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THE ASSESSMENT OF PRIORITIES FOR INCREASING LIFE EXPECTANCY IN RUSSIA

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Abstract

Russia is one of the few countries in the world where life expectancy in 2010 was the same as in 1960 or even lower. The leading causes of death are cardiovascular diseases, malignant neoplasm, and external causes. Mortality crisis in Russia is of such magnitude and urgency that the limited available resources can be applied only to the problems of the highest priority in the most cost-effective way. This paper presents results of assessment of life expectancy losses and damage cost from decrease of life expectancy due to different risk factors for 82 federal subjects of Russia. To identify preventable causes of death the difference between Russia and the countries of European Union is considered.

Key words: *life expectancy, lost years of potential life, damage from decrease of life expectancy, damage from different causes of death*

1. INTRODUCTION

A high death rate is one of the most difficult medical and demographic problems of the social development in modern Russia. One of the aspects of this problem is a high level of premature mortality in the working age. To improve the effectiveness of the risk management for the life of the population, new instruments of the economic analysis of the premature mortality consequences are necessary. That's why many attempts are taken to estimate the value of a human life or the damage from the early death due to various reasons.

2. BACKGROUND

In accordance with established terminology, death risk from a negative factor is a death probability as a result of exposure to such factors. An age-specific death rate μ(a) is a basic health and demographic index used for assessing the death risk. It is defined as the probability density of death at the age of a, on condition of surviving up to this age. The classical definition of theoretical probability is given as follows:

$$\mu(a) = \lim_{\Delta a \to 0} \Pr(x|y)/\Delta a,$$

where Pr(x|y) is a probability of event x under condition y, x – a man died in the interval (a, a+Δa), y – a man lived up to age a.

Survivorship function P(a) is defined as the unconditional probability of living up from birth to the age of a. If N_0 – is a number of people who were born, and $N(a)$ – is the same number of people surviving to age a, then

$$\mu(a) = -\frac{1}{N(a)}\frac{dN(a)}{da}; \quad (1)$$

$$P(a) = N(a)/N_0. \quad (2)$$

These equations show that

$$P(a) = \exp\left(-\int_0^a \mu(a)da\right). \quad (3)$$

Let us set $P(e,a)$ as a conditional probability for the person at the age e to survive till the age a

$$P(e,a) = P(a)/P(e). \tag{4}$$

Full (from birth) life expectancy Θ(0) can be calculated as

$$\Theta(0) = \int_0^\infty P(a)da. \tag{5}$$

Life expectancy for a man at the age of *e* is calculated similarly:

$$\Theta(e) = \int_e^\infty P(e,a)da. \tag{6}$$

The life-long death risk $R^i(e)$ for a man at the age of *e* is defined as a probability to die from the *i* source of risk throughout the expected lifetime

$$R^i(e) = \int_e^\infty P(e,a)\mu^i(a)da. \tag{7}$$

The condition of normalization is

$$\sum_i R^i(e) = 1. \tag{8}$$

The intensity of the death risk from the *i* source of risk $r^i(e,a)$ for a man at the age of *e*

$$r^i(e,a) = P(e,a)\mu^i(a). \tag{9}$$

In practice, the mortality rates are usually calculated separately for each age group. In this case, the formulas (1-9) are converted to the discrete form.

Lets μ_j is a probability to die during the *j* year of life, on condition to survive up this age, i.e. μ_1 is a probability of dying from the age of birth to exact age of 1 year, and μ_{70} is a probability of dying from the exact age of 69 till the exact age 70. Then the probability of survival from birth to the moment of reaching the exact age *a* is

$$P_{0,a} = \prod_{j=1}^{j=a}(1-\mu_j). \tag{10}$$

$P_{e,a}$ – a probability of surviving till the age *a* for a man, who reached the age of *e*, is calculated similarly to the formula (4):

$$P_{e,a}=P_a/P_e. \tag{11}$$

Full (from birth) life expectancy Θ_0 equals to

$$\Theta_0 = \sum_{k=1}^{k=\infty}\prod_{j=1}^{j=k}(1-\mu_j). \tag{12}$$

For a man, who reached the age of *e*, life expectancy Θ_e is calculated as

$$\Theta_e = \sum_{k=e+1}^{k=\infty}\prod_{j=e+1}^{j=k}(1-\mu_j). \tag{13}$$

Full (from birth) the lifetime death risk from the *i* source of risk R_0^i equals

$$R_0^i = \sum_{k=1}^{k=\infty}\mu_k^i\prod_{j=1}^{j=k-1}(1-\mu_j), \tag{14}$$

where μ_0=0.

R_e^i – the lifetime death risk from the *i* source of risk for a man, who reached the age of *e*, equals

$$R_e^i = \sum_{k=e+1}^{k=\infty} \mu_k^i \prod_{j=e}^{j=k-1} (1-\mu_j)\,. \tag{15}$$

If a man survived till the age of *e*, the probability of dying from all causes during the age interval from *e* to *a* equals

$$R_{e,a} = \sum_{k=e+1}^{k=a} \mu_k \prod_{j=e}^{j=k-1} (1-\mu_j)\,. \tag{16}$$

$R_{e,a}^i$ – the death risk from the *i* source of the risk during the arbitrary age interval from *e* to *a*, on a condition that a man survived till the age of *e*, is calculated similarly

$$R_{e,a}^i = \sum_{k=e+1}^{k=a} \mu_k^i \prod_{j=e}^{j=k-1} (1-\mu_j)\,. \tag{17}$$

To assess the impact of specific causes of death on life expectancy, such measure as the increase of life expectancy under eliminating the *i* cause of death $\Delta\Theta_0^{-i}$ is used

$$\Delta\Theta_0^{-i} = \Theta_0^{-i} - \Theta_0 = \sum_{k=1}^{k=\infty} \prod_{j=1}^{j=k} (1-\mu_j^{-i}) - \sum_{k=1}^{k=\infty} \prod_{j=1}^{j=k} (1-\mu_j)\,, \tag{18}$$

were Θ_0^{-i} is a full (from birth) life expectancy at birth under eliminating the *i* cause of death; μ_j^{-i} is the probability of dying during the *j* year of life on condition of surviving up to this age under eliminating the *i* cause of death.

