Global Burden of Disease: Magnitudes and Measures

Kevin Chan, MD, MPH, FRCPC, FAAP
Assistant Professor, University of Toronto and Hospital for Sick Children and Fellow, Munk Centre for Global Studies

Prepared as part of an education project of the Global Health Education Consortium and collaborating partners
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Learning Objectives

- Look at the Causes of Mortality
- Describe How Deaths are defined
- Describe 4 methods to generate health values
- Highlight Summary Measures of Population Health
- Describe the Global Burden of Disease Project
- Calculate the Disability-Adjusted Life Year (DALY)
- Highlight common criticism of DALY
- Look at mortality and DALYs projected to 2030
World Population Births and Deaths

See Notes
Causes of Death in the World, 2002

Total Deaths = 57 million

Communicable, maternal, perinatal and nutritional conditions
Noncommunicable disease
Injuries

See Notes
How are deaths defined?


• Death is “the underlying cause of disease or injuries leading directly to death, or the circumstances of an accident or violence that produced the fatal injury.”

• For more information on death certificates, see:

# Top 10 Causes of Death Worldwide

<table>
<thead>
<tr>
<th>High-Income</th>
<th>Middle Income</th>
<th>Low Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHD (17.1%)</td>
<td>Stroke (14.6%)</td>
<td>CHD (10.8%)</td>
</tr>
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<td>Stroke (9.8%)</td>
<td>CHD (13.4%)</td>
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</tr>
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<td>Lung Cancer (5.8%)</td>
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<td>TB (3.8%)</td>
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<tr>
<td>Breast CA (1.9%)</td>
<td>Road traffic (2.6%)</td>
<td>COPD (3.1%)</td>
</tr>
<tr>
<td>Stomach CA (1.8%)</td>
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</tbody>
</table>
What is Health?

• Physical health?
• Mental health?
• Social health?
• Spiritual health?

• What is common across age, culture, race, and gender?
Generating values of health

There are four general ways to help calculate health values to help combine two important health outcome attributes, survival duration and the quality of life. The methods are:

1. Standard Gamble
2. Time Trade-off
3. Person Trade-off
4. Rating or visual analog scales
Standard Gamble

The standard gamble is the risk you’re willing to take to achieve perfect health versus death, against a certain chronic state for a given period of time. You have 2 choices:

Choice 1: A person is returned to normal health and will live ‘x’ years with a probability p, or will die immediately with a probability 1-p.
Choice 2: A person will live with a chronic disease for ‘x’ years

The probability ‘p’ refers to the health utility value given for the chronic state. The gamble refers to the risk that one would be willing to take to avoid a chronic and debilitating disease.
Time Trade-Off

You have 2 choices:
Choice 1: Imagine living 10 years with a disease.
Choice 2: How many ‘x’ years would this be equivalent to in full health?

The question is how much time would you be willing to live in full health as compared with the specified chronic disease?
Person Trade-Off

You have to find a point of equivalency:

“How many people cured of condition A is the same as 100 people cured of condition B?” For example, how many people cured of AIDS is the equivalent of 100 persons cured of TB?

The purpose is to find points of equivalence of different states. In general, these should be similar across different conditions.

Source: http://www.juliantrubin.com/imageses/scale.gif
Rating or Visual Analog Scale

Individuals rank (rating) or place (visual analog scale) where they think how much a disease should be rated

(Where would you put on the line pneumonia, cancer, diabetes, arthritis, a severe cold?)
Measures of Population Health

• There are four measures gauge a population’s health status.
  1. Life expectancy at birth
  2. Quality Adjusted Life Years (QALY)
  3. Health Adjusted Life Expectancy (an alternative measure of QALY)
  4. Disability Adjusted Life Years (DALY)
Life Expectancy

• Measures the expected age of death at birth.
• Life expectancy is sensitive to childhood deaths.
• Highest life expectancy at birth: Japan at 82.6 years (79.0 for males, 86.1 for females) in 2006
• Lowest life expectancy: Mozambique at 39.2 years (38.3 for males, 39.9 for females) in 2006

Source: WPP 2006
Quality Adjusted Life Years (QALYs)

