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# Assessment of Health Care Cost-Effectiveness Considering a Reduction in Population Health Loss

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**Abstract**
The article examines a set of indicators characterizing the state and losses of population health due to morbidity and premature mortality, and describes approaches and methods for their assessment. The regularities of the growth of mortality levels from the age have been determined, on the basis of which the law of diminishing marginal utility of health care expenditures has been formed, depending on the increase in the average life expectancy. A method for assessing the effectiveness of health care expenditures in terms of reducing natural losses due to premature mortality is proposed. The peculiarities of using this method with the economic justification of financial support to reduce the risks of death from specific nosologies are considered. The clustering of the countries of the world in terms of the ratio of health losses to health care expenditures has been obtained and the effectiveness of health care expenditures in various countries of the world community has been assessed.
**Keywords:** risk of death, premature mortality, age-specific mortality distribution, health losses, health care cost-effectiveness.

## INTRODUCTION

The problems of rational allocation of resources to the basic elements of the health care system which ensures the improvement of the quality and accessibility of medical care and on this basis strengthening of public health, reducing the morbidity and population mortality, are among the priority areas of public policy in developed countries, primarily in relation to their social-economic significance. Their solution is largely associated with obtaining reliable assessments of the natural and temporal losses of health and life of people because of the main reasons [1].

Socio-economic statistics and health statistics operate with a rather wide range of indicators, on the basis of which it is possible to judge the population losses caused by its morbidity and premature mortality. Among them, common and age-specific coefficients of mortality, morbidity, disability, as well as indicators of life expectancy (LE) and lost years of potential life determined on their basis are most common. General and age-specific mortality coefficients are calculated as the ratio of the number of deaths, cases of sickness, and disability of the considered cohort of the population (the total population, age- and sex-specific population group) to the total number of this cohort [1; 2; 3; 4; 5; 6].

It should be noted here that the overall coefficients, in particular the coefficient of mortality, representing the number of deaths per 1,000 people, can introduce some errors in the assessment of population losses, since the mortality level depends on age significantly. In this connection, when comparing such losses in different subjects, standardized general mortality coefficients are usually used, calculated using observed age-specific coefficients and the standard (same) for all subjects of age-specific population structure [7]. However, in this case, the assessments of losses are distorted because of the discrepancy between the standard and the actual (established) population structures [8].

The indicator of life expectancy at birth makes it possible to estimate the population's losses due to premature mortality per one person in relation to a given reference value. As such a standard, the LE in the leading country for this indicator or the biological maximum of time left to live (for example, 100 years) is often used [4].

The indicators of morbidity and disability began to be taken into account when assessing the health losses of the population relatively recently, approximately since 1990, as part of the implementation of projects for calculating the global burden of diseases financed by WHO and the World Bank for Reconstruction and Development. Initially, the research encompassed 37 countries, and by 2010 their number had increased to 187 [4].

In terms of content, the indicators of global burden of diseases are the sum of assessments of years of life not lived up to the standard life expectancy of an average resident of the country in question and the losses of life due to a decrease in its quality because of earlier diseases and/or disabilities.

At the same time, the methodology for calculating these indicators is constantly improving and refined [4]. In particular, in the last research of 2013, the maximum number of years of life for men and women was increased to 92 years (in earlier studies, this figure was 80 years). In addition, the years of life lived in a state of disability (YLD) began to be assessed taking into account the concomitant diseases, the risk of development of which increases in the presence of disability. Significant changes in the methodology for calculating losses include the rejection of the use of discounted indicators of years of life in the calculation of years of life lived with a disability (YLD) and years of life lost due to premature mortality (YLL). This is justified by the fact that according to the opinion of most experts, the significance of a year of healthy life is the same, regardless of the age of the individual. However, it was decided to use more weight when considering mortality and health problems of children of 0-5 years old.

It should be noted that the introduction of significant changes to the methodology of calculating indicators of global burden of diseases made it impossible to directly compare the results of studies of health losses of different years without adjusting them.

Obtaining assessments of the indicators of the global burden of diseases in many countries is often difficult because of the lack of necessary information on the morbidity and disability of the population by age groups. In addition, information on causes of death in different age groups is important for health care management. This allows identifying the most effective areas for improving medical care for the population, the financing of which can make a significant contribution to reducing the loss of health.

