

General Guidance for DALYs calculation

VIMC with input from DOVE

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Methods overview

DALYs are an absolute measure of health loss; they count how many years of healthy life are lost due to death and non-fatal illness or impairment. They reflect the number of individuals who are ill or die in each age-sex group and location (Murray. et al. 2012). The Global Burden of Disease project in its 2016 version (GBD 2016) includes 368 diseases and 1675 conditions. For the VIMC purpose, we have made a selection of the specific methods and disability weights (Table 1) that can be applied across all models with reference to the most updated methods provided by the Institute of Health Metrics and Evaluation.

The aim of this guidance is to ensure comparability across all models, specially for aggregation procedures. Also, this will allow us to compare our estimates with the estimates from other research groups.

Basic assumptions on social value choices

1) Life expectancy:

Historical and projected life expectancy estimates are available through *Montagu* for all countries of interest. The modellers should be referencing specific per country life expectancy, as provided in the corresponding demographic data for a particular run version. We use the per country life expectancy as opposed to the world standard life expectancy, as it is a more realistic (conservative) reflection of the impact of vaccination for a particular country instead of an aspirational life expectancy.

2) DALYs allocation:

In order to reflect the impact of the vaccination intervention in the time range we make projections for, the allocation of DALYs should be to the year when the particular infection/disease/death occurred, instead of spreading the DALYs over the life expectancy.

3) Non-age weighting:

Following the most recent GBD approach, DALYs are non-age weighted, reflecting no social preference for the age of individuals.

4) Non-time discounting:

Following the most recent GBD approach, future DALYs are not discounted, reflecting no social preference for the past, present or future times.

Estimation methods

The general equations used to generate the non-discounted, non-age weighted but contry, year, age specific DALYs are given below:

General Equation (Eq 1)

DALYs are calculated by disease and are country/year/age specific. Although, we acknowledge that the total DALYs provided by the modellers to the VIMC might come from the sum of DALYs from various clinical conditions that are not recorded in the Consortium, following these formulas:

$$DALY = YLL + YLD$$

Equation for YLL (Eq 2)

For a particular disease/country/year combination, Years of Life Lost (YLLs) are computed by multiplying the number of deaths M at each age a by a standard life expectancy L at age a for that country, year combination.

$$YLL_{c,y,a} = M_{c,y,a} * L_{c,y,a}$$

Equation for (YLD) (Eq 3)

Years of Life Lived with Disability (YLDs) are computed as the sum of number of new cases N of different condition/sequelae over the average duration d of that condition/sequelae times the disability weight D associated to that condition/sequelae.

$$YLD_{c,y,a} = \sum_{s=1}^n N_{s,c,y,a} * d_s * D_s$$

Where,

M = number of deaths

N = number of cases of a particular condition/sequelae

$L_{c,y,a}$ = life expectancy at the age of death (in years) per country and year

a = age at death or onset (in years)

d = average duration of the case until remission or death (in years)

D = disability weight

c = country

y = year

$s = 1$ to n number of clinical conditions or sequelae per disease

Disability Weights (D) Where possible, the weights are based on the GBD 2016 update IHME_GBD_2016_DISABILITY_WEIGHTS_Y2017M09D14. Most of the relevant weights for each sequelae of each disease of the VIMC remit have been selected and are shown in Table 1.

NOTE If your disease/condition combination is not part of Table 1, or you use a different set of values, please let the *VIMC science team* know.

Table 1: Disability Weights for VIMC diseases

disease	condition/sequelae	GBD_2016_mean
YF	Moderate yellow fever	0.051
YF	Severe yellow fever	0.133
Measles	Moderate measles	0.051
Measles	Severe measles	0.133
Rota	Mild diarrheal diseases	0.074
Rota	Moderate diarrheal diseases	0.188
Rota	Severe diarrheal diseases	0.247
JE	Blindness due to encephalitis	0.187
JE	Severe epilepsy	0.552
JE	Less severe epilepsy	0.263
JE	Seizure-free, treated epilepsy	0.049
JE	Monocular distance vision loss due to encephalitis	0.017
JE	Severe motor plus cognitive impairments due to encephalitis	0.542
JE	Moderate motor plus cognitive impairments due to encephalitis	0.203
JE	Mild motor plus cognitive impairments due to encephalitis	0.031
JE	Mild behavioral problems due to encephalitis	0.045
JE	Severe motor impairment due to encephalitis	0.402
JE	Acute encephalitis	0.133
JE	Borderline intellectual disability due to encephalitis	0.011
JE	Moderate motor impairment due to encephalitis	0.061
JE	Mild intellectual disability due to encephalitis	0.043
JE	Mild motor impairment due to long term due to encephalitis	0.010
JE	Moderate vision impairment due to encephalitis	0.031
JE	Severe vision impairment due to encephalitis	0.184
Rubella	Hearing loss, mild	0.010
Rubella	Hearing loss, mild, with ringing	0.021
Rubella	Hearing loss, moderate	0.027
Rubella	Hearing loss, moderate, with ringing	0.074
Rubella	Hearing loss, severe	0.158
Rubella	Hearing loss, severe, with ringing	0.261
Rubella	Hearing loss, profound	0.204
Rubella	Hearing loss, profound, with ringing	0.277
Rubella	Hearing loss, complete	0.215
Rubella	Hearing loss, complete, with ringing	0.316
HPV	Terminal phase of cervical cancer Terminal phase, with medication	0.540
HPV	Diagnosis and primary therapy phase of cervical cancer Cancer,	0.288
HPV	Controlled phase of cervical cancer Generic uncomplicated disease	0.049
HPV	Metastatic phase of cervical cancer Cancer	0.451
HepB	severe-acute	0.133
HepB	moderate-acute	0.051
HepB	Controlled phase of liver cancer due to hepatitis B Generic uncomplicated disease	0.049
HepB	Terminal phase of liver cancer due to hepatitis B Terminal phase, with medication	0.540
HepB	Diagnosis and primary therapy phase of liver cancer due to hepatitis B Cancer	0.288
HepB	Metastatic phase of liver cancer due to hepatitis B Cancer	0.451
Pneumo	Severe epilepsy	0.552
Pneumo	Less severe epilepsy	0.263
Pneumo	Seizure-free, treated epilepsy	0.049
Pneumo	Profound hearing loss due to pneumococcal meningitis	0.204
Pneumo	Acute pneumococcal meningitis	0.133
Pneumo	Severe hearing loss with ringing due to pneumococcal meningitis	0.261

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Pneumo	Complete hearing loss due to pneumococcal meningitis	0.215
Hib	Monocular distance vision loss due to H influenzae type B meningitis	0.017
Hib	Profound hearing loss due to H influenzae type B meningitis	0.204
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Hib	Borderline intellectual disability due to H influenzae type B meningitis	0.011
MenA	Mild behavioral problems due to meningococcal meningitis	0.045
MenA	Mild hearing loss with ringing due to meningococcal meningitis	0.021
MenA	Complete hearing loss due to meningococcal meningitis	0.215
MenA	Severe hearing loss due to meningococcal meningitis	0.158
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Note: ¹ Source: IHME_GBD_2016_DISABILITY_WEIGHTS_Y2017M09D14

References Murray CJ et al. Lancet. 2012 Dec 15;380(9859):2197-223. doi: 10.1016/S0140-6736(12)61689-4.

Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2016 (GBD 2016) Disability Weights. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2017.