

Definition of lost years of healthy life due to occupational diseases by DALY method

Oszacowanie przedwczesnej śmiertelności spowodowanej chorobami zawodowymi z użyciem metody DALY

Abstract:

An assessment of economic losses of a society due to occupational diseases using the DALY method because of premature mortality and low quality life is highlighted in the paper. The values for the burden of diseases recommended for use of experts of the World Bank are presented. The years lost due to the untimely death of patients from occupational diseases engaged in selected types of economic activity are defined.

Streszczenie:

Przedmiotem niniejszej pracy jest oszacowanie ekonomicznych strat społeczeństwa spowodowanych przedwczesną śmiertelnością i niską jakością życia w wyniku chorób zawodowych, z użyciem metody DALY. Prezentowane dane dotyczące obciążeń społecznych wywołanych tymi chorobami polecane są do wykorzystania przez ekspertów Banku Światowego. Oszacowano liczbę utraconych lat życia spowodowanych przedwczesnym zgonem pacjentów z chorobami zawodowymi w różnych typach aktywności ekonomicznej.

Keywords: occupational morbidity, years of healthy life lost, DALY method

Słowa kluczowe: zachorowalność zawodowa, utracone lata zdrowego życia, metoda DALY

Introduction

An occupational disease occurs as a result of a person's professional activity within a work environment and is specified by the action of factors in the work environment typical for a particular profession [1, 2]. According to the data provided by the International Labor Organization, approximately 160 million cases of occupational diseases are recorded in the world yearly and the resulting negative economic effect on societies amounts to 4-5% of the world's GDP; i.e., more than \$1251.3 billion. [1, 3, 4].

As far back as XVI century, the English economist V. Petti made the first attempt to evaluate human health as an element of national wealth, depending on the type of activity and the ability to work. Later, A. Smith laid the basis for a comprehensive definition for the cost of "human capital".

At the beginning of the XX century, during a period of rapid economic development in society, there occurred a need for scientists to assess medico-demographic processes economically. The problem of defining losses

attributable to premature mortality was studied by Y. Korchak-Chepurkovsky, L. Gersh, E. Filrose, D. Neiman, and others. Beginning in the second part of the XX century, attempts were made to estimate losses due to a worsening in the health of the working population in Ukraine. Among the scientists of the former Soviet Union engaged in studying the problems of the economic assessment of medico-demographic processes, it is necessary to mention V. Korchagin, Y. Lisitsin, B. Prokhorov. The economic consequences of the effect of harmful working conditions on human health were studied by G. Bushuyeva, V. Katsnelson, V. Tkachov [5].

However, irrespective of the great contribution of these scientists, there are few methodical elaborations available in scientific literature and only approximate estimations of losses from occupational diseases. Thus, the official statistics showed that the amount of economic losses from accidents at work and from occupational diseases in the countries of the former Soviet Union did not exceed 2% GDP. However, according to ILO estimations, the losses from diseases related to occupational activity in

developing countries, can reach even 10% GDP. Such great differences, in our mind, are conditioned by the difficulties of a information-methodical character; i.e., imperfections in the method for estimating economic losses and incomplete coverage of data.

Economic losses not only cover the expenses of treatment, rehabilitation, re-qualification of patients and support for the disabled, but also the losses incurred by the direct or indirect effect of the work environment: a decrease in the quality of life and the shortening of life spans, a decrease of health values and work efficiency, disorders of reproductive function in a population, an increase in the load on the public health system, failure to maintain a specific level of GDP; i.e., direct and indirect losses. The amount of direct economic losses according to the assessment of specialists, ranges from 10% to 30%.

The purpose of this study was to develop a method for defining one of the components for indirect losses to society; i.e., years of healthy life lost due to occupational diseases. For this, available methodical elaborations have been used, corrected and adapted to modern social and economic conditions.

Method

The most known integral indicator of the years of healthy life lost is the DALY (disability adjusted life years) metric, which shows the territorial and causal differentiation of medico-social losses in a society. It was proposed in 1990 by Murray and Lopez and was recommended for use by experts at the World Health Organization.

The concept of DALY is based on the postulate concerning the consequences of diseases, according to which, not only can an ailment result in a loss in the quality of an individual's life (limitations in communication, movement, ability to be self-sufficient, etc.), but also in untimely death. DALY is a linear sum of years of a potential life lost because of untimely death, and years spent in a morbid (disabled) state.

The years lost due to untimely death are estimated by the YLL index (years of life lost due to premature mortality), whereas the years lived with a disease or disability of various degrees of burden by the YLD index (years lost due to disability). The main idea of the DALY calculation is the contribution each of these components has on the general number of years of life lost [8, 9]:

- premature mortality

$$YLL = n \cdot L, \quad (1)$$

where

- n – the number of deceased in each age group,
- L – standard duration of life in the year of death;

- morbidity (disabled state)

$$YLD = I \cdot DW \cdot L, \quad (2)$$

where

- I – the number of cases of disease,
- L – mean duration of a disease up to remission or mortality (years);
- DW – burden of disability (a weighted coefficient showing the severity of a disease).

