Measurement of Disease Burden

“Disability Adjusted Life Year”

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The First Person Trade-off Question

- You are a decision maker who has enough money to buy only one of two mutually exclusive health interventions
1. **Intervention A**,  
   - If purchased, will extend the life of 1,000 healthy (non-disabled) individuals for one year, then they will all die  
   - If not purchased, they will all die today
2. **Intervention B**,  
   - If purchased, will extend the life of *n* individuals with a disabling condition for one year, then they will all die  
   - If not purchased, they will all die today
- Which one will you buy?
The First Person Trade-off Question

- You are a decision maker who has enough money to buy only one of two mutually exclusive health interventions

1. **Intervention A**,  
   - If purchased, will extend the life of **1,000 healthy (non-disabled) individuals** for one year, then they will all die  
   - If not purchased, they will all die today

2. **Intervention B**,  
   - If purchased, will extend the life of **\( n \) individuals with a disabling condition** for one year, then they will all die  
   - If not purchased, they will all die today

- If you judges that **1,000 healthy people** would have an equal claim on the resources as **2,000 people with paralysis**, the disability weight assigned to paralysis is equal to \( \frac{1000}{2000} = 0.5 \)
The Second Person Trade-off Question

- You are asked to value a cure for chronic condition relative to an intervention that save life.
- How many people cured of blindness do you consider equal to saving the lives of 1,000 people?
- If the response is 8,000, the corresponding disability weight of blindness is $1,000/8,000 = 0.125$.
- This question raises the kind of issue that may occur in “real world” priority setting.
- Unlike the first question, the second does not presuppose that the lifetime of disabled people is devalued.
Outline of Presentation

- Why DALY?
- What’s DALY?
  - Loss due to premature death
  - Loss due to disability
- Age weighting
- Discount rate
- Return of Health Investment
- Ethical Concerns of DALY
Introduction

- DALY launched in 1990’s by the World Bank and backed by the World Health Organization as a measure of the global burden of disease to make burden from various diseases comparable.

- It is a popular way to quantify health loss due to a specific disease, group of diseases, health problems or exposure to some risk factors.
Shortcomings of Other Parameters

- Mortality statistics e.g. crude death rate, IMR ignore non-fatal burden
- “Incidence” considers only new cases, not much with duration and outcomes
- “Prevalence” looks at surviving portion only thus biased toward chronic problem
- Both incidence & prevalence are disease-specific, difficult to compare across diseases
- “Economic loss” put more weight on productivity and opportunity loss, thus bias toward importance of the rich and the efficient.
Natural History of 2 Lives

Longevity A

Healthy

0 10

Birth

Premature death

Longevity B

Years of living with disability

Ill: DM, HT

Severe disability: Stroke

40

60

70

80

Years of life lost

Longevity B

Premature death

Life Expectancy
What’s DALY?

- DALY combine information about *morbidity* and *mortality* in *numbers of healthy years lost*
- Each state of health is assigned a *disability weighting* on a scale from zero (perfect health) to one (death) by an expert panel
- The disability weighting is multiplied by the number of years lived in that health state and is added to the number of years lost due to that disease
- *Future burdens are discounted* at a rate of 3% per year
- The *value of the lifetime is weighted* so that years of life in childhood and old age are counted less
What’s **DALY**?

**DALY** include loss due to **premature death** and **living with disability**

Health loss = year of life loss (**YLL**) + year of living with disability (**YLD**)

**YLL** compiles data on incidence rate, survival time and case-fatality rate

**YLD** includes data on short-term and long-term disabilities
### QALY VS DALY

<table>
<thead>
<tr>
<th>Disability weighting</th>
<th>Utility</th>
<th>Health state</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.0</td>
<td>Perfect</td>
</tr>
<tr>
<td>0.67</td>
<td>0.33</td>
<td>Deafness</td>
</tr>
<tr>
<td>1.0</td>
<td>0</td>
<td>Death</td>
</tr>
</tbody>
</table>

The diagram compares QALYs (Quality-Adjusted Life Years) and DALYs (Disability-Adjusted Life Years) using a grid. The rows and columns represent disability weighting and utility, respectively. The health states range from Perfect to Death, with corresponding values for disability weighting and utility. The DALYs are represented by the area above the diagonal, and the QALYs are represented by the area below the diagonal.
Priority of Subgroup of Population: Age Weighting

- Whether different age groups could have the same importance are still non-conclusive debates.
- Working age population in developing countries often take care of older and younger generations. Their lost years may affect more people than those in the extreme age group.
- A mathematical weight function for important of age was derived from data from a multi-national survey.
Priority of Subgroup of Population: 
**Age Weighting**

Relative weight = \( C \times \text{Age} \times e^{(-b \times \text{Age})} \)

- \( C = 0.1624 \)
- \( b = 0.04 \)
Current VS Future Burden: Discount Rate

- **Current** health loss is more important than **future** loss of equal value. They can be compared only if the future value is discounted.