- Combines quantity and quality of life
- Measures the effect on an individual over a year, and aggregating it to the population
- Has discounting (3% per year)
  - e.g. (a life worth 1.00 in 2012 is worth 0.97 in 2013)

See Notes
The simplest way to understand how to calculate QALYs is to measure the rectangles. For example, if there was full health for 6 months, and 0.5 health for the next 6 months. The QALY calculations would suggest that the QALY for the year was 0.75.
More QALY calculations

Health Utility

0 40 80 Years

See Notes
Health-Adjusted Life Expectancy (HALE)

- Life expectancy minus the period of less than a full healthy life.
- Uses Health Utility Index for residential and those in hospital institutions.
- Generated by time trade-off.
- Highest HALE is Japan at 75.0 years (72.3 for males, 77.7 for females).
The Global Burden of Disease Study

Five-year study with three goals:

1) Infuse information about morbidity into debates on health policy
2) Decouple epidemiological assessment from advocacy
3) Define a measurement tool that determines relative magnitude of diseases, combining mortality and morbidity, and a tool for cost-effectiveness analysis
Burden of Disease Measures

• Attempt to capture the reduction in the length and/or quality of life
• Burden for all health outcomes should be the same
• Non-health outcomes should be restricted to age and sex
• DALY measures health gaps, not health utility
  – “Utility” as used in economics is a measure of satisfaction to a consumer of a good, service, or in this case, health status
• A sum of mortality and morbidity effects

See Notes
DALY Calculations

• DALY = Disability Adjusted Life Year
  – Ranges from 0 (no disability) to 1 (death)
  – Converse of the QALY (quality adjusted life year)
  – Uses life table to compare with maximum life expectancy of Japan (80.0 years for males, 82.5 years for females)
  – Uses health professional expert groups to define values
More DALY Calculations

Health Utility

While QALYs or HALEs look at Healthy living, DALYs look at a health gap from an ideal life expectancy. Note, that if you live longer than this ideal life expectancy, the DALY is NOT measured.
The DALY

DALY = Years of Life Lost (YLL) + Years of Life with Disability (YLD)

YLL = (Maximum Life Expectancy - Age at Death) + Age Weighting Factor + Discount Rate

YLD = (Maximum Life Expectancy - Age of Disability) + Age Weighting Factor + Discount Rate + Disability Weight

See Notes
Age Weighting

- Maximum at age 25
- Idea is to maximize values of years during the most “productive years” versus the ages requiring help
- Thus disabilities during childhood and post-retirement years are given less weight

See Notes
Discounting

• Most people prefer benefits now rather than later
• The standard for the DALY is 3% per year
• Discounting and time preference are not synonymous. Time preference refers to a preference for utility (ie, improved health status) sooner rather than later
Disability Weights

• These are the weights attached to specific disabilities.
• 7 classes of disability weights have been created
Criticisms of the DALY

1. Patient versus community versus health experts’ valuations of health
2. Age-based weighting does not favor the young or old.
3. Disabilities are additive in nature and could add up to more than 1 “death” for persons having more than one disability
4. No priority is given to those worse off, unlike the usual societal tendencies to help those worse off
5. Discriminates against people with limited treatment potential, e.g., those with cancer, stroke paralysis
More Criticisms of the DALY

6. Does not assess qualitative difference in outcomes.
7. Difference in the length of life lost
8. Discounts future health outcomes
# Mortality by 2030

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<tr>
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<td>CHD (15.8%)</td>
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<td>Road traffic (2.5%)</td>
<td>Diabetes (2.1%)</td>
</tr>
<tr>
<td>Prostate CA (1.8%)</td>
<td>Liver CA (2.2%)</td>
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</table>

See Notes
# DALYs by 2030

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<tr>
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<tr>
<td>Depression (9.8%)</td>
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<td>HIV/AIDS (14.6%)</td>
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<td>Depression (4.7%)</td>
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<td>Stroke (4.5%)</td>
<td>Road traffic (4.0%)</td>
<td>LRI (4.4%)</td>
</tr>
<tr>
<td>Hearing loss (4.1%)</td>
<td>Violence (2.9%)</td>
<td>Diarrheal disease (2.8%)</td>
</tr>
<tr>
<td>Lung CA (3.0%)</td>
<td>Vision loss, age (2.9%)</td>
<td>Stroke (2.8%)</td>
</tr>
<tr>
<td>Osteoarthritis (2.9%)</td>
<td>Hearing loss (2.9%)</td>
<td>Cataracts (2.8%)</td>
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<td>COPD (2.5%)</td>
<td>Diabetes (2.6%)</td>
<td>Malaria (2.5%)</td>
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</table>
What measures of the Global Burden of Disease are Used Today?

