Faculty of Medicine
Public Health

Lecture 6
Mortality and burden of disease attributable to selected major risks

By

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## Presentation outline 14-6-2017

<table>
<thead>
<tr>
<th>Concepts related to the global burden of disease</th>
<th>08:00 to 08:10</th>
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<tbody>
<tr>
<td>Major categories of morbidity and mortality</td>
<td>08:10 to 08:20</td>
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<tr>
<td>DALYs: capture overall disease burden</td>
<td>08:20 to 08:30</td>
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<tr>
<td>Global health situation: Variations in health status between countries</td>
<td>08:30 to 08:40</td>
</tr>
<tr>
<td>Variations in health status within countries</td>
<td>08:40 to 09:00</td>
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</table>
Disease burden

• Disease burden is the impact of a health problem as measured by financial cost, mortality, morbidity, or other indicators.
Burden of disease

• In other words, the burden of disease is a measurement of the gap between the current health of a population and an ideal scenario where everyone completes their full life expectancy in full health.

The Global Burden of Disease project attempts to measure this total disease burden.
Disease burden

• Disease burden can be attributed to either **specific diseases** (e.g. HIV, TB, obesity, diabetes) and **also risks for ill health** (unsafe sex, overcrowding, smoking, excess cholesterol).

• Therefore, the measurement of GBD allows us to **address preventable diseases in each region of the world** - how much of risks to health could be avoided in future years.
Global Burden of Diseases

• GBD is a measure of the amount of disease, disability, and death in the world today.

• It is a product of complex and interwoven demographic, economic, social, political, religious and environmental factors.

• It refers to the collective impact of disease on the world population.
Global burden of diseases

Population health summary measures can be reported at international, national, or local levels. They have three main uses:

• To compare population health across communities and over time;

• To provide a full picture of which diseases, injuries and risk factors contribute the most to poor health in a specific population, including identification of the most important health problems and whether they are getting better or worse over time (this is probably the most common use of summary measures of health);

• To assess which information or sources of information are missing, uncertain, or of low quality.
Global burden of diseases

- National and local governments must determine priorities for health research and make decisions about investment in health systems and in health interventions in the face of limited resources, constantly increasing demands for healthcare, the development of new interventions and treatments, and increasing healthcare costs.
- Having a consistent and comparable description of the burden of diseases and the risk factors that contribute to them is important to health decision-making and planning processes.
- Summary measures of population health are popular and widely used because they provide understandable representations of complex epidemiology that can be used to develop efficient preventive strategies.
Factors which threaten health and are widely spread in populations have been identified in different regions of the world. These risks are strongly related to patterns of living and particularly to consumption.
Relationship between risks to health and disease burden.....

The **vast majority of threats to health** occur more frequently in the poor and in those with little education and lowly occupations. Therefore, the **leading risks to health identified in developing countries are** also the leading health **risks at the global level**:

- **Underweight** – the **leading** risk factor for disease and death in the world today. Particularly affects young children, women during pregnancy and the elderly.
- **Unsafe sex** - the main factor in the spread of HIV/AIDS. > 99% of HIV infections in Africa are attributable to unsafe sex.
- **Unsafe water.**
- **Poor sanitation and hygiene** - about 2 million deaths from childhood infectious diarrhoea still occur every year in the developing countries of the world.
- **Iron deficiency.**
- **In-door smoke.** Half of the world’s population is exposed to in-door pollution, mainly the result of burning solid fuels for cooking and heating. Globally, it is estimated that 36% of all lower respiratory infections and 22% of chronic obstructive pulmonary disease are associated with in-door pollution.
Measuring Health and Disease

• **Rationale (Why)**
  – Assess health status over time
  – Reduce disease consequence
  – Application of evidence-based public health practice*

• **Burden (How)**
  – Frequency (incidence or prevalence)
  – Severity (premature mortality and extent of disability)
  – Consequences (health, social, economic)
  – Type of people affected (gender, age)…disparities
Ultimate Measure of Ill-health?

• Death is most common
  – Easy to determine
  – Commonly tabulated

• Severe problems as a measure
  – Everyone dies
  – Health never achieved
  – Age is clearly important

• Deaths + Illness = ?
Traditional approach

• The obvious and traditional approach is to measure overall mortality in different countries.