- If \( r \) % is discount rate
  
  \[ \text{DALY in nth years} = (100-r)^n \text{ current year} \]

- If **discount rate** = 10%

  - 100 DALY next year = 90% this year
  - 100 DALY 2 years after = \(.9\times.9 = 81\)% of this year
  - 100 DALY 3 years after = \(.9\times.9\times.9 = 72.9\)% of this year

- Sum of discounted values = total **DALY**
Calculation of \textbf{YLL}

A 50 y.o. patient died on 1 Jan 2000. Life limit assumed 70 years, discount rate 3%.

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>50</td>
<td>51</td>
<td>52</td>
</tr>
<tr>
<td>Age-weight</td>
<td>1.10</td>
<td>1.08</td>
<td>1.06</td>
</tr>
<tr>
<td>Discounting factor</td>
<td>1.00</td>
<td>0.97</td>
<td>0.94</td>
</tr>
<tr>
<td>Disc loss</td>
<td>1.1*1.0</td>
<td>1.08*0.97</td>
<td>1.06*0.94</td>
</tr>
</tbody>
</table>

\textbf{Total YLL} = 1.1*1.0+1.08*0.97+1.06*0.94+.....
Calculation of YLD

A 50 y.o. person living with asymptomatic HIV for 5 years and full-blown AIDS for 2 more years.

Disability during asymptomatic HIV+ = 0.125/year

Disability during AIDS = 0.505/year
## YLD During Asymptomatic HIV+

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>50</td>
<td>51</td>
<td>52</td>
<td>53</td>
<td>54</td>
</tr>
<tr>
<td>Age-weight</td>
<td>1.10</td>
<td>1.08</td>
<td>1.06</td>
<td>1.03</td>
<td>1.01</td>
</tr>
<tr>
<td>Discounting factor</td>
<td>1.00</td>
<td>0.97</td>
<td>0.94</td>
<td>0.91</td>
<td>0.89</td>
</tr>
<tr>
<td>Weight from HIV+</td>
<td>0.125</td>
<td>0.125</td>
<td>0.125</td>
<td>0.125</td>
<td>0.125</td>
</tr>
<tr>
<td>Weight from AIDS</td>
<td>........</td>
<td>........</td>
<td>.....</td>
<td>........</td>
<td>........</td>
</tr>
</tbody>
</table>

\[
\text{YLD} = 0.125(1.1 \times 1 + 1.08 \times 0.97 + 1.06 \times 0.94 \ldots ..) = 0.62
\]
## YLD During Full-blown AIDS

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calendar year</td>
<td>2005</td>
<td>2006</td>
</tr>
<tr>
<td>Age</td>
<td>54</td>
<td>55</td>
</tr>
<tr>
<td>Age-weight</td>
<td>0.99</td>
<td>0.97</td>
</tr>
<tr>
<td>Discounting factor</td>
<td>0.86</td>
<td>0.83</td>
</tr>
<tr>
<td>Weight from HIV+</td>
<td>...........</td>
<td>...........</td>
</tr>
<tr>
<td>Weight from AIDS</td>
<td>0.505</td>
<td>0.505</td>
</tr>
</tbody>
</table>

Total **YLD** = 0.505(0.99*0.86 + 0.97*0.83) = 0.84
DALY of HIV/AIDS

- In this example

\[
\text{YLD} = (\text{five years of disability from HIV+ or 0.62}) + (\text{two years of disability from full-blown AIDS or 0.84})
\]

\[
\text{YLL} = \text{death at the age of 57 instead of 70 years}
\]

In Thailand, in HIV/AIDS problem, \text{YLL} is much higher than \text{YLD} as affected population are young adults and survival time is short.
How Much Gain for How Much Lose

- Which program will you invest?
Return of Health Investment

- Health investment, either in promotive, preventive, curative or rehabilitative, results in reduction of DALY

- Comparing cost-effectiveness of investment can be done by comparing the *amount of money spent per one DALY reduction*

- DALY reduction depends on *the magnitude of problem without the program and the effectiveness of the program*

- This reduction can be minimal in a readily low risk area or an intervention without prior proof of efficacy
Ethical Concerns of DALY
Same Lives, but Different

- DALY is similar to “person-year”; 25 DALY can come from:
  - 25 persons each lost by 1 DALY or
  - 1 person with a serious loss of 25 DALY or
  - 5 persons each lost 5 DALY

They are all assume the same loss which may not be valid
Ethical Concerns of DALY
Same Lives, but Different

- All life do not count equally:
  - a death at younger age represented a greater loss of life than a death at an older age
  - saving the life of a 60 year old does not count the same as saving the life of a 25 year old.

This kind of calculation often holds true regardless of the use of age-weight function
Ethical Concerns of DALY
Same Lives, but Different

- DALY explicitly presupposes that the lives of disabled people have *less value* than those of people without disabilities

- The method assumes that disabled people are *less entitled* to scarce health resources for interventions that would extend their lives
Any question?