In our opinion, assessments of temporal health losses can be obtained on the basis of comparing the age structure of mortality for a particular reason in the territory under consideration with its analogues obtained for previous periods of time or in the standard country. At the same time, the available information on mortality for these reasons in different age- and sex-specific population groups in the countries of the world community can be used. The result of this comparison is an assessment of the increase in the loss of life years of an average individual of a certain age living in the territory in question, with respect to losses in the previous period, or losses on the assumption that he or she resides in the standard country. Comparison of the dynamics of the levels of these losses and changes in the volume of financing of health care systems makes it possible to make an informed judgment about the effectiveness of these expenditures in terms of strengthening the health of the population.

## METHODS

The comparison of average life expectancy, as an integral indicator of public health, and the volume of health care system financing per one citizen of the country, revealed the following relationship between these indicators (see Figure 1).

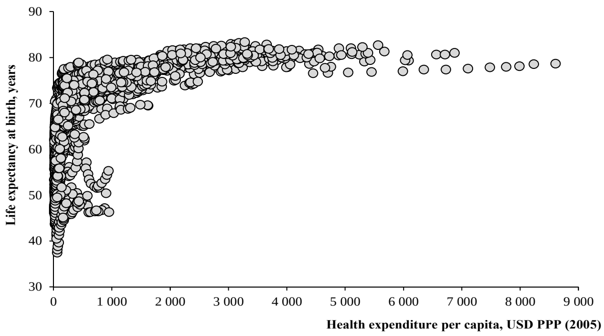


**Figure 1 – Dependence of the indicator of average life expectancy on per capita health care expenditures in US dollars in terms of 2005 PPP for the countries of the world for the period of 1999-2011**

The relationship between the LE indicator and health expenditures in the countries of the world community is consistent with the law of diminishing marginal utility. According to it, every additional investment of money in the health care sector gives an ever-decreasing efficiency in the form of an increase in life expectancy at birth. This suggests that monetary investments cannot increase life expectancy indefinitely, because the upper threshold of life expectancy is limited by the biological capabilities of the human organism.

However, in different countries, this law is characterized by certain peculiarities due to differences in the effectiveness of health care expenditures, as well as the impact of other factors on health condition (living standards, climate, etc.).

Life expectancy in a particular country is inversely related to the risk of death of its citizens. In turn, the risk of death depends on the age of an individual (see Figure 2).

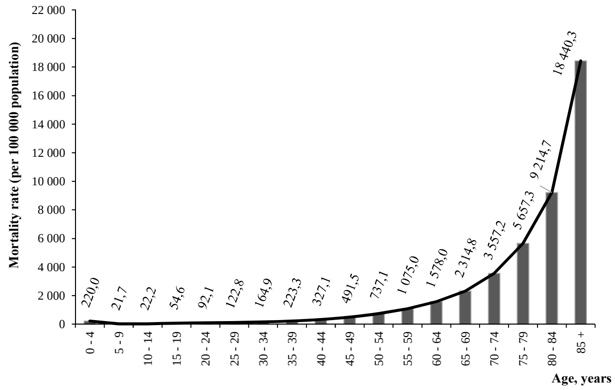


**Figure 2 – Dependence of the risk of death from all causes for the population of different age groups for the countries of the world for the period of 1999-2011**

The dependence of the risk of death on age in Figure 2 is approximated with great accuracy by an increasing exponential curve. At the same time, for the analysis of the effectiveness of public health strengthening policy, the inverse relationship of the type "age – risk of death", which allows depicting the loss of health in the form of years of life, is of more interest. This makes it possible to perform a comparative analysis of the results of modeling with the research of other specialists, and also allows the transition to cost assessments of effects from changes in health losses.

The general form of the equation of the relationship between the age and the risk of death $r$ from all causes is characterized by the following expression:

$y_t(r) = \alpha_0 + \alpha_1 \cdot \ln r,$

where $y_t(r)$ is the age at which the risk of death from all causes is at level $r$ in the time period $t$; $r \in [r_{\min}; r_{\max}]$ ; $r_{\min}$, $r_{\max}$ are the lower and upper thresholds for the risk of death, which can be specified expertly, or can be determined as the minimum and maximum values from those observed for a certain period of time among the countries in question; and $\alpha_0$ and $\alpha_1$are assessed model parameters.

Note that the parameter $\alpha_1$ represents the coefficient of elasticity of the risk of death from age. The smaller is $\alpha_1$, the less is the dependence of the mortality level on age. In this regard, the observed decrease in the elasticity of death risks from age can be interpreted as a result of advances in the health care system.