• The next slide shows some of the important, standardised mortality rates that are universally accepted and have specific definitions.
## Traditional approach

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
<th>Formula</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant Mortality Rate (IMR)</td>
<td>No. deaths between birth and age 1 year</td>
<td>$\frac{\text{No. deaths}}{\text{Total no. live births}} \times 1000$</td>
<td></td>
</tr>
<tr>
<td>Perinatal Mortality Rate (PMR)</td>
<td>No. deaths from the 28th completed week of gestation till the end of the 1st week of life</td>
<td>$\frac{\text{No. deaths}}{\text{Total no. live &amp; stillbirths}} \times 1000$</td>
<td></td>
</tr>
<tr>
<td>Under five Mortality Rate (U5MR)</td>
<td>No. deaths occurring below the age of 5 years</td>
<td>$\frac{\text{No. deaths}}{\text{Total no. live births}} \times 1000$</td>
<td></td>
</tr>
<tr>
<td>Maternal Mortality Rate (MMR)</td>
<td>No. maternal deaths per 100,000 live births</td>
<td></td>
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</tbody>
</table>
Calculations used in Burden of Disease Measurement

• While individuals generally know when they are healthy or sick, there is no consensus about how to define the health of a population or on how much a given population is affected by illness or disease.

• For many years, population health was evaluated using mortality-based indicators only. In other words, the health of a population was determined by how many people died and why – the causes and rates of death.

• Although mortality-based indicators are useful, they do not provide all the information necessary to assess the health of a population or to compare the effectiveness of interventions to protect or improve health.

• That is, they do not take into consideration the effects of being ill, perhaps for many years, before death or recovery. Summary measures provide a fuller account of the health of a population because they include estimates of the effects of morbidity as well as mortality.
Need for a $C^4$ Database in Health
(Which we have had in many other fields for long periods)

• **Combined** mortality and morbidity
• **Complete**
  – Much of the world unrepresented in past databases
  – Many important disabilities unaccounted
• **Consistent** definitions of disease states
• **Coherent**
  – Deaths by disease need to add to total
    • By age and sex
    • Match with demographic stats
  – No natural discipline, i.e. no import stats from the afterlife tabulating how many died of what
“Summary Measures of Population Health” (SMPH).

The important uses of SMPH are:

● To **make comparisons** of the average health levels in different population subgroups or in the same population over time.

● **Assessment of the relative contribution** of two different diseases, injuries or risk factors, to overall population health.

● **Identifying and quantifying overall health inequalities** within a population, thus identifying the “at risk” or vulnerable groups, needing greater services.

● **Provide inputs for short-listing of national health priorities** for national health planning.
Health-Adjusted Life Years (HALYs)

- **Health-Adjusted Life Years (HALYs)** are summary measures of population health used in burden of disease estimates.
- They combine the effects of **disability** or **disease** (morbidity) and death (mortality) simultaneously.
- **HALYs**, an **umbrella term** for a number of such summary measures, allow for comparisons to be made across illnesses, interventions, and populations. The data are normally presented by age, sex, and region.
- **To calculate the HALYs** of a disease, three general steps are required. As Gold et al., describe, researchers must:
  
  1. **Describe the associated state of health** (“health state”) or **disease conditions**;
  2. **Develop numerical values** or weights for the health state or **condition**;
  3. **Combine the numerical values** of each health state with estimates of life expectancy.
Health Adjusted Life Years
HALY

• Basically the number of fully healthy life years lost to a particular disease or risk factor.

• Considers the age at which the disease or death occurs and the duration and severity of any disability created.
HALYs

• The morbidity components of HALYs are referred to as **Health-Related Quality of Life (HRQL)** and are represented on a scale of **0 to 1**.

• Two common measures of HALYs,
  - **Quality-Adjusted Life Years (QALYs)** and
  - **Disability-Adjusted Life Years (DALYs)**,

  As will be seen, QALY and DALY have different purposes and use different approaches to calculate HRQL associated with disease conditions or good health.
Summary Measures of Health “Gaps” : The commonly used are

- Years of Potential Life Lost (YPLL) and
- Disability Adjusted Life Years (DALY).
Disability Adjusted Life Year
The DALY, a kind of HALY

• **Principle #1**: The only differences in the rating of a death or disability should be due to age and sex, not to income, culture, location, social class.

• **Principle #2**: Everyone in the world has right to best life expectancy in world

**DALY = YLL + YLD**

– _Years of Lost Life_ (due to mortality)
– _Years Lost to Disability_ (due to injury & illness)
Disability-Adjusted Life Years (DALYs)

- An important development of this project was a single indicator of total disease burden – the DALY.

\[
\text{DALY} = \text{YLL} + \text{YLD}
\]

- Years of Lost Life (due to premature mortality)
- Years Lost to Disability (due to injury or illness)

The DALY is the internationally-accepted measure of death and disability and is increasingly cited as a powerful tool for decision makers in international health.
Why are DALYs important?

