

The concept of “liver disease” includes various structural and functional disorders caused by excessive consumption of alcoholic beverages. Alcoholic lesions take the first place in the structure of all liver diseases, after which chronic and acute diseases of the viral etiology are the most frequent.

The disease incidence rate of liver diseases is 69.9 per 100 000 people in 2015 [6]. According to the Federal State Statistics Service, in 2015 the number of adults in Russia was 118,048,024 [7]. The cost of one completed clinical case, according to the MMI, is 44 832 rubles [3]. The hospitalization rate is 3.3 per 1,000 people [9].

The total number of patients with this pathology was calculated using the formula:

$$118,048,024 * 69.9 / 100,000 = 82,516 \text{ people}$$

The number of hospitalizations in hospitals with liver diseases is calculated by the formula (1):

$$118\,048\,024 * 3.3 / 1000 = 389\,558 \text{ hospitalizations.}$$

To determine the number of hospitalizations associated with excessive alcohol consumption, it was considered that 75% of liver diseases were caused by alcohol [10]:

$$389\,558 * 75/100 = 292\,169 \text{ hospitalizations due to alcohol.}$$

The cost of inpatient treatment was calculated taking into account the number of hospitalizations due to alcohol and the cost of one completed clinical case:

$$C(\text{total}) = 292,169 * 44,832 = 13,098,514,305 \text{ rubles.}$$

In calculating the cost of outpatient admission, the following data were used:

- the cost of one outpatient visit is 302.41 rubles [4.11];
- The average frequency of outpatient visits for one patient is 2 times a year.

The cost of outpatient treatment of patients with liver diseases was calculated:

$$82\,516 * 302.41 \text{ rubles} = 24\,953\,533 \text{ rubles - the cost of one outpatient visits.}$$

$$24\,953\,533 * 2 = 49,907,066 \text{ rubles.}$$

The total amount of costs associated with liver disease, consists of the costs of inpatient and outpatient treatment:



$C(\text{total}) = C(\text{stat.}) + C(\text{amb.}) = 13,098,514,305 + 49,907,066 \text{ rubles} = 13,148,421,371 \text{ rubles.}$

#### *Diseases of the pancreas*

Systematic excessive consumption of alcoholic beverages negatively affects the secretory function of the pancreas. Because of the accumulation of secretions in the gland cells and duct cells, the degeneration and death of these cells can occur, as a result of which acute or chronic pancreatitis can develop. As a result, secondary diabetes may also develop due to a decrease in insulin production. Pancreatic diseases in 80% of cases are associated with excessive alcohol consumption [12,13].

For the calculations, we used the following data:

- morbidity rate - 1046.1 per 100 000 people [6];
- hospitalization rate - 3.3 per 1000 people;
- cost of 1 completed clinical case - 35 740,75 rubles [3].

Calculation results:

$118\,048\,024 \times 1046.1 / 100\,000 = 1\,234\,900$  cases of pancreatitis

$118\,048\,024 \times 3.3 / 1000 = 389,558$  hospitalizations with pancreatitis

$389\,558 \times 80/100 = 311,647$  hospitalizations with pancreatitis caused by alcohol

$311\,647 \times 35\,740,75 \text{ rubles} = 11,138,489,772 \text{ rubles}$  - expenses for inpatient treatment of diseases of the pancreas.

The total number of outpatient visits of patients with alcohol-induced pancreatitis:

$1\,234\,900 \times 80/100 \times 2 = 1,975,841$  visits

The cost of one outpatient visit is 302.41 rubles [4].

$C(\text{amb}) = 1\,975\,841 \times 302.41 = 597\,513\,958 \text{ rubles}$  - the cost of outpatient treatment of patients with pancreatitis caused by alcohol.

Total costs of treatment of pancreatitis:

$C(\text{total panc}) = C(\text{inp}) + C(\text{outp}) = 11\,138\,489\,772 + 597\,513\,958 = 11\,736\,003\,730 \text{ rubles}$

#### *Hemorrhagic stroke (cerebral hemorrhage)*

Hemorrhagic stroke is a disease caused by a hemorrhage to the brain as a result of rupture of the vessel wall against due to a high blood pressure and to the wall thinning. Alcohol by various mechanisms can lead to thinning of the wall, and therefore, increase the likelihood of hemorrhagic stroke.

19% of all cases of hemorrhagic stroke are associated with excessive alcohol consumption [14,15].

The calculation of costs was based on the following parameters:

- morbidity rate — 39.4 per 100 000 people [6];
- the cost of one completed clinical case - 56,417.92 rubles [3].

Calculation of costs was carried out using the formulas (1-4):

$118,048,024 \times 39.4 / 100,000 = 46,511$  cases;

$46\,511 \times 19/100 = 8,837$  cases caused by excessive alcohol consumption;

$8\,837 \times 56\,417.92 \text{ rubles} = 498\,569\,395 \text{ rubles}$  - the cost of treating hemorrhagic stroke in the hospital.

#### *Cerebral infarction*

The cerebral infarction is extremely close to a hemorrhagic stroke by the etiology, since the the main pathophysiological mechanism in this disease is a thinning of a vascular wall in the brain. It means that the effect of alcohol on the occurrence of cerebral infarction is similar - 19% [14,15].

The calculations were carried out using the following data:

- morbidity rate - 259.2 per 100 000 people [6];
- cost of one completed clinical case - 56,417.92 rubles [3];

$118\,048\,024 \times 259.2 / 100\,000 = 305\,980$  cases

$305\,980 \times 19/100 = 58,136$  - cases caused by excessive alcohol consumption

$58\,136 \times 56\,417,92 \text{ rubles} = 3,279,928,607 \text{ rubles}$  - the cost of treating a cerebral infarction in a hospital.