Equations of the type (1) obtained for different time periods allow assessing the changes in the health status of the population according to the age difference corresponding to the same level of risk of death. This difference for a fixed risk of death $r$ is defined as:

$L(r) = y_{T_1}(r) - y_{T_2}(r)$,

where $y_{T_1}(r)$ and $y_{T_2}(r)$ – are the age at which the risk of death from all causes is at the level $r$ in the time period $T_1$ and $T_2$.

For example, if the risk of death in the period of time $T_1$ of population at the average age of 56.49 years old is $500 \cdot 10^{-5}$, and in the period of time $T_2$ the population of age of 58.15 years old is affected by the similar risk level, the difference in the average age of death is 1.66 years, which indicates a positive effect.

Due to significant differences in the countries of the world in terms of the age structure of mortality, the characteristics $y$ should be standardized taking into account the actual structure for a certain period of time.

The standardized indicator of the age of death from all causes in the $j$-th country $d_j^t$ in the time period $t$ is proposed to be calculated using the following formula:

$$d_j^t = \frac{\sum_{x=0}^{90}\left(\tilde{z}_{j(x;x+5)}^t \cdot h_{(x;x+5)}\right)}{\sum_{x=0}^{90}\tilde{z}_{j(x;x+5)}^t}, j = \overline{1,J},$$

where $(x; x+5)$ is the five-year age expectancy; $x = 0,5,10,...,90$; $h_{(x;x+5)}$ is the middle of a five-year expectancy; $(x; x+5)$ ; $J$ is the number of countries considered; $\tilde{z}_{j(x;x+5)}^t$ is an estimate of the number of deaths at the age of $(x; x+5)$ in the $j$-th country in the period $t$, adjusted for the age structure of the population:

$$\tilde{z}_{j(x;x+5)}^t = N_{(x;x+5)}^s \cdot \frac{Z_{j(x;x+5)}^t}{N_{j(x;x+5)}^t}, \quad (2)$$

$Z_{j(x;x+5)}^t$ is the number of deaths from all causes at the age of $(x; x+5)$ in the $j$-th country in the time period $t$; $N_{j(x;x+5)}^t$ is the population of the five-year age group $(x; x+5)$ in the $j$-th country in the period of time $t$; $N_{(x;x+5)}^s$ is the population of the five-year age group $(x; x+5)$ in the population structure corresponding to the reference hypothetical world standard developed by the experts of the World Health Organization [9].

When analyzing the changes over time of the standardized average age of death in a country, its aggregated characteristics for a certain time expectancy $T$ (several years) can be considered:

$$d_j = \frac{1}{T}\sum_{t=1}^{T} d_j^t.$$

Using the data in Table 1 and on the basis of the expressions (3)-(4), the standardized average age of death from all causes in Hungary can be determined. For example, in 2011 its value was 67.66 years:

$$d_{\text{Hungary}} = \frac{44938{,}7}{664.2} = 67.66 \quad (3)$$

This result is largely predetermined by socio-economic conditions of life in the country and does not depend on the age-and-sex specifics of its population. In this connection, the assessments of the average age of death obtained on the basis of the expressions (3)-(4) are comparable in dynamics and in different countries.