DALYs attempt to provide an appropriate, balanced attention to the effects of *non-fatal* as well as *fatal* diseases on overall health. In the absence of such assessments, conditions which cause decrements in function but not mortality tend to be neglected.

DALYs help to inform debates on priorities for health service delivery, research and planning. For example, DALYs can be used to:

- Compare the health of one population with another – and allow decision makers to focus on health systems with the worst performance
- Compare the health of the same population at different points in time
- Compare the health of subgroups within a population - to identify health inequalities
DALYs

• The DALY method was developed in 1990 by researchers at the World Bank and Harvard University to quantify the burden of disease and disability in populations.
• It measures the difference or gap between the current health of a population and an ideal situation; i.e. where everyone reaches the standard life expectancy in perfect.
• The DALY method is based on an assumption that time is the most appropriate measure for burden of disease, including the time lived with disability and the time lost due to premature mortality:
• DALY = Years of life lost due to premature mortality (YLL) + Years lived with disability (YLD)
DALYs

**DALY**
Disability Adjusted Life Years measure the overall burden of disease, expressed as the cumulative number of years lost due to ill-health, disability or early death.

\[
\text{DALY} = \text{YLD} + \text{YLL}
\]

- **YLD**: Years Lived with Disability
- **YLL**: Years Life Lost

Source: Wiki Commons
DALYs attempt to capture the overall disease burden

**Diagram Description**

- **Risk**
  - Disability
  - Disease
  - Death

- **QALYs**
  - Prevalence
  - Incidence

- **Mortality Rates**
  - Maternal
  - Infant
  - Perinatal
  - Under five
  - Overall

*Quality Adjusted Life Years (QALYs) = Number of fully healthy years lost to a particular disease or risk factor*
QALYs

• Quality-adjusted life years are usually used to analyze clinical interventions.
• The goal is to maximize the “good” of quality of life.
• QALYs use utility weights (0 = death and 1 = perfect health)
• QALYs can measure both the effectiveness and the cost-effectiveness of an intervention.
QALYs

• For example, QALYs can compare an intervention that can help prolong life but has serious side effects (such as permanent disability caused by radiation or chemotherapy for cancer), with an intervention that improves quality of life without prolonging it (such a palliative pain management).

• The measure can give an idea of how many extra months or years of life of reasonable quality of health a person might gain with each intervention.

• QALYs are calculated by multiplying the number of years of life added, by the HRQL.

• \[ \text{QALYs} = \text{additional number years of life} \times \text{HRQL} \]
What are the major diseases in the world today?

- This bar diagram shows the sharp contrast in disease burden as well as the pattern of diseases in the three country groups – with disease burden measured by DALYs. The diagram shows clearly that the greatest burden for nearly all diseases falls upon people living in group 1 countries.
Health risks in different world regions

• The next 3 slides show the disease burden (measured by DALYs) attributable to 10 leading health risks according to country group

• Note how single risks underlie several diseases and how these relationships differ in different regions

• Note that the total number of DALYs (x axis) is much greater in the developing than the developed worlds
Burden of disease attributable to 10 selected leading risk factors, by level of development
What strategies can reduce risks to health?

"Any health action - promotive, preventive, curative, or rehabilitative activity, where the primary intent is to improve health."

Most risk-reducing strategies involve a component of behaviour change.

**The population**
- Reduce risks in the population as a whole
  - Legislation, tax, financial incentives by government
  - Health promotion campaigns
  - Engineering solutions; e.g. safety belts in vehicles, provision of piped water

**The individual**
- Target individuals within a particular population
  - Change health behaviours of individuals through personal interaction with a health provider
## Classification of countries

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>Developing countries with high mortality</td>
<td>Sub-Saharan Africa, South-East Asia</td>
</tr>
<tr>
<td>Group II</td>
<td>Developing countries with low mortality</td>
<td>China, Latin America</td>
</tr>
<tr>
<td>Group III</td>
<td>Developed / Industrialised countries</td>
<td>Europe, North America</td>
</tr>
</tbody>
</table>
1993-2013: Extraordinary Health & Economic Progress

Movement of populations from low income to higher income between 1990 and 2011
Death Rates Today in Poorest Countries

<table>
<thead>
<tr>
<th></th>
<th>Low-Income Countries</th>
<th>Lower Middle-Income Countries</th>
<th>2035 Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under-5 death rate per 1,000 live births</td>
<td>104</td>
<td>63</td>
<td>16</td>
</tr>
<tr>
<td>Annual AIDS death rate per 100,000 population</td>
<td>77</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>Annual TB death rate per 100,000 population</td>
<td>55</td>
<td>28</td>
<td>4</td>
</tr>
</tbody>
</table>
## Progress on Maternal Mortality Ratio by 2035

