

THE INFLUENCE OF DALY PARAMETERS ON THE ESTIMATION OF BURDEN OF DISEASE

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Abstract: DALY is the sum of the present value of future years of life lost by premature deaths and the present value of future life years adjusted for severity on any physical and mental disability caused by an illness or an accident. The aim of this study was to describe the specific effect of parameter variation included in the estimation of the burden on tuberculosis in Romania, 2008. β parameter variations lead to variations in the distribution of DALYs by age (β growth has led to a higher proportion of younger age groups and β decrease had opposite effect) and the variations in the parameters r and K had no effect on the differences between genders, nationwide DALY percent in men ranged from 80.96 to 81.16% but it led to variations in the share of YLD in DALY composition, which can lead to variations in decisions about the interventions in the field of TB care.

Cuvinte

cheie: tuberculoză, DALY, ani de viață ajustați prin dizabilitate, YLL, YLD, rata discount

Rezumat: DALY reprezintă suma dintre valoarea prezentă a anilor viitori de viață pierduți prin decese premature și valoarea prezentă a anilor viitori de viață ajustați pentru severitate dată de orice dizabilitate fizică și mentală cauzată de o boală sau un accident. Scopul acestui studiu a fost de a descrie efectul specific al variației ajustorilor incluși în estimarea prin DALY a poverii dată de tuberculoză în România, anul 2008. Variațiile parametrului β au dus la variații în repartitia DALY pe grupe de vârstă (creșterea β a dus la o pondere mai mare a grupelor de vârstă tinere și invers) iar variațiile parametrilor r și K nu au avut efect asupra diferențelor dintre sexe, la nivel național ponderea DALY la bărbați a variat între 80,96 - 81,16%, dar au dus la variații în ponderea YLD din compoziția DALY, ceea ce poate duce la variații ale deciziilor în legătură cu intervențiile din sectorul de asistență medicală pneumofiziologică.

INTRODUCTION

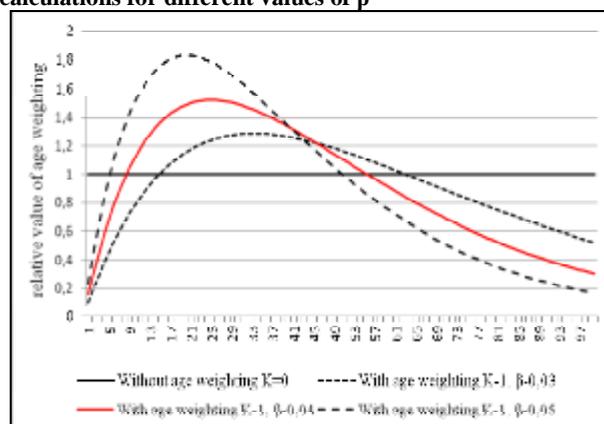
Assessing the population health was traditionally achieved on the basis of mortality analysis, by medical causes of death, by age group, by gender and, when data were available, on the basis of incidence and prevalence of diseases. Disability Adjusted Life Years (DALY), proposed in the Global Burden of Disease 1990 study to estimate the burden of disease in a population simultaneously evaluates premature mortality and the non-fatal outcomes of the disease and is calculated as the sum of potential years of life lost (YLL) and years of life lost through disability (YLD).

DALY calculation formula, as it was provided by the authors, include the formula for YLD and YLL and introduce parameters for social adjustments (r - annual discount rate, K - age weighting modulation factor, β - parameter from age weighting function, C - constant), these adjustments producing many more debates about the methodology of calculation of indicators than no data for mortality, incidence and prevalence in some parts of the world.

According to GBD 1990, a year of healthy life lived at young age or old age receive a relative value less than one year of healthy life lived at other ages by introducing constant a $K = 1$ for age weighting. When K is 0, all ages have a relative value of 1 (figure no. 1) and if is 1, then DALY includes a weighting function $Cxe^{\beta x}$ depending on the age, where X is the age in years and β and C are constants. Criticisms for introducing the age weighting function were as follows:

- On the principles of fairness, each year of life should have the same value;(1)
- Age relative values are uncertain and have not been empirically validated on large populations;
- Assigning relative values of ages adds another level of complexity to the analysis and has only a minor effect on the ranking of diseases (2)
- The relative values of ages determine a higher YLL for the age group of 0-39 years old.(2)

Figure no. 1. Age weighting function included in DALY calculations for different values of β



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For Global Burden of Disease study (GBD) in 1990, Murray and Lopez chose $\beta = 0.04$ to obtain a model close to that derived from empirical data. β values greater than 0.04 give more weight to the young ages (figure no. 1) and less to the advanced ages and β less than 0.04 give more age weight to advanced ages.

Parameter C, estimated for GBD study 1990 at 0.1658 was chosen so that the total DALY be the same regardless of whether or not the age-related weighting is applied.