• Despite criticism, DALYs predominate health priority debates

• Mortality still has a role in the assessments

• Political pressure on neglected diseases, such as HIV/AIDS, TB, and malaria, can have a major impact on policies and programs
Summary

• The world population continues to grow, with increasing number of deaths
• Different methods to generate values of morbidity: Standard Gamble, Time Trade-Off, Person Trade-Off, and Rating/Visual Analog Scales
• Different Summary Measures of Population Health: Life expectancy, QALYs (include HALE) and DALYs
• QALY: Combines quantity and quality of life
• DALY: Health-Gap measure
Summary (continued)

- Global Burden of Disease
  - Attempted to add morbidity
  - Decoupled epidemiology from advocacy
  - Provided the DALY
- Know the assumptions behind the DALY and how they’re calculated
- Be aware of the criticisms of the DALY
- The DALY provides a different health priority listing than mortality
The next five slides provide a short quiz. Note your answers on a separate piece of paper and then compare your results with the answers that follow.
1. The death certificate reads as follows: “Mr. X died from cardiac arrest stemming from right-sided heart failure due to renal failure from Alport’s nephritis?” How would ICD-10 classify the cause of death?

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<table>
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<tbody>
<tr>
<td>A</td>
<td>Cardiac arrest</td>
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<tr>
<td>B</td>
<td>Right-sided heart failure</td>
</tr>
<tr>
<td>C</td>
<td>Renal failure</td>
</tr>
<tr>
<td>D</td>
<td>Alport’s nephritis</td>
</tr>
</tbody>
</table>
2. What is the number one cause of death worldwide?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>A</td>
<td>Heart disease</td>
</tr>
<tr>
<td>B</td>
<td>Stroke</td>
</tr>
<tr>
<td>C</td>
<td>HIV/AIDS</td>
</tr>
<tr>
<td>D</td>
<td>Lower Respiratory Tract Infection pneumonia)</td>
</tr>
<tr>
<td>E</td>
<td>Lung Cancer</td>
</tr>
</tbody>
</table>
3. You have to find a point of equivalency: “How many people cured of condition A is the same as 100 people cured of condition B?” What measurement method would you use?

<table>
<thead>
<tr>
<th></th>
<th>Method</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>Standard Gamble</td>
</tr>
<tr>
<td>B</td>
<td>Interview</td>
</tr>
<tr>
<td>C</td>
<td>Time Trade-Off</td>
</tr>
<tr>
<td>D</td>
<td>Person Trade-Off</td>
</tr>
<tr>
<td>E</td>
<td>Visual Analog Scale</td>
</tr>
</tbody>
</table>
4. Which of these does **NOT** describe the QALY?

<p>| | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Combines quantity and quality of life measures</td>
</tr>
<tr>
<td>B</td>
<td>Utilizes a health utility index.</td>
</tr>
<tr>
<td>C</td>
<td>Recognized as a health gap measure.</td>
</tr>
<tr>
<td>D</td>
<td>Usually has discounting.</td>
</tr>
<tr>
<td>E</td>
<td>HALE is a type of QALY</td>
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</table>
5. Which of the following is **not** a component of the DALY?

<p>| | |</p>
<table>
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<tbody>
<tr>
<td>A</td>
<td>Age Weighting</td>
</tr>
<tr>
<td>B</td>
<td>Discounting</td>
</tr>
<tr>
<td>C</td>
<td>Disability Weight</td>
</tr>
<tr>
<td>D</td>
<td>Happiness</td>
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1. The death certificate reads as follows: “Mr. X died from cardiac arrest stemming from right-sided heart failure due to renal failure from Alport’s nephritis?” How would ICD-10 classify the cause of death?