**Table 1 provides an example of calculating the standardized age of death from all causes in Hungary.**

| **An example of calculating the average age of death from all causes in Hungary in 2011Age group $(x; x+5)$** | **Absolute number of deaths, pers, $Z_{j(x;x+5)}^t$** | **Population, pers. $N_{j(x;x+5)}^t$** | **Standard age distribution of the population (WHO Standard), pers. $N_{(x;x+5)}^s$** | **Number of deaths in WHO's standard population structure, taking into account the magnitude of the risk of death from all causes, pers. $\tilde{z}_{j(x;x+5)}^t$** | **Middle age expectancy, years $h_{(x;x+5)}$** | **$\tilde{z}_{j(x;x+5)}^t \cdot h_{(x;x+5)}$** |
|---|---|---|---|---|---|---|
| 0-4 | 523 | 476,726 | 8,860 | 9.7 | 3 | 29,2 |
| 5-9 | 47 | 483,735 | 8,690 | 0.8 | 7.5 | 6,3 |
| 10-14 | 60 | 489,068 | 8,600 | 1.1 | 12.5 | 13,2 |
| 15-19 | 199 | 578,612 | 8,470 | 2.9 | 17.5 | 51,0 |
| 20-24 | 288 | 640,877 | 8,220 | 3.7 | 22.5 | 83,1 |
| 25-29 | 333 | 679,234 | 7,930 | 3.9 | 27.5 | 106,9 |
| 30-34 | 563 | 807,195 | 7,610 | 5.3 | 32.5 | 172,5 |
| 35-39 | 930 | 806,009 | 7,150 | 8.2 | 37.5 | 309,4 |
| 40-44 | 1,704 | 705,325 | 6,590 | 15.9 | 42.5 | 676,6 |
| 45-49 | 2,973 | 594,886 | 6,040 | 30.2 | 47.5 | 1,433,8 |
| 50-54 | 5,806 | 652,148 | 5,370 | 47.8 | 52.5 | 2,509,9 |
| 55-59 | 9,863 | 754,992 | 4,550 | 59.4 | 57.5 | 3,417,8 |
| 60-64 | 11,319 | 627,095 | 3,720 | 67.1 | 62.5 | 4,196,6 |
| 65-69 | 12,131 | 512,518 | 2,960 | 70.1 | 67.5 | 4,729,1 |
| 70-74 | 14,426 | 419,965 | 2,210 | 75.9 | 72.5 | 5,503,8 |
| 75-79 | 18,124 | 333,587 | 1,520 | 82.6 | 77.5 | 6,400,2 |
| 80-84 | 20,988 | 236,427 | 910 | 80.8 | 82.5 | 6,664,5 |
| 85+ | 28,509 | 173,338 | 600 | 98.7 | 87.5 | 8,634,7 |
| Total: | 128,786 | 9,971,737 | 100,000 | 664.2 | – | 44,938,7 |

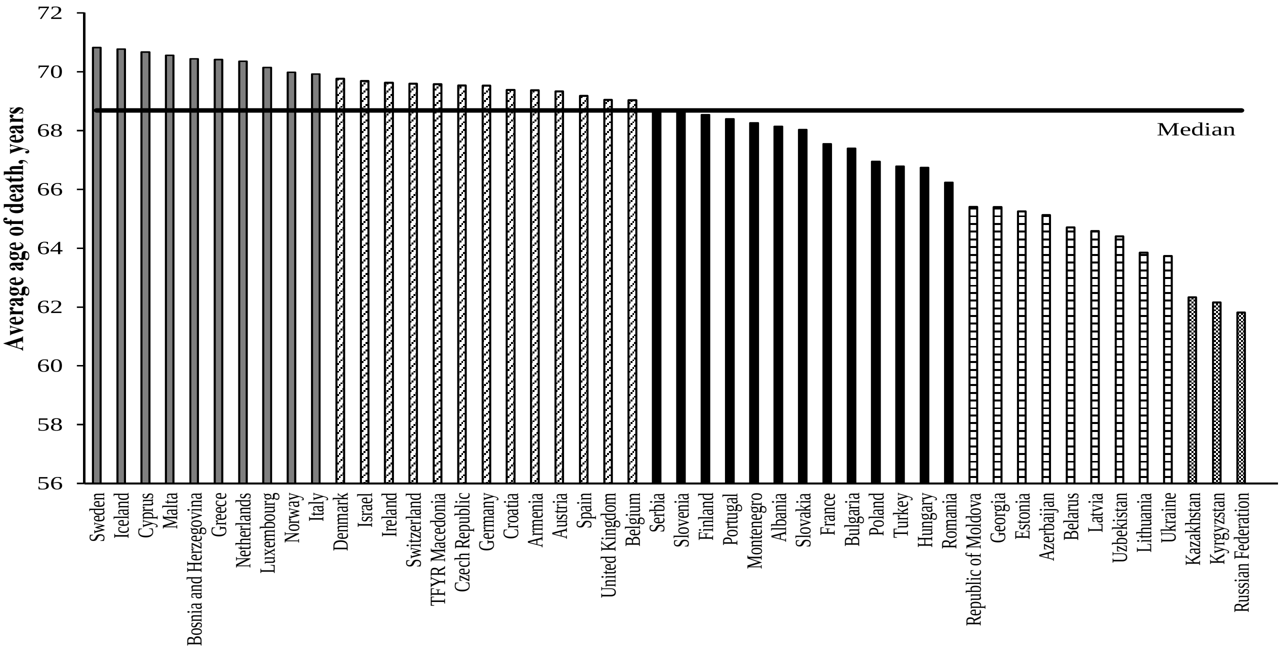


**Figure 3 – Distribution of some countries of the world by the indicator of the standardized age of death averaged over the period of 2000-2012 (per an average individual)**

## RESULTS

The proposed approach was tested on assessments of the effectiveness of changes in the volume of financing health systems in 48 countries of the world. The information base was the data of the European Mortality Database and the World Bank Indicators Database for the period 2000-2012.