#### *Myocardial infarction*

Myocardial infarction is one of the clinical manifestations of coronary heart disease (CHD), manifested by the development of necrosis in the heart muscle tissue due to inadequate oxygen supply. Myocardial infarction is one of the leading causes of death in the general population, so it attracts a lot of attention of doctors. Myocardial infarction implies immediate hospitalization and long-term, comprehensive inpatient treatment.

The calculation was carried out using the following data:

- morbidity rate - 159.87 per 100 000 [6];
- cost of one completed case of treatment - 43 717.61 rubles [3];
- 40% of heart attacks are associated with alcohol [16].

A mathematical calculation of costs was carried out using the data:

$118\,048\,024 \times 159.87 / 100\,000 = 188\,723$  - the total number of hospitalization cases due to myocardial infarction

$188\,723 \times 40/100 = 75,489$  - total number of hospitalizations caused by alcohol

$C(\text{MI}) = 75,489 \times 43,717.61 \text{ rubles} = 3,300,213,979 \text{ rubles}$  - the cost of inpatient treatment of patients with myocardial infarction caused by excessive alcohol consumption.

#### *Neoplasms*

Neoplasms are a pathological process that is characterized by the formation of a new tissue in the body, in which there are changes in the genetic apparatus of cells, which leads to disturbances in the regulation of their growth and division.

The International Agency for the Study of Cancer categorizes ethanol in alcoholic beverages as a carcinogen [53].

Alcohol contributes to the occurrence of such disorders through a variety of mechanisms, but the main component is the toxic products of metabolism, mainly acetaldehyde.

According to scientific data, about 5% of neoplasms are associated with excessive alcohol consumption [17,18].

The following data were used to calculate the costs of inpatient treatment:

- morbidity rate - 1300.7 per 100 000 people [6];
- The average cost of one completed clinical case is 41,423 rubles [3];
- The hospitalization rate is 6.2 per 1000 people [5.19].

Costs were calculated using provided data:

$118\,048\,024 \times 1300.7 / 100\,000 = 1\,535\,451$  - the total number of patients.

$118\,048\,024 \times 6.2 / 100 = 731\,898$  - the total number of hospitalizations.

$731\,898 \times 5/100 = 36,595$  - the total number of hospitalizations due to alcohol.

$36\,595 \times 41\,423 = 1\,515\,870\,022 \text{ rubles}$  - the cost of treatment in the hospital of patients with neoplasms.

Treatment of tumors involves not only inpatient treatment, but also constant monitoring of the doctor, therefore the total costs also include the costs of outpatient treatment.

The following data were used to calculate the outpatient costs:

- morbidity rate - 1300.7 per 100 000 people [6];
- the total number of all neoplasms caused by alcohol
- frequency of outpatient administration - 4.3 times a year
- The average cost of outpatient visits is 322.17 rubles [4]

To calculate the amount of costs, the following formulas were used:

$1\,535\,451 \times 5/100 = 76\,773$  patients with neoplasms caused by excessive alcohol consumption

$76\,773 \times 4.3 = 330\,122$  - the total number of outpatient visits by patients with neoplasms caused by excessive alcohol consumption.

$330\,122 \times 322,17 = 106,355,369 \text{ rubles}$  - the cost of outpatient treatment during the year.

The total cost of treatment of neoplasms consists of costs for inpatient and outpatient treatment:

$C(\text{new total}) = C(\text{hosp}) + C(\text{outp}) = 1\,515\,870\,022 \text{ rubles} + 106\,355\,369 \text{ rubles} = 1\,622\,225\,392 \text{ rubles.}$

#### *Traumatism*

The situation with injuries in Russia is extremely tense. More than 12 million injuries are registered in the country annually, and, according to some estimates, it makes up about 75% of the real number of accidents. In 2015, there were 13,243,500 injuries reported [20]. Trauma takes the second place in the structure of mortality in Russia and the third place in the list of causes of disability.

According to researchers, 47% of injuries occur due to alcohol. The hospitalization rate averages 20.54 per 1000 population [21,22]. The cost of one completed case of treatment in a hospital is 25,341 rubles [3,8].

Using the formulas, the total costs for hospitalization in the trauma departments were calculated:

$118\,048\,024 \times 20.54 / 1000 = 2\,424\,706$  hospitalizations in the trauma departments

$2\,424\,706 \times 47/100 = 1\,139\,612$  - number of hospitalizations due to alcohol

$1\,139\,612 \times 25\,341 \text{ rubles} = 61\,444\,485\,211 \text{ rubles}$  - the cost of hospitalization in the trauma departments due to alcohol.

#### *Diabetes*

DM (diabetes mellitus) is one of the most acute problems of modern medicine and society as a whole. Every 10-15 years the number of people with diabetes is doubling in the world, which reflects the scale of the problem.

In the United States, in 2000, 12.1 million people had type 2 diabetes, and in 2014 this number was already 22 million [24].

Calculation of costs for inpatient treatment:

In 7.1% of cases, diabetes is associated with excessive alcohol consumption [23, 25, 26].

The incidence rate is 3436.8 per 100,000 people [6]. The hospitalization rate is 1.5 per 1,000 people. The weighted cost of one completed treatment is 14,506 rubles [3].

Calculation of costs for inpatient treatment was carried out using the formulas:

$118\ 048\ 024 \times 3436.8 / 100\ 000 = 4\ 057\ 074$  - in patients with diabetes in the adult population

$118\ 048\ 024 \times 1.5 / 1000 = 177\ 072$  - number of hospitalizations with diabetes mellitus

$177\ 072 \times 7.1 / 100 = 12\ 572$  - number of hospitalizations with diabetes mellitus caused by excessive alcohol consumption.

$177\ 072 \times 14,506$  rubles = 182,376,123 rubles - total costs for inpatient treatment of diabetes caused by excessive alcohol consumption.

Outpatient treatment costs:

Using the formula (2) we calculated the number of patients with diabetes, the cause of which is excessive consumption of alcohol.