Below is the base mathematical model for defining the standard meaning of DALY [10]:

$$DALY = - \left[\frac{D \cdot C \cdot e^{-\beta a}}{(\beta + r)^2} \right] [e^{-(\beta+r)L} (1 + (\beta + r)(L + a)) - (1 + (r + \beta)a)], \quad (3)$$

where

- D – a weighted coefficient of the burden of disease,
- a – meaning of the median of the age interval to which the recorded case refers (or the age when the disease sets in),
- r – discount rate,
- L – duration of the state – the years of life on the average which have been lost as a result of one case of disease or mortality. The value L is calculated by the formulae of the arithmetic mean weighted from the lost years of life for a definite age period and the number of cases recorded in it separately for each nosologic form,

C and β – constants, showing the statistic weight of the age.

To calculate DALY it is necessary to answer a number of questions in order:

- to define a potentially possible life span;
- to ground weighted coefficients of a disease burden and the “value” of healthy life for different age groups;
- to compare the value of a healthy life in the present with its value in future.

The calculation for the years of life lost in the case of a disease or premature mortality determines a potential life span. The highest potential for the life span of women in Japan is used as the world's standard rate and which is 82 years (for men – 80 years) [11]. However, for an ordinary Ukrainian citizen the probability of living a shorter life is very high. In addition, the period of life without health disorders, which cause disability and, in time, invalidity, is also very short. Taking into account the very high gender differences in the life spans of our fellow citizens, the definition for the years of healthy life lost should be based on the national tables of survival.

In order to provide a comparison of the years of healthy life lost due to different diseases and the impossibility of comparing the time lived with a disease or disability with

the time lost due to premature mortality weighted average values for burden of disease (disability) are used. The weighted values range from "0" for absolute health to "1" in the case of mortality and are defined by experts according to the abilities of patients who are active in reproductive, educational, occupational and recreational spheres. Table 1 shows the weighted values of burden of diseases recommended for use by experts at the World Bank [10, 13].

Tab. 1 Weighted values of burden of diseases

Characteristics of the state of health	Values
1. Restricted ability to be active in least one sphere: reproductive, educational, occupational, recreational	0.096
2. Restricted ability to be more active in any of the following spheres: reproductive, educational, occupational, recreational	0.220
3. Restricted ability to be active in two or more of the following spheres: reproductive, educational, occupational, recreational	0.400
4. Restricted ability to be active in all the below mentioned spheres: reproductive, educational, occupational, recreational	0.600
5. The support needed in everyday activity as it relates to cooking, shopping, housekeeping, etc.	0.810
6. The support needed in every-day activity as it relates to acquiring food, maintaining personal hygiene, etc.	0.920

Thus, the weighted values defined by experts are: for malignant tumors – 0.9; pneumoconiosis – 0.4; psychological diseases – 0.5; muscular-skeletal system – 0.5; hearing loss due to exposure to noise – 0.3.

The problem in establishing the value of a healthy life for various age groups is one of the most discussed in the DALY definition, because a year of life for any age is of equal worth. In a World Bank report, it is mentioned that "the value" of a healthy life, and so the weighted values, respectively, increase in age from birth until 25 years of age. Therefore, when defining DALY it is exactly the social values of differing age groups that are taken into account, where age dynamics on the level of personal social productivity is an indicator. In formulae 3, the definition of the burden of disease indicator and age differences are taken into account thanks to the use of C and β constants.

Comparing the value of a healthy life at present with its value in future is made by discounting. It is considered that the "value" of a healthy life at present is somewhat higher than its "value" in future. Therefore, defining DALY rates of discount are calculated at the level of 3%.

Each health problem can probably result in:

- 1) mortality;
- 2) disability before mortality;
- 3) permanent disability;
- 4) full recovery.

Factors determining occupational health are of a constant character and the information about the recovery from an

occupational disease is not available, therefore, the DALY calculation in this study is made by two possible courses of an occupational disease: a disability before mortality and a permanent disability. The procedure for determining the burden of disease indicator is achieved by using the data pertaining to the number of deceased from occupational diseases with the established cause-effect relation of the disease on their occupational activity by 1.01.2011.

Results

According to data from the Centre of Medical Statistics at the Ministry of Health in Ukraine, the number of the deceased in 2010 as a result of occupational diseases with the established cause-effect relation of their professional activity, amounted to 313 individuals. The majority of the deceased were underground coal mining workers. In the medical history of most cases, different chronic diseases of the respiratory system and pneumoconiosis caused by chemical substances, gases, organic or non-organic dusts were recorded. The age of the deceased ranged from 38, in uranium and thorium ore mining, to 84 years in coal mining. Among the deceased, only 15% survived to the age of the life expectancy in Ukraine, and only 2% to the international standard age.