While calculating assessments of the impact of the different death causes on life expectancy for the population of the subordinate entities of the Russian Federation a problem arises. The scientists have to face the lack of published statistical reports on age-specific mortality in the regions. In this case, as a first approximation we can assume that

$$\mu_j^{Reg} = \frac{M^{Reg}}{M^{RF}} \cdot \mu_j^{RF}\,, \tag{19}$$

where M^{Reg} and M^{RF} are standardized death rates for the population of the region under examination and for the Russian Federation. These standardized indexes are regularly published in demographic statistics digests. Similarly, a quantity μ_j^{-i} can be estimated.

To characterize the mortality at the population level, the index *PYLL* (potential years of life lost) is used. It is a number of years, which were not lived by a population up to the normative age, usually 70. It is assumed that each individual can live for 70 years. It is called a «productive» life and therefore death at the age of *a* results in a loss of 70–*a*, if *a*<70. It is assumed that all deaths occur in the middle of the age interval (including usage of 5-year intervals). So-called unlived years are calculated for each age interval X_j:

$$X_j = T - a_j, \tag{20}$$

where *T* is an upper age limit (usually 70 years), a_j is a middle of the proper age interval. Years of potential life lost are calculated as the sum of products of the total number of deaths in each age group for the years they unlived

$$PYLL = \sum_j D_j X_j\,, \tag{21}$$

were D_j is a number of people who died in the age group j during the year. Similarly the years of potential life lost because of the i cause of death – $PYLL^i$ can be calculated.

$$PYLL^i = \sum_j D_j^i X_j \,, \tag{22}$$

were D_j^i is a number of people who died in the age group j from the i cause of death during the year.

According to this analysis, «weight» of each person, who died from a specific cause, is the number of years unlived by the person to a specified age limit, so the «weight» of an older person is smaller than the «weight» of a newborn. Causes of death, which lead to the biggest losses in a man-year, may be considered to be a priority. The absolute number of the potential life years lost gives the opportunity to measure the scale of the problems associated with premature mortality of the population.

Similarly, an index of «years of potential life in the working-age lost» $PYLL_{Work}$ can be introduced. In this case the age limit T is assumed to be 60 years for men and 55 for women. For individuals who died after the age of 16, $PYLL_{Work}$ is calculated according to the formulas similar to (20)-(22). For individuals who died before the age of 16, $PYLL_{Work}$ is assumed to be 44 years for men and 39 years for women.

3. RESULTS

Table 1 shows results of calculation of the expected reduction in life expectancy at birth as a result of three leading causes of death: cardiovascular diseases, malignant neoplasm, and external causes for the Russian Federation in whole and for 82 federal subjects of Russia (2010). Calculations were executed on the base of equation (18) and statistics (*Medical and Demographic Indicators* 2011).

Table 1 (part 1). Expected reduction in life expectancy in result of three leading causes of death

	Cardiovascular diseases		Malignant neoplasms		External causes of death	
	male	female	male	female	male	female
Russian Federation	**8.41**	**7.76**	**1.97**	**1.98**	**3.86**	**1.32**
Belgorod Oblast	10.89	9.84	2.10	1.88	2.72	0.81
Bryansk Oblast	10.09	8.56	2.09	1.61	4.64	1.34
Vladimir Oblast	10.32	8.85	1.99	1.92	3.72	1.04
Voronezh Oblast	9.11	7.61	1.87	1.70	3.59	1.04
Ivanovo Oblast	7.03	6.41	1.82	1.83	4.15	1.49
Tver Oblast	10.15	8.38	1.74	1.84	4.86	1.61
Kaluga Oblast	9.41	8.11	1.99	1.93	4.03	1.40
Kostroma Oblast	10.63	8.05	1.75	1.79	4.23	1.35
Kursk Oblast	8.40	6.77	2.20	1.78	3.08	0.96
Lipetsk Oblast	9.49	6.90	1.79	1.51	3.79	0.95
Moscow	7.42	8.27	2.22	2.66	1.67	0.72
Moscow Oblast	9.82	8.77	2.09	2.26	3.40	1.10
Oryol Oblast	10.06	8.57	2.15	1.79	4.04	1.26
Ryazan Oblast	9.08	6.55	2.08	1.90	4.00	1.09
Smolensk Oblast	9.53	7.20	1.64	1.71	4.50	1.65
Tambov Oblast	10.28	8.42	2.19	1.78	3.81	1.04
Tula Oblast	9.07	7.72	2.02	1.97	3.70	1.26
Yaroslavl Oblast	9.75	7.28	2.09	1.93	4.21	1.28

Arkhangelsk Oblast	9.11	7.63	1.98	1.86	4.98	1.64
Vologda Oblast	9.12	7.32	1.80	1.68	4.84	1.45

Table 1 (part 2). Expected reduction in life expectancy in result of three leading causes of death