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<table>
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<tr>
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</table>
| A | Cardiac arrest | Incorrect.  
This is an immediate cause of death. It is not the underlying cause of death. The correct answer is Alport’s nephritis. |
| B | Right-sided heart failure | Incorrect.  
This is an immediate cause of death. It is not the underlying cause of death. The correct answer is Alport’s nephritis. |
| C | Renal failure | Incorrect.  
This is an immediate cause of death. It is not the underlying cause of death. The correct answer is Alport’s nephritis. |
| D | Alport’s nephritis | Correct.  
This is the underlying cause of death. This is the correct answer |
2. What is the number one cause of death worldwide?

<table>
<thead>
<tr>
<th></th>
<th>Cause</th>
<th>Answer</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Heart disease</td>
<td>Correct.</td>
<td>This is the number one cause of death worldwide. It causes 12.6% of deaths worldwide.</td>
</tr>
<tr>
<td>B</td>
<td>Stroke</td>
<td>Incorrect.</td>
<td>This is the number two cause of death worldwide. It causes 9.7% of deaths worldwide. Heart disease is the number one cause.</td>
</tr>
<tr>
<td>C</td>
<td>HIV/AIDS</td>
<td>Incorrect.</td>
<td>This is the number four cause of death worldwide. It causes 4.9% of deaths worldwide. Heart disease is the number one cause.</td>
</tr>
<tr>
<td>D</td>
<td>Lower Respiratory Tract Infection (pneumonia)</td>
<td>Incorrect.</td>
<td>This is the number three cause of death worldwide. It causes 6.8% of deaths worldwide.</td>
</tr>
<tr>
<td>E</td>
<td>Lung Cancer</td>
<td>Incorrect.</td>
<td>This is the number eight cause of death worldwide. It causes 2.2% of deaths worldwide. Heart disease is the number one cause.</td>
</tr>
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3. You have to find a point of equivalency: “How many people cured of condition A is the same as 100 people cured of condition B?” What measurement method would you use?

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<td>Standard Gamble</td>
<td>Incorrect</td>
<td>The correct answer is the person trade-off (D)</td>
</tr>
<tr>
<td>B</td>
<td>Interview</td>
<td>Incorrect</td>
<td>This is not one of the standard methods.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The correct answer is the person trade-off (D)</td>
</tr>
<tr>
<td>C</td>
<td>Time Trade-Off</td>
<td>Incorrect</td>
<td></td>
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<td></td>
<td>The correct answer is the person trade-off (D)</td>
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<tr>
<td>D</td>
<td>Person Trade-Off</td>
<td>Correct</td>
<td></td>
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<tr>
<td>E</td>
<td>Visual Analog Scale</td>
<td>Incorrect</td>
<td>The correct answer is the person trade-off (D)</td>
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4. Which of these does **NOT** describe the QALY?

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Correct/Incorrect Reason</th>
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<tbody>
<tr>
<td>A</td>
<td>Combines quantity and quality of life measures</td>
<td>Incorrect. This is true. Answer (c), “Recognized as a health gap measure,” does not describe a QALY.</td>
</tr>
<tr>
<td>B</td>
<td>Utilizes a health utility index.</td>
<td>Incorrect. This is true. Answer (c), “Recognized as a health gap measure,” does not describe a QALY.</td>
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<tr>
<td>C</td>
<td>Recognized as a health gap measure.</td>
<td>Correct. This is false. The DALY is a health gap measure. The QALY is a health expectancy measure</td>
</tr>
<tr>
<td>D</td>
<td>Usually has discounting.</td>
<td>Incorrect. This is true. Answer (c), “Recognized as a health gap measure,” does not describe a QALY.</td>
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<td>E</td>
<td>HALE is a type of QALY</td>
<td>Incorrect. This is true. Answer (c), “Recognized as a health gap measure,” does not describe a QALY.</td>
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5. Which of the following is **not** a component of the DALY?

