Disability Adjusted Life Years (DALY) Calculator: Methodology

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http://healtheconomics.tuftsmedicalcenter.org/orchard/daly-calculator

Motivation

Cost-effectiveness analysis (CEA) has been a popular tool to quantify trade-offs between health gains of a health intervention and additional resources required to achieve the health gains. The cost-effectiveness information of multiple interventions can help decision-makers to allocate limited health care resources to maximize the efficiency. To promote comparability of various interventions across different disease areas, standard guidelines in CEA recommend using a standardized measure that encompasses both morbidity and mortality, such as quality-adjusted life years (QALY) or disability-adjusted life years (DALYs)[1,2].

While cost-per-DALY studies largely focus on low-middle income countries[3], the cost-per-DALY metric only accounts for a limited proportion of health economics literature[4]. Many CEAs still use "natural" units to measure health gains, such as cost per death averted or postponed, or cost per case averted or cured. Those measures may be more easily understood by clinicians and policy makers, but they are more difficult to compare across health areas and thus harder to use for informing broad resource allocation decisions. It is not clear, for example, how to compare the cost of averting a case of diabetes to the cost of averting an injury.

To make more CEA data available in standardized metrics, particularly in the DALY, we aim to develop a convenient tool that can convert health outcomes expressed in non-DALY metrics (e.g. cases averted, deaths averted) into DALYs. Converted outcome measures could then be used to generate standardized cost-effectiveness metrics, such as cost-per-DALY averted.

Methodology

Disability-adjusted life years are a measure of health loss due to disability and represent the sum of years of life lost (YLL) and years lived in disease (YLD). Considering fewer DALYs are better, health interventions aim to avert DALYs. Based on the standard DALY formula[5], we created two separate sets of equations for estimating YLL and YLD in the R statistical programming language[6]: one set for individual-level[5,7] and another for the population-level[8] calculation of DALYs.

To populate equation parameters, we extracted information from the literature and the Global Burden of Disease (GBD) study, including the equations' constant[9], age weighting constant[9], and default values[10,11], standardized disability weights[12], and life expectancy[13]. Because GBD life expectancy estimates are only available for five-year increments (i.e., 10-15

years old, 15-20 years old), we extrapolated the life expectancy for each discrete age (i.e., 10, 11, 12, 13, 14, 15), assuming the life expectancy between age groups follows a linear trend.

Then, we developed a user interface using the R package Shiny[14] for interactive web app development. Users require specifying the following information for the individual-level calculation: disease; the age of onset of disease; the age of premature death due to disease; a discount rate (optional); an age weighting parameter (optional). For the population-level calculation, additional information, such as incidence cases (cases/year) and incidence deaths (deaths/year), is required.

The calculator pulls both disability weights associated with the selected disease and life expectancy associated with the age of premature death input into the function. It also calculates years lived with disease (age of premature death input minus age of onset input). When the user clicks the "Calculate" button, an outcome table consisting of YLLs, YLDs, and total DALYs estimated by our function appears. If inputs are illogical or impossible, corresponding error messages will appear rather than an outcome table. Each of these outcomes, which are rounded to the nearest whole number, is displayed to the right of the input panel.

Validation

We have validated our calculator in three ways: replicating original calculations, coding the model in a different program for consistency, and comparing results to another published R function. We replicated calculations from the original source of DALY equations[2] using those paper's inputs values. Outputs matched to an acceptable extent. Our calculator uses updated life expectancy tables, constant value, and disability weights, and thus could not exactly match the outputs of the paper. However, when parameters were manually replaced in the calculator's function with those specified in the paper, the output results were identical. Secondarily, a separate staff member coded a function in Excel according to the original source paper[2] to ensure consistency of outputs. Then the calculator was again validated against another R function for calculating DALYs, published by Devleesschauwer et al.[15] Outcomes matched between functions in each of these cases.

Future directions

We will continue to validate externally our calculator in two ways: 1) by using existing cost-effectiveness studies that report both non-DALY metrics (e.g., cases averted) and the DALY metric and 2) by using GBD supporting information to recreate the study's disease burden estimates in DALYs. Using our DALY calculator, we will first convert available non-DALY estimates from literature to cost-per-DALY ratios, and then compare our converted cost-per-DALY ratios with those from the sources stated above. Following external validation, we will conduct additional case studies to convert cost-effectiveness ratios using non-DALY metrics to standardized cost-per-DALY averted and publish conversion tables on our website.

Citation

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