At the first stage, standardized indicators of the age of death from all causes for each year of the time expectancy were calculated for all the countries of the world community under consideration, and their averaging over the time was calculated in accordance with the expressions (3)-(5) [10; 11; 12]. Figure 3 shows the distribution of countries by the standardized age of death from all causes (hereinafter referred to as the average age of death), compared with the median level for countries.

The median average age of death from all causes for the 48 countries examined was 68.68 years. The scope of the indicator exceeded 900%. The greatest value of 70.82 years for the period under consideration was recorded in Sweden. The lowest was in Russia (61.81 years).

Further, in order to summarize the results, the countries under consideration were divided into five clusters, depending on the magnitude of the deviations of the indicator of the average age of death from the median level for countries. The first cluster includes countries in which the average age of death is within 69.92 ÷ 70.82 years (which is higher than the median level by 1.8-3.1%). It includes Sweden, Iceland, the Netherlands, Norway, Cyprus, Malta and some others. The second cluster with the age of death 69.03 ÷ 69.76 years (which is higher than the median level by 0.5-1.6%) includes Denmark, Israel, Ireland, Switzerland, Germany, the Czech Republic and others. The third cluster with an average age of death of 66.23 ÷ 68.69 years (which corresponds to a median level or below it by up to 3.6%) includes Serbia, Slovenia, Slovakia, Montenegro, Poland, Hungary, Finland, and others. The fourth cluster of countries with an average death rate of 63.73 ÷ 65.40 years (which is below the median level by 4.8-7.2%), includes the Baltic states, Azerbaijan, Georgia, Moldova, Belarus and others. The fifth cluster of countries with the average age of death of 61.80 ÷ 62.33 years (which is below the median level by 9.3-10.0%) includes Kazakhstan, Kyrgyzstan and Russia.

It should be noted that in the countries of the first and second clusters, where the average age of death is above the median level, there are no significant differences in the values of this indicator. At the same time, in the countries of other clusters with the average age of death below the median level, the differences in its values are more significant. The maximum observed excess of this indicator over the median level in the countries of the first and second clusters was approximately 3%, while the minimum observed average age of death in the countries of the fifth cluster was below the median value by more than 10%.

The median level can be considered as a threshold (natural or background mortality level). Countries that managed to reach this level are more difficult to achieve its subsequent increase due to the limited biological capabilities of the human organism. However, it can be said that there is a potential for improving the effectiveness of the health care system in the countries where the average age of death is below the median.

Table 2 presents the distribution characteristics of the average age of death in the formed clusters of the countries of the world community. Low levels of intragroup variation of the indicator under consideration testify to a fairly high homogeneity of the formed clusters.

**Table 2 – Statistical characteristics of the distribution of the average age of death in clusters of countries of the world from 2000 to 2012**

| Cluster of countries | Average age of death, years | Standard quadratic deviation, years | Span of variation, years | Variation, % | Deviation of the average in the group from the median level | |
|---|---|---|---|---|---|---|
| | | | | | years | % |
| First | 70.41 | 0.30 | 0.90 | 0.42 | 1.72 | 2.51 |
| Second | 69.44 | 0.23 | 0.73 | 0.33 | 0.75 | 1.09 |
| Third | 67.73 | 0.80 | 2.45 | 1.18 | -0.96 | -1.40 |
| Forth | 64.72 | 0.60 | 1.67 | 0.93 | -3.97 | -5.78 |
| Fifth | 62.10 | – | 0.52 | – | -6.59 | -9.59 |