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<tr>
<td>A</td>
<td>Age Weighting</td>
<td>Incorrect.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This is part of the DALY.</td>
</tr>
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<td>B</td>
<td>Discounting</td>
<td>Incorrect.</td>
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<td>Incorrect.</td>
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<tr>
<td></td>
<td></td>
<td>This is part of the DALY.</td>
</tr>
<tr>
<td>D</td>
<td>Happiness</td>
<td>Correct.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This is #9 on the global list.</td>
</tr>
<tr>
<td>E</td>
<td>Age of Death</td>
<td>Incorrect.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This is part of the DALY.</td>
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</tbody>
</table>
Papers


Papers


Books


Web links

The Global Health Education Consortium and the Consortium of Universities for Global Health gratefully acknowledge the support provided for developing teaching modules from the:

*Margaret Kendrick Blodgett Foundation*
*The Josiah Macy, Jr. Foundation*
*Arnold P. Gold Foundation*

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Supplementary notes for Module #21

<table>
<thead>
<tr>
<th>Module title</th>
<th>Global Burden of Disease: Magnitudes and Measures</th>
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<tbody>
<tr>
<td>Lead author</td>
<td>Kevin Chan</td>
</tr>
<tr>
<td></td>
<td>University of Toronto</td>
</tr>
<tr>
<td>Date</td>
<td>August 8, 2012</td>
</tr>
</tbody>
</table>
Slide notes

Notes on Learning Objectives

This module will go through the current state of mortality, and describe how deaths are defined. It will then look at different methods for valuation of health states, specifically looking at 4 common methods to help determine morbidity. The module will then look at common summary measures of population health. It will then describe the Global Burden of Disease Project and its key measure, the Disability-Adjusted Life Year (DALY). The module concludes with projections of mortality and DALYs for the year 2030.

Back to Module

Notes on World Birth and Deaths

This figure shows the continuing growth in world population. A few things should be noted. First, there are more births than deaths throughout the time frame up to 2050. The world population is projected to grow to 8.9 billion by 2050.

Second, there has been evidence of a demographic transition, which implies a sudden growth in the population that occurred around 1980-1985 (as seen by an increase in the gap between births minus deaths, and then a subsequent narrowing). This demographic transition was triggered by a significant decrease in childhood mortality.

Third, there is a continuous rise in the number of deaths. This is most likely due to older populations dying, rather than childhood deaths. We will explore the causes of deaths throughout the next few slides.

Back to Module

Notes on Causes of Death in the World, 2002

GBD and the WHO use 3 broad category definitions. The first category is a broad term for communicable, disease with maternal, perinatal and nutritional conditions. Maternal conditions refer to any cause of death during pregnancy and labor. Perinatal conditions refer to death that occurs in the child during or just after birth, such as birth asphyxia, and low birth weight. Nutritional conditions refer to caloric malnutrition, and micronutrient deficiencies that may lead to death.
The second category is noncommunicable diseases, such as heart attacks, stroke, and cancer. The final category is injuries, including motor vehicle accidents, homicide, and suicide.

In developed countries, 77% of deaths are from non-communicable disease, 14% of deaths are from communicable disease, and 9% of deaths from injuries. In developing countries, 55% of deaths are from communicable disease, 37% of deaths are from non-communicable disease, and 8% from injuries.

Two broad statements can be concluded from these findings. First, communicable disease is still a disproportionate burden in developing countries. Second, non-communicable disease plays a role in both developed and developing countries.

**Back to Module**

**Notes on How are Deaths Defined?**

In North America, the causes of death are obtained from medical records from death certificates by a physician or coroner. On most death certificates, there are spaces to provide causes of death, including the immediate, intervening and underlying cause. The underlying cause is what is utilized to derive figures and reports of death.

The causes of death utilize the *Manual of the International Statistical Classification of Disease, Injuries and Causes of Death*, Tenth Revision (ICD-10). The importance is that individuals should be aware with that more accurate assessment of diagnoses or definitional changes in diseases may change over time.


**Back to Module**

**Notes on Top 10 Causes of Death Worldwide**

CHD refers to coronary heart disease.

LRI refers to lower respiratory tract infection (mostly pneumonia)

COPD refers to chronic obstructive pulmonary disease, mainly emphysema.

CA refers to cancer.

HD refers to heart disease.