Table 2 shows the assessed years of healthy life lost calculated by the formulae (3) as a result of the premature mortality and low life quality of workers on the assumption that each worker within 10 years, on average, suffered from an occupational disease.

Tab. 2. Years lost due to premature mortality

Type of economic activity	The number of deceased individuals	DALY, years	
		Premature mortality	Low life quality
05.10 Coal mining	253	1654.7	1088.0
07.10 Iron ore mining	8	27.9	26.8
07.21 Uranium and thorium ore mining	9	63.7	41.9
Other types of economic activity	43	196.0	118.1

In 2010 the total number of years of healthy life lost due to premature mortality from occupational diseases amounted to 1942.3 DALYs, and due to low life quality, 1274.8 DALYs.

The amount of the deficient GDP is a cost parameter of economic losses from occupational diseases. As regards official statistical data, the GDP per capita in 2010 amounted to 23 600 UAH, one can then suppose that the rate of the deficient GDP, even without taking inflation into consideration reached 75.9 million UAH.

The previous calculations of direct economic losses show that losses from occupational diseases in Ukraine,

including mainly losses incurred by enterprises, the social insurance fund, the pension fund and the health system budget for 2010 reached 4094.4 mln Hryvna [6].

Therefore, taking the deficient GDP into account, due to untimely death and low life quality, the amount of losses in GDP amounts to 0.38%. As regards estimations by ILO specialists, the level of losses from occupational diseases can range from 5% to 10%, the problem as it relates to defining the cost of the deficient GDP requires further study.

Conclusion

1. At present DALY is considered to be a unified index of the burden of diseases making it possible:
 - to assess medico-social losses of a society not only due to morbidity, disability or premature mortality, but also to any combination of the above-mentioned causes;
 - to assess direct and indirect economic losses from any causes or their combinations;
 - to ground recommendations on the determination of strategic priorities in the national public health system.
2. Presently, DALY is used insufficiently in Ukraine because of an unavailability of the adapted method for its assessment.

REFERENCES

- [1] Kundiev Y.I. Occupational health in Ukraine. An epidemiological analysis / Kundiev Y.I., Nahorna A.M. / Kiev: Avicenna, 2007 (in Russian).
- [2] Bilyk I.O. Disability. Available from: <http://www.minjust.gov.ua/0/23359>
- [3] Kundiev Y.I. Occupational morbidity in Ukraine within a long-term supervision / Kundiev Y.I., Nahorna A.M. Ukrainian Journal of Occupational Health. 2005; (1): 3-11 (in Ukrainian).
- [4] For the work safety. Available from: http://www.ilo.org/public/russian/region/eurpro/moscow/areas/safety/docs/safework_fact_sheetrus1_1.pdf
- [5] Katsnelson V.A. Analysis of economic consequences of the effect of unfavorable work conditions and industrial pollution of the environment on the human health, and economic efficiency of preventive measures / A. Katsnelson, G.A. Bushuyeva, V.V. Tkachev, E.V. Polzik. Moscow, 1988:43 (in Russian).
- [6] Kolodyazhna O.I. Main principles and methodological bases in the definition of economic losses due to occupational morbidity of the working population of Ukraine / O.I. Kolodyazhna, A.M. Nahorna, M.P. Sokolova. Ukrainian Journal of Occupational Health. 2012; 29 (1): 81-85 (in Ukrainian).
- [7] Fox-Rushby J.A., Yanson K. Calculating and presenting disability adjusted life years (DALYs) in cost-effectiveness analysis. Health Policy Plan 2001, WHO, Geneva.
- [8] Global health risks: mortality and burden of disease attributable to selected major risks. Geneva, WHO; 2009.
- [9] Haagsma J.A., Polinder S., Lyons R.A., Lund J., Ditsuan V., Prinsloo M., Veerman J.L., van Beeck E.F. Improved and standardized method for assessing years lived with disability after injury. Bulletin of the World Health Organization. 2012.
- [10] Murray C.J. Quantifying the burden of disease; the technical basis for disability-adjusted life years. World Health Organization Bulletin OMS, 1994.
- [11] Nuria Homedes. The Disability Adjusted Life Year (DALY) Definition, Measurement And Potential Use, 1995. Available from: http://www.worldbank.org/html/extdr/hnp/hddflash/workp/wp_00068.html.
- [12] Titarenko L.V. Modern approaches to the procedure of integral assessment of health indices for railway transport tuberculosis workers. Available from: <http://vestnik.mednet.ru/content/view/290/30/lang.ru/>.
- [13] Occupational risk. Theory and practice of assessment: Monograph / Eds. A.G. Hkrupachev, A.A. Khadartsev. Tula: Edition of Tula State University. 2011:330 (in Russian).
- [14] Rostovtsev V.N. The procedure of the combined assessment of losses of health due to morbidity and mortality // V.N. Rostovtsev, L.N. Lomat, O.I. Ryabkov, I.B. Marchenkova, B.E. Kuzmenko. Minsk; 2008: 28 (in Russian).