In GBD 1990, discount rate of 3% was applied annually for the years lost in the future to get thereof a net present value. Using this discount rate, over 15 years, a year of life gained will be worth 35% less than a year of life gained today. Applying discount function for future benefits is a common practice of economic analysis and reflects the preference for the present to the uncertain future. The rate of 3% has been recommended for health economic analyses, both for the costs and consequences.(3)

PURPOSE

The purpose of this study is to describe the specific effect of variation of DALY parameters to the burden estimation on tuberculosis in Romania, 2008.

METHODS

The study is a descriptive one and it is consisted in the application of variation of parameters K, r, β , C included in DALY formula for estimating the burden of disease.

Variations were applied to formulas:

$$YLL = \frac{K C a^{rL}}{(r+\beta)^L} \left\{ e^{-(r+\beta)(L+a)} [-(r+\beta)(L+a) - 1] - e^{-(r+\beta)a} [-(r+\beta)a - 1] \right\} + \frac{1-e^{-rL}}{r} (1-e^{-rL})$$

where: K – age weighting modulation factor, r – discount rate, L – standard life expectancy at age a, C - constant, β – parameter from the age weighting function, a – age of death

$$YLD = D \left\{ \frac{C C a^{rL}}{(r+\beta)^L} \left\{ e^{-(r+\beta)(L+a)} [-(r+\beta)(L+a) - 1] - e^{-(r+\beta)a} [-(r+\beta)a - 1] \right\} + \frac{1-e^{-rL}}{r} (1-e^{-rL}) \right\}$$

where: K – age weighting modulation factor, D – disability weight, r – discount rate, L – duration of disability, C - constant, β – parameter from the age weighting function, a – age of onset of disability.

Thus, for the annual discount rate, variants 0 (no annual adjustment in future years lost) were used or 3% (variant used in the GBD study 1990), for K, variants 0 (no weighting ages) and 1 (uneven weighted ages) were used.

For variations of β and C parameters, the variants in the following table were used:

Table no. 1. C parameter variations depending on the parameter β

| Parameter β | Parameter C |
|-------------------|-------------|
| 0.02 | 0.0634 |
| 0.03 | 0.1051 |
| 0.04 | 0.1658 |
| 0.05 | 0.2487 |
| 0.06 | 0.3560 |

Parameter C was chosen by the GBD 1990 authors so that the total global DALY to be the same with and without weighting ages.(4) In this article, the same pair of constants β and C for K = 1 were used.

As shown in figure no. 1, by increasing the parameter β decreases the age with the highest the relative value and increases it relative value. The described above variations were applied to the results obtained for DALY by tuberculosis in Romania in 2008.

To estimate the burden of disease, the following types of data were used: the number of new cases of tuberculosis, by gender and county, provided by the “Marius Nasta” Institute of Pneumology and the data on population and the deaths occurred because of tuberculosis, by gender and county, provided by the National Institute of Public Health - National Centre for Public Health Statistics and Information.

For the disability weight (D), the values used in Global Burden of Disease 1990 study were taken into account, as well as the subsequent ones (table no. 2)

Table no. 2. Disability weight GBD 1990 for tuberculosis

| Untreated forms | | | | | Treated forms | | | | |
|--------------------|-------|-------|-------|-------|--------------------|-------|-------|-------|-------|
| Age groups (years) | | | | | Age groups (years) | | | | |
| 0-4 | 5-14 | 15-44 | 45-59 | 60+ | 0-4 | 5-14 | 15-44 | 45-59 | 60+ |
| 0.294 | 0.294 | 0.264 | 0.274 | 0.274 | 0.294 | 0.294 | 0.264 | 0.274 | 0.274 |

RESULTS

Applying the annual discount rate of 3% and age-related weighting (K = 1), as were used in the GBD 1990 study and the alternatives that do not apply discount rate or age weighting coefficient K, led to the following results for tuberculosis disease burden, expressed in DALY:

Table no. 3. DALY structure by comparing the effect on tuberculosis burden of variations in the coefficients r and K, Romania, 2008

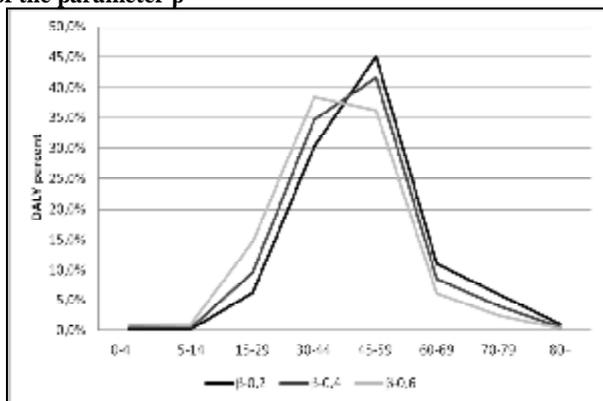
| | DALY (r = 0%, K = 0) | DALY (r = 3%, K = 0) | DALY (r = 3%, K = 1) |
|---------------------------|----------------------|----------------------|----------------------|
| Total DALY | 48,696 | 32,047 | 28,105 |
| Percentage per outcome | | | |
| Total YLL | 94,82% | 92,19% | 89,47% |
| Total YLD | 5,18% | 7,81% | 10,53% |
| Percentage per gender | | | |
| Men | 81,05% | 81,16% | 80,96% |
| Women | 18,95% | 18,84% | 19,04% |
| Percentage per age groups | | | |
| 0-4 | 0,60% | 0,45% | 0,44% |
| 5-14 | 0,32% | 0,35% | 0,46% |
| 15-29 | 7,59% | 6,51% | 9,55% |
| 30-44 | 33,13% | 29,35% | 34,70% |
| 45-59 | 43,04% | 44,44% | 41,66% |
| 60-69 | 9,51% | 11,26% | 8,50% |
| 70-79 | 4,96% | 6,46% | 4,07% |
| 80+ | 0,85% | 1,18% | 0,61% |