	Cardiovascular diseases		Malignant neoplasms		External causes of death	
	male	female	male	female	male	female
Kaliningrad Oblast	7.66	6.74	1.79	1.98	4.09	1.59
Saint Petersburg	8.67	8.31	2.41	2.81	2.46	0.97
Leningrad Oblast	7.63	7.39	2.01	1.94	4.87	1.80
Murmansk Oblast	11.99	9.36	1.90	1.87	2.80	1.10
Novgorod Oblast	10.18	8.10	1.60	1.63	4.78	1.65
Pskov Oblast	9.71	7.50	1.65	1.69	5.15	1.89
Karelia, Republic of	9.09	6.69	1.95	1.98	4.52	1.46
Komi Republic	7.84	6.21	1.91	1.74	4.64	1.87
Krasnodar Krai	8.58	7.92	2.13	2.11	3.08	0.97
Astrakhan Oblast	8.33	7.36	2.00	1.96	3.70	1.24
Volgograd Oblast	8.91	8.93	2.05	2.01	3.43	1.09
Rostov Oblast	8.23	8.18	1.93	2.04	2.57	0.86
Adygea, Republic of	9.03	8.43	2.11	2.10	3.71	1.06
Kalmykia, Republic of	7.14	6.21	1.76	1.82	3.92	1.07
Stavropol Krai	9.08	7.28	1.93	1.89	2.75	0.95
Ingushetia, Republic of	7.48	8.04	1.49	1.40	1.46	0.57
Dagestan, Republic of	6.69	7.65	1.76	1.63	2.09	0.61
Kabardino-Balkar Republic	8.86	9.66	1.88	1.87	2.31	0.67
North Ossetia-Alania, Republic of	10.24	8.32	1.99	1.84	2.33	0.71
Karachay-Cherkess Republic	9.47	8.60	1.97	1.93	2.88	0.72
Chechen Republic	9.17	10.74	1.90	1.77	1.02	0.29
Nizhny Novgorod Oblast	9.55	8.82	1.78	1.84	3.50	1.07
Kirov Oblast	9.46	8.04	1.79	1.68	4.96	1.74
Samara Oblast	7.37	6.87	1.82	1.91	4.39	1.58
Orenburg Oblast	8.90	8.25	2.10	1.97	4.19	1.28
Penza Oblast	10.49	8.65	1.97	1.71	4.34	1.32
Perm Krai	9.38	7.67	1.77	1.79	5.35	1.96
Saratov Oblast	8.41	7.50	1.78	1.76	3.92	1.23

Ulyanovsk Oblast	9.79	9.21	2.03	1.81	4.41	1.35
Bashkortostan, Republic of	7.20	6.21	1.48	1.57	4.23	1.34
Mari El Republic	8.04	7.76	1.75	1.52	5.71	1.84
Mordovia, Republic of	7.89	5.82	1.99	1.74	4.01	1.13
Tatarstan, Republic of	10.46	8.64	1.87	1.77	3.86	1.08
Udmurt Republic	9.37	7.55	1.81	1.61	5.30	1.69
Chuvash Republic	5.88	4.94	1.62	1.47	5.92	2.28
Khanty-Mansi Autonomous Okrug – Yugra	8.18	8.12	2.15	2.11	3.30	1.26
Yamalo-Nenets Autonomous Okrug	7.03	8.79	2.27	2.09	3.43	1.16
Kurgan Oblast	6.63	5.16	2.20	2.01	4.98	1.71
Sverdlovsk Oblast	8.16	7.32	2.20	2.03	4.55	1.67
Tyumen Oblast	8.53	7.74	1.60	1.69	3.76	1.33
Chelyabinsk Oblast	8.00	7.06	2.18	2.16	4.63	1.58

Table 1 (part 3). Expected reduction in life expectancy in result of three leading causes of death

	Cardiovascular diseases		Malignant neoplasms		External causes of death	
	male	female	male	female	male	female
Altai Krai	7.25	7.00	2.19	1.99	4.05	1.61
Krasnoyarsk Krai	7.30	6.78	2.21	2.11	4.88	1.79
Irkutsk Oblast	7.55	7.28	1.80	1.94	4.89	1.84
Kemerovo Oblast	6.37	6.60	1.82	1.96	6.03	2.29
Novosibirsk Oblast	8.32	7.52	2.30	2.06	3.91	1.32
Omsk Oblast	8.59	7.97	2.04	2.01	3.99	1.37
Tomsk Oblast	7.25	6.29	2.39	2.26	4.66	1.54
Zabaykalsky Krai	6.91	6.89	1.56	1.90	6.25	2.38
Buryatia, Republic of	7.16	7.59	1.76	1.90	6.48	2.48
Altai Republic	6.27	6.44	1.78	1.82	6.26	3.26
Tuva Republic	4.98	6.60	1.31	1.65	8.41	4.66
Khakassia, Republic of	7.02	7.12	1.90	2.00	4.65	2.14
Primorsk Krai	8.84	8.16	1.89	2.08	3.89	1.51
Khadarovsk Krai	9.63	8.35	1.83	1.84	4.90	1.69
Amur Oblast	8.97	7.60	1.48	1.60	5.12	2.12
Kamchatka Krai	9.34	9.08	1.77	1.92	3.12	1.04
Magadan Oblast	7.16	7.08	1.74	2.08	4.01	1.49
Sakhalin Oblast	7.97	7.95	2.01	2.04	5.37	2.13
Chukotka Autonomous Okrug	7.46	8.47	1.12	1.94	5.40	3.45
Sakha (Yakutia)	7.87	7.29	1.52	1.84	5.04	1.73

Republic						
Jewish Autonomous Oblast	9.41	7.55	1.61	1.73	5.38	2.04

Table 2 shows results of calculation of years of potential life lost in the working age (age 16-60 for men and 16-55 for women) due to the same three causes of death (as on 2010). Calculations were executed on the base of equation (22) and statistics (*Medical and Demographic Indicators* 2011).