$4\ 057\ 074 \times 7.1 / 100 = 288\ 052$  - number of patients with diabetes, the cause of which is excessive consumption of alcohol.

Costs of outpatient treatment were calculated taking into account the following indicators:

- Frequency of outpatient visits to one patient - 4 times a year;
- the cost of one outpatient visit is 302.41 rubles

$C(\text{outp}) = 288,052 \times 4 \times 302.41 = 348\ 439\ 570$  rubles.

The total cost of treating diabetes caused by excessive alcohol consumption is:

$C(\text{total DM}) = C(\text{hosp}) + C(\text{outp}) = 182\ 376\ 123 + 348\ 439\ 570 = 530\ 815\ 693$  rubles.

**Heart failure**

Heart failure is one of the most urgent problems of modern cardiology. Because of insufficient blood supply to all organs and systems, due to the inferior functioning of the heart, all the functions of the body deplete, but the most obvious symptoms are shortness of breath, fatigue and swelling.

In 20% of cases, heart failure is associated with excessive alcohol consumption [27,28].

The calculation was carried out using the following indicators:

- morbidity rate - 600 per 100 000 people [6];
- hospitalization rate - 2.12 per 1000 people

- cost of one completed clinical case - 37,090.43 rubles [3].

With the help of formulas, calculations were done:

$118\ 048\ 024 \times 600 / 100\ 000 = 708\ 288$  - cases of heart failure among adults

$708\ 288 \times 2.12 / 1000 = 250\ 261$  - hospitalizations due to heart failure

$250\ 261 \times 20 / 100 = 50,052$  - hospitalizations due to heart failure caused by excessive alcohol consumption

$50\ 052 \times 37\ 090.43 = 1\ 856\ 463\ 636$  rubles - the total sum of expenses on treatment of patients with heart failure caused by excessive alcohol consumption, in the hospital.

**Polyneuropathy**

Polyneuropathy is a multiple damage of the peripheral nerves, which leads to the development of flaccid paralysis and the lack of sensitivity. The main factor of pathogenesis of alcoholic polyneuropathy is toxic damage caused by products of ethyl alcohol exchange. In general, this condition is observed in individuals in the late stages of the alcohol dependence syndrome, and often they become disabled.

According to the research results, 10% of people with alcoholism have polyneuropathy [29].

The cost of one completed clinical case is 40 331.73 rubles [3].

The total number of registered patients with alcoholism is 2,080,340 people [2].

The calculation was carried out according to the formulas:

$2\ 080\ 340 \times 10 / 100 = 208\ 034$  - number of hospitalizations of patients with alcoholic polyneuropathy.

$C(\text{total}) = 2,080,340 \times 40,331.73$  rubles = 8,390,371,119 rubles - the cost of treatment in a hospital for patients with alcoholic neuropathy.

**Alcoholic cardiomyopathy**

The cause of the development of alcoholic cardiomyopathy is the long-term detrimental effect of toxic products of ethyl alcohol exchange on the heart muscle, which leads to its diffuse lesion. The main reason for the development of this disease is the of alcoholic beverages intake for 10 years or more. Alcoholic cardiomyopathy can develop into chronic heart failure and other forms of cardiac dysfunction.

Alcoholic cardiomyopathy occurs in 30% of people who abuse alcohol [28, 30].

The cost of one outpatient visit is 344.34 rubles [4].

With the use of formulas 1-4, mathematical calculations of costs for outpatient treatment of alcoholic cardiomyopathy were carried out:

$2\ 080\ 340 \times 30 / 100 = 624\ 102$  - number of patients with alcoholic cardiomyopathy

$C(\text{outp}) = 624\ 102 \times 344.34$  rubles = 214,903,283 rubles - the total cost of outpatient treatment of alcoholic cardiomyopathy.

Comparison of the biggest items of budget expenditures, billion rubles

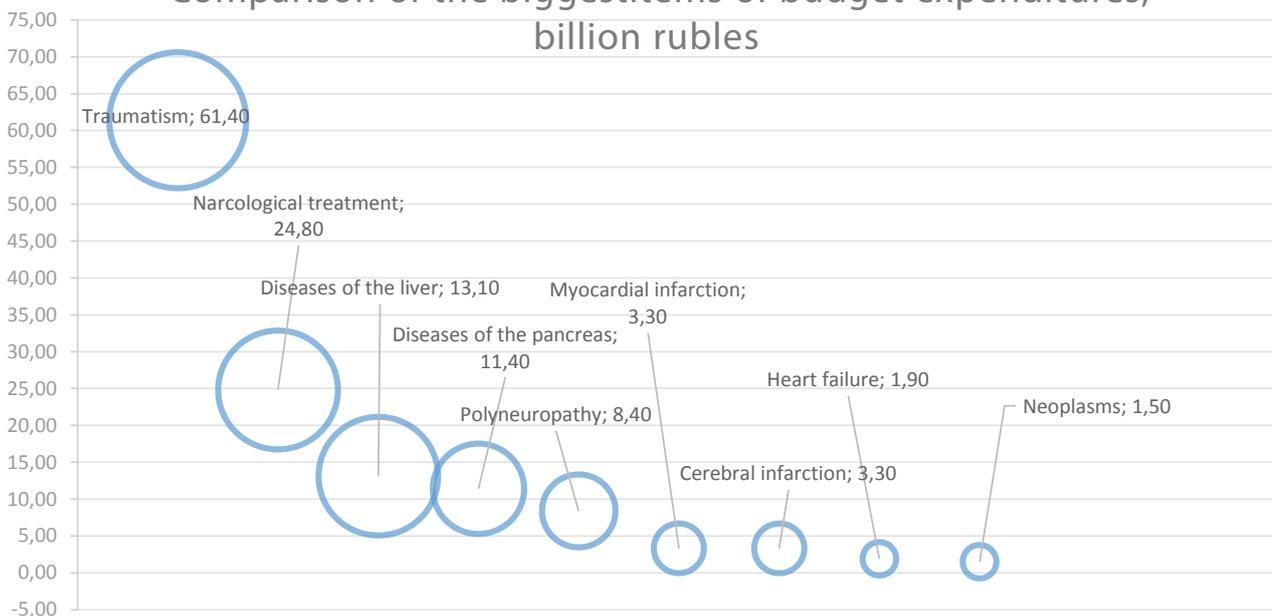


Figure 1. Comparative characteristics of direct costs for diseases associated with excessive alcohol consumption.