**Table 3 – Mortality rates of the population by five-year age groups in clusters of countries of the world, per 100,000 people, averaged over the period 2000-2012**

| Cluster of countries / Age, years | First | Second | Third | Forth | Fifth |
|---|---|---|---|---|---|
| 45-49 | 198.46 | 274.16 | 426.72 | 677.95 | 880.20 |
| 50-54 | 324.10 | 445.37 | 666.79 | 994.38 | 1,255.05 |
| 55-59 | 517.11 | 688.84 | 976.82 | 1,432.98 | 1,759.32 |
| 60-64 | 822.30 | 1,067.41 | 1,429.70 | 2,049.84 | 2,520.57 |
| 65-69 | 1,326.28 | 1,667.56 | 2,132.67 | 2,929.72 | 3,517.54 |
| 70-74 | 2,252.02 | 2,758.88 | 3,369.64 | 4,278.53 | 5,126.78 |
| 75-79 | 3,954.56 | 4,661.82 | 5,547.12 | 6,514.42 | 7,608.52 |
| 80-84 | 7,175.67 | 8,062.53 | 9,291.91 | 10,239.22 | 11,304.22 |
| older than 85 years | 16,583.81 | 17,717.15 | 18,619.71 | 19,127.59 | 20,153.16 |

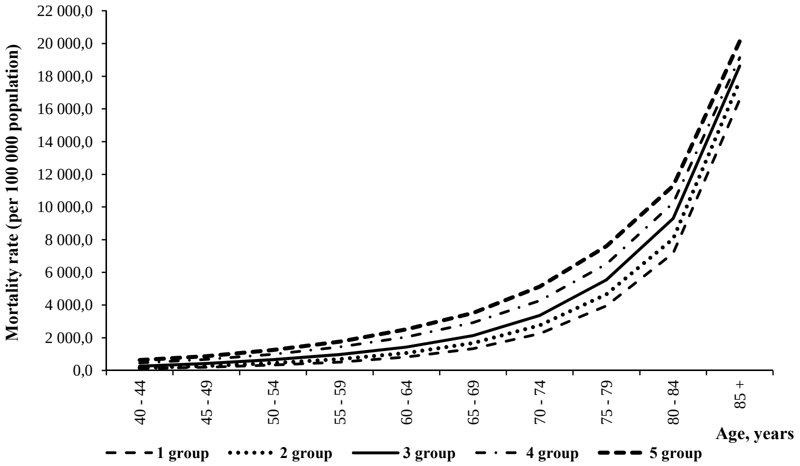


**Figure 4 – Mortality level (risk of dying) from all causes for the population of different age groups in some countries of the world on average for the period 2000-2012 (per 100,000 people)**

**Table 4 – Assessments of the parameters of the dependence "risk of death-age" model for the clusters of countries for two periods**

| Cluster of countries | Period from 2000 to 2004 | | Period from 2010 to 2012 | |
|---|---|---|---|---|
| | $\alpha_0$ | $\alpha_1$ | $\alpha_0$ | $\alpha_1$ |
| First | -1.58 | 9.34 | 0.69 | 9.25 |
| Second | -8.11 | 9.96 | -5.59 | 9.77 |
| Third | -17.02 | 10.79 | -15.72 | 10.82 |
| Forth | -30.60 | 12.12 | -29.90 | 12.25 |
| Fifth | -44.61 | 13.53 | -32.43 | 12.29 |

**Table 5 – Correlation of changes in the volume of health care expenditures and the reduction in losses due to premature mortality in clusters of countries for the periods from 2000 to 2004 and from 2010 to 2012, calculated per capita**

| Cluster of countries | Reduction of losses due to premature mortality, years | Growth of expenditures, USD | Growth of expenditures, % |
|---|---|---|---|
| First | 1.38 | 1137.74 | 46.88 |
| Second | 0.85 | 1183.60 | 55.77 |
| Third | 1.55 | 703.67 | 65.04 |
| Forth | 1.84 | 423.24 | 113.14 |
| Fifth | 0.87 | 615.13 | 175.19 |