Table 2 (part 1). Years of potential life lost in the working age in result of three leading causes of death

	Cardiovascular diseases		Malignant neoplasms		External causes of death	
	male	female	male	female	male	female
Russian Federation						
Belgorod Oblast	85399.4	19530.4	4450.8	2409.0	19498.0	3314.4
Bryansk Oblast	79997.8	16939.1	4376.9	1900.4	29328.9	4712.4
Vladimir Oblast	98561.9	21141.4	5131.0	2671.6	28074.0	4162.8
Voronezh Oblast	132242.4	27503.0	6982.9	3517.7	40841.3	6509.1
Ivanovo Oblast	55461.6	12320.8	3355.7	1846.1	22644.7	4356.7
Tver Oblast	96288.4	19605.3	4519.0	2441.1	34233.3	6006.6
Kaluga Oblast	61394.1	12947.6	3347.6	1776.5	20660.3	3808.9
Kostroma Oblast	45708.6	8943.0	2098.1	1136.9	14302.9	2480.0
Kursk Oblast	63394.4	12788.4	4104.4	1842.6	16910.1	2911.7
Lipetsk Oblast	72135.8	13566.5	3567.2	1648.8	22055.0	3053.5
Moscow	422408.0	116382.8	28684.3	23410.8	86426.1	21228.1
Moscow Oblast	444406.7	98709.7	24290.3	14947.8	127564.1	21936.8

Table 2 (part 2). Years of potential life lost in the working age in result of three leading causes of death

	Cardiovascular diseases		Malignant neoplasms		External causes of death	
	male	female	male	female	male	female
Oryol Oblast	47708.3	10212.8	2697.5	1268.6	15133.9	2668.1
Ryazan Oblast	67241.6	12455.7	3904.0	1945.4	22611.4	3305.4
Smolensk Oblast	67838.9	13073.4	3103.5	1673.4	23748.3	4569.4
Tambov Oblast	68615.9	13682.2	3877.9	1710.4	20080.1	2947.9
Tula Oblast	95082.9	19771.0	5366.3	2819.8	29122.3	5223.0
Yaroslavl Oblast	74619.6	14896.1	4125.9	2213.5	25842.3	4406.0
Arkhangelsk Oblast	78947.5	16001.8	4392.5	2208.9	33329.9	5866.5
Vologda Oblast	77578.0	15516.5	4000.4	1963.6	30469.2	5008.0
Kaliningrad Oblast	48830.2	10460.6	2750.3	1683.7	20260.2	4144.9
Saint Petersburg	218402.0	54986.8	14418.7	11149.0	56157.3	12436.8

Leningrad Oblast	95259.8	21085.3	5934.2	3062.1	43991.0	8252.0
Murmansk Oblast	63798.3	12444.9	2857.1	1499.4	13496.8	2548.4
Novgorod Oblast	46746.8	9412.4	2042.2	1053.0	16055.0	2959.9
Pskov Oblast	49727.9	9464.8	2304.4	1145.3	18843.1	3474.9
Karelia, Republic of	41515.3	7912.2	2276.6	1251.2	15306.9	2678.9
Komi Republic	56755.4	11036.7	3341.4	1628.9	23821.6	5046.7
Krasnodar Krai	243671.6	56893.8	14927.2	9085.8	75068.3	13624.4
Astrakhan Oblast	55263.9	11970.5	3281.0	1801.2	19538.7	3615.2
Volgograd Oblast	134521.5	32291.0	7752.5	4454.2	43548.0	7688.7
Rostov Oblast	210995.5	50819.4	12113.8	7513.0	54200.4	10004.2
Adygea, Republic of	21622.9	5052.0	1286.9	767.2	7578.4	1257.2
Kalmykia, Republic of	14613.8	3072.1	875.1	491.2	6005.6	930.2
Stavropol Krai	130638.6	28044.9	7063.1	4305.0	36641.0	7390.8
Ingushetia, Republic of	7593.9	2735.8	386.7	366.5	2061.9	690.5
Dagestan, Republic of	80268.6	24877.1	4975.0	3536.9	27476.0	5357.7
Kabardino-Balkar Republic	34363.9	9830.5	1848.7	1292.2	9091.0	1668.9
North Ossetia-Alania, Republic of	29675.2	7027.8	1523.0	1008.3	7222.3	1365.0
Karachay-Cherkess Republic	21437.0	5403.5	1158.8	774.3	6274.7	1006.5
Chechen Republic	44040.5	13311.8	2438.8	1645.1	6233.6	1126.6
Nizhny Novgorod Oblast	210590.8	47286.5	10332.9	5804.3	60457.6	9970.5
Kirov Oblast	83514.9	17073.2	4195.3	2063.8	32636.7	6224.2
Samara Oblast	167125.9	38396.2	9724.3	5804.2	72633.5	14396.6
Orenburg Oblast	116325.0	26444.0	6968.5	3703.8	43097.0	7445.1
Penza Oblast	83501.4	17477.0	4227.7	2079.3	28514.8	4833.2
Perm Krai	164508.5	34732.5	8150.3	4581.4	72693.4	15156.0
Saratov Oblast	135000.6	30262.1	7097.4	4051.9	48741.5	8579.0
Ulyanovsk Oblast	80381.8	18392.9	4405.9	2199.4	28063.0	4796.5
Bashkortostan, Republic of	194694.7	41584.1	9734.6	5810.8	85359.7	15621.0
Mari El Republic	42151.4	9482.0	2297.0	1053.9	20993.4	3755.4
Mordovia, Republic of	45419.0	8429.8	2759.1	1334.0	16785.1	2604.9
Tatarstan, Republic of	209494.3	45791.6	10095.9	5795.8	69574.5	11375.1
Udmurt Republic	89052.2	18718.8	4493.8	2307.7	40048.7	7400.5
Chuvash Republic	54723.6	11264.0	3382.3	1717.3	36758.4	8075.2