**Table 1.** Direct costs of the treatment of diseases associated with excessive use of alcohol

Item of budget expenditures	Total costs, million rubles
Traumatism	61 400
Narcological treatment	24 800
Diseases of the liver	13 100
Diseases of the pancreas	11 400
Polyneuropathy	8 400
Myocardial infarction	3 300
Cerebral infarction	3 300
Heart failure	1 900
Neoplasms	1 500
Diabetes	500
Hemorrhagic stroke	500
Alcoholic cardiomyopathy	200

### Indirect costs analysis

Mortality of the employable population due to various reasons related to excessive alcohol consumption

#### Road accidents

The total number of fatalities in road accidents on the territory of the Russian Federation is many times greater than the number of deaths from any diseases, which has a huge impact on GDP and the economy as a whole. In addition, this statistical data is overshadowed by the fact that the most active citizens die in road accidents.

According to the Ministry of Internal Affairs of Russia, alcoholic intoxication is involved in almost 9% of all road accidents, while in 3% of cases drivers with signs of alcoholic intoxication refused to undergo medical examination [31,32,33].

According to calculations of many economists, the amount of damage from road accidents varies from 0.5% to 5%, but the majority agree that the most realistic estimate is about 2.5%, which we will adhere to [35, 36].

The GDP of Russia in 2015 was 80,804,000,000,000 rubles [34]. The total number of road accidents amounted to 184 000, and the accidents involving drunk drivers - 16 000, with the participation of drivers with signs of alcohol intoxication, who refused to undergo medical examination - 4600 [32,33]. Damage from accidents for GDP is considered to be equal to 2.5%.

The damage to GDP from road accidents, caused by drunken drivers:

$$((16,000 + 4,600) / 184,000) \times 2.5\% = 0.28\% \text{ of GDP}$$

$0.28\% \times 80,804,000,000,000 \text{ rubles} = 226,163,369,565 \text{ rubles}$  - the amount of direct damage to GDP.

According to the statistics of the Ministry of Internal Affairs of Russia, 24,857 road accidents were caused by pedestrians, of which 16.9% (4201) were caused by pedestrians in a state of alcoholic intoxication [32,33].

$$4201 / 184,000 \times 2.5\% = 0.057\%$$

$0.057\% \times 80,804,000,000,000 \text{ rubles} = 46,120,123,605 \text{ rubles}$  - damage from road accidents caused by pedestrians in a state of alcoholic intoxication.

Total damage from road accidents with one or more participants in a state of alcohol intoxication:

$$C \text{ (road accidents)} = 226\,163\,369\,565 \text{ rubles} + 46\,120\,123\,605 \text{ rubles} = 272\,283\,493\,170 \text{ rubles.}$$

#### Alcohol poisoning

Acute alcohol poisoning is most often associated with the intake of beverages with an ethyl alcohol content of more than 12%. According to various experts, the lethal dose of alcohol for a person is 5 or more per mil (5 or more grams of pure alcohol in 1 liter of blood). This indicator is subject to significant fluctuations due to age, body weight, rate of alcohol intake, as well as individual characteristics, the so-called "alcohol resistance".

In 2015, 15,400 people died from accidental alcohol poisoning. More than 70% of people who have been poisoned by alcohol are chronic alcoholics. Mortality of the employable population is 30% [6].

The central value for calculating economic damage is labor productivity. It is calculated on the basis of Rosstat data on GDP and the number of man-hours per year. In 2015, it was 1 046 268 rubles per year [34,37].

The damage from fatal alcohol poisoning is expressed in the loss of productivity due to premature death of the employable population.

$15\,400 \times 30/100 = 4620$  - the number of deaths among the employable population from accidental alcohol poisoning.

$4620 \times 1\,046\,268 \text{ rubles} = 4\,833\,758\,160 \text{ rubles}$  - the amount of damage from alcohol poisoning.

#### Drownings

Drownings remain one of the weighty causes of death from accidents, only slightly less than alcohol poisoning. Young people, mostly men, die most frequently [49].

In 2015, 7,366 people died from accidental drowning, with 67% of cases due to alcohol. Mortality of the working-age population from drowning is 85.5% [38].

$$7366 \times 67/100 = 4935 \text{ - number of drownings associated with alcohol}$$

$4935 \times 85.5 / 100 = 4220$  - the number of alcohol-related drownings among the employable population

Total damage from drowning related to alcohol among employable population:

$$4220 \times 1\,046\,268 \text{ rubles} = 4\,414\,846\,159 \text{ rubles.}$$

#### Cerebrovascular diseases

295,602 people died from the diseased of this group in 2015 [38]. In 15% of cases, this disease is associated with the excessive intake of alcohol. 30% of deaths occur in persons of working age [15]. Labor productivity - 1 046 268 rubles.

$$295\,602 \times 15/100 = 44,340 \text{ - deaths from cerebrovascular diseases associated with alcohol}$$

$44\,340 \times 30/100 = 13,302$  - deaths in working age from alcohol-induced cerebrovascular diseases

$13\,302 \times 1\,046\,268 \text{ rubles} = 13\,917\,551\,100 \text{ rubles}$  - the amount of damage from mortality of the employable population from hemorrhagic stroke and other cerebrovascular diseases caused by excessive consumption of alcohol.