These income groups refer to World Bank Classifications, and the source of the data is:

A few general observations should be made. In every case, coronary heart disease is a major contributor to death. Lower respiratory traction infections are seen in all groups. As well, noncommunicable diseases are more prominent in the higher income groups with little impact from communicable disease. However, both communicable and non-communicable diseases are prominent in the lower income groups, reflecting the “dual burden” of disease in middle and low income countries.

**Back to Module**

**Notes on What is Health?**

Before we get to the various types of measurements, we need to examine what is meant by “health”. It is easy to measure death or perfect health as the extremes of measures, but for less than perfect health states, how do we measure them?

Is it just physical health, or could it also include mental, social, and spiritual health?

How we define these are extremely difficult and our perception of our own health (“self-rated health”) may differ from the perceptions of the same health condition of other individuals (“community-rated health”), because we fail to take into account an individual’s adaptation to a specific health state.

**Back to Module**

**Notes on Time Trade-Off**

The time trade-off is the measure of time you’re willing to trade-off in a perfectly healthy state, as compared to living a full duration in a less than perfectly healthy state.

For example, say you were going to have 10 years of life with arthritis. The trade-off question would be, how many years of living perfectly healthy, would you be willing to trade to avoid these 10 years with arthritis?

**Back to Module**

**Notes on Person Trade-Off**

The person trade-off utilizes person-equivalents to measure the trade-off between two different states. By comparing various diseases, a method of finding an equivalent health state should occur.
One problem is that not all results are internally consistent.

For example, if 200 people are cured for disease 2 compared to 100 people cured for disease 1, and 300 people are cured from disease 3 compared to 100 people cured for disease 2, it suggests that 600 people cured for disease should be the same as people cured for disease 1. However, testing rarely shows this consistency. (Ubel 1996)

Back to Module

Notes on Rating or Visual Analog Scale

The Rating or Visual Analog Scale asks individuals to place where they think a disease is rated on a scale of 1-10. It is the simplest method to help evaluate the burden of a specific illness, but does not ask for comparisons to other diseases.

For example, you might right diabetes as an 8, and lung cancer as a 5. However, determining the appropriate scale differs from individual to individual.

Many people believe that respondents need to think less with these scales. Some scales that use rating or Visual Analog Scales include the Quality of Well-Being (QWB) scale and the EuroQol EQ-5D (in part).

Back to Module

Notes on Life Expectancy

The first summary measure of population health is generally used is a country’s life expectancy at birth. According to WHO figures, Japan has the highest life expectancy, and Mozambique has the lowest life expectancy.

It is important to note that early childhood and infant deaths can lower the average life expectancy significantly. Thus, two poor countries may have very different life expectancies at birth but not much difference for life expectancies for those at age five.

Furthermore, measurements of life expectancy concentrate on mortality (death), but do not assess morbidity (illness).

Back to Module

Notes on Quality Adjusted Life Years (QALYs)

QALYs were developed in the 1960s primarily for use in cost-effectiveness analysis. It allowed the comparison of obtaining an extra unit of health per dollar, when pitting one intervention versus another. QALY attempts to combine mortality
and morbidity components by taking into account the “burden of illness” from achieving full health.

The QALY highlights the “quality of life” is an important outcome measure for health care and helps prioritize assessments of medical care, technology and public health interventions. The key is to measure the preference of different health outcomes from death (0) to perfect health (1.0), using Health Related Quality of Life (HRQL) weights.

They can be described by the individual itself (patient weights) or by how others would describe them (community weights), or by an outside “expert panel” (expert weights).

Back to Module

Notes on More QALY Calculations

Over a period of time, the areas underneath the curve can be summated together to calculate the full amount of QALYs. In this diagram, it is the sum of the rectangles. In reality, it’s impossible to measure every single day, so that some degree of precision is lost in the calculation of the QALYs.

A calculation for the average QALY per person is made (irrespective of the distribution), and then the total population is multiplied by the average QALY to provide the total QALYs per population. By using average figures, there is a loss of precision in the individual variation.

Back to Module

Notes on Health-Adjusted Life Expectancy (HALE)

The Health-Adjusted Life Expectancy (HALE) uses the Health Utility Index.