Table 2 (part 3). Years of potential life lost in the working age in result of three leading causes of death

	Cardiovascular diseases		Malignant neoplasms		External causes of death	
	male	female	male	female	male	female
Khanty-Mansi Autonomous Okrug – Yugra	85419.5	20120.6	5365.8	3145.3	28480.9	6052.7
Yamalo-Nenets Autonomous Okrug	23409.1	6619.4	1707.2	1015.0	9553.2	1855.1
Kurgan Oblast	41919.8	8114.2	3201.1	1617.3	21402.0	4157.5
Sverdlovsk Oblast	215972.8	49006.3	14063.9	7740.6	96104.7	19977.9
Tyumen Oblast	191795.1	42876.5	9025.0	5553.8	69800.7	13904.0
Chelyabinsk Oblast	173389.5	38959.1	11365.9	6680.9	78576.2	15503.5
Altai Krai	118724.9	27376.4	8446.5	4329.7	48233.6	10844.0
Krasnoyarsk Krai	147860.8	33614.3	10396.8	5682.8	73096.5	15120.1
Irkutsk Oblast	133903.9	31587.5	7769.0	4620.6	64253.0	13719.3
Kemerovo Oblast	140732.4	34157.1	9254.7	5361.5	86713.9	18797.0
Novosibirsk Oblast	136903.8	30593.0	9135.1	4801.6	52758.0	9833.3
Omsk Oblast	107687.1	24918.9	6399.2	3660.7	40020.5	7790.4
Tomsk Oblast	51124.8	11096.0	3888.6	2138.0	25764.5	4812.2
Zabaykalsky Krai	63362.0	14622.6	3464.9	2140.4	40376.3	8440.1
Buryatia, Republic of	51967.0	12925.5	3099.5	1820.8	34736.1	7575.7
Altai Republic	10091.0	2443.1	666.5	374.2	6840.6	2127.8
Tuva Republic	14942.9	4818.7	883.9	625.1	15653.0	5419.4
Khakassia, Republic of	26868.4	6527.5	1718.5	1014.3	12978.9	3412.9
Primorsk Krai	124868.8	26690.4	6707.8	3856.6	43504.7	8509.3
Khadarovsk Krai	91554.1	19400.7	4556.2	2441.4	38311.5	6836.2
Amur Oblast	60542.1	12328.6	2642.6	1417.4	25254.9	5519.5
Kamchatka Krai	25463.3	5195.0	1237.7	640.6	6531.6	1027.9
Magadan Oblast	11232.6	2298.5	644.4	355.3	3950.6	728.6
Sakhalin Oblast	35726.2	7618.3	2195.7	1066.7	16169.8	3188.7
Chukotka Autonomous Okrug	6109.6	1265.6	240.4	149.4	2225.7	662.8
Sakha (Yakutia) Republic	55032.8	12210.0	2669.1	1741.4	27351.6	5349.5
Jewish Autonomous Oblast	12970.6	2570.7	597.4	319.1	5734.4	1134.9

In order to compare the damage cost from mortality due to different causes of death it is necessary to get a monetary evaluation of a human year or years of the potential years of life lost. This problem is extremely difficult. Many philosophical and ethical doctrines are based on the principle that "human life is priceless", thereby eliminating any possibility to discuss this matter. However, in a market economy it is a very pressing problem.

Analysis of the literature allows us to say that the following concepts, measuring the price of a human life, were formed (Vaganov 1999, Shogren and Stamland 2001, Branon 2004-2005, Nifantova and Shipitsina 2012):

- evaluation from the standpoint of the theory of human capital;
- indirect estimation taking into account non-monetary social costs;
- evaluation of individuals' willingness to pay for the elimination of the death risk;
- estimation based on the determination of insurance premiums and compensations based under court decision;
- evaluation of the social investments, aimed to reduce the risk of premature mortality of the individual.

In this research we used index of reduction of the gross regional product (GRP) due to the loss of potential life years in the working-age population because of cardiovascular diseases, malignant neoplasms and external causes of death. The results are presented in Table 3.

Table 3 (part 1). Reduction of the GRP (million roubles as on 2010) due to the loss of potential life years in the working-age population in result of three leading causes of death

	Cardiovascular diseases		Malignant neoplasms		External causes of death	
	GRP reduction	% out of GRP	GRP reduction	% out of GRP	GRP reduction	% out of GRP
Russian Federation						
Belgorod Oblast	44600	11.2	2916	0.73	9696	2.4
Bryansk Oblast	18117	12.6	1173	0.81	6362	4.4
Vladimir Oblast	30294	13.9	1975	0.90	8158	3.7
Voronezh Oblast	37394	11.4	2458	0.75	11084	3.4
Ivanovo Oblast	10479	10.7	804	0.82	4175	4.3
Tver Oblast	31654	14.5	1901	0.87	10991	5.0
Kaluga Oblast	22341	12.1	1540	0.83	7353	4.0
Kostroma Oblast	12607	13.7	746	0.81	3871	4.2
Kursk Oblast	21821	11.3	1703	0.89	5678	3.0
Lipetsk Oblast	30926	12.1	1882	0.74	9061	3.6
Moscow	619806	7.4	59928	0.71	123842	1.5
Moscow Oblast	221637	12.3	16012	0.89	61009	3.4
Oryol Oblast	12625	12.3	865	0.84	3880	3.8
Ryazan Oblast	20261	11.7	1487	0.86	6589	3.8
Smolensk Oblast	19917	13.4	1176	0.79	6971	4.7
Tambov Oblast	17611	12.7	1196	0.86	4928	3.5