#### Alcoholic liver disease

12,426 people died of alcoholic liver disease [38]. Nosology itself implies that 100% of cases are associated with excessive consumption of alcohol. Mortality of the employable population is 70%.

$12\,426 \text{ people} \times 70/100 = 8\,698$  - the number of deaths among people of working age from alcoholic liver disease.

$8\,698 \times 1\,046\,268 \text{ rubles} = 9\,100\,648\,318 \text{ rubles}$  - total damage from death of persons of working age from alcoholic liver disease.

#### Diseases of the pancreas

The main cause of acute pancreatitis is alcohol abuse, which leads to impaired pancreatic function and the release of toxic products into the bloodstream. According to various studies, 80% of deaths from acute pancreatitis are due to alcohol [12,13]. 70% of deaths occur in persons of working age. 11,996 people died of pancreatitis in 2015[38].

$$11,996 \times 80/100 = 9,597 \text{ deaths from alcohol-related pancreatitis}$$

$9\,597 \times 70/100 = 6\,718$  - deaths among persons of working age from alcohol-related pancreatitis

$6\,718 \times 1\,046\,268 \text{ rubles} = 7\,028\,577\,320 \text{ rubles}$  - the total amount of damage due to premature death from pancreatitis caused by excessive consumption of alcohol.

#### Cardiovascular diseases

492,303 people died of this group of diseases in 2015 [38]. In 20% of cases these diseases are associated with alcohol abuse. People of working age die in 30% of cases [16,28].

$$492\,303 \times 20/100 = 98\,460 \text{ - deaths associated with alcohol}$$

$$98\,460 \times 30/100 = 29,538 \text{ - deaths among persons of working age}$$

$29\,538 \times 1\,046\,268 \text{ rubles} = 30\,904\,852\,512 \text{ rubles}$  - the total amount of damage from premature death of persons of working age from cardiovascular diseases associated with alcohol.

#### Neoplasms

290,400 people died of this group of diseases in 2015. Alcohol is associated with 5% of cases of neoplasms [17,18]. Mortality of the employable population is 67.1%.

$$290\,400 \times 5/100 = 14\,520 \text{ - number of deaths related to alcohol}$$

$14\,520 \times 67.1 / 100 = 9\,743$  - number of deaths among working-age people

$9\,743 \times 1,046,268 \text{ rubles} = 10,193,705,424 \text{ rubles}$  - the total damage from the mortality of the employable population due to malignancies caused by alcohol abuse.

**Fires**

Fires cause significant material damage, and often take away lives of people. The total damage from fires consists of the following indicators: direct material damage, costs of the fire brigades' trips and ambulance trips.

In 2015, 146,209 fires were reported. Direct material damage from the total number of fires in 2015 amounted to 22,870,367,000 rubles [40]. 55% of fires are connected to alcohol. In the fires in 2015 9,419 people died and 10,977 people were injured. The cost of an ambulance trip is 1,819.50 rubles, and the cost of a fire brigade trip is about 10,000 rubles [42,43].

$146\,209 \times 55/100 = 80\,415$  - number of fires related to alcohol  
 $80\,415 \times 10\,000$  rubles = 804 150 000 - expenses for fire brigade trips.  
 $(9,419 + 10,977) \times (55/100) \times 1,819.50$  rubles = 20,430,802 - cost for ambulances trips.

$22,870,367,000 \times 55/100 = 12,578,701,850$  - material damage from fires related to alcohol

Total losses from fires related to alcohol:

$C$  (fires total) = 12 578 701 850 + 804 150 000 + 20 430 802 = 13 403 282 152 rubles.

**Suicides**

Suicides represent a very important social problem, because they represent a direct reflection of the general mood in society. In times of crisis, there has traditionally been an increase in suicides and violent deaths in general.

In 2015, there were 24,982 suicides recorded in Russia [38]. On average, 40% of suicides in the blood showed the presence of alcohol [1,49]. 75% of suicides are committed by people of working age. The cost of transporting one body to the morgue is about 1 000 rubles [44].

$24\,982 \times 40/100 = 9,993$  - suicides with alcohol found in the blood  
 $9,993 \times 75/100 = 7,495$  - suicides of working age  
 $7\,495 \times 1\,000$  rubles = 7 495 000 rubles - the cost of transporting the body to the morgue

$7\,495 \times 1\,046\,268$  rubles = 7 841 360 153 rubles - losses from suicides of people of working age with alcohol found in their blood.

Total loss from suicides related to alcohol:

$C$  (total) = 7 841 360 153 + 7 495 000 = 7 848 855 153 rubles.

**Expenses on the detention in correctional facilities of people who have committed offenses in a state of intoxication**

The most important indicator of social harm, caused by alcohol, is data on the number of offenses committed in a state of intoxication.

Statistics show that alcoholism is often associated with more aggressive behavior, which leads to more crimes. Also, drunkenness is one of the main causes of domestic violence - in regions with widespread brewing, household crime rates in the state of alcoholic intoxication are 70-75% [1.49].

In 2015, 436,662 crimes were committed in a state of intoxication, of which 48,783 serious and 15,645 especially serious, which demonstrates how destructive alcoholism is for society [45].

The average cost of maintaining a single prisoner a year is approximately 33,000 rubles [46].

$436\,662 \times 33\,000$  rubles = 14 409 846 000 rubles - expenses for the

maintenance of prisoners who committed crimes in a state of intoxication, in correctional colonies.

**The cost of social orphan care**

Social orphans are children whose parents abandon them or are deprived of parental rights, and therefore can not take care of their children. In the presence of one or two parents who abuse alcohol an unhealthy moral and psychological atmosphere in the family is formed. The commission of a crime by one the parents in the state of alcoholic intoxication can completely destroy the family.