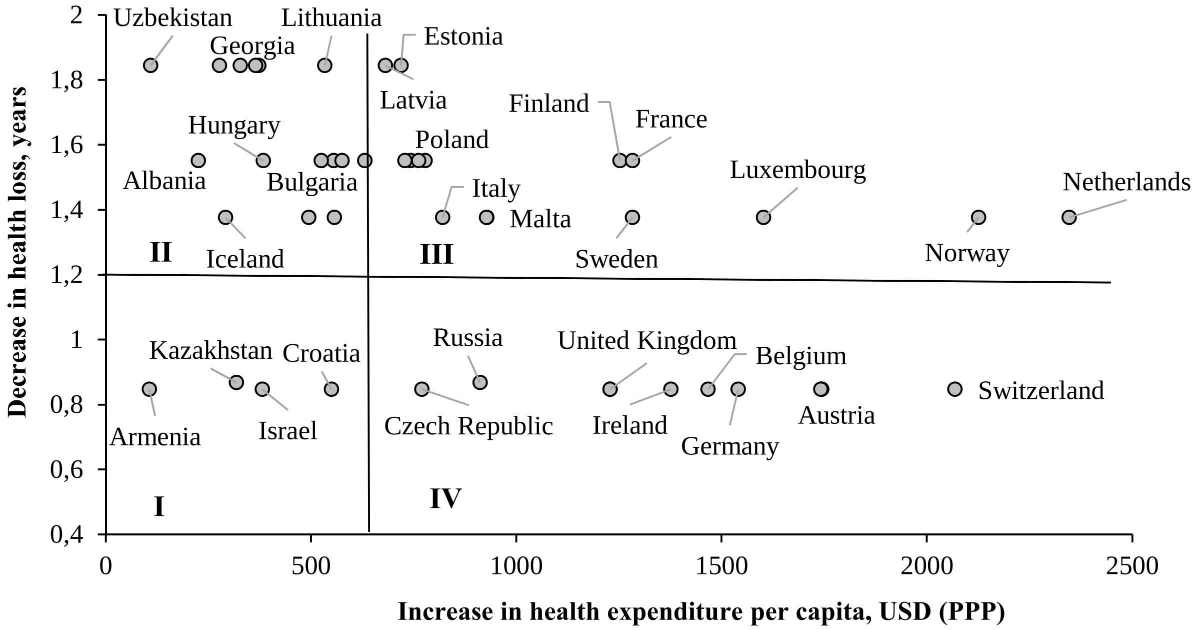


**Figure 5 – Comparison of changes in the volume of health care expenditures and the magnitude of the reduction in losses due to premature mortality, per person**

Differences in the levels of the average age of death in the formed clusters of countries are mainly predetermined by the discrepancies in the age distribution of the risk of death in older age groups. Figure 4 shows the dependencies of this indicator, estimated by five-year age groups as the ratio of the number of deaths to the size of the group. For the population under the age of 45, the group risk of death is almost zero, and since the age of 45, the exponential growth of risk has been observed.

Table 3 shows the risk levels of death in age groups over 45 years according to the clusters of the countries of the world per 100,000 people.

According to the data in Table 3, the levels of the risk of death are most significantly different in the extreme first and fifth clusters of countries for the population of the 45-49 age group (more than 4 times). With an increase in age, these differences decrease. For the population over the age of 85, it decreases to 22%. It is important to note that the reduction in the difference of the risk of death for the population over the age of 85 is observed for all clusters. In particular, in the second cluster, in comparison with the first one, the excess of the risk of death for the population over the age of 85 was 6.8%, and for the population of the age 45-49 – 38%.

In order to assess the effectiveness of health care expenditures in the obtained clusters of countries, an analysis of changes in the age distribution of deaths for 2000-2012 was made. The magnitude of the change in health loss, presented in the form of an increase in lost life years as a result of mortality from all causes, was determined as the difference in the ages of death of individuals for the periods 2000-2004 and 2010-2012, assessed with the same values of the risk of death. In determining the age at which an individual is subject to a certain threshold of the risk of death, the equations characterizing the "age-risk of death" relationship (expression (1)) are used with setting the interval of the risk of death $r \in \left[139 \cdot 10^{-5}; 22{,}000 \cdot 10^{-5}\right]$. The lower limit of the risk of death equal to $139 \cdot 10^{-5}$ characterizes the minimum observed risk of death among the countries under consideration (this value corresponds to the risk of death in the first cluster of countries for the population of 45-49 years in 2012). The upper limit equal to $22{,}000 \cdot 10^{-5}$ characterizes the maximum risk of death observed among the countries under consideration (the risk of death in the fifth cluster of countries for the population of 45-49 in 2003).

Table 4 gives assessments of the parameters of the models of the dependence of the risk of death for the clusters of countries in question over the two time periods: 2000-2004 and 2010-2012. The assessed parameters of all the models obtained are statistically significant and the determination coefficients for the models exceed 99%, which indicates the validity of the representation of dependencies of age on the risk of death by equations of the type (1).

The information presented in Table 4 as a whole shows that in all countries the risk of death in all age groups decreased by 2010-2012 in comparison with the period 2000-2004. This is evidenced by the increased values of the coefficients $\alpha_0$ and the decreased values of the coefficients $\alpha_1$ over the considered period.