Tula Oblast	29631	12.5	2112	0.89	8861	3.7
Yaroslavl Oblast	27846	11.9	1972	0.84	9410	4.0
Arkhangelsk Oblast	43182	12.1	3002	0.84	17826	5.0
Vologda Oblast	31967	12.7	2048	0.81	12182	4.8
Kaliningrad Oblast	19641	10.1	1469	0.75	8084	4.1
Saint Petersburg	150230	9.0	14050	0.84	37693	2.3
Leningrad Oblast	55170	11.0	4266	0.85	24773	4.9
Murmansk Oblast	34355	14.6	1963	0.84	7230	3.1
Novgorod Oblast	19057	15.0	1050	0.83	6453	5.1
Pskov Oblast	12504	14.8	729	0.86	4715	5.6
Karelia, Republic of	16027	12.5	1144	0.90	5832	4.6
Komi Republic	40988	11.6	3005	0.85	17454	5.0
Krasnodar Krai	96983	9.6	7748	0.77	28618	2.8
Astrakhan Oblast	15723	10.8	1188	0.82	5415	3.7
Volgograd Oblast	46225	10.6	3383	0.77	14198	3.2
Rostov Oblast	63642	10.1	4771	0.75	15607	2.5
Adygea, Republic of	4746	10.3	366	0.79	1572	3.4
Kalmykia, Republic of	2341	9.6	181	0.74	918	3.8
Stavropol Krai	29480	9.3	2112	0.67	8180	2.6
Ingushetia, Republic of	903	4.2	66	0.31	241	1.1
Dagestan, Republic of	16571	5.8	1341	0.47	5175	1.8
Kabardino-Balkar Republic	6224	8.2	442	0.58	1515	2.0
North Ossetia-Alania, Republic of	6461	8.6	446	0.60	1512	2.0

Table 3 (part 2). Reduction of the GRP (million roubles as on 2010) due to the loss of potential life years in the working-age population in result of three leading causes of death

Karachay-Cherkess Republic	3952	9.1	285	0.66	1072	2.5
Chechen Republic	5434	7.8	387	0.56	697	1.0
Nizhny Novgorod Oblast	83138	12.9	5203	0.80	22706	3.5
Kirov Oblast	20624	12.4	1283	0.77	7968	4.8
Samara Oblast	71979	10.4	5438	0.78	30480	4.4
Orenburg Oblast	52136	11.5	3897	0.86	18457	4.1
Penza Oblast	19169	12.1	1197	0.76	6330	4.0
Perm Krai	78230	12.4	4999	0.79	34493	5.5
Saratov Oblast	40035	10.8	2701	0.73	13886	3.8
Ulyanovsk Oblast	21691	12.4	1451	0.83	7216	4.1

Bashkortostan, Republic of	71335	9.4	4693	0.62	30487	4.0
Mari El Republic	9724	11.8	631	0.77	4661	5.7
Mordovia, Republic of	10821	10.4	823	0.79	3896	3.7
Tatarstan, Republic of	109409	10.9	6811	0.68	34693	3.5
Udmurt Republic	30255	11.4	1909	0.72	13321	5.0
Chuvash Republic	12956	8.5	1001	0.66	8803	5.8
Khanty-Mansi Autonomous Okrug – Yugra	197167	10.0	15900	0.80	64515	3.3
Yamalo-Nenets Autonomous Okrug	63176	8.2	5727	0.74	24002	3.1
Kurgan Oblast	10735	9.3	1034	0.90	5484	4.8
Sverdlovsk Oblast	104353	10.1	8587	0.83	45715	4.4
Tyumen Oblast	56291	10.3	3497	0.64	20078	3.7
Chelyabinsk Oblast	64861	10.0	5512	0.85	28736	4.4
Altai Krai	29786	9.9	2605	0.87	12044	4.0
Krasnoyarsk Krai	106800	10.2	9463	0.90	51916	4.9
Irkutsk Oblast	59761	11.1	4474	0.83	28157	5.2
Kemerovo Oblast	64401	10.3	5382	0.86	38853	6.2
Novosibirsk Oblast	48521	10.1	4037	0.84	18132	3.8
Omsk Oblast	39795	10.7	3019	0.81	14348	3.9
Tomsk Oblast	26543	9.3	2571	0.90	13044	4.6
Zabaykalsky Krai	18338	11.3	1318	0.81	11479	7.1
Buryatia, Republic of	14661	10.8	1112	0.82	9559	7.0
Altai Republic	2190	10.1	182	0.84	1567	7.2
Tuva Republic	3290	10.8	251	0.82	3508	11.5
Khakassia, Republic of	9521	10.2	779	0.83	4673	5.0
Primorsk Krai	57012	12.3	3974	0.86	19566	4.2
Khadarovsk Krai	45560	13.0	2873	0.82	18538	5.3
Amur Oblast	25257	14.1	1407	0.78	10666	5.9
Kamchatka Krai	14765	14.5	905	0.89	3641	3.6
Magadan Oblast	7538	13.0	557	0.96	2607	4.5
Sakhalin Oblast	67337	13.7	5068	1.03	30074	6.1
Chukotka Autonomous Okrug	9103	21.7	481	1.15	3565	8.5
Sakha (Yakutia) Republic	42193	11.0	2768	0.72	20519	5.3
Jewish Autonomous Oblast	4607	14.2	272	0.83	2036	6.3

Life-saving aspects and lifetime impacts identification process is one of the most important parts of any health management system, as it lays the foundation for how the management system will run in the future and the improvements it should address.

To assess priorities for increasing life expectancy it is necessary to establish, implement and maintain a procedure(s):

a) To identify leading cause(s) of death among population in whole and among working age population that have or can have significant impact(s) on life expectancy,

b) To identify those lifetime impacts that can be controlled by the society and those that can be influenced, taking into account planned or new developments of the health management system and the society as a whole.