We can notice that by applying a discount rate has an effect on the proportion of total YLD in DALY. When the discount rate was of 0%, the YLD was of 5.18% when it was applied a discount rate of 3%, the YLD was of 10.53% and of 7.81% depending on whether or not age-related weighting (K = 1 or K = 0) is applied. For tuberculosis, variations in the discount rate and applying age-related weighting had no effect

on disease burden distribution between men and women and between age groups.

Variations of β parameter cause variation of distribution tuberculosis burden by age, so a value of β greater than 0.04 cause a higher proportion of younger age groups burden and lower proportion for higher age groups and conversely, a value β less than 0.04 lead to lower share of younger age groups and a higher share of age groups (figure no. 2).

Figure no. 2. Share of DALY given by tuberculosis in Romania, in 2008, by age group, according to the variation of the parameter β



The biggest difference between men and women for YLL/death by age was 0.82 years/death in the age group 65-69 years old for YLL (3.1) and 3.09 years/death at age group 50-54 years old for YLL (0.0) as can be seen in figure no. 3.

Figure no. 3. The effect of applying age weighting and discount rate on the difference between YLL/death in men and women for tuberculosis in Romania, 2008

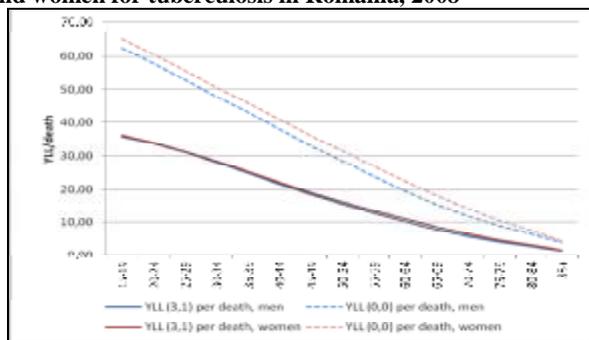
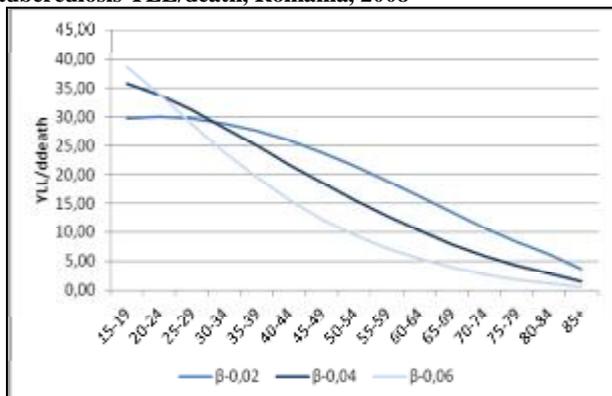


Figure no. 4. Effect of β parameter variations on tuberculosis YLL/death, Romania, 2008



To see the effect of variation of the parameter β on YLL/death, the discount rate of 0.03% and $K = 1$ were maintained with the values of 0.02, 0.04 and 0.06 for β . Thus, it was observed that for the same real situation of deaths by age group, Yll/death increased at higher age groups for small values of β .

CONCLUSIONS AND DISCUSSIONS

As it was shown in the present study and literature, DALY is the sum of the present value of future years of life lost by premature deaths and the present value of future life years adjusted for severity on any physical and mental disabilities caused by an illness or an injury. Therefore, the DALY is a measure of what is lost and not of what is gained and the goal is to reduce DALY. Details on the DALY building were the reason of much debate given that, from choosing a set of key parameters and a set of social values by which to calculate, based on actual data of the population, an indicator summative as DALY type, they will form the basis of decisions of choice of health programmes.

β parameter variations lead to variations in the distribution of DALYs by age (β growth has led to a higher proportion of younger age groups and vice versa).

Variations in the parameters r and K had no effect on the differences between genders, nationwide DALY in men ranged from 80.96 to 81.16% but led to variations in the composition YLD, which can lead to variations of decisions about TB healthcare sector interventions.

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