

Disability-Adjusted Life Year conversion

CASE STUDY #2: DENGUE CASES TO DALYS

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AIM

This case study aims to establish an example of the process to convert disease-specific health outcomes (i.e., hospitalized dengue cases) to disability-adjusted life years (DALYs), a standardized health outcome measure that can be compared across multiple disease areas. We estimated DALYs averted attributable to hospitalized dengue cases among 2.9 million people targeted through a larviciding campaign in Cambodia, based on an analysis conducted by Suaya and colleagues [1].

METHODS

PARAMETERS

Suaya et al.'s 2007 paper, "Cost-effectiveness of annual targeted larviciding campaigns in Cambodia against the dengue vector *Aedes aegypti*" was selected [1]. Since this paper reported both hospitalized dengue cases and associated DALYs, we were able calibrate estimated DALYs from our online calculator to the reported DALYs in the paper. The targeted larviciding campaigns focused on 2.9 million people in two urban areas of Cambodia from 2001 to 2005. Most parameters were extracted from the paper, except for life expectancy at premature death, which was assumed based on an idealized population in Japan estimated by an external source. [2] A full list of parameters can be found in Table 1.

ONLINE CALCULATOR

The online DALY calculator is a Web app that, on individual and population levels, estimates years of life lost (YLL), years lived with disease (YLD), and total DALYs attributable to a particular disease. Further details regarding the DALY calculator are published elsewhere. [3] To add precision to the original calculator, we updated the original standard life expectancy table with country- and gender-specific life expectancy. As users are not able to specify custom disability weights and life expectancy inputs, the expectation was that the calculator would provide an approximate estimate for this conversion; the goal was to explore and calibrate its accuracy and usability. Dengue disease options with disability parameters closest to those reported in the original article was selected to estimate YLLs for the disease stage.

CUSTOM R CODE

The function underlying the online DALY calculator can be imported into the statistical package R [4] and used with custom parameter inputs. To improve usability of the online calculator, disability weights and life expectancy at death are fixed parameters pulled from standardized data sources [2, 5, 6] depending on disease, country, gender, and age of death user inputs. These standardized values, however, do not exactly match the parameters used by Suaya et al. We used the disability weight for severe dengue (0.13) in our calculator [5] as a proxy for hospitalized dengue, which is lower than the estimate used in the source paper. This may underestimate DALYs compared to those reported by Suaya et al. However, the underestimation is consistent for both the treatment and comparison groups, thus the direction of bias for the incremental health outcomes due to treatment (larviciding campaign) is uncertain. To obtain a more accurate estimation, we used the underlying code from the online calculator tool to customize disability values to match exactly those reported in the paper by Suaya et al. This code can be found in Appendix 1.

ESTIMATE CALCULATION

Suaya et al. grouped their study cohort into subsets of hospitalized and ambulatory dengue cases. Due to the insufficient input parameters reported to calculate DALYs associated with ambulatory dengue cases, we only calculated DALYs associated with hospitalized dengue cases. We estimated DALYs for both the larviciding campaign (treatment) and 'do-nothing' (comparator) scenario, as well as DALYs averted due to the treatment.

We also made assumptions concerning life expectancy at premature death. First, we used life tables for an idealized population estimated by GBD [2] to best match the one reported in the paper. We also switched the standard life expectancy to the life expectancy of the Cambodian population [6] to estimate more accurate country-specific DALYs averted by the larviciding campaign. We estimated DALYs averted based on the difference between the number of DALYs accrued by populations in untreated areas and DALYs accrued by the population served by the larviciding campaign.

RESULTS

Estimated DALYs for the treatment and comparison populations as well as DALYs averted due to the larviciding campaign can be found in Table 2. The original paper reported a total of 2,980 hospitalized dengue cases and 854 DALYs averted due to the campaign. By using GBD life expectancy for an idealized population (Japan), the number of DALYs averted estimated by our online calculator was 848 (a difference of 0.7%), and by our custom R code was 864 (a 1.2% difference). Estimates based on Cambodia-specific life expectancy are also reported in Table 2; because life expectancy is more than 10 years lower in Cambodia than in the idealized estimates, the number of DALYs averted by larviciding (832) is also lower.

The difference between the number of DALYs estimated by the online calculator and the custom R code stems from the use of standardized disability weights and life expectancy estimates in the online calculator versus custom parameters in the R code. The difference between the DALY estimates created by our methods and that reported by Suaya et al. is about 1%. The remaining differences are likely due to uncertainty around exact life expectancy estimates in the paper and any rounding mechanisms due to the calculation process.

In summary, the use of both the DALY calculator and customized R code produced estimates of years of life lost and DALYs that were comparable to those used in an original, published cost-effectiveness evaluation of a larviciding campaign against Dengue in Cambodia. Future validation efforts will focus on a variety of disease areas, including non-communicable disease.

Table 1: Parameters sourced from Suaya et al.

| | Description | Number | Source reported in article | Source externally |
|--------------------------|---|---------------------|-----------------------------------|------------------------------|
| Disability weight | Hospitalized dengue cases | 0.15 | Gubler & Meltzer (1999) [7] | |
| Life expectancy | Cambodia population | 67.13 | | GBD [6] |
| | Idealized population | 78.82 | | GBD [2] |
| Age of onset | Age of death minus length of infection to death | 7.98 | Shepard et al. (2004) [8] | |
| Age of death | | 8 | Murray (1994) [9] | |
| Incident cases | | larviciding 2688 | 'do-nothing' 5670 | Tourdjman et al. (2005) [10] |
| | Incident deaths | 21 | 44 | Tourdjman et al. (2005) [10] |
| Discount rate | 3% | | | |
| Age weighting | 4% | | | |

Table 2: Outcomes of DALY conversion calculation on online calculator and with custom R code

| | | Larviciding Campaign | | | 'Do-nothing' | | | Differences |
|-------------------|----------------------|----------------------|------|-------|--------------|------|-------|-------------|
| | | YLLs | YLDs | DALYs | YLLs | YLDs | DALYs | DALYs |
| Suaya et al. | | | | | | | | 854 |
| Online Calculator | Idealized population | 774 | 0 | 774 | 1622 | 0 | 1622 | 848 |
| | Cambodia population | 760 | 0 | 760 | 1592 | 0 | 1592 | 832 |
| Custom R code | | 773 | 15 | 788 | 1620 | 32 | 1652 | 864 |

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Appendix 1: Custom R code used to calculate DALYs

```
library('devtools')
install_github('TuftsCEVR/DALYCalculator')
library('DALYcalculator')

#Suaya 2007: Dengue

#POPULATION LEVEL
#TREATMET: LARVICIDING CAMPAIGN
  TREATMENT <-DALYcalculator::f_DALYpop(K=1, C = 0.16243, r=0.03, beta=0.04,
a_death=8, a_disability=7.96, YLL_L=78.82, D=0.15 ,incident_cases = 2688,
incident_deaths = 21)
names(TREATMENT)<-c("YLLs", "YLDs", "DALYs")
  TREATMENT

#COMPARISON: 'Do-nothing'
  COMPARISON <-DALYcalculator::f_DALYpop(K=1, C = 0.16243, r=0.03, beta=0.04,
a_death=8, a_disability=7.96, YLL_L=78.82, D=0.15 ,incident_cases = 5670,
incident_deaths = 44)
  names(COMPARISON)<- c("YLLs", "YLDs", "DALYs")
  COMPARISON
```

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