<table>
<thead>
<tr>
<th></th>
<th>Today</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-income countries</td>
<td>412</td>
<td>102</td>
</tr>
<tr>
<td>Middle-income countries</td>
<td>260</td>
<td>64</td>
</tr>
<tr>
<td>4C countries (range)</td>
<td>25-73</td>
<td></td>
</tr>
</tbody>
</table>

Number of deaths in pregnancy and childbirth per 100,000 live births
Leading causes of attributable global mortality and burden of disease, 2004

<table>
<thead>
<tr>
<th>Attributable Mortality</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. High blood pressure</td>
<td>12.8</td>
</tr>
<tr>
<td>2. Tobacco use</td>
<td>8.7</td>
</tr>
<tr>
<td>3. High blood glucose</td>
<td>5.8</td>
</tr>
<tr>
<td>4. Physical inactivity</td>
<td>5.5</td>
</tr>
<tr>
<td>5. Overweight and obesity</td>
<td>4.8</td>
</tr>
<tr>
<td>6. High cholesterol</td>
<td>4.5</td>
</tr>
<tr>
<td>7. Unsafe sex</td>
<td>4.0</td>
</tr>
<tr>
<td>8. Alcohol use</td>
<td>3.8</td>
</tr>
<tr>
<td>9. Childhood underweight</td>
<td>3.8</td>
</tr>
<tr>
<td>10. Indoor smoke from solid fuels</td>
<td>3.3</td>
</tr>
</tbody>
</table>

59 million total global deaths in 2004

<table>
<thead>
<tr>
<th>Attributable DALYs</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Childhood underweight</td>
<td>5.9</td>
</tr>
<tr>
<td>2. Unsafe sex</td>
<td>4.6</td>
</tr>
<tr>
<td>3. Alcohol use</td>
<td>4.5</td>
</tr>
<tr>
<td>4. Unsafe water, sanitation, hygiene</td>
<td>4.2</td>
</tr>
<tr>
<td>5. High blood pressure</td>
<td>3.7</td>
</tr>
<tr>
<td>6. Tobacco use</td>
<td>3.7</td>
</tr>
<tr>
<td>7. Suboptimal breastfeeding</td>
<td>2.9</td>
</tr>
<tr>
<td>8. High blood glucose</td>
<td>2.7</td>
</tr>
<tr>
<td>9. Indoor smoke from solid fuels</td>
<td>2.7</td>
</tr>
<tr>
<td>10. Overweight and obesity</td>
<td>2.3</td>
</tr>
</tbody>
</table>

1.5 billion total global DALYs in 2004
Deaths attributed to 19 leading factors, by country income level, 2004

Mortality in thousands (total: 58.8 million)
Percentage of disability-adjusted life years (DALYs) attributed to 19 leading risk factors, by country income level, 2004

Per cent of global DALYs (total: 1.53 billion)
Major causes of death in children under 5 with disease-specific contribution of undernutrition, 2004

- Diarrhoea: 73%
- Pneumonia: 17%
- Severe neonatal infections: 11%
- Prematurity: 11%
- Birth asphyxia and trauma: 8%
- Malnutrition: 45%
- Other infections: 12%
- Measles: 4%
- Malaria: 7%
- Injuries: 4%
- Non communicable: 7%

Shaded area indicates contribution of undernutrition to each cause of death.
Per cent distribution of age at death by region, 2004
Distribution of deaths by leading cause groups, males and females, world, 2004
Child mortality rates by cause and region, 2004
Adult mortality rates by major cause group and region, 2004

Figure 7: Adult mortality rates by major cause group and region, 2004

- High income
- Western Pacific
- Americas
- Eastern Mediterranean
- South-East Asia
- Europe
- Africa

Legend:
- Cardiovascular diseases
- Cancers
- Other noncommunicable diseases
- Injuries
- HIV/AIDS
- Other infectious and parasitic diseases
- Maternal and nutritional conditions

Deaths per 1000 adults aged 15–59 years
Projected global deaths for selected causes, 2004–2030
Estimated prevalence of moderate and severe disability by region, sex and age, global burden of disease estimates for 2004
Global Burden of Disease Database

• Developed at Harvard University originally for the World Bank

• Extended greatly in the mid-1990s and now adopted by the World Health Organization
  – Updated database published on web each year and summarized in World Health Report

• Dozens of countries now have NBDs

• Even states (provinces) and cities have them, including SF and LA