In Russia, there are 409 897 officially registered orphans. 80% of them are social orphans [47].

In orphanages there are 60,162 children, the average cost of maintaining 1 child in the organization that carries out orphan care is about 500,000 rubles.

$60\,162 \times (80/100) \times 500,000$  rubles = 24,064,800,000 rubles - expenses for maintaining social orphans in orphanages

In foster families, there are 148,466 children. The state compensates families the costs of maintaining such children. Up to 12 years, the average compensation is 15,000 rubles per child, after reaching the age of 12 the sum is 20,000 rubles [48].

To calculate the cost, we believe that children under 12 years old –make up 60% of all orphans in foster families, older than 12 years - 40%.

$(148\,466 \times (60/100) \times 15,000 + 148,466 \times (40/100) \times 20,000) \times (80/100)$  = 2,019,137,600 rubles - the cost of compensations for the maintenance of children in foster care.

Total costs of maintaining social orphans:

$C$  (total) = 24 064 800 000 rubles + 2 019 137 600 rubles = 26 083 937 600 rubles.

**Congenital anomalies**

Congenital anomalies are the collective name of abnormalities, which mainly arise in the process of intrauterine development. The factors leading to the development of such malformations are called teratogenic. Alcohol is one of the strongest and most common teratogenic factors. Up to 10% of all congenital developmental abnormalities are associated with the use of alcohol by the mother during pregnancy [40].

In 2015, 56,000 children with malformations were born. There are 222,000 children aged 1 to 14 years with congenital anomalies [38].

For all newborns with malformations, surgical treatment is envisaged, the average cost of which is 102,000 rubles [3].

$56\,000 \times (10/100) \times 102\,000$  rubles = 571 200 000 rubles - the cost of surgical treatment of congenital malformations.

Also, these children should be very often observed at the doctor - an average of 36 times a year. The cost of visiting a pediatrician is 128 rubles [4].

$56\,000 \times (10/100) \times 36 \times 128$  rubles = 25,800,768 rubles

Children aged 1 to 14 should also visit the doctor, but less often, on average, 4 times a year:

$222\,000 \times (10/100) \times 4 \times 128$  rubles = 11,364,624 rubles.

The total cost of treatment for congenital disorders caused by alcohol:

$C$  (total) = 571,200,000 rubles + 25,800,768 rubles + 11,364,624 rubles = 608,365,392 rubles.

Comparison of the biggest items of indirect costs, billion rubles

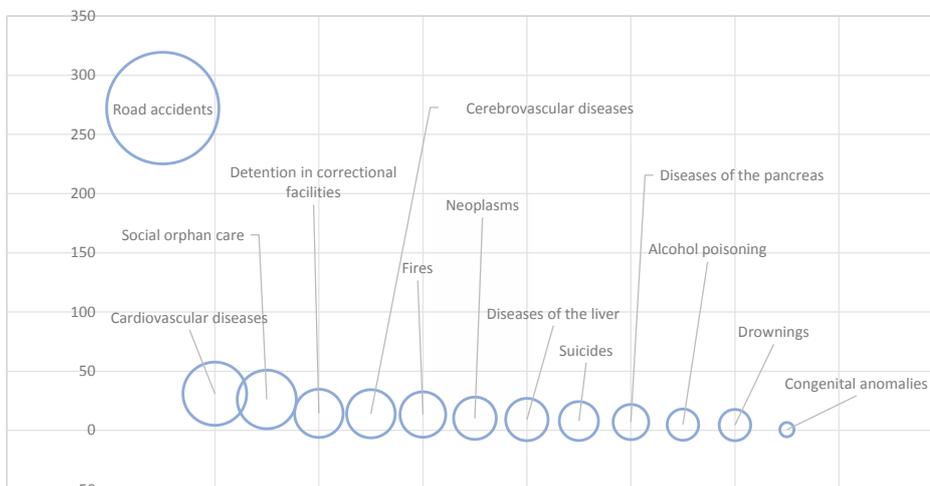


Figure 2. Comparative characteristics of indirect costs.



**Table 2.** Comparison of indirect costs.

Item of budget expenditures	Total costs, million rubles
Road accidents	272 300
Cardiovascular diseases	30 904
Social orphan care	26 083
Detention in correctional facilities	14 409
Cerebrovascular diseases	13 918
Fires	13 400
Neoplasms	10 193
Diseases of the liver	9 100
Suicides	7 900
Diseases of the prostate	7 029
Alcohol poisoning	4 834
Drownings	4 445
Congenital anomalies	608

Summing direct and indirect costs to obtain a total damage of 547,360,940,464 rubles, which makes up 0.68% of Russian GDP in 2015.

**Discussion**

**Table 3.** Ten of the largest items of budget expenditure, both direct and indirect.

Item of budget expenditures	Total costs, million rubles
Road accidents	272 283
Traumatism	61 400
Cardiovascular diseases	30 900
Social orphan care	26 083
Narcological treatment	24 783
Detention in correctional facilities	14 409
Cerebrovascular diseases	13 918
Fires	13 382
Diseases of the liver	13 148
Diseases of the pancreas	11 736

**Table 4.** Comparative characteristics of the most significant changes in direct and indirect costs.

Item of budget expenditures	2017, million rubles	2010, million rubles	Change
Road accidents	272 283	82 523	+230%
Traumatism	61 400	71 411	-14%
Social orphan care	26 083	98 112	-73%
Narcological treatment	24 783	5 649	+339%
Cerebrovascular diseases	13 918	9 985	+39 %
Fires	13 383	5 959	+125%
Diseases of the liver	13 148	20 499	-36%
Polyneuropathy	8 390	16 778	-50%
Diseases of the pancreas	7 029	1 218	+477%