The Health Utility Index is a survey that looked at eight areas of personal health: vision, hearing, speech, mobility, emotional state, thinking and memory, dexterity and the level of pain and discomfort, and validity through a rank preference survey. This is combined to provide the Health Utility Index (ranging from 0 to 1, representing full health). To develop the Health Utility Index, a time trade-off measure is used.

A cross-sectional life table is created, and the corresponding mean Health Utility Index is used to help calculate the HALE, for both those in residential living and those that live in hospital institutions.

The gap between life expectancy and HALE represents a measure of the burden of ill health. The HALE is important for looking at the concept of compression/expansion of morbidity. The question that we’re interested in over time is not only if people are living longer, but are the living longer with less
disability. If a population is living 5 years longer, an improvement in health would see the HALE increasing by 5 years or more.

Over the past 30 years, there has been evidence of compression of morbidity (that is, people are living longer and healthier).

Back to Module

Notes on The Global Burden of Disease Study

The Global Burden of Disease Study was first published and explained in the World Development Report 1993, by the World Bank. The purpose behind the Global Burden of Disease was noted to be three-fold:

1) To put a clearly summary measure of disability;
2) To clearly define and systematically address issues between public health advocacy and the epidemiological evidence of mortality and morbidity (i.e. “What is the real evidence of the burden of a specific disease?”); and
3) To provide a summary tool that could measure the mortality and morbidity combination and use it as a tool for cost-effectiveness analysis.

Back to Module

Notes on Burden of Disease Measures

The Burden of Disease means a combination of the reduction in the length of life, and the reduction in the quality of life. It measures the amount of a lost life year, which is the gap between a population’s current health status and some reference ideal. This health gap is the burden of disease. Unlike the Quality Adjusted Life Year (QALY), DALY is a negative concept, and measures health gaps, NOT health utility.

DALY is the measure of the gap between a population’s health and its “ideal health achievement.”

The underlying principle is there is a common measurement for health outcomes, and that non-health outcome differences should be restricted to age and sex.

Back to Module

Notes on DALY Calculations

The DALY can be viewed as the opposite to the QALY calculations, where the scale runs from 0 for no disability up to 1 for death.
The DALY uses a theoretical maximum life expectancy, using Japan as the ideal country. Back in 1993, the ideal calculations worked to a life expectancy of 80 years for males, and 82.5 years for females.

The process by how the DALYs were calculated was an iterative, deliberative process across different conditions and injuries. The DALY used a person trade-off method to determine different diseases. In the end, the Global Burden of Disease came up with 7 disability classes for the variety of diseases from full health to death.

**Notes on The DALY**

The DALY uses a combination of mortality and morbidity.

The Years of Life Lost (YLL), is a function of the gap between the maximal life expectancy (80.0 years for males, 82.5 years for females) and the age of death.

There is also an age weighting factor and a discount weight that we’ll explore over the next few slides.

The Years of Life with Disability (YLD) uses a similar formula but with a disability weight attached.

**Notes on Age Weighting**

Age weighting refers to the concept that some ages are “valued” more than others. In the Global Burden of Disease, the emphasis was placed on the youngest productive age groups (around the age of 25), while children or more elderly individuals have their values discounted, because of their need for “support”, which reflects the concept that maximizes human capital.

Murray and Acharya (1997) frame the issue as follows:

*Imagine the situation where there is only one course of antibiotics available and two individuals with meningitis arrive simultaneously at the emergency room. The only difference between the two that we know about is their age: one is 2 years old and the other is 22. Their prognosis is identical. Which patient would you choose to treat?*

Age weighting “discounts” the effects of children, but their values are incorporated as they go through the “prime ages” of early adulthood.
Notes on Discounting

Discounting is the concept that adjusts for relieving the burden of illness today as compared to down the road. The standard used in the Global Burden of Disease is 3%. Discounting is most commonly used in finance to reflect that a given amount of money, corrected for inflation, is more valuable now than a year from now, and the year after is worth even less.

The reason behind this is because of the disease eradication versus health research paradox. Without discounting and with improving technology to eradicate disease, it would suggest that disease prevention should be delayed until the technology is available to eradicate disease.

There is also a time paradox, where mortality rates are declining and costs are increasing, which would not be reflected without discounting.