Equations of the type (1) obtained for different periods of time made it possible to assess the changes in the health status of the population on the base of the expression (2) by the age difference corresponding to the same level of the risk of death.

As a result of calculations, it was revealed that in the period from 2010 to 2012, the level of the risk of death, characteristic of the period 2000-2004, in each cluster the same risks of death correspond to later ages, namely in the first cluster of countries the increase in age was an average of 1.37 years, in the second – 0.85 years, in the third – 1.55 years, in the fourth – 1.84 years, and in the fifth – 0.87 years.

## DISCUSSION

The results of the comparative analysis of the reductions in losses due to premature mortality and changes in the value of health expenditures by the countries of the world community for the period from 2010 to 2012 in comparison with the period of 2000-2004 show that the greatest reduction in years lost due to premature mortality in the amount of 1.84 years (an increase in life expectancy) was achieved in the countries of the fourth cluster, which increased the expenditures on health care more than twice. The smallest increase in years of healthy life in the amount of 0.85-0.87 years was reached by the countries of the second and fifth clusters, while the countries of the fifth cluster increased per capita financing by 2.75 times, and the countries of the second – by 1.56 times. On the one hand, this result may indicate inefficient use of health care system resources in the countries of the fifth cluster. On the other hand, it can be caused by significant differences in the initial levels of financing the health care system and the non-linear nature of the relationship between the level of losses and financial investments in the health care system. The size of health care expenditures in the countries of the second cluster by 2010-2012 increased from $2,112 to $3,305 per capita, and in the countries of the fifth cluster - from $351 to $966 per capita. It is possible that in the countries of the fifth cluster, the level of financing of the health care system has not yet reached those values where additional investments can significantly affect the improvement of public health.

The effectiveness of investments in the health care system in different countries of the world community can be assessed on the basis of a typological matrix of indicators of changes in the magnitude of expenditures and public health losses (see Figure 5). The coordinate system in Figure 5 with the "loss reduction" axes and "expenditure increase" forms four quadrants corresponding to the four variants of the ratio of the indicators considered: "high reduction in health losses – high expenditure growth", "high loss reduction – low expenditure growth", "low reduction of losses – high expenditure growth", "low loss reduction – low expenditure growth". Low reduction in health losses with high expenditure growth (area IV in Figure 5) indicates inefficient use of health care resources. Low loss reduction with low expenditure growth is an indicator of the resource deficit (area I in Figure 5), while a high loss reduction with high expenditure changes (area III in Figure 5) can characterize the surplus of resources. The performance of health care systems in countries with high loss reduction and low funding increase (area II in Figure 5) can be assessed as effective.

In a number of countries, such as Switzerland, Austria, Belgium, Germany in 2010-2012 there was a significant increase in per capita expenditures on health care, by more than $1,500 compared with 2000-2004, but their results to reduce losses due to premature deaths were similar to those of countries investing significantly less resources in health care, such as Croatia, the Czech Republic and Israel, which increased the per capita expenditures for the period under review by no more than $800.

## CONCLUSION

The proposed approach to determining the losses due to premature mortality and assessing the effectiveness of health care systems has made it possible to correctly compare the countries of the world community in terms of the growth in life expectancy, regardless of their differences in the age structure of mortality.

Countries that have significantly reduced the losses due to premature deaths and increased life expectancy, which include the states of the former socialist camp – Moldova, Georgia, Estonia, Latvia, Ukraine and some others, have been identified.

Based on the ratio of indicators of the change in the per capita health expenditures and the loss of public health, the effectiveness of investments in the health care system in various countries was assessed. All can be classified into four categories: "high reduction in health losses – high growth of expenditures", "high loss reduction – low growth of expenditures," "low loss reduction – high growth of expenditures," "low loss reduction – low growth of expenditures". In countries of the second category, one dollar invested in the health care system has the greatest effect on reducing health losses and vice versa, in the countries of the third category, there is the smallest effect of invested funds in the health care system.

The results obtained can be used to justify the investment attractiveness of health care projects aimed at reducing mortality and morbidity. At the same time, we consider it necessary to pay attention to the limitations of using this approach to determine the losses due to premature mortality. In particular, it allows determining the loss of health and life only due to the reasons, the risk of morbidity and death from which is dependent on age. In particular, these are diseases of the circulatory system, respiration, neoplasms and some others.

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