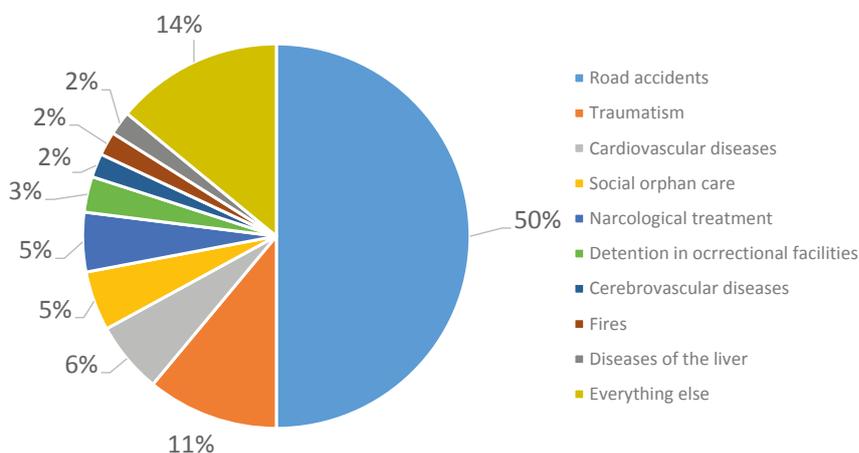
The data obtained with the help of economic modeling confirms that alcoholism and the consequences of excessive consumption of alcoholic beverages are a very serious social and economic problem in the Russian Federation, which costs the country's budget billions of rubles annually. But there is not only material damage that can be assessed, but also immaterial - destroyed families, children who grew up in single-parent families, violence, and general social degradation - these are just a few less obvious serious consequences of alcoholism in Russia.

In 2010, the monograph "Pharmacoeconomics of Alcoholism" was published by Yagudina RI, Kulikova A. Yu., Arinina E.E. and Usenko K.Yu. Authors of the monograph also used economic modeling to determine the magnitude of damage from alcoholism for the economy of the Russian Federation. Due to the significant change in the general conjuncture in the country a comparative analysis of the results of the 2010 and 2017 research is of interest.

From 2010 to 2015, consumption of pure alcohol per capita in Russia decreased from 15 liters to about 10 liters [47], but even at this level it is a very high amount. Also, the number of officially registered alcoholics decreased from 2 774 000 to 2 080 340 people [2].

Reduction of alcohol consumption and the number of officially registered people who are sick with alcohol confirms the effectiveness of the ongoing state alcohol policy. Since 2008, the Russian Federation has been carrying out an extremely active anti-alcohol campaign - the Federal Service for Regulation of the Alcohol Market (Rosalkogolregulirovanie) was established, which immediately took over the functions of administering the Unified State Automated Information System (EGAIS), intended for state control over the volume of production

Comparison of all costs



**Figure 3.** Comparative characteristics of all types of cost

and turnover of ethyl alcohol. From January 1, 2010, Rosalkogolregulirovanie set a minimum price for vodka in the amount of 89 rubles per 0.5 liters, later this amount was constantly growing - on May 13, 2017, the minimum price is 205 rubles, that is, the price has increased more than threefold.

On January 13, 2010, Russian Prime Minister Vladimir Putin approved an anti-alcohol concept in which the State intended to reduce alcohol consumption by 55% by 2020. [48]. Also, in 171-Federal Law "On state regulation of production and alcohol and on limiting alcohol consumption" there are stated restrictions on the time of retail realization of alcohol. In many regions since 2010 the norms of the time of realization have been tightened, the realization of alcoholic products in the evening and in the morning hours is limited, the liability for violating these requirements has been imposed up to criminal.

**Direct costs**

In 2010, the cost of inpatient treatment in narcological dispensaries amounted to 5.47 billion rubles, in 2017 this amount increased to 24.8 billion rubles, despite the reduction in the number of patients from 607,936 to 585,778 people. This is due to an overall increase in MOI tariffs for inpatient treatment in drug treatment units and ambulances.

The cost of treatment of liver diseases decreased from 20.4 billion rubles to 13.1 billion rubles due to a significant reduction in the cost of one hospitalization due to the introduction of the system of CSG, which allowed to optimize the costs of treating the nosologies in one group.

The costs of treating cerebrovascular diseases - hemorrhagic stroke and cerebral infarction - have significantly decreased. Such a significant decrease is due to the use of updated statistical data, in which the frequency of occurrence of cerebrovascular diseases, caused by excessive alcohol consumption, was determined more precisely.

Costs of the treatment of pancreatic diseases, myocardial infarction, neoplasms, diabetes mellitus, heart failure and alcoholic cardiomyopathy remained approximately at the 2010 level. At the same time, the costs of treating injuries decreased significantly, from 71.4 billion rubles to 61.4 billion rubles, mainly due to a reduction in the cost of a single treatment, which was made possible by the introduction of CSG.

The cost of inpatient treatment of polyneuropathy decreased 2 times. Despite the absence of a significant reduction in the cost of treatment of the disease with the introduction of the CRS system, the number of patients decreased, if we take into account the new statistics for which the incidence of alcohol related illnesses decreased by half.

**Indirect costs**

The biggest damage to the Russian economy in 2010 was caused by road accidents, the amount of damage exceeded 82.5 billion rubles. In 2017, the situation is similar - an accident with participants in a state of intoxication causes the most significant damage, which now amounts to more than 272 billion rubles. Despite the decrease in the number of road accidents from 233,809 to 184,000, a very significant growth in GDP led to such a huge increase in damage.

The magnitude of the damage from alcohol poisoning (2 billion rubles in 2010 and 4.8 billion rubles in 2017), drowning (2.27 billion rubles in 2010 and 4.4 billion rubles in 2017), liver cirrhosis (5.45 billion rubles in 2010 and 9.1 billion rubles in 2017), neoplasms (4.4 billion rubles in 2010 and 10.2 billion rubles in 2017), suicides (4 billion rubles in 2010 and 7.8 billion rubles in 2017), the maintenance in the corrective facilities (8.3 billion rubles in 2010 and 14.4 billion rubles in 2017) increased by approximately the level of infla-

tion from the period 2008-2010, indicating a slight change in the structure of these components of cumulative damage.