The first task is relatively easy. The leading causes of death among male population in Russia in 2010 were cardiovascular disease (49.3% of deaths), external causes of death (15.9%), and malignant neoplasms (14.7%). The leading causes of death among female population were the same but in the different order: cardiovascular disease (64.8% of deaths), malignant neoplasms (13.8%), and external causes of death (5.1%). Analysis of data from Tables 1-3 allows drawing the same conclusions.

The second task is more difficult because it is necessary to identify those lifetime impacts that can be controlled by the society, taking into account social and economical realities of Russia. In this situation the approach (Vishnevskiy&Vasin 2011) seems to be useful: authors proposed to compare mortality patterns in Russia and in the most developed countries. In Fig. 1 cancer mortality estimates for 25 cancers are presented for 40 countries in the four United Nations-defined areas of Europe and for the European Union (EU-27) for 2012 (Ferlay et al 2013). It is seen that male and female cancer mortality rates in Russia are approximately the same as in developed European countries. So it's not worth to expect significant new successes in controlling cancer and increase of life expectancy due to the decrease of cancer mortality in Russia, taking into account present social and economic situation.

On the other hand, in Fig. 2 coronary heart disease mortality rates for European countries in 2008 or in the nearest available year are presented (*Coronary heart disease statistics* 2010). It is seen that male and female coronary heart disease mortality rates in Russia are in several times greater than in developed European countries. This fact indicates that coronary heart disease (and cardiovascular disease in whole) mortality rates can be controlled, because developed European countries demonstrate successes in this area. The control of cardiovascular disease mortality is not only medical task. Cardiovascular disease is attributed to stress and to harmful habits, such as smoking and alcoholism. (Also attributed to alcoholism is the high rate of injury and poisoning, the second highest cause of male death in Russia). The fall in cardiovascular deaths is possible due to a combination of increased public understanding of risk factors, government policies aimed at helping people achieve healthy lifestyles and improved treatment for cardiovascular disease aimed both at treating the condition once it has presented and preventing the condition before presentation.

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REFERENCES

Branon I. winter 2004-2005, 'What is a life worth?', *Regulation*, pp. 60-63.

Coronary heart disease statistics. 2010 edition 2010, British Heart Foundation Health Promotion Research Group. Department of Public Health, University of Oxford.

Ferlay J, Steiliarova-Foucher E, Lortet-Tieulent J, Rosso S, Coebergh JWW, Comber H, Forman D, Bray F 2013, 'Cancer incidence and mortality patterns in Europe: Estimates for 40 countries in 2012', *European Journal of Cancer*, vol. 49, pp. 1374-1403.

Medical and Demographic Indicators of Russia 2010, 2011, Federal Research Institute for Health Organization and Information of Ministry of Health of Russian Federation, Moscow (in Russian).

Nifantova RV & Shipitsyna SE 2012, 'Modern methods of human life evaluation', Economy of Region, no. 3, pp.289-294.

Shogren J. & Stamland T. 2001, 'Skills and the Value of Life', *Journal of Political Economy*, vol. 110, no 5, pp. 1168-1173.

Vaganov PA 1999, 'Risk of death and life price', *Jurisprudence*, no. 3, pp. 67-82 (in Russian)

Vishnevskiy AG & Vasin SA 2011, 'Causes of death and priorities for mortality decrease in Russia', *HSE Economic Journal*, vol. 15, no. 4, pp. 472-496 (in Russian).