Back to Module

Notes on Disability Weights

Each disease has a “disability weight” attached to them. The Global Burden of Disease classified them into 7 distinct categories. The disability weights used the person-trade-off methodology to look at social preferences.

There have been some concerns with using the person trade-off methodology. First, there is a problem of adaptation. In theory, an individual may have a significant worsening of health during the acute phase, but over time, he/she may adapt to the situation, and have an increased view of health. If one was to utilize pre-adaptation figures, it makes prevention and rehabilitation cost effective, but treatment for keeping an individual alive, less cost-effective. However, if post-adaptation figures are used, the opposite effect is observed.

A second concern is that the valuation of quantity and quality of life for “other people’s preferences” may be different than the valuation of quantity and quality of life for oneself.

Finally, the framing of how questions are worded may lead to different results.

Back to Module

Notes on Criticisms of the DALY

The first criticism against the DALY is that the decision to utilize health professional experts as against community and individual assessments may lead to an over-inflation of the value put against disabilities.

The second concern is differential age-weighting, which seems to be an especially large penalty on the elderly, whose valuation of disability seems to be lessoned.
similar argument has been made against children that their diseases have been age-weighted against their diseases being deemed a priority.

The third concern is that disabilities are additive in nature. Therefore, if someone has 2 diseases, the interactions are not calculated, but the disabilities are just added to each other. For example, if being blind has a DALY of 0.5, and being deaf has a DALY of 0.3, the DALY burden would be 0.8. In theory, the DALY weight could be more than 1.0 (which is the value of death).

The fourth concern was that there was no equity value placed in the DALY. In general, health tends to prioritize those that are “worse off”. The DALY attempts to make no consideration for the “worse off”.

The fifth concern is that those with limited treatment potentials (e.g. cancer patients), have no prioritization under this scheme.

The sixth criticism is that the quality differences in outcomes aren’t taken into account. For example, treatment of life-saving decisions which benefit a few versus health-improving interventions across a lot of people is distinctly different.

Back to Module

Notes on More Criticisms of the DALY

The seventh criticism is there is a difference between the maximum life expectancy between males and females. In general, the observed sex difference between males and females is 7 years in wealthy nations. Some of these differences were due to lifestyle differences in tobacco and alcohol, and a 2.5 year arbitrary difference was decided.

The final criticism is that the discount measure of health outcomes may be too high or too low, and that 3% is an arbitrary figure. In calculations for other health outcomes in developed countries, 7% may be a figure that is used. However, Murray justifies this as a low estimate that may be more applicable to developing countries.

Back to Module

Notes on Mortality by 2030

The work by Mathers and Loncar (2006) shows that mortality predictions are still quite consistent with the original work by Murray and Lopez (1997). In high income countries, non-communicable diseases include heart disease, stroke, and lung cancer predominate.

In middle income countries, stroke, heart disease, and COPD (emphysema) predominate. Interestingly, lung cancer is also high on the list, implying that
tobacco use is becoming rampant in middle income countries, and HIV/AIDS is become a bigger problem.

In low income countries, heart disease and HIV/AIDS, and stroke are big killers. However, communicable diseases (LRI, diarrheal disease, and malaria) play a major role as well.

**Back to Module**

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**Notes on DALYs by 2030**

When we take a look at DALYs, the emphasis shifts.

High on the priority list is depression and its related co-morbidities across all income groups. This is surprising, because it does not show up on the radar in the mortality lists, but plays a large contributor of burden to society.

In high income countries, issues of affluence are also a problem, including heart disease, alcohol, and diabetes. Alzheimer’s dementia also plays an important role.

In middle and low income countries, HIV/AIDS is a major contributor.

In middle income countries, stroke, heart disease, and emphysema are important. In low income countries, perinatal mortality is still playing a role, and basic prevention from road traffic accidents.

**Back to Module**

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**Notes on What Measures of Global Burden of Disease are Used Today?**

Despite the criticisms of the DALY, it is still the predominate measure used today in global health priority debates. Although mortality is sometimes used, mortality is recognized as being insufficient, and a measure that includes morbidity is preferred.

Political pressure on specific special-interest diseases still occurs, but the DALY is increasingly being used to inform our debates on the burden of disease and the priorities that should be made in informing health.

**Back to Module**