On the contrary, the damage from hemorrhagic stroke increased by 40%, from 10 billion rubles in 2010 to 14 billion rubles in 2017, despite an almost twofold increase in the number of deaths from this group of diseases - from 142,200 to 295,602 people. This was due to the refinement of statistical research data, which clarified the frequency of the onset of the disease due to alcohol and also the new MMI tariffs.

The damage from pancreatitis has increased almost 6-fold, from 1.2 billion rubles to 7 billion rubles, which is associated with an increase in the number of deaths from this disease, as well as refinement of research data establishing a link between alcohol consumption and the presence of pancreatitis.

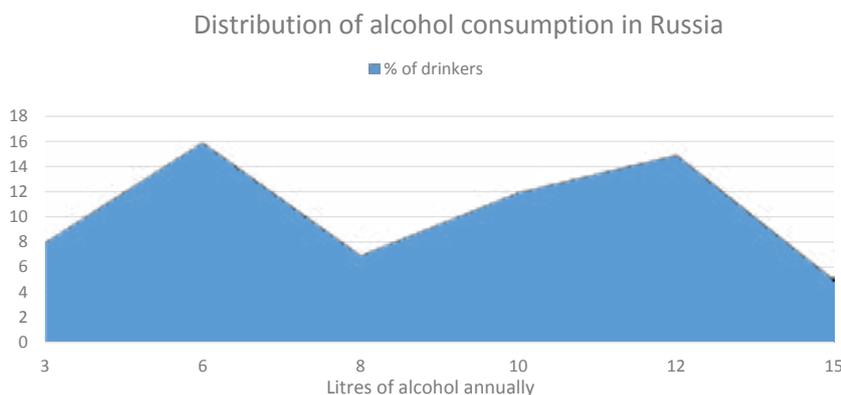
The damage from cardiovascular deaths increased insignificantly, from 27.6 billion rubles to 30.9 billion rubles, which became possible due to a 2.6-fold decrease in the number of deaths from this group of diseases.

The damage from fires grew stronger than the rest, more than doubling in value, from 6 billion rubles in 2010 to 13.4 billion rubles in 2017, even despite the reduction in the number of fires from 211,163 to 146,209, that is, by 31%. This was due to a significant increase in the value of property, as now direct damage from fires is more than 22.8 billion rubles a year against 5.7 billion in 2010.

However, one item of budget expenditures from indirect costs has significantly decreased - the cost of "social orphans" care.

Since 2007, there are special programs aimed at increasing the number of adopted children in Russia. Back in 2007, the President of Russia signed Decree No. 761 of the President of the Russian Federation on June 14, 2007, "On the Year of the Family." The celebration of the Year of the Family was the beginning of a broader support for foster families. In 2009, the Government of the Russian Federation issued Decree No. 19 on January 12, 2009, "On the procedure of the payment of a one-time monetary incentive to one of the parents (foster parents) upon the award of the Parental Glory Order and the provision of other interbudgetary transfers from the federal budget to the budgets of the constituent entities of the Russian Federation for payment of a one-time monetary incentive to people awarded with the Parental Glory Order, Government Decree of December 27, 2010 N 1119 "On the provision of subventions from the federal budget to budgets of Russian Federation subjects for the payment of benefits in all forms to families adopting children deprived of parental care." Also, the payment was increased for each child who was transferred to the family for upbringing (Federal Law N81-FZ On State Benefits for Citizens Having Children, Article 12.1., The Right to a Lump-sum Allowance for the Transfer of the Child for Upbringing to the Family). All this contributed to the reduction of total costs from 98.1 billion rubles in 2010 to 26 billion rubles in 2017. However, not only savings, but also the fact that a child has a family is important. In a family, a child clearly feels more comfortable, secure, he creates social contacts with new parents or caregivers, which has a beneficial effect on his future development, which helps to break the negative trend of social degradation of the population under the influence of alcohol.

Also, an important aspect is the decrease in the number of people who drink heavily. According to data by Aleksandr Nemtsov, head of the Informatics and System Studies Department of the Moscow Research Institute of Psychiatry of the Ministry of Health of the Russian Federation, [49] alcohol consumption in Russia is characterized by a division into two groups - light drinkers and heavy drinkers. This can be represented graphically:



**Figure 4.** Distribution of the Russian population by alcohol consumption.



The transition of a person from the left group to the right is virtually irreversible, as long-term use of high doses of alcoholic beverages creates a psycho-emotional and physical dependence on alcohol, so it is advisable not to allow the transition from the left group to the right, in every way limiting alcohol consumption, especially among the young and socially active population.

### Conclusion

As part of the analysis of economic damage caused by alcohol to the economy of the Russian Federation, it was determined that the total damage is 547 billion rubles, or 0.68% of GDP. This is comparable with the budget of the city of St. Petersburg. However, if we consider these amounts in the long term, since 2010, the damage in absolute terms has decreased by 100 billion rubles, and in relation to GDP it has decreased more than 3 times. This demonstrates the effectiveness of the current policy in the field of alcohol consumption regulation, as well as in the area of reforming medical institutions, since now they can provide medical care at a higher level with lower costs.

The most significant contribution to the total damage is caused by road accidents, injuries, mortality from cardiovascular diseases, the maintenance of "social orphans" and drug treatment. More stringent measures of responsibility for driving under the influence, restricting the sale of alcoholic beverages during festive events in all regions to limit injuries, promote healthy lifestyles will be effective measures to reduce damage from the excessive alcohol consumption.

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