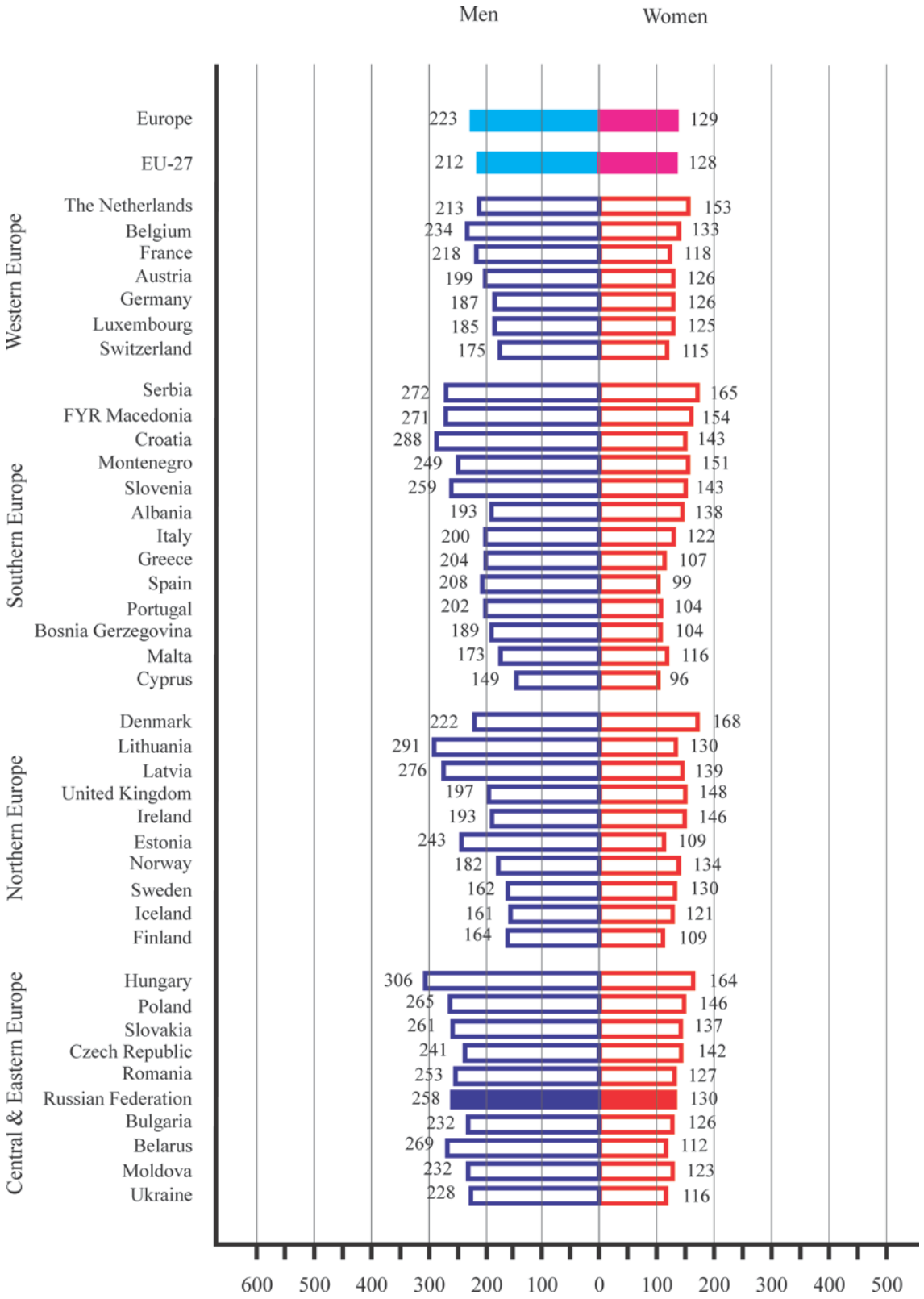


Fig. 1. Age-standardised cancer mortality rates (European standard) by sex, area and country in Europe 2012, all cancers excluding non-melanoma skin cancers

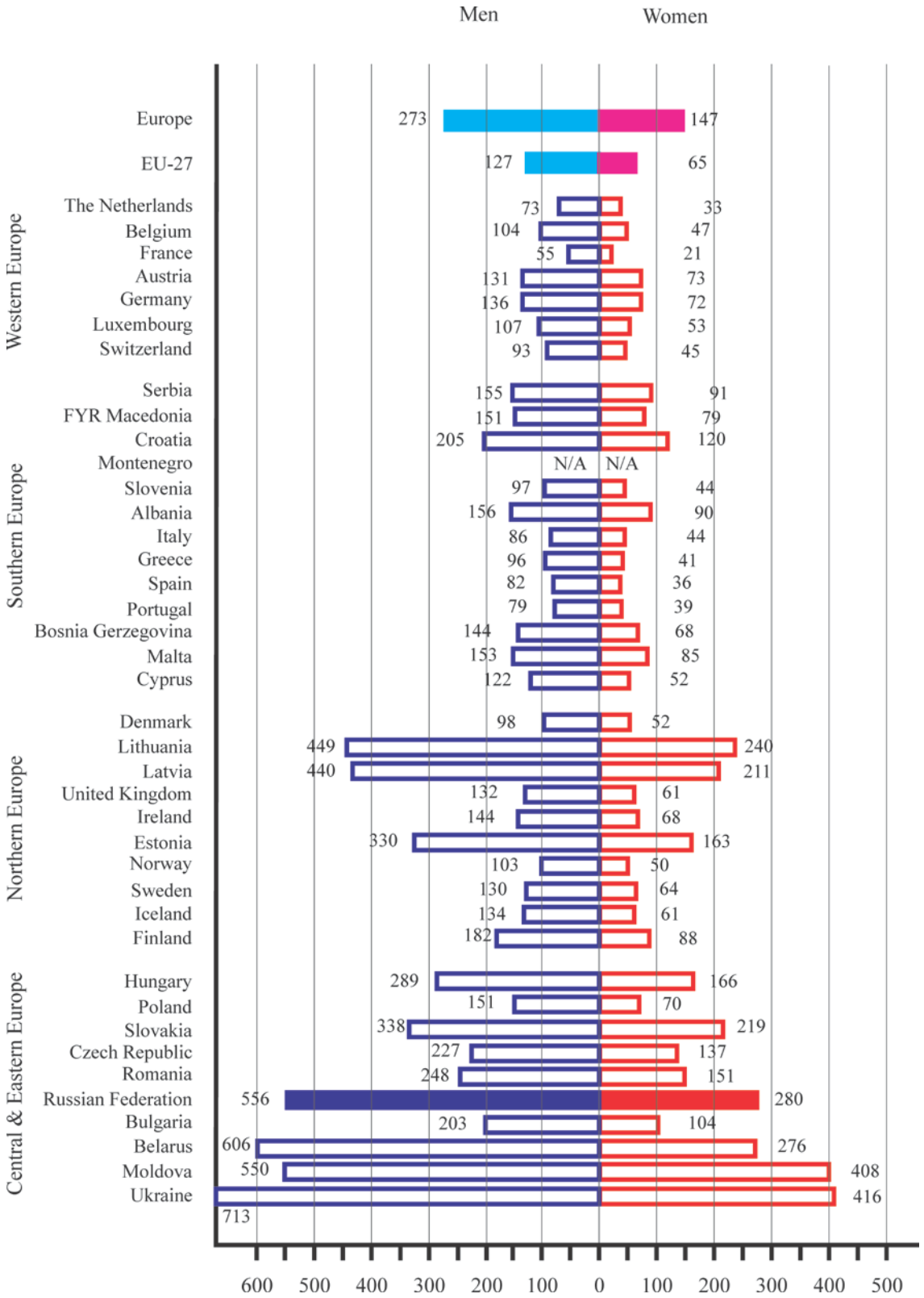


Fig. 2. Age-standardised coronary heart disease mortality rates (European standard) by sex, area and country in Europe (2008 ore the nearest available year)